Economics Bulletin

Volume 35, Issue 1

Effects of Exchange Rate Volatility on Exports: Evidence from India

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Abstract

This study empirically examines the effects of real exchange rate volatility on India's exports using time series data for the period from 1970-71 to 2011-12. This study uses a simple rolling standard deviation as a measure of exchange rate volatility and implements the Johansen cointegration technique to understand the long run relationship among the variables. This study finds that there exists one co-integrating the relationship among exports, real exchange rate volatility and World GDP. India's export volume is positively related to the World GDP. India's export volume is negatively affected by its own real exchange rate volatility. The empirical results indicate that a moderation in the exchange rate volatility can increase the export volume in case of India.

I thank Dr. S. Raja Sethu Durai and Jagadish Prasad Sahu for their suggestions and help. The views expressed in this paper are Personal. Error if any is my own.
Citation: Sidheswar Panda and Ranjan Kumar Mohanty, (2015) "Effects of Exchange Rate Volatility on Exports: Evidence from India", *Economics Bulletin*, Volume 35, Issue 1, pages 305-312
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Submitted: July 07, 2014. **Published:** March 11, 2015.

1. Introduction

In the era of a globalized world, the interdependence amongst countries in terms of international trade of goods and services and capital flows has increased considerably. The growth rate of an economy is predominately depending on the real exchange rate because of its increased international trade activities. Although the impact of international trade on the developing countries is still moderate compared to that of developed countries. There is a considerable change in the trade composition of the developing countries with a magnificent shift from exporting commodity to manufacturing product exports. This change in the trade composition has made the developing countries terms of trade more stable, but its exports are becoming more sensitive to exchange rate fluctuations.

The advent of floating exchange rate around the world has induced greater interest in understanding the impact of exchange rate variability on the volume of international trade. Higher degree of volatility and uncertainty of exchange rate movement in recent times has led policy makers and researchers to investigate the nature and extent of the impact of such movement on the volume of trade. In the literature, the general argument is that higher exchange rate volatility negatively affecting international trade (Chowdhury, 1993; Arize, 1998; Arize *et al*, 2000; Wang *et al*, 2007; Chit *et al*, 2010), but there are some studies that argue in favor of a positive relationship (De Grauwe, 1992; Broll and Eckwert, 1999). However, there exist empirical studies in favor of both the arguments. With misalignments and adjustment problems in the tradable goods sectors, the floating exchange rate regime has led to longer fluctuations in the real exchange rate of major currencies. In this situation, the knowledge of the degree of exchange rate volatility is necessary in order to design both exchange rate and trade policies (De Grauwe, 1988; Arize *et al*, 2000).

1.2. Exchange Rate Volatility and Exports

After the demise of the Bretton Woods system, the exchange rate volatility is perceived as significant and a prominent feature of flexible exchange rate system. Hooper and Kohlhagen (1978) gave a theoretical explanation on the relationship between exchange rate volatility and international trade. They argue that the higher exchange rate volatility increases the cost for the risk-averse traders and also reduces the foreign trade due to unpredictable condition in the change of exchange rates, the profit becomes uncertain and thereby reduces the benefits of international trade. In the developing countries the forward markets are not accessible to all the traders due to the absence of hedging in the exchange rate risk. If there is a hedging in the forward market then there will be more cost and limitations in the market. Since many developing countries, especially the emerging market economies now trade with a wide range of partner countries, it is very difficult to plan the magnitude and timing of all international trade in order to take the advantage of the forward markets.

The growing importance of intraregional trade for key developing countries has increased the magnitude of the real effects of the fluctuations in the bilateral exchange rates between neighbor (or near-neighbor) developing countries (Jadresic *et al*, 1999). India follows a managed float exchange rate regime with the currency follows a controlled floating exchange with the effective rate linked to a basket of currencies of its major trading partners (Reddy, 1999). Due to the flexibility in the foreign exchange rate market and exchange rate determination, there is excess volatility, which has an adverse impact on price discovery, export performance, sustainability of current account balance and balance sheet in view of dollarization. The most commonly held belief is that greater exchange rate volatility generates uncertainty and increases the level of risk. This risk has tremendous impact on international trade and a very interesting area of research. The main objective of this study is to understand the effects of exchange rate volatility on the exports from a developing country's perspective.

