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The study of co-integration and direction of causality among International trade, GDP and foreign exchange rate in India

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Abstract

India's international trade is growing at a faster rate compared to the growth of GDP over the past two decades. As a result the ratio of international trade to GDP has gone up over the years. The magnitude of India's international trade is usually dependent on several macro-economic factors. GDP is one of them. A large number of factors are responsible for effecting country's trade in a significant manner. To find out the impact of these factors in international trade the current study has been undertaken. The paper focuses on India's international trade dynamics under the influence of taken macro-economic variables. The paper aims to investigate the possible co-integration and direction of causality among Gross domestic product, international trade, and exchange rate in India (for the period of 1991-2018).Granger causality tests among international trade, GDP and foreign exchange rate (Indian rupee vs US $) has been appliedafter employing Phillip Perron test to check unit root in the series. Vector Auto regression test has been conducted to check the impact of lags (till lag 2) of taken variables on each other and OLS regression has been used to create the Model of international under taken variables.

Key words: International Trade, GDP, Exchange Rate, Granger Causality test, Vector Auto regression, Phillip perron test

Introduction

International trade and Gross Domestic Product play an important role in a country's development. There is a direct link between the growth of International trade, GDP growth and economic development of a country.International trade is a commotion which strategies importance in the development process of a developing economy.In current economic environment it is extremely difficult to find the example of a closed economy. All economies of the world have become open keeping the economic growth in mind.

Gross Domestic Product presents the true economic health of the country. GDP also acts as one of the key determinants of international trade. A country which yields surplus of a good, i.e

produces more than its necessities, will export it to other countries in exchange for the surplus produces of those countries.Accelerationcan be noticed in GDP when international trade of the country rises.GDP rises when there is an increase in exports and trade surplus (the total value of goods and services that native producers' trade internationally exceeds the total value of foreign goods and services that domestic consumers buy). On the other hand if domestic consumers spend more on imports than the exports of country– a trade deficit – then GDP decreases.Whether determined by exogenous shocks or by policy, the relative estimations of currencies and their exchange rates often have important repercussions on international trade and GDP both. If we analyze the recent trade growth pattern a fall in trade growth or conjunction toward modest longer-term growth rates discloses some interesting changes in trade growth patterns. The exchange rate appreciation adds to an increase in imports and decreased exports, with depreciation acting vice versa.

According to the literature available there is a positive
relationship between GDP growth rate and excha nge rate but the degrees of this relationship vary in different time frames. A higher GDP will give boost to exports due to surplus production and to imports due to income effect. Thus the exchange rate will also be impacted. High imports will depreciate home currency while increase in exports will stabilize it.Thus we see the mutualinterdependence among international trade, GDP and Exchange rate. The current study tries to find out the relationship and direction among international trade of India, it's GDP and exchange rate between Indian rupee and US $.

Review of Related Literature

Real Exchange Rate and International Reserves in an Era of Growing Financial and Trade Integration (2008) by Joshua Aizenman and Daniel Riera-Crichtonevaluates the impact of international reserves, terms-of-trade shocks, and capital flows on the real exchange rate (REER). This buffer effect is especially significant for Asian countries, and for countries exporting natural resources. Financial depth reduces the buffer role of international reserves in developing countries. Auboin and Ruta (2011) and Leigh et al (2015) provide more detailed surveys of the extensive literature on the relationship between the exchange rate and trade. AssafAlmog, TizianoSquartini and Diego Garlaschelli(2015) created a GDP driven model for the international trade network. Yaya keho and Miao Grace Wang (2017) have studied the impact of trade openness on economic growth. They concluded a positive and strong

complementary relationship between trade openness and capital formation in promoting economic growth.A number of studies point to positive growth effects of trade openness (e.g. Chang, Kaltani, & Loayza,2009; Dollar and Kraay, 2004; Frankel and Romer, 1999; Freund &Bolaky, 2008). The research has found a gap of literature on the relationship among international trade, GDP and exchange rate. So the current topic has been taken for the study.

Purpose

The paper aims to investigate the possible co-integration and direction of causality among Gross domestic product, international trade, and exchange rate in India.The data for current study covers the period of 1991-2018.

Objectives of the study:

- To aims to investigate the possible co-integration and direction of causality among Gross domestic product, international trade, and exchange rate in India.
- To form a model of international trade taking the mentioned variables as predictor.

