Exchange Rate Volatility and Export Growth : Post-Reform Experience of India

** Niyati Bhanja*
*** Amaresh Samantaraya*
**** Arif Billah Dar*

Abstract

This paper seeks to investigate empirically the impact of exchange rate volatility on India's export growth over the period between from April 1993 to September 2010. The measure of volatility is estimated for both the nominal and the real effective exchange rate (NEER and REER) using Bollerslev's GARCH model and the wavelet decomposition technique. The ordinary least square (OLS) procedure is then employed to verify the link between export growth and the volatility of exchange rate. The results of ordinary least squares (OLS) suggests that both real and nominal exchange rate volatility exerts a significant positive impact on export growth, irrespective of different measures of volatility employed. Moreover, corroborating conventional wisdom, the foreign economic activities and the domestic import are also found to have a significant positive effect on the growth of exports.

Keywords **: export growth, NEER, REER, Garch, wavelet, volatility, exchange rate**
JEL Classification: F31, F41

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The tremendous surge in capital inflows and increase in cross border financial transactions over the last few decades have believed to add substantial volatility and uncertainty to the behavior of international exchange rate. The debate on volatility of foreign exchange rate appeared in the international economic policy forum with the collapse of Bretton Woods system of fixed exchange rate, and the subsequent advent of market driven flexible rate regime in 1973. The introduction of market forces into the foreign exchange market have considerably raised the level and frequency of exchange rate fluctuations, triggering lively debate and substantial research interests over the transmission channels of exchange rate volatility and its impact on the real economy.

The issue of exchange rate volatility, however, received serious consideration in the Indian economic policy decisions during the second half of 1990s, when as a part of the extensive economic liberalization package initiated in 1991, Indian exchange rate system underwent a series of structural changes. Historically, the Indian Rupee was pegged to the Pound Sterling until 1975 followed by adjustable basket-peg regime until 1992. Subsequently, after a transitional period of dual exchange rates, India finally shifted to a market-based exchange rate system in March 1993. This regime shift along with the introduction of current account convertibility in August 1994 and gradual opening of the capital account to foreign capital flows have paved the way for greater volatility in the rupee exchange rate. In this context, Gupta (2008) observed risk and uncertainty as an integral part of the Indian forex market, stemming mostly from the prevailing rupee-USD exchange rate.

The volatility of exchange rate has several implications on the macroeconomic front. The monetary authority, thus, always remains vigilant towards the exchange rate movements. A wide and frequent fluctuation in the exchange rate distorts the structure of output and investment along with inefficient allocation of domestic absorption and external trade. Moreover, undue downward movement in exchange rate depresses exports by raising prices and thereby eroding international price competitiveness of exportables. This may contribute towards heavy inflation in the economy (Ramachandran, Kavitha, & Maran, 2008). The exchange rate as a key policy variable, therefore, has been perceived and utilized by the policy makers in maintaining international price competitiveness and promoting Indian

* *Research Scholar,* Department of Economics, School of Management, Pondicherry University, Kalapet, Puducherry- 605 014. E-mail: niyati.eco@gmail.com, niyatibhanja@hotmail.com
** *Reader,* Department of Economics, Pondicherry University, Kalapet, Puducherry- 605 014. E-mail: amaresheco@gmail.com
*** *Research Scholar,* Department of Economics, Pondicherry University, Kalapet, Puducherry- 605 014.
E-mail: billaharif0@gmail.com

exports. The conventional wisdom follows that excessive exchange rate volatility and persistent misalignments are potential in depressing trade flows and in distorting investment decisions as well as in misallocation of the outsourcing locations chosen by multinational firms. The exchange rate volatility, for instance, may reduce trade volume by creating uncertainty about the profits made from international transactions and by restricting international flow of capital. Moreover, excess volatility induces traders to cover the exchange rate risk by adding a risk premium on the internationally traded products causing prices to rise. Further, exchange rate volatility hampers international transactions by affecting domestic currency and price of exports and imports. In addition, increase in the level of risk shifts the risk-averse individuals to those transactions which are less risky. It is, therefore, argued that fluctuating exchange rate is likely to affect the level of trade negatively due to higher risk and uncertainty in the international transactions.[1]

Objective of the Study

The present study seeks to understand the behaviour of exchange rate volatility during the post-reform period in India and its impact on the growth of Indian exports.

