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AN ERROR-CORRECTION ANALYSIS OF INDIA-US TRADE FLOWS

AVIRAL KUMAR TIWARI*

ICFAI University Tripura, India

The study finds that India's exports to the US have been significantly affected by GDP per capita of the US, WPI of the India and the US, and exchange rate; and India's import from the US is significantly affected the India's GDP and WPI in the long-run. Static analysis of causality asserts that WPI of the US Granger causes the India's exports to the US and the GDP of the US. Further, WPI of the India Granger causes the GDP of the US and the exchange rate Granger causes WPI of the US. Moreover, GDP of the India Granger causes her imports from the US; and WPI of the India and exchange rate Granger cause WPI of the US.

Keywords: Bilateral Trade, Granger-Causality, IRFs
JEL classification: C310, F15

1. INTRODUCTION

The Indian economy is now much more allied to the global economy than it was 20 years ago. In this globalised world, individual countries are more influenced by changes in world trade patterns and prices, changes in global capital market conditions and associated investor perceptions, and changes in technology etc. The impact of globalisation on the Indian economy presents opportunities and poses challenges and risks.

Economic and trade relations between the India and the United States (US) have experienced a number of swings since India's independence in 1947. During much of the 1950s and early 1960s, the US was a leading trading partner for the India, providing the nation with about a third of its imports. However, those economic ties swiftly collapsed when India promoted closer ties with the Soviet Union (SU) following the Indo-Pak war of 1965. For the next 40 years, political and economic associations between the India and the US were relatively cool. The United Nations Development Programme (UNDP) ranked India 119th out of 169 countries on its 2010 Human

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Development Index (HDI), up from 127th in both 2004 and 2005. In the India, economic reforms begun in 1991, under the Congress-led government of Prime Minister Narsimha Rao and then finance minister, Dr. Manmohan Singh boosted growth and led to major new inbound foreign investment in the mid-1990s. However, economic reform efforts stagnated under weak alliance governments later in the decade, and combined with the 1997 Asian financial crisis and international sanctions on India (as a result of its 1998 nuclear tests) further dampened the economic outlook. Following the 1999 parliamentary elections, the Bhartiya Janata Party (BJP)-led government launched second-generation economic reforms, including major deregulation, privatisation, and tariff-reducing measures.

Since 2004, the Washington and the New Delhi have been pursuing a "strategic partnership" based on numerous shared values and improved economic and trade relations.[1] The India is in the midst of a rapid economic expansion, and many US companies view the India as a worthwhile market and a candidate for foreign investment. For its part, the current Indian government sees itself ongoing the economic reforms started in 1991, aimed at transforming a quasi-socialist economy into a more open, market-oriented economy. As India's largest trade and investment partner, the US strongly supports New Delhi's continuing economic reform policies; a US-India Trade Policy Forum was created in November 2005 to expand bilateral economic engagement and provide a venue for discussing multilateral trade issues. On March 2, 2006, President George W. Bush and Indian Prime Minister Dr. Manmohan Singh endorsed the goal of doubling bilateral trade in three years. Despite the growth in bilateral trade and the improvement in trade relations, there are still a number of economic and trade issues between India and the US. Both nations seek better market access to the other's domestic markets, as well as the lowering of perceived trade barriers. In addition, both India and the US would like to see changes in the other nation's legal and regulatory policies to help guard and encourage exports and foreign direct investment. India was the 22nd largest export market for US goods in 2005 and US exports to and imports from India in 2007-08 had an estimated value of Rs. 84625.1 crore and Rs. 83388.1 crore respectively.

The rationale of this article partly lies with the importance of the bilateral trade between the India and US and how these trade flows respond in both the long run and the short run to changes in the relative prices and changes in the income. The relative price variation may result from changes in the national price levels, tariff reductions, and/or exchange rate changes. Previous studies have provided long-run estimates regarding the aggregate effects of changes in domestic incomes and relative prices, on overall trade flows, but relatively little with respect to bilateral trade particularly in the context of India and US. Therefore, in the present study we focus on this aspect by

[1] For a broader discussion of the bilateral relationship, see CRS Report RL33529, *India-U.S. Relations, K.* by Alan Kronstadt. Our discussion presented in this section is based on this report broadly.

recognising the increasing political and economic relation of India with US.

If we see empirical studies in the area of trade flow determinants and free trade agreements, we find a number of studies in bilateral framework for developed countries and limited work for developing countries. For example, Cushman (1990), Haynes *et al*. (1996), Bahmani-Oskooee and Brooks (1999), and Nadenichek (2000), among others, studied on the bilateral trade between the US and one or more of its trading partners. This study aims to fill this gap and study bilateral trade elasticity between the India and her major trading partner that is US. In the present context, we will briefly focus on the recent studies that have analysed trade of one or more countries with the US. Bahmani-Oskooee and Harvery (2006), by utilising the bounds approach, suggest that a real depreciation of the Malaysian Ringgit can increase Malaysians trade balance with China, France, Germany, Indonesia, and the U.S. Narayan (2006) investigated the nexus between China's trade balance and the real exchange rate vis-à-vis the US. Using the bounds testing approach to cointegration, the author found the evidence that China's trade balance and real exchange rate vis-à-vis the US are cointegrated. Further, using the autoregressive distributed lag model the author finds that in both the short run and the long run a real devaluation of the Chinese RMB improves the trade balance; as a result, there is no evidence of a J-curve type adjustment. Yol and Baharumshah (2007) utilised the panel cointegration technique to examine the effects of exchange rate changes on the bilateral trade balance between 10 African countries and the U.S. Their study revealed that a real exchange rate depreciation improves the bilateral trade balance for Botswana, Egypt, Kenya, Nigeria, Tunisia, and Uganda vis-à-vis the U.S., but worsens Tanzania's trade balance with the U.S. Halicioglu (2008) empirically analysed bilateral J-curve dynamics of Turkey with her 13 trading partners using quarterly time series data over the period 1985-2005. The empirical results indicated that whilst there is no J-curve effect in the short-run, but in the long-run, the real depreciation of the Turkish lira has positive impact on Turkey's trade balance in couple of countries. Kim (2009) assessing the impact of macroeconomic determinants on Korea's bilateral trade deficit with her trading partners, e.g., Japan and US, found the evidence of cointegrating relationship. Korean currency depreciation improved trade balance, while J-curve effect was found in the context of trade with Japan. Bahmani-Oskooee and Harvey (2010) examined the relation between the Malaysian trade balance and her real exchange rate. The authors utilised disaggregate data by country and consider Malaysia's bilateral trade balance with her 14 largest trading partners. However, the long-run results revealed improvement in Malaysia's bilateral trade balance at least in four cases. Furthermore, in two of these cases, the new definition of the J-curve received empirical support. Zhuang and Koo (2008) by analyzing another dimensions of the bilateral relation examined the effects of a U.S.-Korea free trade agreement (FTA) on various sectors of the economy in the two countries using a general equilibrium model. The authors found that the increase in U.S.-Korea bilateral trade volume in recent years is through intra-industry trade of high-technology products. They added "under a U.S.-Korea FTA, the bilateral trade volume would increase for virtually all the sectors and the GDP and social welfare would improve for both countries". They also mention that because of this FTA producers of textile products in the United States and producers of agriculture and food products in South Korea would suffer. Bahmani-Oskooee and Kara (2008), by accounting for stationarity of the data and using cointegration and error-correction modeling, found no strong evidence in support of the Orcutt's hypothesis. Chang *et al*. (2005) used the unrestricted error correction model, the bounds test analysis to re-analyze the long-term relationships between the demand for imports and it's determinants for South Korea over the period 1980-2000. They found cointegration relationship among the volume of imports, income, and relative prices and the estimated long-run (short-run) elasticities of import demand with respect to income and relative price were 1.86 (0.86) and -0.2 (-0.05), respectively. Authors concluded that neither monetary nor fiscal policies may be used as instruments to maintain the trade balance in South Korea's favor during this sample period. Rey (2006) investigated the impact of nominal and real effective exchange rate volatility on exports of six Middle Eastern and North Africa (MENA) countries to 15 member countries of the European Union (EU), for the period 1970Q1-2002Q4. For the analysis they used moving average standard deviation and conditional standard deviation at ARCH model are used to generate four different measures of volatility for each country. The author found the cointegration relationship, negative for four countries (Algeria, Egypt, Tunisia, and Turkey), positive for the last two (Israel and Morocco), between MENA exports and exchange rate volatility. Further, the author showed by using an error correction model that the Granger-causality effects of the volatility on real exports are significant, whereas the effects of real exchange rate and the gross domestic product of EU are more contrasted. Bahmani-Oskooee and Cheema (2009) employed disaggregated data at bilateral level between Pakistan and her 13 major trading partners to determine if we can discover partners whose trade balances react to changes in the real bilateral exchange rate. The authors found from bounds testing approach that results are still inconclusive and show that only in half of the cases the real bilateral exchange rate plays a role. Jin *et al*. (2006) used a computable general equilibrium model to evaluate the economic effects of a free trade agreement among China, Japan, and South Korea on the world economy. The authors found that there are strong trade diversion effects of the FTA between the member countries and the rest of the world. They added further that the member countries under the FTA tend to specialize on the basis of resource endowments, but there exists a significant amount of intra-industry trade among the member countries in all sectors except agricultural and service/utility sectors. Finding from their study showed that the FTA stimulates the economies of the three countries through increased trade volume and a significant negative effect on economies of non-member countries.