This paper analyzes the long run relationship between India's real exchange rate volatility and India's exports. This will help us in understanding the relationship between home currency volatility on India's exports. The paper is organized as follows. Section 2 describes the data and explains in details the methodology used in this study. Section 3 provides the empirical analysis carried out in this study and elaborately discusses the results. Finally, section 4 provides conclusive remarks.

2. Data & Methodology

This study uses time series data. To understand the long run relationship between India's real exchange rate volatility on its own exports, annual time series data for the period from 1970-71 to 2010-11 is used. The sample is chosen due to the advent of floating exchange rate regime in 1973-74. Data are obtained from the Handbook of Statistics on Indian Economy published by the Reserve Bank of India (RBI) and Historical Statistics of World Economy from International Monetary Fund (IMF).

2.1 Construction of Variables

The variables used in this study include real export volume, real GDP of a country, world GDP in real terms and real exchange rate volatility. All the variables are taken in their natural logarithm. The description of the variables used in the study are as follows:

(i) Real Export Volume (EX)

The Real export volume represents the value of all goods and market services provided to the rest of the world at a constant price. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fee and other services such as communication, construction, financial, information, business, personal and government services. They exclude consumption of employees and investment income (formerly known as factor services) and transfer payment.

(ii) Real GDP (Y)

It represents the real foreign economic activities for a country i at the time t which is measured by the real GDP of the country i.

$$\text{Real GDP} = \frac{\text{Nominal GDP}}{\text{Price Index}}$$

Real GDP is a macroeconomic measure of the value of output adjusted for price change. All countries real GDP data are constant in the U.S. dollar, the dollar of GDP is converted from domestic currencies using official exchange rates.

(iv) Exchange Rate (ER)

The price of one currency in terms of another currency is called the exchange rate. Exchange rates are most important prices in an open economy because of their strong influence on the current account and other macroeconomic variables (Krugman, 2003).

(vi) Exchange Rate Volatility (V)

Following Arize *et al* (2000) and Chowdhury (1993), the moving standard deviation of the growth of the real exchange rate is used to measure of exchange rate volatility in order to account for periods of high exchange rate variability and low exchange rate variability. The moving standard deviation of the real exchange rate as the proxy for volatility is expressed as:

$$V=\left[\frac{1}{3}\sum_{1}^{3}(RER_{it+1}-RER_t)^2\right]^{\frac{1}{2}} \quad (1)$$

Where, the *RER* is the real exchange rate. The advantage of this measurement is to be able capture higher frequency movement in the exchange rate and it uses every value in the group of the data being used.

2.2. Econometric Methodology

In this time series analysis, real export volume of India is used as a dependent variable and the exchange rate volatility of India and world GDP are used as independent variables. This study uses a simple time series model described as:

$$lnEX_t=\beta_0+\beta_1 lnY_t+\beta_2 lnRER_t+\varepsilon_t \quad (2)$$

Where, $lnEX_t$ represents the logarithm of real export of India at time *t*.
Lent represents the logarithm of world GDP at time *t*.
$lnRER_t$ represents real exchange rate volatility at time *t*.

We have used simple standard deviation method to measure the exchange rate volatility of India's exchange rate during the period from 1970-71 to 2010-11. Before going for any econometric estimation we have analyzed the time series properties of the various variables.

a) <u>Unit Root Test</u>

Johansen's (1991, 1995) cointegration test warrants each series (in natural logs) is integrated of the same order. To do this we employed the standard Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests and confirmed that each series is I (1) processed. The series under study is contained single unit root, and integrated of the same order implies there exists a possible co-movement between the series.

<u>*Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests*</u>

A simple first order autoregressive process can be expressed by the following general equation

$$y_t = \mu_0 + \mu_1 t + \alpha y_{t-1} + \varepsilon_t \quad (3)$$

Where, Y_t is the stochastic process. μ_0, μ_1 and α are parameters and ε_t is a random disturbance term with white noise properties. μ_0 is called drift or constant or intercept. The nature of the time series described by equation (3) depends on parameter values.