Literature Review

Intense research efforts have been devoted to exploring the link between exchange rate volatility and exports. There is a strand of literature that reports inverse links between export flow and volatility though theoretically, the link is ambiguous. In a pioneering study, Hooper and Kohlhagen (1978) elaborated the negative association between the volatility-exports. The study argued that exchange rate volatility reduces trade volume unambiguously, irrespective of the risk borne by importers or exporters. According to this argument, traders are risk-averse and hedging is impossible or costly; therefore, exchange rate volatility is most likely to depress foreign trade by reducing risk-adjusted profit from it. However, when exchange rate risk is born by the exporter, the impact of exchange risk on the prices of traded goods is positive, while the effect is negative with risk borne by the importers. In the same line of argument, Caballero and Corbo (1989) also discussed the probable negative impact of exchange rate volatility on exports. According to them, for a risk-averse firm, the concavity of its utility function may be so large that it can offset the convexity of the profit function; leading exports to be negatively affected by the exchange rate volatility. However, another strand of argument follows that exchange rate volatility imposes costs on risk-averse market participants who generally respond by favoring domestic to foreign trade at the margin. This view regards traders as bearers of undiversified exchange risk. Moreover, if hedging is impossible or costly and traders are risk-averse, then the risk-adjusted expected profit from trade will fall with an increase in the exchange risk.

A number of studies reported evidence supporting inverse relation between trade-volatility. Ahmed (2009) analyzed empirically, the exchange rate volatility, and it impacts on bilateral exports' growth for Bangladesh. The results from cointegration analysis suggested a negative effect of exchange rate volatility on exports to major trading partners, e.g. Western European and North American countries both in the short run and long run. However, no significant relationship was observed for exports to India and Pakistan. Chit (2008) used panel cointegration tests to examine the bilateral exports among five ASEAN-China Free Trade Area (ACFTA) countries and found bilateral real exchange rate volatility to have a significant negative impact on the bilateral exports of the major ACFTA countries, although the magnitude of the impact remained fairly small. In a subsequent study, Chit, Rizoy, and Willenbockel (2008) examined the impact of bilateral real exchange rate volatility on real exports of five emerging East Asian countries. Combining a traditional long-run export demand model with gravity type variables, the results provided strong evidence for a negative impact exchange rate volatility on the exports of emerging East Asian countries. Alam and Ahmed (2012) after applying autoregressive distributed lag model also found the really effective exchange rate to affect exports of Pakistan adversely in the long run. Corroborative evidence was also obtained by Grier and Smallwood (2007), Alam (2010), and Aliyu (2010).

Against this strand of argument and empirical evidence, DeGrauwe (1988) forwarded an argument for a positive relation between exchange rate volatility and export growth. For a sufficiently risk-averse individual, he argued, the marginal utility from export earnings rises with an increase in exchange rate uncertainty, which in turn enhances

[1] De Grauwe (1988) and Broll and Eckwert (1999) among others, however, argued for the possible positive effect of volatility on the export volume.

incentives for greater production and expansion of export volume. This constitutes the income effect of exchange rate volatility. The substitution effect of volatility is identified with movement away from risky activities by traders because of reduction in perceived benefits from such activities due to higher risk from increased volatility. This acts as a hindrance to foreign trade. Moreover, the nature of impact on the foreign trade of the volatility depends on the relative strength of these two effects. If the income effect is relatively stronger, the increase in exchange rate volatility may enhance export volume; hence, there may be a possibility of positive relation between exchange rate volatility and real export.

