Iranian Economic Review 2022, 26(4): 853-875
DOI: 10.22059/IER.2021.81585

RESEARCH PAPER

Exchange Rate Volatility and India-U.S. Export at Commodity Level: Evidence from an Autoregressive Distributed Lag Approach

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Received: 24 November 2020, Revised: 08 January 2021, Accepted: 12 February 2021

Abstract
The paper focuses on the impact of exchange rate volatility on the trade flow between India and the US. Previous research on India's trade flow has concentrated on India's overall aggregate export across border nations. Many maintain the work on bilateral trade pair-wise, although very few have observed the commodities trade at a disintegrated scale. This paper explores Indian export trade at disaggregate commodity-wise, undertaking 60 Indian exporting commodities to the US. We apply generalized autoregressive conditional heteroscedasticity (GARCH) based models to gauge the real exchange rate volatility and to discover the short-run and long-run relationships; an autoregressive distributed lag model is applied to the time series data. The empirical analysis at the disaggregate level of export indicates the short-run as well as the long-run effect of exchange rate volatility. However, the estimated short-run effect, which lasts onto the long-run effect, is in 16 exporting commodities. This paper provides more specific information about the relationship between exchange rate volatility and bilateral export commodities using individual-level data. The study's finding helps to undertake the view of invariability and consider the industry before policymakers.
Keywords: Export, Trade, Time series ARDL, EGARCH, Commodity, India.
JEL Classification: C22, F1, F14, F31, O19.

Introduction

The valuation or volatility reverberates on international trade, the balance of trade, and economic performance. The discourse on trade imbalance has created interest in understanding the effect of exchange rates on international trade. Exchange rate volatility has always been an inordinately sensitive variable; its extended deviations of currencies from their balanced level repeatedly press costs on the economy. The economy of India had an unexpectedly high export rise in the period leading to the crisis, but now it has undergone in most of the commodities as international trade prices and exchange rate movement are closely related, so exchange rates have an effect on across-border gains and trade volumes. The reverberation of exchange rate fluctuations on trade holds a considerable accumulation of studies. The clan of seminal benefaction by Clark (1973) and Hooper (1978) underpin the effects theoretically. However, the evidence in this issue has always been undetermined. For instance, Grauwe (1988) and Thursby and Thursby (1987), in their earlier research, have seen a negative relationship between the export of the nation and variability. In the hindmost studies, the association between uncertainty and trade concludes to be contradictory, being positive or negative by Klein (1990) and Barkoulas and Baum (2002), else ways Bahmani-Oskooee and Hegerty (2007) review positive and negative effects empirically.

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Furthermore, the guild of work Bahmani-Oskooee and Harvey (2011); Bahmani- Oskooee and Hegerty (2007); Bahmani-Oskooee and Gelan (2018); Bahmani- Oskooee et al. (2014); Sharma and Pal (2018) has been on exchange rate uncertainty and bilateral trade or cross border trade considering both developed and developing countries provide mixed inferences on the relationship and its performance. From the literature, we ran across a few studies which included India in addition to other countries. For instance, Doroodian's (1999) probe covers three developing countries, which includes South Korea, Malaysia, and India, to examine the influence of uncertainty on export volume. Similarly, Hooy and Choong (2010) and Sharma and Pal (2018) examine bilateral trade flow between India & three Asian countries and India's across-nation trade with U.S., Germany, Japan, and China. These studies give different opposing evidence and are unable to reconcile the linkage between exchange rate volatility and trade flow.

The aim of this research is to inquest the relation between real exchange rate volatility and export at disaggregate, which is an individual level between India and the US bilaterally. Primarily, we probe the association between exchange rate fluctuation and India-U.S. export trading at the commodity level in a time series framework. Though, voluminous literature uses the time series setting for only aggregate analysis. India followed an import substitution policy until 1991, and in the preceding years 1991, it was not an open economy; after the introduction of trade liberalization in 1991, India witnessed massive export growth. Also, India-US has more commodities trade than other trading countries (Sharma and Pal, 2018). Thereby, the United States is not chosen aimlessly as remarkable changes make the US a compulsive country to investigate the relationship between exchange rate volatility and export trade. To the best of my knowledge, this paper explores India's export at the commodity level individually, unlike other articles. As it differs, primly, by examining every commodity individually exported by India to its first and most significant trading partner, the United States, as reported by the world bank. Secondly, we investigated the impact of volatility using real exchange rate over the nominal exchange rate, as the real exchange rate is more relevant over the medium-term time horizon. Also, it is more appropriate over the nominal as the variability of nominal offsets the firm's profit and cost (Gotur, 1985). Devereux (2015) suggests that at the individual level, the traded goods price must be equal across the border but the differential price indices across the nations. So, the non-traded goods price differs in the different nations leading to real exchange rate trends. Thus we use the real exchange rate as an exogenous variable and also for estimating the volatility. Thirdly, this paper uses longer and monthly time frequency for estimating more accurate results.

To this background, the study contributes to the related literature by employing econometric techniques to acquire robust and accurate results. Exchange rate volatility cannot be applied straight to the model, whereby it can be measured by various statistical techniques. Firstly, to estimate exchange rate volatility generalized autoregressive conditionally heteroscedastic model (GARCH) is utilized, as it is considered more appropriate and accurate than the standard deviation-based method. We use the ARDL approach by Pesaran et al. (2001) to estimate the linkage between real exchange rate fluctuation and bilateral export trade in the short and long run. The ARDL modeling has an accessory advantage on long-run coefficients in accumulating reconcilable estimates, which are asymptotically normal with flexibility even when the underlying variables are of a different order of integration. The ARDL approach is well-liked because of assorted advantages compared to other cointegration procedures. In addition, it is not necessary to a prior ascertainment of the order of the integration between the underlying variables, unlike other outlooks of cointegration like Engle and Granger (1987), Johensen and Juselieus (1990), and Phillip and Hansen (1990) which necessitate same order of level of integration. Furthermore, the ARDL approach also permits variables with different optimal lags. Accordingly, second we use India-U.S. export trade, to which we disclose the linkage at commodity level. The exploration of research is at micro level as to gain more specific and detailed information in reference to the relationship between exchange rate volatility and export trade flow at disaggregate level. Thirdly, we employ the association on monthly data rather than a quarterly or annual series, as the monthly series has high frequency to typically prime for variability measure. Finally, our results prediction considers real exchange rate over nominal exchange rate though there are many literatures on this discussion explaining to which is more appropriate of both real and nominal exchange rate thereafter considering that our research is on bilateral trade which involves US so we chose to use real exchange rate.

The rest of the paper is a rubric, as the subsequent division entails the theoretical review of trade flow and exchange rate fluctuation. Section 3 delineates the measure of exchange rate volatility. Section 4 represents the data and methodology. Section 5 includes the empirical methodologies of the time series analysis of commodities. Section 6 delivers the conclusion, and Section 7 covers the possible policy implication. Sources and descriptive statistic is in Appendix A.

A Theoretical Contour

The association of exchange rate volatility and trade flow is sensitive due to many factors. As the instability in currencies from the equilibrium point, it tends to impose adding costs on the trade. The exchange rate is determined as endogenous as well as exogenous from different percepts, like from the trader's currency variation view; it is an exogenous factor where from the macro-economic or financial view, it is an endogenous framework.