Design/methodology/approach

Annual data covering the 1991-2018period have been used to investigate co-integration and Granger causality tests among international trade, GDP and foreign exchange rate (Indian rupee vs US $) after employing unit root tests to see if the variables under consideration are stationary.

Granger (1969) proposed a time-series data based approach in order to determine causality. In the Granger-sense x is a cause of y if it is useful in forecasting y. This paper uses a simple Granger-causality test in order to test whether there is a bidirectional relationship betweeninternational trade, GDP and between exchange rate and international trade and GDP and exchange rate. Thus, according to Mahdavi and Sohrabian (1989), the following equations can be specified

1. $(International\ trade)t = \alpha + Xmi=1\ \beta i(international\ trade)t-i + Xn\ j=1\ \tau j\ (GDP)t-j + \mu t$
2. $(International\ trade)t = \alpha + Xmi=1\ \beta i(international\ trade)t-i + Xn\ j=1\ \tau j\ (exchange\ rate)t-j + \mu t$
3. $(GDP)t = \alpha + Xmi=1\ \beta i(GDP)t-i + Xn\ j=1\ \tau j\ (international\ trade)t-j + \mu t$
4. $(GDP)t = \alpha + Xmi=1\ \beta i(GDP)t-i + Xn\ j=1\ \tau j\ (Exchange\ rate)t-j + \mu t$
5. $(Exchange\ rate)t = \alpha + Xmi=1\ \beta i(Exchange\ rate)t-i + Xn\ j=1\ \tau j\ (international\ trade)t-j + \mu t$
6. $(Exchange\ rate)t = \alpha + Xmi=1\ \beta i(Exchange\ rate)t-i + Xn\ j=1\ \tau j\ (GDP)t-j + \mu t$

Phillip Perron test has been applied to check the stationarity of the three time series ie, International trade, Gross Domestic Product and Foreign Exchange rate.Vector Auto regression test has been applied to check the impact of lags (till lag 2) of taken variables on each other. Granger causality test has been applied to check cause and effect relationship between GDP and International trade, International trade and exchange rate.

Research limitations/implications

Expanded data can be used for further comparison.

Practical implication/value

This study investigates the possible co-integration and the direction of causality between the international trade, GDP and exchange rate triangle not only in the case of India but also in the relevant literature to the best of one's knowledge.

Analysis and interpretation

The **stationarity time series** means all the statistical properties such as mean, variance, autocorrelation, etc. are all constant over **time**. Phillip perron test was applied to check the unit root in the three time series. The time series of GDP is stationary is first differencing, international trade at second differencing and exchange rate at first differencing. Following table presents the result of phillipsperron test to check stationarity in time series.

Table:1

Phillips-Perron Unit Root Test

data: diff(`GDP (billion US $)`)
Dickey-Fuller Z(alpha) = -25.372, Truncation lag parameter = 2, p-value = 0.01
alternative hypothesis: stationary

Phillips-Perron Unit Root Test

data: diff(diff(`International Trade (million US $)`))
Dickey-Fuller Z(alpha) = -23.983, Truncation lag parameter = 2, p-value = 0.01
alternative hypothesis: stationary

Phillips-Perron Unit Root Test

data: diff(`Exchange rate`)
Dickey-Fuller Z(alpha) = -32.501, Truncation lag parameter = 2, p-value = 0.01
alternative hypothesis: stationary

The following tables (table 2,3 and 4) presents the result of vector autoregression test upto two lags of each variable taken for the study. Table 3 represents the impact on GDP and international trade on their own lags as well as the lags of each other. Table 4 represents the impact on

international trade and exchange on their own lags as well as the lags of each other

As per the results GDP is being impacted by its own lag (lag 1), while international trade is getting the impact from the both the lags of GDP, both the lags of exchange rate and its own lag. Exchange rate has the impact of its own lag. In short it can be said that each variable has some effect of its trend from its previous value.