The theoretical basis for positive effect of exchange rate variability on foreign trade was also forwarded by Broll and Eckwert (1999). They developed a model of a price-taking, risk-averse international firm which produces a product for sale in the domestic or foreign market and enjoys enough flexibility to postpone its sales choice between these two markets, contingent upon the realization of the exchange rate. In this context, export strategy is just like an *option* because domestic market returns are always certain, whatever be the realized exchange rate. The domestic price is hence, the "strike price" of the real export option. Therefore, the possibility to export when exchange rates are favorable constitutes the real call-option like source of profit for the export-flexible firm. As the exchange rate volatility increases, so does the value of the option to export to the world market [2]. Higher volatility enhances potential gains from international trade by making extremely high realizations of the foreign spot exchange rate more likely, which tend to induce more profitable export production [3]. However, higher volatility also raises the risk exposure for the firms that work in the opposite direction, depressing production and volume of international trade. The net effect of exchange rate volatility on exports depends upon the degree of relative risk aversion of the firm.

Bacchetta and Wincoop (2000), however, under a simple two-country general equilibrium framework, concluded that the level of trade depends upon the preferences and the policy rules followed by the monetary authority, and that there is no clear-cut relation between the level of trade and exchange rate volatility. They argued that the effect may be negative following the limited scope for hedging against exchange rate risk, the cost involved in the hedging process, and mainly the time-lag involved between the signing of the contract and payment for exports after the actual delivery. At the same time, the impact may be positive as argued by DeGrauwe (1988). An empirical finding in the similar direction was reported by Baum and Caglayan (2006). Their results suggested an indeterminate impact of exchange rate uncertainty on trade flows; that is, in only 20 out of 156 cases, the relations were significant, out of which in 13 models, a positive relation was observed, and in the remaining seven models, the relation was found to be negative.

In the Indian context, corroborative results were also reported by Oskooee and Mitra (2007). Examining disaggregate trade data between the U.S. and India, the study found that in the short run, for 40 industries, trade between the two countries' due to exchange rate volatility was affected negatively, and the effect remained positive for 40% of the industries. In the context of Indian export performance, Prasanna (2011) explored the impact of FDI inflows on manufactured exports. The study found FDI inflows to have a significant positive impact on the Indian manufactured exports. The study thus suggested reassessment of Indian export policy under the FDI framework in order to ensure long-term benefits.

Summing up, there is conflicting evidence in the literature about the relationship between exchange rate volatility and foreign trade, and hence, for export volume. It is to be noted that hardly any consistent conclusion emerges from these studies. The issue, thus, remains largely an empirical question. Besides, the issue bears crucial importance from external-trade policy formulation front in a developing country like India. Nevertheless, available literature in the Indian context seems to be insufficient to draw consistent conclusions regarding the nature of the relationship between foreign exchange volatility and volume of exports. From the aforesaid facts, the present study derives motivation to undertake empirical investigation on effect of exchange volatility on real export growth in case of India.

Data and Methodology

Drawing upon the existing empirical literature, the present study incorporates measures of exchange rate volatility as one of the explanatory variable in the standard export demand equation as specified in the equation (1) to study the impact of exchange rate volatility on real export growth.

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[2] This constitutes a standard property of option values.

[3] The corresponding higher probabilities of low realizations of the foreign spot rate do not offset these gains because firms can move away from the export option. Thus, losses are effectively avoided.

$$X_{gt} = \beta_0 + \beta_1 Y_t + \beta_2 EX_t + \beta_3 V_t + \varepsilon_t \qquad (1)$$

where X_{gt} is real export growth at time t, Y_t is a measure of real foreign economic activity at time t, EX_t represents the exchange rate, and V_t is the measure of exchange rate volatility at time t.