In the earliest study, Clark(1973)explores whether exchange rate volatility influences international trade flow taking a single product and its earnings in foreign currency where native currency sees revenue under the watch of exchange rate volatility. Clark's establishment unearths the negative relationship between the volatility and trade across the border. Adding to the work, many provide support relating to similar research till 1990 (for instance, Baron, 1976; Hooper, 1978; Cushman, 1988; Giovannini, 1988). The empirical study in the late 1990s by Arize (1997) supports the significant negative result of exchange rate risk on the export trade of seven industrialized nations which are Denmark, the U.S., Germany, the UK, Japan, Switzerland, and Italy. Whereas, Eckwert and Broil (1999) reflect the positive association between international trade and exchange rate volatility when the firms decide to allocate goods in various markets depending on the fluctuation of exchange rate releases. On the other hand, Obstfeld and Rogoff (1998) provide insight into how exchange rate uncertainties results in dampening the cross-border trade when all the risk-averse industries stands against it. Thus, the literature debate regarding the interaction between export and exchange rate volatility provides distinct results leaving inconclusive.

On the empirical forefront, Bredin et al. (2003) explain a positive impact in the long-run but no impact in short-run of exchange rate volatility on the export of Ireland to the European Union. Hondroyiannis et al. (2008) studied the influence of exchange rate uncertainty on the export of 11large-industrial countries (namely the U.S., Canada, Italy, France, Germany, Japan, Switzerland, the U.K., Ireland, the Netherlands, Norway, and Spain) and there is no evidence supporting the influence between volatility and export. Likewise, Hall et al. (2010) and Boug and Fagereng (2010) fail to show the significant and negative impact on the export of exchange rate volatility of considered countries. Where Bahmani- Oskooee et al. (2013) explore bilateral trade between Brazil and the US which reveals no evidence of the influence on most of the industries in long-run. Similarly, Asteriou et al. (2016) have not found undeviating results of exchange rate variability with export.

On the contrary, Chit et al. (2010) explored trade among 13 developed countries, including five emerging nations, and revealed significant negative results of uncertainty or variability in trade across borders. Similarly, Bahmani-Oskooee and Harvey (2011) explore bilateral trade between the US and Malaysia, and Karagedikli et al. (2016) explore New Zealand trade; both find a significant negative effect of volatility on trade. Along the same lines, Sharma and Pal (2018) and Bahmani-Oskooee et al. (2018) reveal evidence of the significant negative impact of volatility on trade at bilateral and cross-border trade. The comprehensive studies reflecting different findings of the impression of exchange rate uncertainty on trade are mainly vague. Hence, an attempt at a bilateral export performance at a disaggregate level in developing nations is relevant.

Model Representation of Exchange Rate Volatility

The sufficient literature extensively debates whether the real or nominal exchange rate is pertinent to measure volatility for estimating the association with trade flow. Many researchers (for instance, Bahmani-Oskooee and Hegerty, 2007; Bahmani-Oskooee and Aftab, 2017; Bahmani-Oskooee and Arize, 2019) have made the use of real exchange rates for the analysis as the nominal exchange rate does not detain the variance whereas real exchange rate does and also contains the relative prices. The measure of volatility is based on the real exchange rate to reduce the aggregation bias used on trade flow at a bilateral level. Therefore, the volatility of India-U.S. exchange rate is determined in real term. The exchange rate data is in monthly series taken from International Financial Statistics (IFS) of the period from 2004: M12 to 2019: M03.

Various research articles employ an alternative approach to measure the exchange rate volatility. For instance, Ariccia (1999), Klaassen (2004), and Devereux and Lane (2003) applied different statistical techniques to log exchange rates, such as the standard deviation of the first difference or moving average standard deviation for measuring volatility. On the other side, many researchers used the general autoregressive conditional heteroskedasticity (GARCH) modeling to measure exchange rate volatility. The GARCH-based model is effectively most relevant as it captures the uncertainty accurately with time-varying conditional variance (Bollerslev, 1986).

This paper use GARCH (1,1) based models to evaluate the best fit model for measuring the real exchange rate volatility (Sjölander, 2010). The GARCH (1,1), T-GARCH (1,1), and E-GARCH (1,1) models are utilized on the real exchange rate data for extracting its volatility, and best of all, the model is selected based on lower AIC and BIC base as represented in Table II for the further analysis process. The exchange rate volatility is further estimated by applying GARCH based model, but before that, the stationarity of the exchange rate data series is essential to check. The augmented dickey-fuller (ADF) test of Dickey and Fuller (1979) is used for the stationarity check of the real exchange rate, provided it is already in logarithm form. The test result is presented in Table 1, which states that it is stationary at the first difference and not at level.

Table 1. ADF Results

Exchange rate	Intercept	Intercept& Trend	None
At Level			
	0.0813	-2.6075	2.8350
At First Difference			
	-9.0255**	-9.0348**	-8.3840**

Source: Research finding.
Note:
the exchange rate is in natural logarithm form
** denotes a 5% level of significance

Table 2. Model Selection Criterion

Exchange rate	Models	AIC	BIC
	GARCH (1,1)	-5.4708	-5.3610
	T-GARCH (1,1)	-5.4042	-5.2761
	E-GARCH (1,1)*	-5.4827	-5.3623

Source: Research finding.
Note:
* denotes specific volatility estimation model
AIC: Akaike information criterion
BIC: Bayesian information criterion

The exchange rate volatility is required to be measured as it cannot be obtained directly. We apply different types of GARCH-based models (Table II) for estimating the volatility of the real exchange rate. To determine the exchange rate volatility, we used GARCH (1, 1) based modeling, applying the GARCH model priory to the data. Next, we use the asymmetric, which is EGARCH of Nelson (1991) and TGARCH model advised by Glosten et al. (1993) and Zakoian (1994) to forecast volatility. Further, to check their suitability, we consider the Akaike information criterion (AIC) and Bayesian information criterion (BIC) to choose the most appropriate technique. Therefore, the result in Table 2 of the criterion suggest of EGARCH model to measure volatility. As in the view of USD-IND the EGARCH model is the best as it fulfils for all the criteria. The EGARCH by Nelson, (1991) is described as follows.

$$\log(h_t) = \omega + \alpha\left[\left|\frac{u_{t-1}}{\sqrt{h_{t-1}}} - \sqrt{2/\pi}\right|\right] + \beta log h_{t-1} + \gamma\frac{u_{t-1}}{\sqrt{h_{t-1}}} \tag{1}$$

Data and Model Specification

Time Series Data of Commodities

To explore the effect of exchange rate volatility on India's export with a trading partner, the U.S. The reason to choose the US amongst other trading countries is that the number of commodities exported from India is higher than other countries. The data on export is sourced from "Economic Outlook," a dataset of the Center for Monitoring Indian Economy (CMIE). For the trade series of export from India to the US, we take 60 commodities covering the period from 2004: M12 to 2019: M03, according to the data availability. The measure of the commodities is taken in volume in the demand function from the same database. All variables utilized in the study are transformed in the logarithm form. Most studies of similar interest have used gross domestic product (GDP) as a measure of national income. However, our study uses monthly data series, and GDP is only available quarterly or annually. Thus, the aggregate industrial production index (IIP) is used as a proxy for national income (GDP) for the analysis. Furthermore, due to the significant depression period in 2008, we include dummy variables, i.e., dummy'08 has been included in every model to capture the effect of drastic years.