Rest of the paper is organised as follows. Section 2 presents objectives, model, variables definition, and methodology adopted for empirical analysis, followed by presentation of the data analysis and findings in section 3. In section 4, we present the conclusions and policy implications, which we have drawn from the empirical analysis.

2. OBJECTIVES, MODEL AND METHODOLOGY

This paper has three objectives. First, to compute income and price elasticities (in decomposed form of US prices, Indian prices, and exchange rate) of export and import demand functions in bilateral trade framework. The second objective is to find out the direction of the causality among the test variables in a static framework and the third is to find out the direction of the causality among the test variables in a dynamic framework.

In a bilateral trade flow modeling framework (in our case trade flow is between the India and the US), the economic theory suggests that the long-run quantity demanded of imports is related to domestic income or activity variable in our country (that is GDP), the foreign currency price of imported goods (WPI of the US), the price of domestic goods competitive with imports (WPI of the India), and exchange rate relative to imports. Similarly, the long-run exports quantity demanded is a function of income of the partner/trading party (GDP of the India), the dollar price of exports (WPI of the India), the price of export substitute goods in India (WPI of the US), and the exchange rate.

The common practice of this type of research is to assume zero degree of homogeneity of price, in which case imports and exports prices can be defined as relative prices. That is, for example (as in our case), relative price of exports will be equal to the product of the ratio of WPI of India to WPI of US and exchange rate, and likewise for imports. However, in this study we are not making such kind of assumption because this kind of assumption has been in debate since the paper of Murray and Ginman (1976). Further, we do not use homogeneity assumption because of few reasons as rightly pointed out by Fullerton and Sprinkle (2005). First, the split-price specification is less restrictive and valid even if homogeneity assumption is fulfilled. Homogeneity assumption implicitly forces one to define imports and exports in terms of the domestic price of the importing country. Due to this reason, a significant amount of information is lost as it becomes impossible to determine the effects of exchange rate changes on trade flows in isolation from changes in relative prices. And this is more important if the effect of exchange rate is different in magnitude than changes in relative prices.

Therefore, in simplest form India's exports to and imports from US can be written as follows:

$$\ln(Q\mathrm{X})_t = \alpha_0 + \alpha_1 \ln(GDPI)_t + \alpha_2 \ln(WPII)_t + \alpha_3 \ln(WPIUS)_t + \alpha_4 \ln(ER)_t\,, \qquad (1)$$
$$(\alpha_1 > 0, \alpha_2 < 0, \alpha_3 > 0, \alpha_4 < 0)$$

$$\ln(QM)_t = \alpha'_0 + \alpha'_1 \ln(GDPUS)_t + \alpha'_2 \ln(WPII)_t + \alpha'_3 \ln(WPIUS)_t + \alpha'_4 \ln(ER)_t\,, \qquad (2)$$
$$(\alpha'_1 > 0, \alpha'_2 < 0, \alpha'_3 > 0, \alpha'_4 > 0)$$

where *QX* is the value of exports of the India (measured in Rs. crore), *QM* is the value of imports of the India (measured in Rs. crore), *GDPI* is real Gross domestic product per capita of the India (measured in US dollar at constant prices of 2000), *GDPUS* is the Gross domestic product of the US (measured in US dollar at constant prices of 2000), *WPI* is the whole sale price index of the India (measured at constant prices of 2005 and based on period average), *WPIUS* is the whole sale price Index of the US (measured at constant prices of 2005 and based on period average), and *ER* is the market exchange rate (measured as period average Rs. per dollar).[2] We used data for the period of 1960-2007 with annual observations.

To know the causality among the test variables used in the Equations (1) and (2) in the vector error correction model (VECM) framework certain pre-estimations (like testing the stationarity of the variables included in the VECM analysis and seeking the cointegration of the series) we should carry out, without which conclusions drawn from the estimation will not be valid. Therefore, in the first step we have carried out unit root analysis by applying two different tests namely, (Augmented) Dickey Fuller (hereafter, DF/ADF) test, Phillips and Perron (hereafter, PP) (1988) test. In all cases, we will test the unit root property of the variables by employing the model suggested by the graphical plot of the variables in question. Augmented form of the DF test is used when there is problem of serial correlation and to choose appropriate lag length Schwarz Information Criteria (hereafter, SIC) has been preferred. Since PP test has advancements over DF/ADF test in the sense that whereas DF/ADF test use a parametric auto-regression to approximate the ARMA structure of the errors in the test regression, PP test correct for any serial correlation and heteroskedasticity in the errors in non-parametric framework. Therefore, it is also used for analysis. In PP test to select appropriate lag length, we have adopted Newey-West using Bartlet kernel method. In both tests, null hypothesis in that series is nonstationary, or the series has a unit root. For all cases if critical value (which is based on Mackinnon, 1996) exceeds the calculated value in absolute terms (less in negative terms) null hypothesis will not be rejected implying that that series is nonstationary. In both these tests, test involves the testing of coefficient associated with one year past value of dependent variable.