Table: 2

vector autoregression					
Equation	**Parms**	**RMSE**	**R-sq**	**F**	**P>F**
GDP and international trade					
GDPbillion US $	5	96.0141	0.9876	417.943	0.000
InternationaltrademillionUS$	5	50543.7	0.9761	214.839	0.000
international trade and exchange rate					
Equation	**Parms**	**RMSE**	**R-sq**	**F**	**P>F**
InternationaltrademillionUS$	5	51649.1	0.9751	205.519	0.000
Exchanghe rate	5	3.18576	0.933	73.1217	0.000

Table: 3

		coef.	**Std. Err.**	**t**	**p>|t|**	**(95% confidence interval)**	
GDPbillion US $							
	GDPbillion US $						
	L1	1.197215	0.299874	3.99	0.001	0.573593	1.820837
	L2	-0.081025	0.389235	-0.21	0.837	-0.890483	0.728434
	InternationaltrademillionUS$						
	L1	-0.000567	0.000423	-1.34	0.195	-0.001447	0.0003132
	L2	0.000421	0.000525	0.8	0.432	-0.000671	0.001513
	_cons	25.14723	41.4931	0.61	0.551	-61.14239	111.4368
InternationaltrademillionUS$							
	GDPbillion US $						
	L1	426.1119	157.8594	2.7	0.013	97.82526	754.3986
	L2	-412.9536	204.9008	-2.02	0.057	-839.0681	13.16094
	InternationaltrademillionUS$						
	L1	0.900687	0.222745	4.04	0.001	0.437463	1.363912
	L2	-0.000673	0.276424	-0.01	0.998	-0.575527	0.5741825
	_cons	13182.6	21842.76	0.6	0.553	-32241.9	58607.11

Table: 4

		coef.	Std. Err.	t	p>|t|	(95% confidence interval)	
Internationaltrademillion US$							
	Internationaltrademillion US$						
	L1	1.281843	0.1803638	7.11	0.0001	0.9067561	1.65693
	L2	-0.2784952	0.2069992	-1.35	0.193	-0.708973	0.151983
	Exchange Rate						
	L1	-8469.741	3590.482	-2.36	0.028	-15936.56	-1002.924
	L2	8633.252	2973.16	2.9	0.008	2450.227	14816.28
	_cons	27166.92	70445.36	0.39	0.704	-119332.2	173666.1
Exchange Rate							
	Internationaltrademillion US$						
	L1	8.88E-06	0.0000111	0.8	0.434	-0.000014	0.000032
	L2	1.84E-06	0.0000128	0.14	0.887	-0.000024	0.0000284
	Exchange Rate						
	L1	0.4846412	0.2214638	2.19	0.04	0.024082	0.9452003
	L2	0.2748458	0.1833869	1.5	0.149	-0.106528	0.6562197
	_cons	9.562349	4.345126	2.2	0.039	0.5261653	18.59853

The following table is present the Granger Cause between taken variable. First the granger cause was tested between GDP and international trade, then international trade and exchange rate and finally on exchange rate and GDP. As per the result we can conclude the unidirectional relationship which moves from GDP to international trade and GDP to exchange rate. Bidirectional relationship can be observed between international trade and exchange rate.

Table: 5

Granger Causality Wald Test					
Equation	Excluded	F	df	df_r	Prob>F
GDPbillion US $	InternationaltrademillionUS $	0.97226	2	21	0.3946
GDPbillion US $	All	0.97226	2	21	0.3946
InternationaltrademillionUS$	GDPbillion US $	4.9029	2	21	0.0179
InternationaltrademillionUS$	All	4.9029	2	21	0.0179
InternationaltrademillionUS$	Exchange Rate	4.2502	2	21	0.0282
InternationaltrademillionUS$	All	4.2502	2	21	0.0282

Exchange Rate	InternationaltrademillionUS$	3.8715	2	21	0.037
Exchange Rate	All	3.8715	2	21	0.037
GDPbillion US $	Exchange Rate	0.79785	2	21	0.4635
GDPbillion US $	All	0.79785	2	21	0.4635
Exchange Rate	GDPbillion US $	3.5945	2	21	0.0454
Exchange Rate	All	3.5945	2	21	0.0454

Regression Model: The dynamic regression model of the international trade taking GDP and exchange rate as predictors has been created. Table 6 shows that the p value is significant and r-squared is 0.9369. As per the result obtained we can conclude that the predictors are significantly making an impact of our dependent variable which is international trade.

lm(formula = `International Trade (million US $)` ~ `GDP (billion US $)` + `Exchange rate`)