Model Specification

The analysis involves trade data at the bilateral level and simultaneously at the commodity level, as reported by India. The paper focuses on capturing the effect of volatility on both longrun and shortrun. As the dataset is a combination of both stationary I(0) and non stationary variables I(1). We apply the model of most literature work, the autogressive distributed lag approach (ARDL) of Pesaran et al. (2001). The paper presents the export trade flow from the India's perspective. Majority of literature like Thursby and Thursby (1987); Asseery and Peel (1991); Varangis (1994); Bahmani-Oskooee et al. (2009) confirm that export depends on other country's income. Therefore, the long-run export function in log-linear form is specified as follows:

$$ln\,X_t^{IND} = \alpha + blnY_t^{US} + clnREX_t + dlnVOL_t + \varepsilon_t \qquad (2)$$

Wherein equation 2 identifieslnX, lnY, REX, VOL as India's export volume, US income proxied by industrial production, exchange rate, and exchange rate volatility as estimated in the preceding section, the export volume of the commodities at time *t* and *ln* present the variables in logarithm term respectively. India's export is expected to rise with the increase in US income and the depreciation in the dollar, i.e., REX, which means b could be positive and c could be negative. The VOL is the exchange rate uncertainty, its effect could be positive or negative, and an impression of d could be negative or positive.

As mentioned in many previous studies, Equation (1) estimates the long-run effects of US income, exchange rate volatility, and real exchange on the export volume of each commodity. However, the study also analyzed the short-run effects of exchange rate volatility. After that, following the application of the approach by Bahmani-Oskooee and Tankui (2008), we reframe Equation (1) in the error correction model as follows:

$$\Delta\ln X_t^{IND} = c_1 + \sum_{j=1}^{n1}\gamma_j\,\Delta\ln X_{t-j}^{IND} + \sum_{j=0}^{n2}\delta_j\,\Delta lnY_{t-j}^{US} + \sum_{j=0}^{n3}k_j\,\Delta lnREX_{t-j} + \sum_{j=0}^{n4}\lambda_j\,\Delta lnVOL_{t-j} + \alpha_1\ln X_{t-1}^{IND} + \alpha_2 lnY_{t-1}^{US} + \alpha_3 lnREX_{t-1} + \alpha_4 lnVOL_{t-1} + \varepsilon_t \qquad (3)$$

Equation (2) represents the error correction model, which Pesaran et al. (2001) describe relative to the OLS technique to capture the non-stationary (I1) and stationary (I0) variables in the error correction model by checking the F statistic test. If the F-test is joint significant, there is cointegration in the variables and the lagged variables detained in Equation (2). The bound-test approach by Pesaran et al. (2001) keeps the assumption of I(1) as the upper bound and I(0) as the lower bound for the use of critical values. Therefore, the assurance of a long-run relationship between variables is captured when F-statistic is above the critical value of the upper bound. Still, if it is below the critical value of the lower bound, it results in no cointegration among variables. The short-run and long-run influence of exchange rate volatility is decided by the assessment of λ_j and $\alpha_1 - \alpha_4$ in the estimantion of Equation (2), after normalization of α_1[2]As described before, Bahmani- Oskooee and Mitra (2008) model (2) holds the assumption of being symmetric.

Empirical Results

As mentioned before, most of the studies have captured the influence on annual data only, but where in this study, we employ the monthly series of commodities of the period 2004: M12 to 2019: M03 throughout all the models for empirical estimation. Next, we estimate the India demand model using the error-correction model (Equation 2) on an aggregate of Indian export to the US shown under the name of all commodities. Similarly, we apply the error-correction model to Indian exporting 60 commodities individually to capture whether these commodities disclose the influence of exchange rate volatility.

As ARDL bound testing model given by Pesaran et al. (2001) is flexible with the use of different order of integration which is (I0) and (I1), and no critical condition of having same order integration. Firstly, we test the stationarity of all the industries and all the exogenous variables, and it is found that they have a mix of both (I0) and (I1)[1]. Thus, to analyze the relationship between real exchange rate variability, national income, real exchange rate, and its volatility with each exported commodity, we applied ARDL bound testing model, and many

[1]. As because of the space constraint the unit root result is presented but it can be available on request.

articles used the same model, for instance, Bahmani-Oskooee et al. (2013); Bahmani- Oskooee and Baek (2016) and Arbabian et al. (2019).

The bound test in ARDL enhances the application where variables have a mixed order of integration, that is (I0) and (I1). This test gives two forms of critical value which are referred to as bound value. Further, this testing is based on the *F* statistics explaining if the value of *F* statistics falls above the bound value. The decision is conclusive, stating whether the variables are cointegrated or not, but if the *F* statistics fall somewhere within the bound values, then it is an inconclusive decision. Additionally, this ARDL model estimates short-run as well as long-run relationships simultaneously, proceeding to the minimization of barriers related to omitted variables and auto-correlation. Also, the ARDL model includes an unrestricted error correction technique, also known as ECM, which delivers the speed of adjustment. The ARDL model is represented in Equations (2) and (3).

Since we analyze monthly data, a maximum of eight lags are used on each of the first-differenced variables. Akaike Information Criterion (AIC) is used to obtain an optimum model. For the diagnostic statistics and estimates, we identify the significance as *** as a 1 % significance level, ** as a 5% significance level, and * as a 10% significance level. For the concision of presentation, only coefficient estimates of short-run exchange rate volatility and coefficient estimates of long-run of all the variables are reported in Table3, where its diagnostic statistics description is in Table 4, respectively.

Table 3.