When it is found that variables used in this study are nonstationary and having same order of integration, we have proceeded for cointegration analysis. In this study we have preferred Johansen and Juselius (1990) (hereafter JJ) method (as Gonzalo, 1994, has suggested that JJ test is superior to other tests of cointegration). JJ test provides two Likelihood Ratio (LR) test statistics for cointegration analysis. First test is trace (λ_{trace}) statistics and the second one is maximum eigenvalue (λ_{trace}) statistics. The trace statistics tests the null hypothesis that the number of cointegrating relations is r against

[2] Data source of GDP per capita of the US and the India is World Development Indicators. Values of Exports and Imports of the India from the US have been obtained from Hand Book of Statistics of Indian Economy and Indian Economy Data base Vol. II, while exchange rate and WPI of India and US has been assessed from IMF CD-ROM of International Financial Statistics.

of k cointegration relations, where k is the number of endogenous variables. The maximum eigenvalue test, tests the null hypothesis that there are r cointegrating vectors against an alternative of $r+1$ cointegrating vectors. Critical value for estimation has been obtained from Mackinnon, Haug, and Michelis (1999) which differs slightly from those provided by JJ. For both tests if the test statistic value is greater than the critical value, the null hypothesis of r cointegrating vectors is rejected in favor of the corresponding alternative hypothesis. It is, however, worthwhile to mention that the JJ test is found to be sensitive to the choice of deterministic assumptions used in testing the cointegration. There are five models of VARs based on different assumptions. Model 1 assumes no deterministic trend in data and no intercept or trend in the VAR and in the cointegrating equation. Model 2 assumes no deterministic trend in the data, but an intercept in the cointegrating equation, and no intercept in VAR. Model 3 assumes a linear trend in the data and an intercept in cointegrating equation. Model 4 assumes a linear deterministic trend in the data, intercept and trend in cointegrating equation, and no trend in VAR. Model 5 assumes a quadratic deterministic trend in the data, intercept and trend in VAR, and linear trend in VAR. Johansen (1991) suggested that in order to choose right model we should test the joint hypothesis of the rank order and the deterministic components. This test is known as Pantula Principal. As we are not very sure that in data used in this study, whether deterministic trend is present and VAR also has linear trend or not, we have carried out joint test for all five models. The model chosen is the of that minimizes the value of SIC and in case that it is found that two models are giving the minimum value of SIC, the better (theoretically appropriate) has been chosen.

Once the cointegrating vectors have been estimated among a set of variables one can proceed to carry out VECM analysis. If variables in the system are nonstationary and cointegrated, the Granger-causality test in VECM framework will be based on the following equations in case of say X_t and Y_t two variables:

$$\Delta X_t = \alpha_x + \sum_{i=1}^{k} \beta_{x,i} \Delta X_{t-i} + \sum_{i=1}^{k} \gamma_{x,i} \Delta Y_{t-i} + \varphi_x ECT_{x,t-i} + \varepsilon_{x,t} \,, \tag{3}$$

$$\Delta Y_t = \alpha_y + \sum_{i=1}^{k} \beta_{y,i} \Delta Y_{t-i} + \sum_{i=1}^{k} \gamma_{y,i} \Delta X_{t-i} + \varphi_y ECT_{y,t-i} + \varepsilon_{y,t} \,, \tag{4}$$

where φ_x and φ_y are the parameters of the *ECT* term, measuring the error correction mechanism that drives the X_t and Y_t back to their long run equilibrium relationship.

The null hypothesis (H_0) for the Equation (3) $H_0 : \sum_{i}^{k} \gamma_{x,i} = 0$ suggests that the lagged terms ΔY do not belong to the regression, i.e., it does not Granger cause ΔX.

Conversely, the null hypothesis (H_0) for the Equation (4) is $H_0 : \sum_{i}^{k} \gamma_{y,i} = 0$, suggesting that the lagged terms ΔX do not belong to regression i.e., it does not Granger cause ΔY. The joint test of these null hypotheses can be tested either by Wald Chi-square (χ^2) test. This Wald Chi-square (χ^2) test gives us an indication of the 'short-term' causal effects or strict exogenity of the variables. If the coefficients of $\gamma_{x,i}$ are statistically significant, but $\gamma_{y,i}$ are not statistically significant, then X is said to have been caused by Y (unidirectional). The reverse causality holds if coefficients of $\gamma_{y,i}$ are statistically significant while $\gamma_{x,i}$ are not. Nevertheless, if both $\gamma_{y,i}$ and $\gamma_{x,i}$ are statistically significant, then causality runs both ways (bidirectional). Independence is identified when the $\gamma_{x,i}$ and $\gamma_{y,i}$ coefficients are not statistically significant in both the regressions. On the other hand, the significance of the lagged error-correction term(s) (measured through t-test) will indicate the Granger causality (or endogenity of the dependent variable). The coefficient of the lagged error-correction term, however, is a short-term adjustment coefficient and represents the proportion by which the long-term disequilibrium (or imbalance) in the dependent variable is being corrected in each short period. The non-significance or elimination of any of the lagged error-correction terms affects the implied long-term relationship and may be a violation of theory. The non-significance of any of the 'differenced' variables which reflects only the short-term relationship, does not involve such a violation because the theory typically has nothing to say about short-term relationships. The non-significance of both the t-test(s) as well as the Wald Chi-square (χ^2) tests in the VECM will imply econometric exogenity of the dependent variable.[3]

Diagnostic checks analysis has been performed to the models used for VECM to test the stochastic properties of the model such as residuals autocorrelation, heteroskedasticity, normality parameters stability (by applying Chow's test), Wald-test of lag exclusion, and ARCH-LM test.[4] Finally VECM stability[5] analysis has been

[3] The lagged error-correction term contains the log-run information, since it is derived from the long-term cointegration relationship(s). Weak exogenity of the variable refers to ECM-dependence, i.e., dependence upon stochastic trend.

[4] Presence of autocorrelation/serial correlation has been tested by using Lagrange Multiplier (LM) test and adopted same lag order as that of corresponding lag order in VECM by following Harris (1995, p. 82). Presence of heteroskedasticity has been tested by using White heteroskedasticity test. Normality of residuals has been tested through Jarque-Bera (JB) normality test following Urzua's (1997) method of residual factorization (orthogonalization) as it makes a small sample correction to the transformed residuals before computing JB test as sample elicit size of the present study is small. Further, in case of ARCH-LM we have used same lag order as used in VECM analysis.

carried out. This was because if the model is stochastic then only further analysis based on the model is possible and inference drawn from the results of VEC modelling will not be biased. If any of these tests support the null hypothesis then we have adopted lag structure suggested by AIC and again model selection test, cointegration test and finally VECM analysis has been carried out. Again, we have performed diagnostic checks unless we have obtained a good estimated model. After obtaining correct specification, we have carried out Impulse Response Functions (IRFs) analysis. Since Wald Chi-square (χ^2) test and t-test in VECM may be interpreted as within sample causality tests, they only indicate the Granger-exogenity or endogenity of the dependent variable within period under consideration (see Masih and Masih, 1996). These tests do not provide information regarding the relative strength of the Granger causal chain amongst the variable beyond the period under study. In order to analyse the dynamic properties of the system the Impulse Response Functions (IRFs) are computed.[6] Impulse response function traces the impact of a shock in a variable into the system, over a period of time (in present study 10 years). More specifically, an IRF traces the effect of a one standard deviation shock to one of the innovations (error terms) and its impact on current and future values of the endogenous variables.