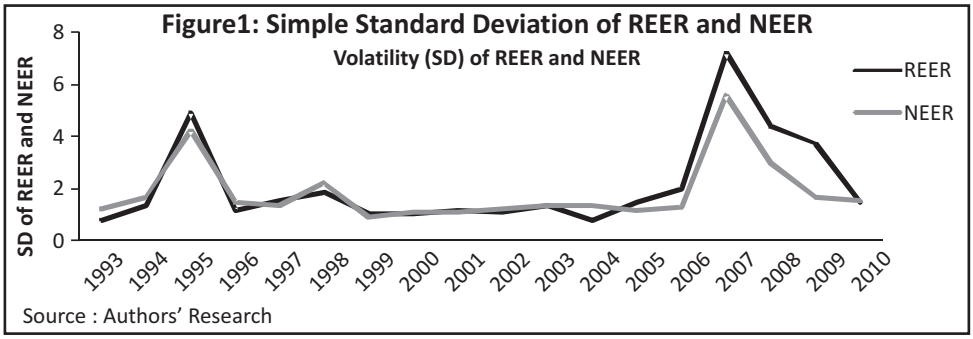
With special reference to India, the conventional export demand function can further be modified in light of compositional changes that the Indian export basket has undergone since the economic reforms of 1990s. Reflecting on increased interdependence between exports and imports ; there have been compositional shifts in the structure of India's imports towards more export-oriented products during 1990s. Industries with the highest growth rate of imports have been largely those with a medium-to-high-technology content that produce intermediary products for exports (RBI's Report on Currency and Finance, 2002-03). To capture the impact of imports on export growth, we ran a separate regression for import demand equation and took the residual generated in the process as the proxy for it.

Moreover, the global financial crisis that erupted in 2008 caused the overall Indian merchandise export to plunge from the third quarter of 2008-09, which started to show some resilience only during the last quarter of 2009-10 (RBI's Report on Currency and Finance, 2008-09). A dummy variable, thus, was inserted as another independent variable with a view to capture the effect of crunched world income and consumption, which stemmed from the global financial crisis, on the Indian export growth. Further, a one month lag variable of export growth was also introduced in the system. The equation (1), thus, was modified by inserting import-residual variable (RIMP), dummy for the Financial Crisis (DUM), and one period lag variable of export growth ($X_{g,t-1}$) specified as:

$$X_{gt} = \beta_0 + \beta_1 Y_t + \beta_2 EX_t + \beta_3 V_t + \beta_4 RIMP + \beta_5 DUM + \beta_6 X_{g,t-1} + \varepsilon_t \qquad (2)$$

The study uses monthly time-series data covering the period from April 1993 till September 2010. This sample had been chosen for two reasons: **(a)** the market determined exchange rate regime commenced from March 1993, **(b)** consistent data on REER and NEER are available only from April 1993 onwards. The real export variable was measured as the export volume in US dollar terms (data taken from the Handbook of Statistics on Indian Economy, 2011-12 Published by the Reserve Bank of India). Then, the year-on-year percentage growth rate of real exports was calculated, that simultaneously removed trend and seasonal components from the real export series. The index of industrial production (IIP) of advanced countries, used as the proxy for the world economic activity and purchasing power of the trading partners, was collected from the International Financial Statistics (IFS) database published by the International Monetary Fund (IMF). The world IIP series was adjusted seasonally using Census X-12 method. For exchange rate variable, the study used both nominal effective exchange rate (NEER) as well as real effective exchange rate (REER) measured as the trade-based weighted average of 36 currencies of India's major trade partners, published by the RBI. For the estimation of the export demand function, this study makes use of two different measures of exchange rate volatility. Our first measure of exchange rate volatility was estimated by using time-varying conditional variance of REER and NEER using the generalized conditional heteroskedasticity (GARCH) methodology proposed by Bollerslev (1986). In this study, classical GARCH (1,1) along with a higher order of GARCH (1,2) and GARCH (2,1) had been computed for both REER and NEER series, but for REER estimated coefficients of GARCH(1,2) and GARCH(2,1) for NEER were found to be more appropriate. We also used the Wavelet decomposition methodology to calculate the volatility of NEER and REER. Wavelet is a non-parametric decomposition that decomposes a series into lower and higher time frequency scales. Since volatility or short-term fluctuations are supposed to be embedded in