	Short-run coefficient estimates				Long-run coefficient estimates				
Commodities	**$\Delta LnVOL_t$**	**$\Delta LnVOL_{t-1}$**	**$\Delta LnVOL_{t-2}$**	**$\Delta LnVOL_{t-3}$**	**Constant**	**Dummy'08**	**LnY_{US}**	**LnREX**	**LnVOL**
All commodities	0.01 (0.10)				4.51 (1.89)*	-0.56 (2.83)***	0.56 (0.91)	0.66 (4.01)***	-0.06 (0.62)
Agricultural & allied products(9.1875)	0.02 (0.21)	-0.12 (1.32)	-0.20 (2.08)**		12.46 (0.97)	0.29 (0.48)	-1.22 (0.36)	0.70 (0.73)	0.24 (0.47)
Alcoholic beverages(0.0101)	0.20 (0.64)				3.64 (0.85)	0.27 (1.44)	-1.16 (1.01)	0.46 (1.35)	-0.08 (0.46)
Aluminium other than products(0.5809)	0.20 (0.64)				3.64 (0.85)	0.27 (1.44)	-1.16 (1.01)	0.46 (1.35)	-0.08 (0.46)
Basmati rice(0.2773)	0.31 (1.48)	-0.63 (3.21)***	-0.31 (1.55)		-16.21 (2.02)**	-0.86 (1.52)	6.06 (2.81)***	-0.10 (0.16)	0.87 (2.56)***
Carpets(1.4869)	-0.09 (0.94)				-14.93 (5.51)***	-0.58 (4.10)***	2.23 (3.04)***	1.24 (5.53)***	-0.68 (5.71)***
Cashew(0.6136)	0.02 (0.07)	-1.02 (2.98)***	-0.75 (2.13)**	-0.29 (0.83)	20.49 (1.36)	-3.82 (2.39)**	4.79 (1.18)	-5.55 (2.92)***	1.89 (1.85)*
Castor oil(0.2136)	0.57 (1.07)	-0.15 (0.30)	-1.51 (3.02)***	-0.79 (1.49)	21.72 (3.19)***	-0.41 (1.28)	-3.28 (1.81)*	0.74 (1.49)	0.70 (2.48)***
Chemicals/Residual chemicals & related products(15.8096)	-0.21(2.42)**	-0.07 (0.81)	-0.03 (0.33)	-0.14 (1.61)	9.52 (2.55)***	-1.02 (3.25)***	-0.11 (0.11)	0.67 (2.14)**	0.40 (2.20)**
Coffee(0.0725)	-0.80 (3.18)***				4.00 (0.58)	-0.25 (0.91)	-3.52(1.81)*	2. (4.62)***	-0.61 (1.96)**

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Commodities	**$\Delta LnVOL_t$**	**$\Delta LnVOL_{t-1}$**	**$\Delta LnVOL_{t-2}$**	**$\Delta LnVOL_{t-3}$**	**Constant**	**Dummy'08**	**LnY_{US}**	**LnREX**	**LnVOL**
Coir & coir manufactures(0.1586)	0.04(0.26)				-4.50 (1.16)	-0.24(1.39)	0.56 (0.53)	0.28 (0.91)	-0.54 (3.33)***
Cosmetics/toiletries(0.3942)	-0.03 (0.17)	-0.01 (0.09)	-0.28 (1.88)*	-0.38 (2.50)***	21.48 (3.81)***	0.32 (1.33)	-4.90 (3.10)***	1.08 (2.28)**	-0.17 (0.67)
Drugs, pharmaceuticals & fine chemicals(10.0662)	-0.18 (1.78)*	-0.10 (0.97)	-0.05 (0.44)	-0.19 (1.72)*	13.09 (2.95)***	-1.74 (4.20)***	-0.45 (0.37)	0.50 (1.37)	0.61 (2.98)***
Dyes intermediates & coal tar chemicals(0.6989)	0.55 (2.35)**				11.46 (1.66)	0.10 (0.32)	-0.75 (0.39)	-0.42 (0.75)	0.15 (0.51)
Electronic goods(3.2080)	0.06 (0.63)				7.13 (3.05)***	0.20 (1.95)**	-0.38 (0.61)	0.32(1.68)	-0.01 (0.07)
Engineering goods(19.6536)	-0.10 (0.90)				-2.25 (0.79)	0.29 (2.02)**	0.88 (1.16)	1.08 (5.27)***	-0.29 (2.54)***
Ferrous and non-ferrous metal(5.6334)	0.11 (0.81)				-6.39 (1.48)	0.26 (1.47)	2.70 (2.36)**	0.21 (0.60)	-0.04 (0.23)
Floriculture products(0.0481)	-0.16 (1.25)	0.41 (3.16)***			-12.80 (4.38)***	0.16 (1.14)	1.84 (2.32)**	0.35 (1.49)	-0.65 (5.15)***
Footwear of rubber/canvas(0.0139)	-0.20 (0.59)	0.26 (0.76)	0.23 (0.71)	0.76 (2.26)**	-28.26 (3.91)***	-0.87 (2.87)***	0.20 (0.10)	3.17 (5.04)***	-1.91 (5.70)***
Fruits Fresh/Processe(0.1862)	-0.63 (2.21)**	0.38 (1.68)			10.75 (2.80)***	0.34 (2.05)**	-2.64 (2.52)***	1.27 (3.93)***	-0.02 (0.13)

Table 3.

Table III Continues

	Short-run coefficient estimates				Long-run coefficient estimates				
Commodities	**$\Delta LnVOL_t$**	**$\Delta LnVOL_{t-1}$**	**$\Delta LnVOL_{t-2}$**	**$\Delta LnVOL_{t-3}$**	**Constant**	**Dummy'08**	**LnY_{US}**	**LnREX**	**LnVOL**
Gems & jewellery(21.2637)	-0.28 (1.42)				0.24 (0.11)	-0.05 (0.52)	0.70 (1.22)	0.74 (4.25)***	-0.26 (2.76)***
Glass/glassware/ceramics/refractories/cement(0.5078)	-0.05 (0.42)				-6.01 (1.77)*	0.14 (0.86)	0.45 (0.49)	1.75 (6.93)***	-0.21 (1.47)
Handicrafts excluding handmade carpets(0.8416)	-0.05 (0.19)				-42.41 (2.47)***	-0.33 (0.45)	8.87 (1.80)*	1.40 (0.95)	-0.12 (0.14)
Inorganic/Organic/Agro-chemicals(2.4075)	-0.05 (0.43)				-1.38 (0.47)	0.34 (2.72)***	0.33 (0.42)	1.63 (6.81)***	0.04 (0.31)
Iron and steel(1.4778)	-0.07 (0.30)				-14.93 (2.27)**	0.13 (0.46)	5.96 (3.39)***	-1.56(2.92)***	0.08 (0.31)
Jute manufacture including floor coverings(0.2071)	-0.11 (0.97)				-7.83 (2.87)***	-0.44 (3.74)***	2.40 (3.32)***	-0.29(1.29)**	-0.22 (2.01)**
Leather & leather manufactures(1.6892)	0.13 (1.44)				-8.69 (2.45)**	-0.05 (0.36)	2.21 (2.34)**	0.84 (2.92)***	-0.14 (0.97)
Machine tools & hand tools(7.1402)	-0.15 (1.24)				-8.13 (2.15)**	0.43 (2.49)***	1.59 (1.66)	1.33 (4.65)***	-0.36 (2.24)**
Machinery & instruments(6.3930)	-0.02 (0.14)				-7.71 (1.93)*	0.69 (2.22)**	1.91 (1.86)*	1.00 (3.81)***	-0.27 (1.77)*
Manmade staple fibre(0.1490)	-0.04 (0.23)				2.73 (0.50)	-0.28 (0.74)	-0.92 (0.64)	1.37 (3.32)***	0.05 (0.17)

Table 3.