3. DATA ANALYSIS AND RESULTS INTERPRETATION

First, we analysed descriptive statistic (see Table 1 in appendix) and then unit root test has been carried out for all variables using Dickey-Fuller (DF) or Augmented Dickey-Fuller test (ADF) (if the problem of autocorrelation is found to exist) and Phillips-Perron (PP) test. Model for unit root analysis has been decided based on the graphical plot of variables, which we presented in Figure 1 of appendix. Results of descriptive statistics are presented Table 1 of appendix, which shows that all variables are not log normally distributed at 5% level of significance. Results of unit roots are reported in Table 1.

[5] If the estimated VECM is stable then the inverse roots of characteristics Autoregressive (AR) polynomial will have modulus less than one and lie inside the unit circle. There will be *kp* roots, where *k* is the number of endogenous variables and *p* is the largest lag.

[6] To compute IRFs generalized approach has been preferred over Choleskey orthogonalization approach or other orthogonalization approaches because it is invariant of ordering of the variables, as results of IRFs are sensitive to the ordering of the variables.

Table 1. Results of Unit Root

Variables	Unit Root Tests			
	Constant	Constant and Trend	DF/ADF (k)	PP (k)
Ln(India's Imports from US)	-	Yes	-1.986241 (0)	-1.908502 (4)
D(Ln(India's Imports from US))	Yes	-	-6.236470*** (0)	-6.272389*** (6)
Ln(Exchange rate)	-	Yes	-1.789404 (0)	-1.688938 (3)
D(Ln(Exchange rate))	Yes	-	-3.136868** (0)	-4.104490***(0)
Ln(GDPPC of India)	-	Yes	0.482300 (0)	2.058832 (6)
D(Ln(GDPPC of India))	Yes	-	-5.582776*** (0)	-5.689316***(4)
Ln(GDPPC of US)	-	Yes	-4.310544*** (1)	-2.321738 (11)
D(Ln(GDPPC of US))	Yes	-	-5.317259*** (1)	-5.295589***(14)
Ln(India's Exports to US)	-	Yes	-2.122810	-2.100023 (2)
D(Ln(India's Exports to US))	Yes	-	-7.777228*** (0)	-7.716139***(3)
Ln(WPI of India)	-	Yes	-2.360577 (1)	-1.807397 (1)
D(Ln(WPI of India))	Yes	-	-5.000766*** (0)	-4.788201*** (5)
Ln(WPI of US)	-	Yes	-2.039678 (3)	-1.277267(4)
D(Ln(WPI of US))	Yes	-	-2.326790 (2)	-2.886508*(10)

Notes: ***, ** and * denotes significant at 1%, 5% and 10% level. (k) Denotes lag length. Selection of lag length in DF/ADF test is based on SIC and in PP test it is based on Newey-West using Bartlett kernel and HAC corrected variance (Bartlett kernel).

Source: Author's calculation

It is evident from the Table 1 that all variables are nonstationary in their level form and they are turning to be stationary after first difference i.e., I(1). Since all variable are I(1) we can proceed for cointegration analysis. To proceed for cointegration first step is selection of appropriate lag length. Therefore, we have carried out a joint test of lag length selection for exports and import function separately, which suggests (basing upon SIC) we should take one lag of each variable[7] in both cases. Therefore, we have chosen lag intervals (1, 1) and then joint test for cointegrating vector and model selection has been performed,[8] in order to know the trend assumption to be made for cointegration as well as VECM analysis. We found from the results of Pantula Principle that SIC has preferred model 3 and model 4 equally, for our export function as well as import function. However, if we use model 4 for analysis for export function we found that VECM results are not confirmed by diagnostic checks analysis and if we choose model 3 and 4 for import function both are found not to be well fit through diagnostic checks analysis. Therefore, in this paper we have presented results of all analysis based on

[7] Results of lag length selection can be obtained by request to the author's.

[8] Results of model selection test and results of model 4 and its diagnostic analysis can be obtained by request to the author.

model 3 for export function and model 5 (which is suggested by AIC) for import function as these models passes diagnostic checks.[9] First, we present result of cointegration test for export function in Table 2, which is based on model 3, i.e., assumption of a linear trend in the data, an intercept in cointegrating equation and lag interval (1, 1). Thereafter we present results of cointegration test of import function in the following Table 3, which is based on model 5, i.e., assumption of a quadratic deterministic trend in the data, intercept and trend in VAR, and linear trend in VAR and lag interval (1, 1).

Table 2. Cointegration Test of Export Function

Cointegration Test					
[Trend Assumption: Linear Deterministic Trend, Lags Interval (in First Differences): 1 to 1]					
Unrestricted Cointegration Rank Test (Trace)					
H_0	H_a	Eigenvalue	Trace Statistic	5% Critical Value	Prob.
None*	At most 1	0.510924	75.63273	69.81889	0.0159
At most 1	At most 2	0.380232	42.73184	47.85613	0.1392
At most 2	At most 3	0.274242	20.72496	29.79707	0.3750
At most 3	At most 4	0.100249	5.980158	15.49471	0.6979
At most 4	At most 5	0.024072	1.120843	3.841466	0.2897
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)					
H_o	H_a	Eigenvalue	Max-Eigen Statistic	5% Critical Value	Prob.
None **	At most 1	0.510924	32.90089	33.87687	0.0650
At most 1	At most 2	0.380232	22.00688	27.58434	0.2200
At most 2	At most 3	0.274242	14.74480	21.13162	0.3072
At most 3	At most 4	0.100249	4.859316	14.26460	0.7595
At most 4	At most 5	0.024072	1.120843	3.841466	0.2897

Note: * and ** denotes rejection of the hypothesis at the 0.05 and 0.10 level respectively.

Source: Author's calculation

It is evident from the Table 2 that both Trace and Eigenvalue criteria rejects the null hypothesis of at most none cointegrating vector against the alternative of at most one cointegrating vector for export function.

[9] Model 3 assumes a linear trend in the data, an intercept in cointegrating equation. Model 4 assume a linear deterministic trend in the data, intercept and trend in cointegrating equation, and no trend in VAR. Model 5 assumes a quadratic deterministic trend in the data, intercept and trend in VAR, and linear trend in VAR.