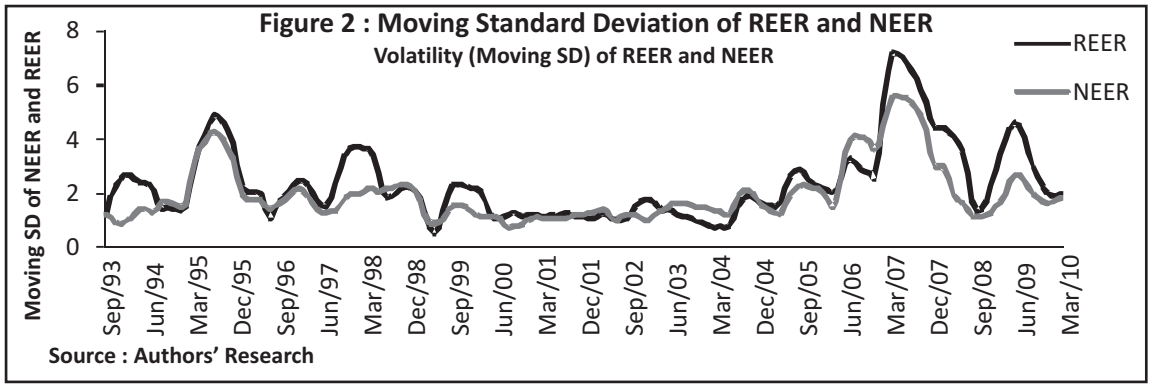
Figure1: Simple Standard Deviation of REER and NEER



Source : Authors' Research

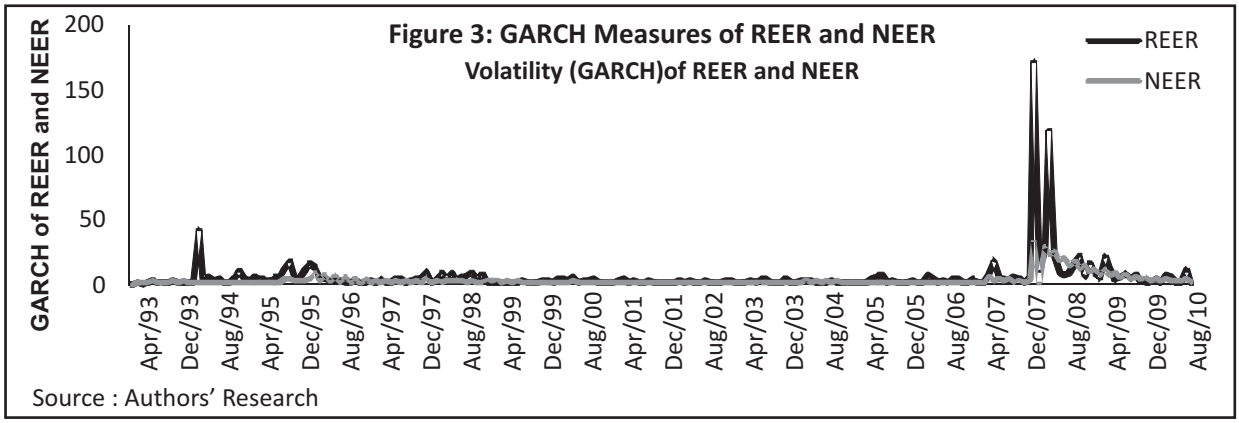
lower scales, we decomposed NEER and REER series into higher and lower frequency scales, and took the square of lower frequency scales of each series, which represents their respective volatility measure.