	Short-run coefficient estimates				Long-run coefficient estimates				
Commodities	**$\Delta LnVOL_t$**	**$\Delta LnVOL_{t-1}$**	**$\Delta LnVOL_{t-2}$**	**$\Delta LnVOL_{t-3}$**	**Constant**	**Dummy'08**	**LnY_{US}**	**LnREX**	**LnVOL**
Manufactured goods(83.4433)	-0.09 (1.31)				1.96 (1.44)	0.00 (0.04)	0.60 (1.59)	0.87 (7.73)***	-0.21 (3.53)***
Marine products(2.9549)	0.24 (1.61)				-22.01 (3.11)***	-0.69 (2.33)**	3.49 (1.84)*	2.34 (3.92)***	-0.35 (1.19)
Mica(0.0074)	0.02 (0.07)	0.51 (2.13)**	-0.59(2.44)**	-0.44(1.81)*	-12.97 (3.40)***	-0.53(3.18)***	3.45 (3.32)***	-0.70(2.11)**	-0.05 (0.28)
Misc. processed items(0.2335)	-0.11 (0.79)				14.59 (2.20)**	0.42 (1.46)	-3.30 (1.82)*	0.70 (1.26)	-0.22 (0.77)
Non-basmati rice (0.0526)	0.54 (2.21)**	-0.36 (1.49)	0.62 (2.57)***		-73.15 (5.98)***	-3.74 (4.33)***	17.34 (5.20)***	-0.28 (0.29)	0.39 (0.75)
Non-POL(95.0492)	-0.04 (0.64)				2.68 (1.30)	0.09 (0.92)	0.48 (0.85)	0.86 (5.09)***	-0.21 (2.43)**
Oilseeds(0.2345)	0.38 (1.43)				-9.76 (1.37)	-0.28 (0.84)	3.28 (1.68)*	0.52 (0.86)	0.41 (1.28)
Ores & minerals(0.6046)	-1.21 (1.64)	1.70 (2.66)***	0.99 (2.46)**		4.43 (0.26)	-0.54 (0.75)	-4.54 (0.90)	0.51 (0.25)	-2.34 (1.91)*
Other commodities(1.8138)	0.10 (0.34)	-0.14 (0.53)*	0.68 (3.06)***		27.98 (5.45)***	-0.08 (0.36)	-4.42 (3.03)***	-0.50 (1.10)	-0.07 (0.27)
Other manufactured goods(27.1923)	-0.36 (1.87)*				-1.24 (0.69)	-0.09 (1.18)	0.94 (1.87)*	0.85 (5.84)***	-0.28 (3.37)***

Table 3.

	Short-run coefficient estimates				Long-run coefficient estimates				
Commodities	**$\Delta LnVOL_t$**	**$\Delta LnVOL_{t-1}$**	**$\Delta LnVOL_{t-2}$**	**$\Delta LnVOL_{t-3}$**	**Constant**	**Dummy'08**	**LnY_{US}**	**LnREX**	**LnVOL**
Paints varnishes and allied products(0.2725)	0.01 (0.06)				3.72 (0.66)	-0.07 (0.29)	1.85 (1.22)	-2.17 (4.71)***	-0.03 (0.15)
Paper/wood products(0.9213)	-0.01 (0.14)				-3.19 (1.28)	-0.09 (0.83)	0.51 (0.75)	1.15 (5.70)***	-0.21 (1.99)**
Plastic & linoleum products(1.3346)	-0.22 (1.93)**				5.56 (1.33)	-0.04 (0.25)	-0.78 (0.70)	0.39 (1.14)	-0.28 (1.62)
Poultry and dairy products(0.1982)	-0.01 (0.02)				23.31 (1.86)*	-2.81 (3.69)***	-5.46 (1.65)	2.24 (2.48)***	0.39 (0.77)
Project goods(0.0294)	2.61 (2.32)**	1.25 (1.86)*	0.83 (1.41)	-0.98 (1.66)	-19.48 (1.02)	0.59 (0.63)	2.88 (0.57)	0.87 (0.46)	-0.39 (0.34)
Pulses(0.0296)	0.08 (0.14)	0.20 (0.34)	1.11 (1.98)**	1.16 (2.18)**	-52.10 (3.75)***	-3.16 (2.95)***	1.79 (0.48)	4.97 (4.78)***	-3.12 (5.43)***
Readymade garments(10.0757)	0.05 (0.67)	0.03 (0.38)	0.05 (0.74)	0.03 (0.43)	3.46 (1.62)	-0.45 (3.53)***	-0.36 (0.60)	0.60 (3.48)***	-0.45 (4.74)***
Rice (0.3298)	0.31 (1.54)	-0.71 (3.75)***			-21.33 (2.72)***	-1.06 (1.78)*	6.82 (3.29)***	0.04 (0.07)	0.72 (2.19)**
Rubber manufactured products(0.7725)	0.05 (0.59)				-2.67 (0.70)	-0.10 (0.64)	0.47 (0.46)	1.27 (4.18)***	-0.08 (0.54)
Sesame & Niger seeds(0.1353)	0.04 (0.24)	-0.37 (2.48)***	-0.27 (1.85)*		2.06 (0.72)	0.20 (1.62)	1.63 (2.13)**	-0.70 (2.90)***	0.40 (3.15)***

Table 3.

	Short-run coefficient estimates				Long-run coefficient estimates				
Commodities	**$\Delta LnVOL_t$**	**$\Delta LnVOL_{t-1}$**	**$\Delta LnVOL_{t-2}$**	**$\Delta LnVOL_{t-3}$**	**Constant**	**Dummy'08**	**LnY_{US}**	**LnREX**	**LnVOL**
Shellac(0.0229)	0.37 (0.91)				-21.17 (1.97)**	-0.45 (0.99)	3.68 (1.28)	0.91 (1.03)	-0.25 (0.55)
Spices(1.0528)	0.12 (1.07)	-0.15 (1.41)	-0.18 (1.69)*		-1.24 (0.22)	0.72 (2.54)***	2.18 (1.43)	0.02 (0.05)	0.41 (1.59)
Sports goods(0.1218)	-0.17 (1.04)	0.32 (2.13)**	-0.01 (0.06)	0.35 (2.35)**	-10.47 (4.97)***	0.04 (0.33)	1.20 (2.06)**	1.28 (7.33)***	-0.38 (3.99)***
Sugar & mollases(0.0231)	-0.18 (0.35)	-1.41 (2.81)***	-1.34 (2.64)***		-18.74 (1.85)*	-0.94 (-2.15)**	4.20 (1.52)	0.73 (0.87)	0.28 (0.63)
Tea(0.1743)	0.29 (2.17)**				9.04 (3.32)***	0.21 (1.78)*	-0.68 (0.90)	-0.07 (-0.33)	0.23 (1.92)*
Textiles (excluding readymade garments)(7.8522)	0.00 (0.01)				-8.75 (4.50)***	-0.19 (2.33)**	2.37 (4.60)***	0.80 (5.09)***	-0.27 (3.37)***
Tobacco(0.0790)	-0.01 (0.03)				-1.10 (0.17)	0.48 (1.87)*	0.86 (0.49)	0.03 (0.07)	0.02 (0.06)
Transport equipment(4.2620)	-0.16 (0.74)				7.03 (1.37)	0.09 (0.37)	-1.97 (1.46)	1.70 (4.75)***	-0.26 (1.32)
Vegetables Fresh/Processe(0.1583)	-0.30 (2.23)**				3.77 (0.88)	0.32 (1.74)*	-1.76 (1.53)	1.04 (3.01)***	-0.47 (2.67)***
Yarns, fabrics, madeups(5.5423)	0.02 (0.23)				-9.54 (4.70)***	-0.14 (1.64)	2.57 (4.79)***	0.80 (4.86)***	-0.21 (2.49)***

Notes: (a) Number inside the parenthesis are absolutes value of t-ratios next to the coefficient
(b) ***Indicates significance level at 1%
**Indicates significance level at 5%
*Indicates significance level at 10%

Source: Research finding.