Table 3. Cointegration Test of Import Function

Cointegration Test [Trend Assumption: Quadratic Deterministic Trend (in First Differences): 1 to 1]

Unrestricted Cointegration Rank Test (Trace)

H_0	H_a	Eigenvalue	Trace Statistic	5% Critical Value	Prob.
None*	At most 1	0.548498	87.94313	79.34145	0.0097
At most 1	At most 2	0.488167	51.36504	55.24578	0.1053
At most 2	At most 3	0.278395	20.55622	35.01090	0.6709
At most 3	At most 4	0.086580	5.547451	18.39771	0.9019
At most 4	At most 5	0.029591	1.381730	3.841466	0.2398

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

H_o	H_a	Eigenvalue	Max-Eigen Statistic	5% Critical Value	Prob.
None **	At most 1	0.548498	36.57809	37.16359	0.0583
At most 1 **	At most 2	0.488167	30.80881	30.81507	0.0501
At most 2	At most 3	0.278395	15.00877	24.25202	0.4969
At most 3	At most 4	0.086580	4.165721	17.14769	0.9540
At most 4	At most 5	0.029591	1.381730	3.841466	0.2398

Note: * and ** denotes rejection of the hypothesis at the 0.05 and 0.10 level respectively.
Source: Author's calculation

It is evident from the Table 3 that Trace criteria rejects the null hypothesis of at most none cointegrating vector against the alternative of at most one cointegrating vector at 5 percentage significance level while Eigenvalue test rejects the null hypothesis of at most one cointegrating relation against the alternative of at most two cointegrating relations at 10 percentage significance level. However, we have chosen one cointegration relation only for the analysis because JJ (1990) has suggested that results of Trace criteria is more robust vis-à-vis Eigenvalue criteria. Since we find evidence of one cointegrating equation of export function as well as for import function, we present results of cointegrating equation for both functions (i.e., export and import function respectively) in Table 4.

Table 4. Cointegrating Equation of Export and Import Function

Normalized Cointegrating Coefficients (Standard Error in Parentheses)

Panel 1	Ln (GDPPC of US)	Ln (WPI of India)	Ln (WPI of US)	Ln (Exchange rate)
Ln (India's Exports to US)	-72.34557*** (13.6434) [5.30260]	62.67526*** (11.2015) [-5.59526]	-37.26953*** (8.86310) [4.20502]	-27.52878**** (6.39037) [4.30786]
Panel 2	**Ln (GDPPC of India)**	**Ln (WPI of India)**	**Ln (WPI of US)**	**Ln (Exchange rate)**
Ln (India's Imports from US)	8.235525*** (0.77545) [10.6203]	5.643651*** (1.28016) [4.40855]	0.576349 (0.82339) [0.69997]	-0.672347 (0.60822) [-1.10543]

Note: *** denotes rejection of the hypothesis at the 0.01 level.
Source: Author's calculation

It is evident from first panel of Table 4, which presents cointegration equation of export function that coefficient of GDP per capita of US, WPI of India and US, and exchange rate have significant impact on the India's exports to US. We also found that only coefficient of exchange rate has the expected sign and coefficients all other variables under consideration have unexpected signs. In addition, the magnitude of the coefficients of the variables show that India's exports to the US are very sensitive to the changes in the GDP of US, WPI of India and less sensitive to the changes in the WPI of US and exchange rate.

Second panel of Table 4, which presents cointegrating equation of import function, shows that only coefficient of India's GDP per capita and WPI of India is significantly different from zero. The coefficient of India's GDP and WPI of US has correct sign and WPI of India and exchange rate have negative signs. The results indicate that the primary long-run determinants of India's import demand from US include India's GDP and WPI. Further, these results also indicate that India's imports from US are quite sensitive to India's GDP vis-à-vis India's WPI.

In the next step, in order to see the long run adjustment and short-run dynamics we have carried out Engle-Granger causality analysis by using lag interval (1, 1) and model 3 for export function, lag interval (1, 1) and model 5 for import function, and one cointegrating relationship in both functions. Results of Engle-Granger causality analysis for both the function have been reported in the following Table 5 and 6 respectively.

Table 5. Engle-Granger Causality Analysis of Export Function

Granger Causality Short Run (Wald test/χ^2)					
Independent Variables (k)	Dependent Variables				
	D(Ln(India's Export to US))	D(Ln(GDPPC of US))	D(Ln(WPI of India))	D(Ln(WPI of US))	D(Ln(Exchange rate))
D(Ln(India's Exports to US))	-	0.002067	0.484146	1.918400	0.005103
D(Ln(GDPPC of US))	0.842931	-	1.081361	0.926858	0.708183
D(Ln(WPI of India))	0.445801	2.72035***	-	2.031376	0.874021
D(Ln(WPI of US))	3.153627***	8.867222*	0.933813	-	0.392016
D(Ln(Exchange rate))	0.577519	0.367258	0.153140	8.536518*	-
Granger Causality Long Run					
CointEq1	-0.020056* [-2.77184]	-0.003518* [-3.71880]	0.007541* [2.72825]	0.0037** [2.07417]	-0.006569 [-1.44674]

Notes: (1) *, **and ***denotes significant at 1%, 5%, and 10% level respectively; (2) 'D" denotes first difference; (3) (k) denotes lag length.
Source: Author's calculation

It is evident from Table 4 that WPI of US Granger causes India's exports to US. Further, WPI of US and WPI of India Granger cause GDP of US and exchange rate Granger causes WPI of US.

Cointegrating vectors i.e., error terms are significant when dependent variable is India’s export to US, GDPPC of US, WPI of India, and WPI of US. Value of error correction term (-0.020056), when dependent variable is India’s export to US, indicates that any disequilibrium in India’s export to US will get corrected in the next year by 2.0 percentage only. This implies that speed of error correction is very slow in case of disequilibrium in India’s export to US.

Table 6. Engle-Granger Causality Analysis of Import Function

Granger Causality Short Run (Wald test/χ^2)					
Independent Variables (k)	Dependent Variables				
	D(Ln(India’s Imports from US))	D(Ln(GDPPC of India))	D(Ln(WPI of India))	D(Ln(WPI of US))	D(Ln(Exchange rate))
D(Ln(India’s Imports from US))	-	0.031941	2.544689	0.795658	1.479431
D(Ln(GDPPC of India))	9.266987*	-	8.281179*	0.053811	1.138468
D(Ln(WPI of India))	0.709321	0.105257	-	1.122930	1.657052
D(Ln(WPI of US))	0.032521	0.012659	0.044310	-	1.129643
D(Ln(Exchange rate))	0.247858	0.133076	1.809834	10.9237*	-
Granger Causality Long Run					
CointEq1	-0.552244* [-3.70985]	0.011385 [0.58532]	0.041207 [1.63000]	0.0457** [2.53840]	-0.016738 [-0.36256]

Notes: (1)*, **and ***denotes significant at 1%, 5%, and 10% level respectively; (2) ‘D” denotes first difference.

Source: Author’s calculation

It is evident from Table 8 that GDP of India Granger causes India’s imports from US and WPI of India. Further, exchange rate Granger causes WPI of US.

Cointegrating vectors i.e., error terms are significant when dependent variable is India’s import from US and WPI of US. Value of error correction term (-0.5522) of equation India’s import from US indicates that in the next year itself any disequilibrium in the India’s import from US will get adjusted by 55 percentage.