↳ **Behaviour of Exchange Rate Volatility During the Post-Reform Period :** This section gives greater insight into the behaviour of nominal and real exchange rate - represented by NEER and REER respectively - over the last two decades. The volatility of nominal and real exchange rate is measured by using simple standard deviation, a 12-period moving standard deviation along with appropriate GARCH model and Wavelet decomposition methodology. The simple standard deviations of the NEER and REER are presented in the Figure 1. It is evident from the Figure 1 that the nature of volatility movement of REER and NEER measured by simple standard deviation is quite similar. Both the NEER and REER moved very closely; almost proportionately during 1993 through 2003. Disproportionate movement, however, appeared in the REER volatility 2003 onwards; that took a dip in 2004 and moved up slowly during 2005-06, while NEER volatility remained largely flat. A steep rise in both nominal and real volatility was witnessed during 2008, with REER volatility moving proportionately more to that of NEER. It is well evident from the Figure 1 that apart from the periods corresponding to the Mexican crisis (1995), Asian Crisis (1997-98), and the Global Financial Meltdown (2008), the volatility of real and nominal exchange rates over the years remained mostly moderate.

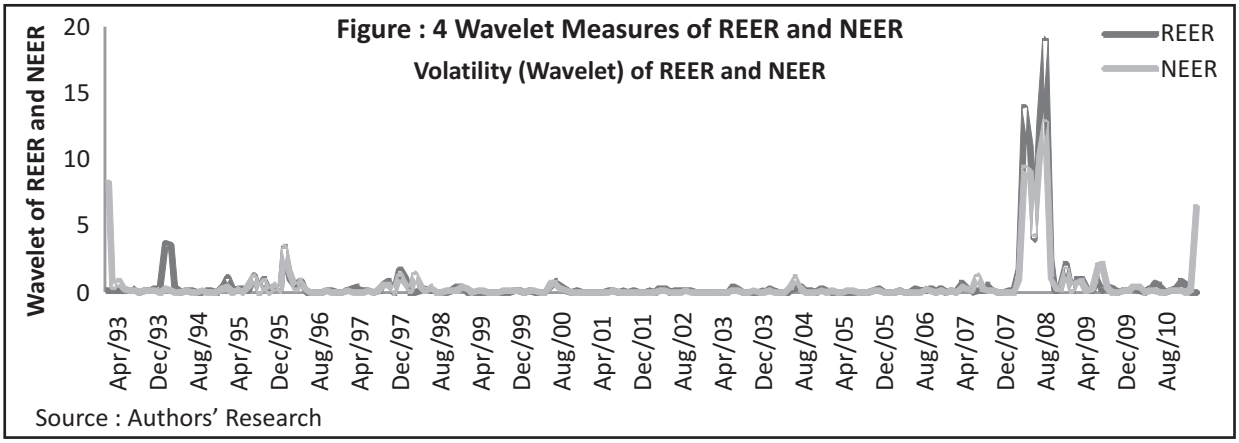


The Figure 2 depicts the moving standard deviation of REER and NEER series. It can be observed that similar to the previous case, the nature of volatility movement of both NEER and REER is very similar. Nevertheless, during most part of the sample period, REER exhibited greater volatility as compared to NEER. With an increase in the volatility of nominal and real exchange rate, REER increased proportionately more to that of NEER, reflecting greater relative price fluctuation. Both real and nominal exchange rate exhibited greater volatility during the period from March 1995-Dec 1995, June 1997, and September 2008, but remained mostly stable in the rest of the period.

The Figure 3 represents the GARCH measure of volatility for REER and NEER. It shows that the movement of NEER has been mostly stable over the years. The behaviour of REER is very much similar to that of NEER. The graph



portrays the volatility of REER to be of almost the same magnitude to that of the NEER during 1996 through 2007. Nevertheless, with some exception, REER exhibited significant spikes as compared to NEER during 1993 and 2008, reflecting perhaps the greater relative price movement during these particular periods. After moving wildly during 2008, REER volatility declined sharply in the subsequent period.



Source : Authors' Research

The Figure 4 depicts volatility of REER and NEER obtained using the wavelet decomposition methodology. Similar to the previous case, the movement of NEER and REER is very much coordinated. Again, during 1994 and 2008, the REER proved to be more volatile as compared to NEER. However, during rest of the periods, volatility of REER and NEER remained almost of the same magnitude. Strikingly, wavelet measure of NEER volatility exhibited comparatively greater volatility than its GARCH counterpart during 2008.