Table 4. Diagnostic Statistic

Commodities	F-Test	ECMt-1	LM	RESET	CUSUM	CUSUMSQ	Adj. R2
Agricultural & allied products	1.35	-0.11 (3.81)	0.15	0.29	S	US	0.91
Alcoholic beverages	21.19***	-0.94 (12.26)	0.48	2.01	S	S	0.05
All commodities	5.81***	-0.41 (6.39)	0.88	1.39	S	S	0.86
Aluminium other than products	7.97***	-0.47 (7.15)	20.16***	0.21	US	US	0.86
Basmati rice	6.46***	-0.40 (6.60)	1.05	11.15***	S	S	0.77
Carpets	7.28***	-0.45 (7.21)	0.68	0.10	S	S	0.81
Cashew	4.32***	-0.18 (5.65)	0.62	10.81	S	S	0.85
Castor oil	32.76***	-1.22 (15.32)	0.95	3.95	S	S	0.32
Chemicals/Residual chemicals & related products	17.48***	-0.01 (1.06)	1.27	4.71	S	S	0.92
Coffee	6.07***	-0.53 (6.58)	0.81	1.56	S	S	0.62
Coir & coir manufactures	20.27***	-0.45 (7.07)	1.69	1.20	S	S	0.56
Cosmetics/toiletries	4.64***	-0.39 (5.76)	0.89	3.91	S	US	0.55
Drugs, pharmaceuticals & fine chemicals	16.68***	-0.38 (6.74)	1.81	3.96	S	S	0.91
Dyes intermediates & coal tar chemicals	5.76***	-0.62 (9.03)	5.16***	1.23	S	S	0.33
Electronic goods	9.33***	-0.49 (7.84)	1.11	0.08	S	S	0.41
Engineering goods	6.73****	-0.62 (7.00)	0.68	0.11	S	S	0.68
Ferrous and non-ferrous metal	13.59***	-0.46 (7.07)	0.94	0.02	US	US	0.54
Floriculture products	11.88***	-0.60 (9.22)	0.37	0.59	S	S	0.62
Footwear of rubber/canvas etc.	9.45***	-0.59 (8.22)	0.94	0.33	S	S	0.54
Fruits Fresh/Processed	5.38***	-0.49 (7.72)	0.19	4.16	S	S	0.68
Gems & jewellery	8.52***	-0.77 (8.06)	2.23	1.00	S	S	0.60
Glass/glassware/ceramics /refractories/cement	5.30***	-0.48 (7.13)	0.93	0.38	US	S	0.88
Handicrafts, excluding handmade carpets	4.43***	-0.25 (4.86)	0.91	0.03	S	S	0.84
Inorganic/organic /agrochemicals	8.00***	-0.50 (7.33)	5.02**	10.56***	US	US	0.87
Iron and steel	4.55***	-0.48 (5.60)	1.17	0.54	S	S	0.50
Jute manufacture including floor coverings	9.10***	-0.54 (7.80)	0.92	1.20	S	US	0.52
Leather & leather manufacture	4.73***	-0.30 (5.27)	1.26	0.80	S	S	0.82
Machine tools & hand tools	19.91***	-0.55 (8.64)	1.06	2.08	S	S	0.79
Machinery & instruments	7.31***	-0.49 (6.99)	1.14	0.43	S	S	0.75
Manmade staple fiber	3.29*	-0.42 (5.06)	1.62	0.03	US	US	0.73
Manufactured goods	6.79***	-0.65 (7.07)	1.85	0.27	S	S	0.80
Marine products	3.61**	-0.26 (5.06)	9.40***	1.21	S	S	0.91
Mica	16.53***	-0.83 (10.86)	1.25	0.99	S	S	0.23
Misc. processed items	4.50***	-0.26 (5.40)	10.98***	0.02	S	S	0.58
Non-basmati rice	4.23***	-0.31 (5.50)	0.71	2.80	S	S	0.88
Non-POL	5.87***	-0.43 (6.58)	0.97	1.01	S	S	0.80
Oilseeds	5.21***	-0.31 (6.20)	0.19	1.35	S	S	0.79
Ores & Minerals	4.07***	-0.29 (5.35)	0.38	1.47	US	S	0.74
Other commodities	3.40**	-0.37 (5.00)	0.45	0.00	S	S	0.76
Other manufactured goods	16.49***	-0.58 (7.70)	3.19	1.80	S	S	0.78
Paints varnishes and allied products	5.86***	-0.40 (6.58)	2.02	1.05	US	S	0.83
Paper/wood products	9.22***	-0.56 (8.36)	1.22	1.68	S	S	0.78
Plastic & linoleum products	4.39***	-0.34 (6.06)	10.32***	5.33	US	S	0.44

Commodities	F-Test	ECMt-1	LM	RESET	CUSUM	CUSUMSQ	Adj. R2
Poultry and dairy products	4.00**	-0.39 (7.33)	0.90	0.50	S	S	0.76
Project goods	2.58	-0.39 (4.35)	2.24	32.24***	S	S	0.31
Pulses	2.96	-0.32 (4.68)	1.42	1.20	S	S	0.88
Readymade garments	7.25***	-0.48 (7.20)	1.52	0.02	S	S	0.67
Rice	5.32***	-0.40 (6.23)	0.71	21.02	S	S	0.79
Rubber manufactured products	4.62***	-0.30 (5.34)	1.99	2.17	S	S	0.88
Sesame & niger seeds	8.16***	-0.67 (7.66)	1.10	1.01	S	S	0.45
Shellac	4.70***	-0.46 (5.63)	4.37***	1.94	S	S	0.34
Spices	3.78**	-0.26 (5.18)	0.50	0.94	S	S	0.78
Sports goods	12.43***	-0.97 (9.50)	3.16	4.88	S	S	0.76
Sugar & molasses	7.67***	-0.68 (7.57)	0.75	0.01	S	S	0.37
Tea	6.86***	-0.64 (6.76)	1.75	1.39	S	S	0.54
Textiles (excluding readymade garments)	7.92***	-0.51 (7.69)	2.90	0.32	US	S	0.81
Tobacco	5.76***	-0.62 (6.48)	0.92	0.76	S	S	0.40
Transport equipment	7.32***	-0.64 (7.10)	0.42	0.74	S	US	0.55
Vegetables Fresh/Processed	5.88***	-0.41 (6.76)	3.05*	0.00	S	S	0.43
Yarns, fabrics, made-ups	8.84***	-0.53 (7.71)	1.12	2.08	US	US	0.80

Source: Research finding.
Note:
(a) Numbers inside the parentheses in the ECM_{t-1} column are absolute t-ratio
(b) ***Indicates significance at 1% level, **indicates significance at 5% level, *indicates significance at 10% level
(c) The critical value of the F-test at 1%,5%, and 10% significance levels when k=5 is 4.15, 3.38, 3.
(d) The LM is a Lagrange Multiplier of residual correlation. It is distributed as Y^2 with one degree of freedom and critical values at 1%, 5%, and 10% levels are 6.63, 3.84, and 2.71.
(e) The RESET is Ramsey test for functional misspecification is also distributed as Y^2 with one degree of freedom and critical values at 1%, 5%, 10% level is 6.63, 3.84, 2.71.