To check the validity of VECM and Granger causality for both functions, we have carried out diagnostic checks analysis employing LM test for serial correlation, White test with cross products to test for the presence of the problem of heteroskedasticity and correctness of the specification of VECM, and J-B test of normality of residuals. Results of diagnostic checks are reported in the following Table 7 for both functions in panel 1 and 2 respectively.

Table 7. Diagnostic Checks Analysis of Export and Import Function

Panel 1: Diagnostic Checks Analysis of Export Function		
VEC Residual Serial Correlation LM Tests		P-Value
1lag	15.72404	0.9228
VEC Residual Normality Tests-Joint J-B test (Orthogonalization: Residual Covariance (Urzua)		
98.49747		0.6599
VEC Residual Heteroskedasticity Tests with Cross Products (Joint test of Chi- square)		
440.2616		0.1097
Panel 2: Diagnostic Checks Analysis of Import Function		
VEC Residual Serial Correlation LM Tests		P-Value
1lag	23.47706	0.5497
VEC Residual Normality Tests-Joint J-B test (Orthogonalization: Residual Covariance (Urzua)		
85.90855		0.9131
VEC Residual Heteroskedasticity Tests with Cross Products (Joint test of Chi- square)		
551.6908		0.2031

Source: Author's calculation

It is evident from the panel 1 of Table 7 that the specification of VECM of export function is correct as no test is rejecting the null hypothesis. Similar results are found for import function from panel 2 of Table 7.

Finally, we have carried out VECM stability test for both export and import function, respectively, and presented results in Figure 1 and 2. It is evident from Figure 1 and 2 that all inverse roots of characteristics Autoregressive (AR) polynomial are having modulus less than one and lie inside the unit circle. Therefore, the estimated VECM of export and import function is stable.

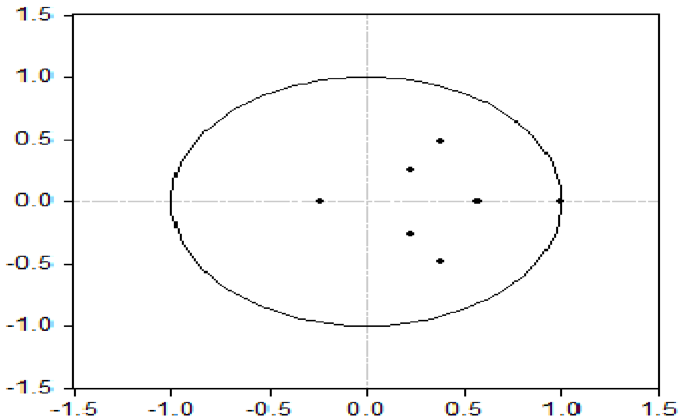

Figure 1. Inverse Roots of AR Characteristic Polynomial for Export Function

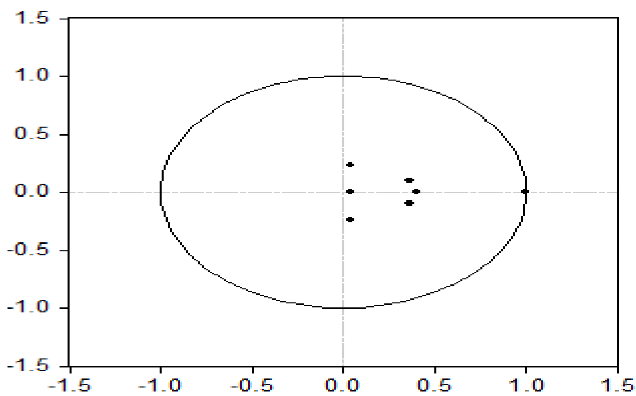

Figure 2. Inverse Roots of AR Characteristic Polynomial for Import Function

Since our model of export and import function used in VECM has correct specification, we can proceed for further analysis. In the next step, in order to see the causality among the variable in dynamic framework/outside the period under consideration we have performed Impulse response functions analysis. Figure 3 and Figure 4 represents the IRFs of the variable under consideration in export and import function respectively.

It is evident from Figure 3 that response of India’s export to US in one SD shock/innovation in WPI and GDP per capita of US is negative in the second year and in third year onwards response becomes positive for any shock in WPI of US and for all other cases response of India’s exports is positive. Response of GDP of US is negative for any shock in all the test variables except for the WPI of India. Response of WIP of India in one SD shock in any of the test variable is positive while response of WPI of US in one SD shock in GDP and WPI of US is negative and in case of all other variables, it is positive. Finally, response of exchange rate in one SD shock in WPI and GDP of US is negative and for all other cases, it is positive.

It is evident from Figure 4 that response of India’s imports to US in one SD shock/innovation in exchange rate is negative and negligible in case of GDP of India. Response of GDP of India is negative in one SD shock in WPI of India, WPI of US and exchange rate and for other cases, it is positive. Response of WIP of India is negative only in case of one SD shock in GDP of India and response of WPI of US is negative only in case of one SD innovation in exchange rate and WPI and GDP of India. Moreover, response of exchange rate is negative only in case of one SD innovation in GDP of India and WPI of US.