The basic Dickey-Fuller (DF) test examines whether the value of parameter α =1 in the equation (3), in other words, the underlying first order difference equation has a unit root. Specifically, assuming their absence of trend term in equation (3) and rewriting in a modified form as below:

$$\Delta y_t = \mu_0 + \delta_0 y_{t-1} + \varepsilon_t \quad (4)$$

The null hypothesis is that process y_t has a unit root, i.e.

$$H_0 : \delta = \alpha - 1 = 0$$

More generally, if the given time series follows a P^{th} order autoregressive process AR_p or even autoregressive moving average process an extended Dickey-fuller test called augmented Dickey-fuller (ADF) test is suggested. Dickey and fuller (1979) provide a parametric approach for the higher order correlation by assuming that the series follows an AR (p) process. ADF is the modified version of Dickey Fuller (DF) test which includes extra lagged terms of the dependent variables in order to eliminate autocorrelation. The leg length is either determined by Akaike information criteria (AIC) or Schwartz Bayesian criteria (SBC).

Specifically, if the original time series follows AR (p) process, the augmented Dickey- fuller (ADF) test involves the estimation of the following regression

$$\Delta y_t = \mu_0 + \delta y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \varepsilon_t \quad (5)$$

Equation (5) is thus recommended if the residual sequence ε_t in equation (4) is not white noise, for example when ε_t are autocorrelated. There are different forms of DF and ADF tests, which are possible by including trend terms in equation (4) and (5) and also excluding drift (intercept or constant) term from these equations.

Phillips-Perron (PP) test

Phillips and Perron (1988) developed the generalization of the ADF test procedure that allows for fairly mild assumptions concerning the distribution of errors. The PP test involves calculation of t-ratio of the coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic. The PP test on the other hand uses nonparametric statistical methods to account for serial correlation in the error term , without necessarily adding lagged difference term as in the ADF case.

The test regression for the Phillips-Perron (PP) test is AR (1) process as

$$\Delta y_t = \alpha_0 + \delta y_{t-1} + \varepsilon_t \quad (6)$$

While the ADF test corrects for higher order serial correlation by adding lagged difference terms on the right hand side, the PP test makes a correction to the t-statistic of the coefficient of λ from the AR (1) regression to account for the serial correlation in disturbance term.

b) The Cointegration Technique

If the series under study is contained single unit root, and integrated of the same order implies there exists a possible co-movement between the series. This means that a linear combination of them is stationary, suggesting the presence of a long-run relationship amongst these variables. Thus, we can test for cointegration, i.e. the existence of at least one long-run linear stationary relationship between these price indexes, using the method of Johansen (1991, 1995). Johansen (1995) showed that the test procedure is unbiased if the rank tests are interpreted as a sequence. Starting from rank zero, the test procedure stops at the first insignificant test statistic. The procedure involves investigation of the *p*-dimensional vector autoregressive process of *k*th order

$$\Delta Y_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} \prod_{t-k} + \varepsilon_t \tag{7}$$

where Δ is the first-difference lag operator, Y_t is a $(p \times 1)$ random vector of time series variables with order of integration less than or equal to one, $I(1)$, μ is a $(p \times 1)$ vector of constants, Γ_i are $(p \times p)$ matrices of parameters, ε_t is a sequence of zero-mean *p*-dimensional white noise vectors and Π is a $(p \times p)$ matrix of parameters the rank of which contains information about long-run relationships among the variables. As it is well known, the VECM expressed in equation (1) reduces to an orthodox vector autoregressive (VAR) model in first-differences if the rank (r) of Π is zero, whilst if Π has full rank, $r = p$, all elements in Y_t are stationary. More interestingly, $0<r<p$ suggests the existence of r cointegrating vectors, such that there exist $(p \times r)$ matrices α and β each of rank r and such that $\Pi= \alpha \beta'$, where the columns of the matrix α are adjustment (or loading) factors and the rows of the matrix β are the cointegrating vectors, with the property that $\beta' y_t$, is stationary even though *it* may comprise individually $I(1)$ processes. Tests of the hypothesis that the number of cointegrating vectors is at most r (r=1,…, p) are conducted using both the maximum eigenvalue and trace test statistic for reduced rank in the context of the restrictions imposed by cointegration on the unrestricted VAR involving the series comprising Y_t.

3. Empirical Results

For the time series model annual data during the period from 1970-71 to 2010-11 is used. The exchange rate volatility is estimated as a simple rolling standard deviation of the exchange rate. Table 3.1 presents the trend and pattern of exchange rate volatility and export growth.