The major stylized fact that seems to come out from the above graphical analysis of the movement of real and nominal exchange rate (represented by REER and NEER respectively) is in response to any shock, the real exchange rate moves more violently than that of the nominal exchange rate. Most often, REER volatility was found to increase proportionately more to that of NEER volatility.

Table 1: Unit Root Test Results

Variable	ADF test	PP test
X_{gt}	-3.60 (0.00)*	-5.58 (0.00)*
NEX	-3.06 (0.03)**	-2.93(0.04)**
REX	-3.77(0.00)*	-3.90(0.00)*
$VNEX^{G}$	-3.25 (0.01)**	-8.40(0.00)*
$VREX^{G}$	-4.56 (0.00)*	-13.40(0.00)*
$VNEX^{W}$	-5.13(0.00)*	-8.26(0.00)*
$VREX^{W}$	-5.27 (0.00)*	-7.24(0.00)*
Y_t	-2.5(0.10)***	-3.89 (0.00)*
RIMP	-5.09 (0.00)*	-6.84 (0.00)*

Figures in parentheses are p- values. *, **, and *** denote statistically significant at the 1% , 5%, and 10% levels respectively.

Source : Compiled by the Authors

Empirical Results and Discussion

This section is devoted to the discussion on the empirical findings of this study for the effect of exchange rate volatility on the export growth in India. Before performing the regression analysis, the test for stationarity for each variable using Augmented Dicky-Fuller (ADF) and Phillip-Perron (PP) method was conducted. The stationarity check for any time-series variable prior to regression analysis is called for, as most often, econometric models using non-stationary

variables violate the desirable statistical properties of the estimators and lead to spurious results. The Table 1 reports the results of unit root tests for each variable used in this study for the estimation of export demand specification given in the equation (2). Superscripts, ^{G} and ^{W} represent GARCH and wavelet decomposition measures of the volatility. The values reported in the table were obtained with intercept only. It is evident from the Table 1 that all the variables under consideration are stationary at their level form or follow the I (0) process.

Hence, we move forward towards the estimation of the export demand function using simple ordinary least square (OLS) methodology. First, we estimated equation (2) for both REER and NEER along with their corresponding GARCH volatility measures and obtained the results as presented in the equations (2A) and (2B). Figures in parentheses are *t*-value*s*. Statistical significance levels at the 1%, 5%, and 10% levels are denoted as *, **, and *** respectively.

$$X_{gt} = -55.66 + 0.16Y_t + 0.48REX_t + 0.06VREX^{G} + 0.20RIMP - 8.21DUM + 0.54X_{g,t-1} + \varepsilon_t \quad (2A)$$

(-2.87)* (1.89)*** (2.63) ** (2.43)** (3.57)* (-2.40)** (8.94)*

Adjusted $R^2 = 0.65$ *F-statistics = 65.80 (0.00) DW-Statistics = 2.28*

$$X_{gt} = -56.82 + 0.28Y_t + 0.41NEX_t + 0.27VNEX^{G} + 0.20RIMP - 10.69DUM + 0.55X_{g,t-1} + \varepsilon_t \quad (2B)$$

(-2.72)* (3.02)* (2.51) ** (2.37) ** (3.46)* (-2.66)* (8.69)*

Adjusted $R^2 = 0.65$ *F-statistics = 65.77 (0.00) DW-Statistics = 2.24*

The above results show that the *t* -statistics of all the explanatory variables in both the equations are significant; implying that they are significant individually. The calculated *F*-statistics for both equations are also significant at the 1% level. We, thus, infer that all the explanatory variables are jointly significant too. The adjusted R^2 in both the equations equals 0.65, indicating that independent variables in the model explain about 65% of the variation in the dependent variable. The *DW* statistics of both our equations are above 2, indicating that the estimations are free from the autocorrelation problem.

In both the equations, the estimates of all slope coefficients show the expected relationship, except for the exchange rate variables (REER and NEER). The estimates of world income have the expected positive sign, indicating income of the major trading partners to have a positive impact on the export demand and hence, on the growth of exports. This is because with an increase in the income of the trading partners, their overall demand for goods also increases, leading to higher demand for imports (export of home country).