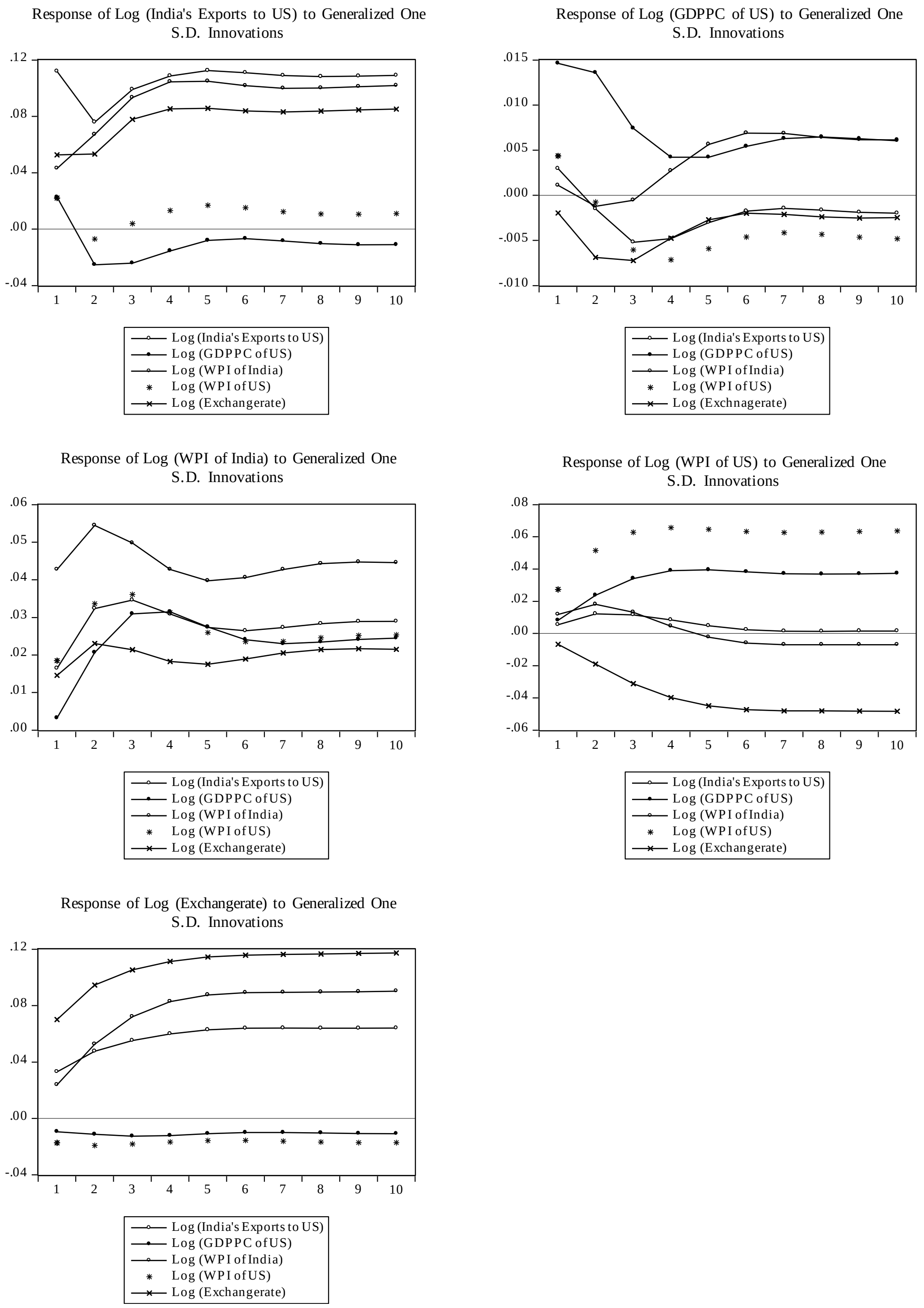

Figure 3. IRFs of Variables in Export Equation

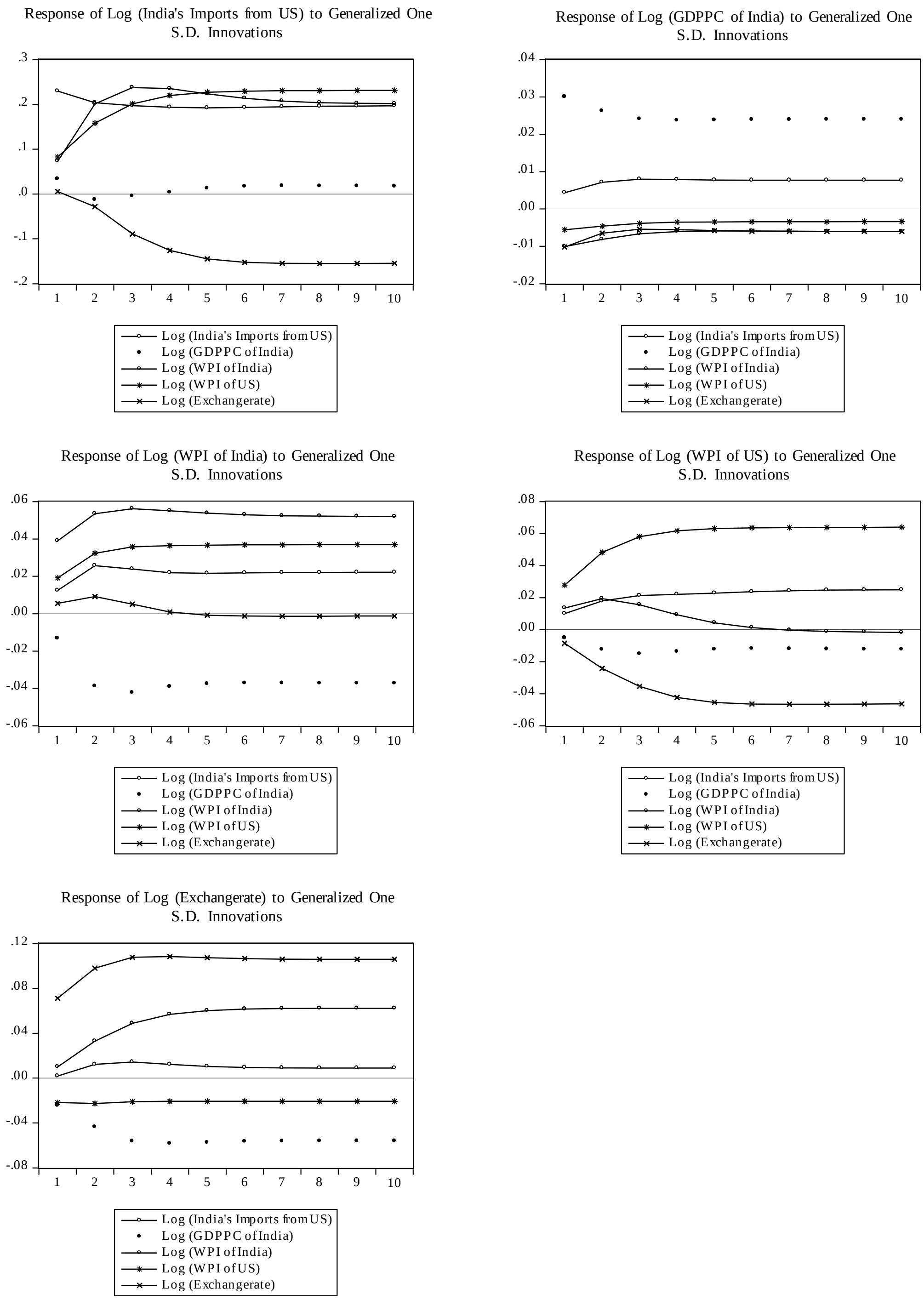

Figure 4. IRFs of Import Equation

4. CONCLUSIONS AND POLICY IMPLICATIONS

In the study we attempted to analyse the bilateral trade relationship between the India and the US. We estimated the long run elasticity of exports of the India to the US and imports of the India from the US. We have also attempted to know the direction of causal relationship between the test variables of our study in both static and dynamic framework. For the analysis, we have used annual data spanning from 1960 to 2007.

From the cointegration analysis of the India's exports to the US equation, we found that GDP per capita of the US, WPI of the India and the US, and exchange rate have significant impact on India's exports to the US. We also found that only exchange rate has expected sign and all other variables under consideration have unexpected signs. In addition, the magnitude of the coefficient of the variable shows that the India's exports to the US are very much sensitive to the changes in the GDP of US and WPI of the India while they are less sensitive to the changes in the WPI of the US and exchange rate. As far as the cointegration analysis of the India's import demand to the US is concerned we found that primary long-run determinants of the India's import demand from the US are the India's GDP and WPI. However, only the coefficient of the India's GDP and WPI of US has correct sign (but insignificant) and WPI of the India and exchange rate have unexpected sign (but insignificant). Further, we found that the India's imports from US are quite sensitive to the India's GDP vis-à-vis her WPI. In addition to that, we found that speed of adjustment of disequilibrium in the India's export to the US is too slow vis-à-vis India's imports from the US.

Static analysis of Granger causality asserts that WPI of US Granger causes India's exports to US and GDP of US. Further, WPI of India Granger causes GDP of US and exchange rate Granger causes WPI of US. Additionally, GDP of India Granger causes India's imports from US and WPI of India and exchange rate Granger cause WPI of US.