Considering the linear export demand model (2), India's aggregate export (all commodities) to the US is insignificant. It shows no influence in the short-run and long-run exchange rate variability coefficient estimates. To avoid bias against aggregation, we pertain the result at a commodity-level of 60 exporting commodities of India exported to the US. The result obtained from the short-run estimates from 60 commodities is that there are 27 commodities with at least one significant coefficient (at a 10% significance level), resulting in the effect of exchange rate volatility in the short-run on export commodities. Although, the effect from the short-run carried into the long-run is only in 16 commodities being reported in Table 3. As can be seen from the result, for eight commodities, the estimated coefficient is significantly positive, while the remaining eight respond significantly negatively. As the export share is measured[3], only one commodity (other manufactured goods) with 27.19% is affected by the volatility of the exchange rate. Additionally, two significant commodities are positively affected by the exchange rate volatility, i.e., chemical-related products with 15.80% of the export share and drugs/pharmaceuticals with 10.06% of the export share. Also, the F-test reported in Table Ⅳ is found to be significant for the long-run estimates supporting the cointegration in the variables for all commodities except pulses, as its F-statistic lie in the intermediate range. Therefore the results are consistent with the finding of Bahmani-Oskooee and Baek (2016). Findings of Arize (2000) on seven countries and Yücel et al. (2019) on Turkey.

Thereafter, we observe the long-run effect of real exchange rate and US income in the export demand model Table 3, the exchange rate in 34 commodities is significant. While, in 7 commodities, their coefficient is negative, so if the currency depreciates, it will boost the export of these commodities, whereas, in 27, it is positive. The long-run coefficient of 25 commodities is significant, while 19 commodities have a significantly positive coefficient; results are corroborated by Arbabian et al. (2019) based on a symmetric assessment of Iran-China industrial trade flow volatility and Bahmani-Oskooee and Baek (2016) examine on US -Korea trade. Thus it explains that US economic activity is an essential player for most commodities as the F-statistic of these commodities is significant 4. The F-statistics calculated for the joint significance of lagged level variables is above the upper bound critical value of 2.08 in 56 commodities. For the remaining commodities, we apply the long-run coefficient from Equation 1 and generate the error-correction term, which is ECM. After that, the lagged-level variable is replaced by ECM_{t-1}in Equation 2 and estimates the model. Next, if ECM_{t-1}coefficient is significantly negative, it supports the cointegration into long-run equilibrium. As reported in Table 4, ECM_{t-1}coefficient is significantly negative in most models. Seemingly, the cointegration in most models is because of the strong relationship between the export of each commodity and US income.

Bringing the insight to other diagnostics, Table 4 also includes Lagrange Multiplier (LM) distributed just as χ^2 by 1 degree of freedom which checks the residual correlation of each estimated error-correction model, hardly significant signifying the auto-correlation free residuals. In addition, Ramsey's RESET test is applied to check for the model misspecification, also distributed as χ^2 with one degree of freedom. It is significant only in 3 commodities (more than the critical value of 6.6) out of 60 commodities. Also, we report the CUSUM, as well as the CUSUMSQ test presenting the stability of both long-run and short run coefficient estimates and specification, is found stable in most of the commodities. In Table 4, the CUSUM and CUSUMSQ are denoted as 'S' for the stable model and 'US' for the unstable model. We also include adjusted R^2 as presenting a measure of goodness of fit, as an observed majority of the models reported are a good fit.

Conclusion

The exchange rate volatility is a measure of the variability of the real exchange rate; it has both positive and negative effects on trade. In developing countries like India, the uncertainty is mainly imposed by the inflation rate. The main concern is exchange rate volatility which can harm or boost the decision of traders. As much literature recites, there are possible chances of trade to increase in some cases or no influence. Following that, comprehensive studies have been done for various countries- pair at disaggregate i.e. at an individual level of commodities to empirically test the impact of exchange rate volatility. This study contributes to the literature by examining bilateral trade between India-U.S. export trades for 60 commodities.

This study examines the exchange rate volatility measure by applying GARCH- the based model. Specifically, the model is employed on the real exchange rate, and monthly data series is used for the analysis. Further, encompassing all the commodities, we use a cointegration-based ARDL model for the empirical analysis. Many works of literature have predicted that exchange rate uncertainty negatively or positively affected trade but at an aggregate level and not at the individual level. This way, the prime focus of the study is to predict the same at a disaggregate level.

Regarding India's export performance, the results show that exchange rate volatility has both positive and negative effects on export performance with the US. Also, the long-run cointegration association is present among export commodities, destination country's income, exchange rate, and exchange rate volatility are supported by the error-correction term being statistically significant. To summarize, the exchange rate volatility impacts the trade flow showing the impact of the short run on 45% of export commodities, and these short-run effects carried to long-run in 16 commodities. It seems as if exchange rate volatility is a significant player in most commodities. Finally, it is observed that the economic condition has been a long-run causal influence for the majority of the commodities trading between the two nations.

Policy Implication

The finding of this study pursues the implications considering the policies of both the exchange rate and trade of the nation. From the hindsight of the results, reducing the risk and generating stability in the exchange rate anticipate augmenting Indian trade with its prime trading partner. Second, from the perspective of the government, it should provide trade credit in easy steps to the native businesses to hedge for long-term investment as it can productively attain higher export growth in the short-run and long run against the exchange rate volatility.

Disclosure Statement

The author announced no potential conflict of interest to research, publication or authorship.

Notes

1. The data span is constrained to the accessibility of data for the export commodities
2. For normalization and related concepts, see Bahmani-Oskooee and Tankui (2008).
3. Measured export shares are in the brackets alongside the name of each commodity in the tables.
4. As reported, the dummy variables coefficient is significant in 29 commodities which are nearly half of the total commodities, which also signifies that they were affected by the significant depression period majorly.

Appendix

Data Sources and Definition

Monthly data consisting of the period of 2004:M12 to 2019:M03 are used for the empirical investigation.

Database

1. The commodity-level data of bilateral trade between India and the US is extracted from the Economic Outlook database of the Center for Monitoring the Indian Economy (CMIE).
2. The aggregate monthly export price index for India: International Financial Statistics (IFS) database of IMF.
3. Nominal exchange rate: International Financial Statistics (IFS) database of IMF.
4. National income for the US is proxied by the aggregate industrial production index (IIP) as GDP is extracted from the Federal Reserve Bank of St. Louis (FRED).
5. The consumer price index (CPI) for India: International Financial Statistics (IFS) database of IMF.

Variable Definition

X_i^{IND} = It is a volume of commodity *i* exported by India. The export data is in dollars for each commodity. As the price level of each commodity is absent thereby, the aggregate export price index is used as the second-best deflator.