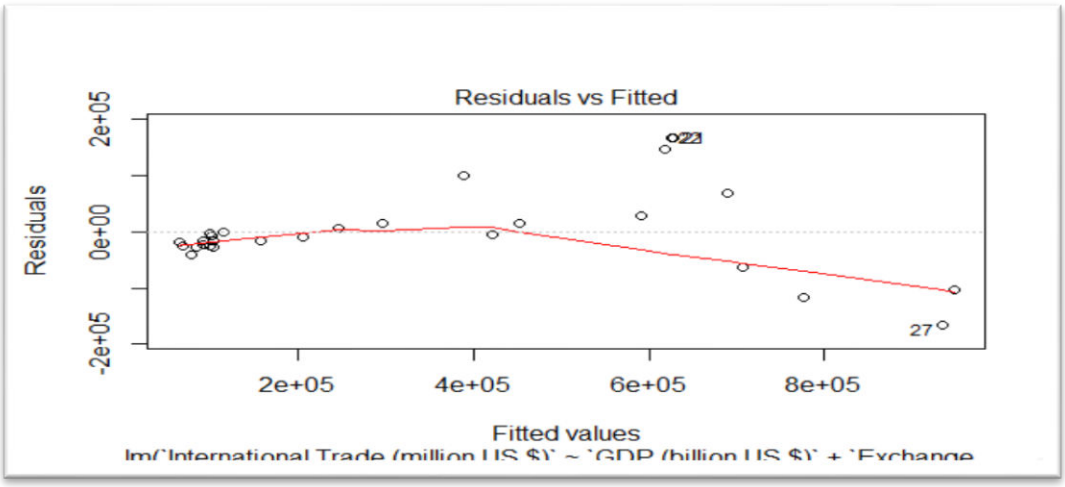
Table: 6

```
Residuals:
    Min      1Q  Median      3Q     Max
-165238  -26446  -13072   15002  166525

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)         36250.74   89483.02   0.405    0.689
`GDP (billion US $)`   403.76      41.05   9.836 4.47e-10 ***
`Exchange rate`      -2708.16    2678.07  -1.011    0.322


Residual standard error: 78690 on 25 degrees of freedom
Multiple R-squared:  0.9369,       Adjusted R-squared:  0.9319
F-statistic: 185.6 on 2 and 25 DF,  p-value: 9.999e-16
```

International trade= 36250.74+ 403.76 GDP – 2708.16 Exchange rate



Findings and Conclusion

India's international trade is likely to be affected by various macro-economic factors, policies and different trade agreements. The magnitude of international trade is directly linked to the size of economy. The size of economy depends on the production of tradable goods in the country every year. After the trade liberalization and changing pattern of development, international trade of the country has shown a boost. On the basis of study the relationship of international trade with certain macro-economic variables has been established.

In the last we can conclude that there is a long-run relationship among international trade, GDP and foreign exchange rate in the case of India. Furthermore, unidirectional causality was investigated that runs from Gross domestic product to international trade and GDP to exchange rate. Bidirectional causality has also been obtained between International trade and exchange rate (Indian rupees vs US $).

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Annexure:

Year	GDP (billion US $)	International Trade (million US $)	Exchange rate
1991	270.105	37409	24.4737
1992	288.208	45163.69	30.6488
1993	279.296	45540.99	31.3655
1994	327.276	54984.74	31.3986
1995	360.282	68290.63	33.4498
1996	392.897	72581.405	35.4999
1997	415.868	76223.18	37.1648
1998	421.35	75607.43	42.47
1999	458.82	86560.55	43.5
2000	468.39	95096.74	46.68
2001	485.44	95240	48.22
2002	514.94	114131.57	47.95
2003	607.07	141991.66	45.62
2004	709.15	195053.37	43.25
2005	820.38	252256.26	44.99
2006	940.26	312149.29	44.11
2007	1216.74	414786.19	39.4
2008	1198.9	488991.67	48.62
2009	1341.89	467124.31	46.41
2010	1675.62	619584.68	44.71
2011	1823.05	795283.41	53.01
2012	1827.64	791137.23	54.99
2013	1856.72	764605.09	61.81
2014	2039.13	758371.89	63.03
2015	2103.59	643298.85	66.2
2016	2290.43	660209.46	67.95
2017	2652.55	769107.15	63.84
2018	2726.32	844103.69	69.97