Dynamic Granger causality analysis of variables export function shows that response of India's imports to the US in one SD innovation in exchange rate is negative and negligible in case of GDP of the India. Response of GDP of the India is negative in one SD shock in WPI of the India, WPI of the US and exchange rate and for other cases, it is positive. The dynamic Granger causality analysis of variables of import function shows that response of the India's export to US is negative in the second year. Further, response of India's exports is positive in one SD innovation in WPI and GDP per capita of the US and from third year onwards, response turned to be positive for any one SD shock in WPI of the US. Response of GDP of the US is negative for any shock in all the test variables except for the WPI of the India.

Hence, findings of this study indicate that policymakers in India may use exchange rate policy to promote large balance of trade surpluses as a mechanism of exports enhancement (in the context of the US particularly) and hence economic growth, particularly in the long run. Further, to boost exports to the US, the India can use WPI as instrument as in one way it is found to increase exports to the US (as WPI of the India has unexpected sign that its coefficient is positive) and on the other side it will curb imports from the US. Therefore, the implications of studies finding are very clear. They suggest that, provided the sufficient time, devaluations can improve the balance of trade of the India via increasing exports to the US. Hence, policy makers can thus improve the trade balance by changing the nominal exchange rates, given that relative domestic price movements do not offset such nominal exchange rate realignments. Put differently, findings of the study provide empirical support for the elasticity optimists who view exchange rate changes as effective mechanisms for correcting trade imbalances. Further, Indian government should focus on policies through money supply too (as money supply is directly linked with WPI of the India) but not income or economic growth as economic growth has been found to having negative impact on trade balance. This is because with the growth of the income, the Indian consumption shifts over imported commodities from the US and hence deteriorates trade balance as our empirical evidence reveals too this fact. Since, the Indian economy had traditionally been agrarian, which is transforming very rapidly towards service sector. However, a huge potential lies in the agriculture sector to earn foreign income and help in improving trade balance in two ways particularly first, by preventing the imports of consumption goods and second, by exports of the commodities. And for that, government should open agricultural research and technical institutes to enhance the market share at local and international level. In addition to that, to perk up the markets share of exports help of marketing activities i.e. good advertisements, well communication, introducing the hidden qualities of new exports items through research should also be utilized. Incentive policy should be explored to enhance exports especially to agricultural sector.

In nutshell, few key points emerge from our empirical investigation. First, a depreciation of the Indian currency can lead to an improvement in her trade balance in the long run via exports enhancement. Second, long run equilibrium will be restored if any deviation occurs in the India’s exports to the US with the speed of adjustment 2% and if deviation occurs in the India’s import it will get corrected with the speed of adjustment of 55%. Third, our results point to the potential role of exchange rate and WPI of the India in influencing the trade balance through exports and imports. Fourth, a very interesting point, our results indicate that an increase in aggregate income of the India, that is GDP can lead to deteriorate in her trade balance with the US as it increases imports from the US. Similarly, increase in aggregate income of the US, i.e., GDP can lead to deteriorate in the India’s trade balance with the US as it decreases imports from the India.

APPENDIX

Table A1. Descriptive Statistics

	Ln(India's Imports from US)	Ln(Exchange rate)	Ln(GDPPC India)	Ln(GDPPC US)	Ln(India's Exports to US)	Ln(WPI of US)	Ln(WPI of India)
Mean	7.853147	2.648395	5.655844	10.08847	7.727150	3.893954	3.129999
Median	7.478631	2.371317	5.540086	10.07536	7.382672	4.158556	3.191766
Maximum	11.34599	3.883829	6.530217	10.54700	11.35473	4.697658	4.698387
Minimum	5.459032	1.560248	5.197727	9.553297	4.630155	2.998728	1.423108
Std. Dev.	1.612916	0.807854	0.375715	0.290899	2.222655	0.578665	1.048303
Skewness	0.393003	0.310360	0.710187	-0.137469	0.241963	-0.476570	-0.107680
Kurtosis	1.966877	1.597347	2.344022	1.910948	1.627063	1.643772	1.695232
Jarque-Bera	3.370299	4.705460	4.895543	2.523250	4.238280	5.495660	3.497598
Probability	0.185417	0.095109	0.086486	0.283193	0.120135	0.064067	0.173983
Observations	48	48	48	48	48	48	48

Source: Data source of GDP per capita of US and India is World Development Indicators, values of Exports and Imports of India from US has been obtained from Hand Book of Statistics of Indian Economy and Indian Economy Data base Vol. II, exchange rate and WPI of India and US has been assessed from IMF CD Rome of International Financial Statistics. Period of the study is 1960 to 2007 and we used annual observations.

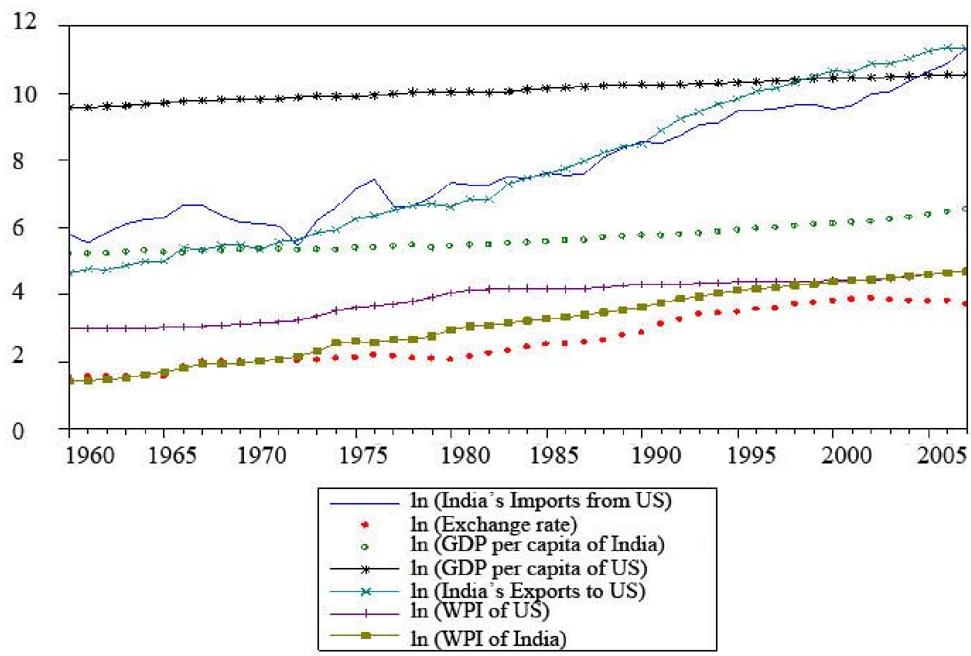

Figure A1. Line Plots of Variables Analyzed

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Mailing Address: Aviral Kumar Tiwari, Research Scholar and Faculty of Applied Economics, Faculty of Management, ICFAI University Tripura, Kamalghat, Sadar, West Tripura, Pin-799210. E-mail: aviral.eco@gmail.com.

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