Y^{US}= It represents the United States income, measured using a proxy of aggregate industrial production index (IIP).

REX = It is a bilateral real exchange rate between Indian Rupee and the dollar: defined as (P_{IND}*NEX/P_{US}). NEX is nominal exchange rate; P_{IND} is CPI -price level in India; P_{US} is CPI-price level in the United States.

VOL = It represents the measure of the USD-IND real exchange rate.

See Table 5 for descriptive statistics.

Table 5. Descriptive Statistics of Variables

Variable	Mean	Maximum	Minimum	St. deviation	Skewness	Kurtosis
REX	3.9259	4.5279	3.4688	0.3051	0.3926	1.9383
IIP U.S	4.6147	4.7156	4.4587	0.0521	-0.8550	3.5371
VOL	-8.3191	-7.4603	-9.8432	0.5253	-0.7611	3.0603
All commodities	10.0780	10.5435	9.3260	0.2657	-0.2904	2.3735
Alcoholic beverages	0.7993	2.1850	-0.3503	0.5162	0.0193	2.6763
Agricultural & allied products	7.5577	8.8251	6.6539	0.5277	0.0456	1.9400
Aluminum other than products	2.8491	6.6588	-0.3080	2.4653	0.1502	1.3021
Basmati rice	4.0047	4.9239	1.7988	0.6688	-0.7941	2.9630
Carpets	5.8653	6.4468	5.1095	0.3483	-0.3105	2.0001
Cashew	4.9441	6.0142	2.0559	0.6405	-1.8351	7.4483
Castor oil	3.5691	5.2687	0.9849	1.0174	-0.7904	2.7063
Chemicals/Residual chemicals & related products	8.1311	8.8959	6.8500	0.4869	-0.3858	2.1067
Variable	**Mean**	**Maximum**	**Minimum**	**St. deviation**	**Skewness**	**Kurtosis**
Coffee	2.6261	4.0862	0.3862	0.7163	-0.5987	3.1128
Coir & coir manufactures	3.6798	4.5553	2.8901	0.3205	0.0194	3.2003
Cosmetics/toiletries	4.4875	6.5347	3.4596	0.3895	0.3728	6.5325
Drugs, pharmaceuticals & fine chemicals	7.6465	8.5417	6.1783	0.5604	-0.5028	2.2995
Dyes intermediates & coal tar chemicals	5.0860	6.0809	4.1997	0.3824	0.5078	2.8193
Electronic goods	6.6695	7.2711	5.8010	0.2060	-0.6601	4.6069
Engineering goods	8.4271	9.4464	0.3327	0.1836	0.1836	2.8401
Ferrous and non-ferrous metal	7.2084	7.8093	6.2696	0.2883	-0.5328	3.0222
Floriculture products	2.4763	3.5569	1.5748	0.3464	0.4318	3.3149
Footwear of rubber/canvas etc.	0.9745	2.9511	-0.4675	0.8392	0.1991	1.9525
Fruits Fresh/Processed	3.7348	4.5974	2.5105	0.4315	-0.4103	2.5639
Gems & Jewelry	8.5337	9.3934	7.5088	0.3061	-0.2142	3.3875
Glass/glassware/ceramics/ refractories/cement	4.6740	5.8043	3.6091	0.5092	0.1040	2.1746
Handicrafts, excluding handmade carpets	4.9739	6.3984	2.1060	0.9053	-0.3702	2.2859
Inorganic/organic/agrochemicals	6.1994	7.1964	5.0755	0.5529	-0.1033	1.8388
Iron and steel	5.7999	7.4121	4.3418	0.5678	0.2053	2.8525
Jute manufacture, including floor coverings	3.9487	4.6852	3.0019	0.2794	0.1662	3.5056
Leather & leather manufacture	5.9700	6.6970	5.2779	0.3563	0.0871	1.9619
Machine tools & hand tools	7.3892	8.2510	6.3763	0.3827	0.2418	3.0188
Machinery & instruments	7.3010	8.1079	6.3097	0.3435	0.0350	3.2576
Manmade staple fiber	3.4218	4.7020	1.3342	0.5927	-0.5446	3.0745
Manufactured goods	9.9031	10.3759	9.2049	0.2562	-0.0606	2.4069

Marine products	6.2250	7.8182	4.6073	0.8375	-0.0328	1.8324
Mica	0.5695	1.6108	-0.3294	0.4610	0.0137	2.2420
Misc. processed items	4.0058	4.7267	3.0218	0.3622	-0.2574	2.5022
Non-basmati rice	2.1281	4.5085	0.0000	1.0987	-0.8930	2.6861
Non-POL	10.0330	10.4750	9.3256	0.2543	-0.2014	2.3708
Oilseeds	3.8641	4.9969	2.1858	0.5837	-0.0354	2.3499
Ores & Minerals	4.6179	6.1936	0.0000	1.2071	-0.8224	3.0473
Other commodities	6.0674	7.6168	5.0296	0.4433	0.1832	2.3917
Other manufactured goods	8.7726	9.5698	7.8183	0.3058	-0.1818	3.0894
Paints varnishes and allied products	4.0809	5.2857	2.7854	0.7074	0.0277	1.5920
Paper/wood products	5.3493	6.0712	4.4341	0.3784	-0.1985	2.3382
Plastic & linoleum products	5.7954	6.5332	5.2241	0.2509	-0.0058	2.6870
Poultry and dairy products	3.3968	5.1084	0.7852	1.0427	-0.5433	2.3663
Project goods	0.6924	6.4414	-0.4675	1.2319	2.0841	7.3149
Variable	**Mean**	**Maximum**	**Minimum**	**St. deviation**	**Skewness**	**Kurtosis**
Pulses	1.5057	3.7784	-0.3759	1.1088	-0.0623	1.6607
Readymade garments	7.8379	8.2673	7.1349	0.1893	-0.5098	3.6808
Rice	4.1798	5.1005	1.7988	0.6787	-0.9336	3.5042
Rubber manufactured products	5.1374	5.9187	4.3030	0.4260	-0.0639	1.7440
Sesame & Niger seeds	3.4720	4.6023	2.1858	0.3279	-0.2394	5.7062
Shellac	1.4166	3.4413	0.0000	0.8118	0.1034	2.4563
Spices	5.4680	6.6605	4.2205	0.4184	-0.6855	3.2789
Sports goods	3.2839	4.6961	2.2352	0.4791	0.5650	3.0520
Sugar & molasses	1.0588	3.9927	-0.2917	1.0529	0.8068	2.8749
Tea	3.7294	4.5738	2.9160	0.3264	0.2348	2.7076
Textiles (excluding readymade garments)	7.5330	8.0375	6.7341	0.3001	-0.3608	2.2622
Tobacco	2.8977	4.1785	1.6350	0.4685	-0.0961	3.2294
Transport equipment	6.7789	9.0997	5.6609	0.5151	0.8906	4.6769
Vegetables Fresh/Processed	3.6545	4.6444	2.9355	0.2956	-0.1834	3.1275
Yarns, fabrics, made-ups	7.1715	7.6996	6.3488	0.3231	-0.3568	2.2227

Source: Research finding.

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