Table 3.1: Average percentage exports Growth and exchange rate Volatility

Year	Average Export Growth rate (%)	Average Exchange rate Volatility
1971-1980	19.25	15
1981-1990	22.2	8
1991-2000	11	9
2001-2012	1.81	17

From the table, we can infer that during 1971-1980 both average growth rate of exports and average exchange rate volatility are at a higher level. In the next decade from 1981 to 1990 the average growth rate of exports peaked at 22.2 percent, whereas the average exchange rate volatility was at a very low level. After liberalization and economic reforms of 1990s, the decade of 1991-2000 saw a fall in average growth rates of exports coupled with a slight rise in exchange rate volatility. In 2001-2010 shows a drastic fall in export growth rate where the exchange rate volatility peaked. When we look at the overall trend of the average export growth rate and average exchange rate volatility there no particular trend emerges.

In a time series econometric first we have to check the stationary of the variables and are required to know the order of integration of the variables. The following section describes the unit root results.

3.1. Unit Root Test Results

In order to verify the order of the integration of the variables we have employed both the ADF and PP Unit root test. The results are presented in Table 3.2.

Table 3.2 Unit Root Test Results

	ADF Test		PP Test		
Variables	Level	First difference	Level	First difference	Inference
LnExport[@]	-0.25	-4.75***	-0.45	-4.67***	I (1)
LnGDP[@]	2.73	-3.77**	4.84	-3.78**	I (1)
Volatility	-0.79	-2.04**	-1.06	-6.58***	I (1)

Note: ***, ** denote significance at 1% and 5% respectively. [@] represents the test equations include trend and intercept.

From the above tables it is clearly evident that all the variables are non-stationary in their level and stationary in first difference. This means that all the three variables are I (1) series. So, we can employ Johansen co-integration test to measure the long run relationship among the variables.

3.2. Johansen Co-integration result

From the unit root test result, it is clear that all variables are integrating same order. So we employ Johansen- Co-integration test and results are presented in Tables 3.3 and 3.4.

Table 3.3: Multivariate co-integration test Results of Trace Test

NullHypothesis λTrace Test Value	Alternative Hypothesis	λTrace Test Value	5% critical Value	P- value
r=0	r>0	29.56***	24.28	0.01
r≤1	r>1	5.27	12.32	0.53
r≤2	r>2	0.18	4.13	0.72

Note: ***denotes the rejection of the hypothesis at the 1% level.

Table 3.4: Multivariate co-integration test Results of Max Test

Null Hypothesis λMax Test	Alternative Hypothesis	λMaxTest Value	5% critical Value	P- value
r=0	r=1	24.29***	17.8	0.00
r=1	r=2	5.08	11.22	0.47
r=2	r=3	0.18	4.13	0.72

Note: *** denotes the rejection of the hypothesis at 1% level.

The results from both Trace statistic and Maximum Eigenvalue statistic have rejected the null hypothesis of no co-integration at the five percent level. At least there exists one long run relationship among these three variables. The normalized co-integrating coefficients are as follows with Standard error in parentheses.

$$\underset{}{LnExport} = \underset{(0.052)}{0.393*LnGDP} - \underset{(0.022)}{0.017*Volatility}$$

This result shows that foreign country's income (LnGDP) is positively affecting India's exports, whereas the domestic exchange rate volatility negatively affects India's export.

4. Conclusion

The empirical literature so far in the relationship between exchange rate volatility and volume of trade provides mixed evidence. To understand the domestic exchange rate volatility on India's exports a time series data for the period from 1970-71 to 2010-11 is used. This study uses a simple rolling standard deviation as a measure of volatility and implemented the Johansen cointegration technique to understand the long run relationship among the variables. There is no particular trend in the relationship between the growth rate of exports and exchange rate volatility from 1970-71 to 2010-11. There exists one co-integrating the long - run relationship between India's exports, India's real exchange rate volatility and World GDP. India's export volume is positively related to the World GDP. India's export volume is negatively affected by its own real exchange rate volatility. From the time series model, the results indicate a moderation in the exchange rate volatility can increase the export volume. So the Reserve Bank of India should consistently monitor the exchange rate volatility and try to moderate it whenever it breaches a particular level.

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