The coefficient of exchange rate volatility is what we were most concerned about in our study. There was no a-priori expectation about the sign of the volatility coefficient, since the relationship between the volatility of the exchange rate and real export is ambiguous. For India, our study finds significant positive relation between both nominal and real exchange rate volatility (GARCH measures) and export growth. The coefficients of GARCH volatility are found to be significant at the 5% level of significance. The positive sign of the volatility coefficients indicates that volatility of real and nominal exchange rate exerts a significant positive impact on the domestic export growth; supporting perhaps the theoretical arguments forwarded by DeGrauwe (1988), Broll and Eckwert (1999), and others.

The import coefficients in both the equations are highly significant at the 1% level, with *t*- values - 3.57 and 3.46. The sign of this coefficient is positive, which implies that with an increase in the Indian imports, the exports of India also increased. This indicates the import intensiveness of Indian exports. The coefficients on the dummy variable also show a significant negative sign, implying that Indian export growth dampened significantly during the 2008-09 financial crisis. The estimates of one period lag of export growth also obtained significantly positive values in our model.

We further move to estimate the same model with a different measure of exchange rate volatility, that is, wavelet decomposition of REER and NEER volatility to check the robustness of the above results. The estimated results with wavelet volatility measures are presented in the equations (2C) and (2D).

$$X_{gt} = -54.78 + 0.14Y_t + 0.48REX_t + 0.68VNEX^{W} + 0.20RIMP - 7.96DUM + 0.54X_{g,t-1} + \varepsilon_t \quad (2C)$$

(-2.83)* (1.82)*** (2.66)* (3.12)* (3.48)* (-2.36) ** (9.19)*

Adjusted $R^2 = 0.66$ *F-statistics = 65.04 (0.00) DW-Statistics = 2.28*

$$X_{gt} = -53.50 + 0.27Y_t + 0.38NEX_t + 0.67VNEX^W + 0.20RIMP - 8.68DUM + 0.56X_{g,t-1} + \varepsilon_t \quad (2D)$$

(-2.62)* (3.04)* (2.39)** (2.24)** (3.54)* (-2.49)** (9.47)*

Adjusted $R^2 = 0.65$ *F-statistics = 65.51 (0.00) DW-Statistics = 2.29*

The results reported for equation (2C) and (2D) are quite similar to that of results of equation (2A) and (2B). The estimated coefficients of both nominal and really effective exchange rates were again found with the wrong signs. However, the coefficients of world income, Indian imports, and lag variable of export growth show the expected positive sign in both the equations, and are statistically significant too. The dummy coefficients also turn out significantly negative as in the earlier cases. The volatility of both nominal and real exchange rate constructed using wavelet decomposition methodology were again found to have a significant positive effect on the export growth. The adjusted R^2, F -statistics, and DW values of equation (2C) and (2D) are also quite close to that of equation (2A) and (2B).

Summary and Conclusion

This paper re-examined the impact of exchange rate volatility on the export growth in the context of India for the period between April 1993 to September 2010. We estimated two measures of exchange rate volatility, the GARCH and the wavelet decomposition of the real and nominal effective exchange rate, to verify the link between export growth and the volatility of exchange rate. The results of ordinary least squares (OLS) are suggestive of the fact that both real and nominal exchange rate volatility have a significant impact on export growth and that the impact is positive, irrespective of different measures for India. Therefore, we conclude that our findings for impact of exchange rate volatility on export growth, to be more specific, the positive effect of the nominal and real exchange rate volatility on export growth, is consistent. The limitation of the study lies in ignoring the price variable (relative price) which measures the competitiveness of exports. Under the OLS framework, we were unable to include the relative price of the exports, for it was found to be non-stationary. Perhaps, not very high adjusted R^2 of the estimated models are due to this drawback. A natural extension of this paper would be to analyze the issue under appropriate cointegration framework to capture the underlying long run dynamics between exchange rate volatility and exports.

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