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Does Exchange Rates Swings Affect Trade? Evidence from an Emerging Open Economy

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ABSTRACT

The volatility of the exchange rate is commonplace for every open economies. If excessive, it would have severe implications for the country's international trades. Using the ARDL and cointegration bound tests on quarterly data (2000:Q2-2022:Q3), the study empirically explore how exchange rate volatility and other macroeconomic variables impacts real exports and imports demands for Nigeria. The evidence identify cointegration and the trade' parsimonious models disclose a negative as well as significant short run effects of the exchange rate volatility. The estimated convergence ECM regressions indicate that exchange rates volatility cause significant decline in real exports and imports in the long run. Under this circumstance, the study supposes measures that will curb fluctuations beyond economic fundamentals. In particular, monetary authority should expand periodic exchange rate intervention to curtail excessive swings. This should be maintained intuitively and regularly appraise to avoid creating any counter-productive response.

Keywords: Exchange Rate Volatility, International Trade, ARDL Model, Cointegration Bound Test, Parsimonious Model
JEL Classifications: H16, F41, F31, C1, C2

1. INTRODUCTION

The issue of international trade remains prominent for the expansion of global economies. Trade allows several countries to expand markets through access to domestically unavailable or non-comparatively produced goods as well as promote economic growth (Kock, 2021; Adekunle et al., 2022). Many countries that involve in cross-border trades are confronted with significant challenges including exchange rate fluctuations, inflation and demand shocks, from their trading partners. After the systemic monetary switched of exchange rate from fixed to flexible in 1973, the rates has been characterised by excessive swings and has instigate uncertainty among traders. The impact of exchange rate swings on trade depends on the trader's attitudes toward risk. Risk averse traders avoid trade in response to an increase exchange rate swing, but risk tolerant traders increase trade to reduce loss of future revenue (Broll and Eckwert, 1999). The implication for trade remains a contentious issue of continuous issues (Bahmani-Oskooee et al., 2016; Bao and Le, 2021; Bahmani-Oskooee and Arize, 2022).

Earlier theoretical postulations propose that exchange rate uncertainties either impede or promote trade. Some studies (Brodsky, 1984; De Grauwe, 1988; Gagnon, 1993; De-Vita and Abbott, 2004) suppose a negative impact on aggregate exports and imports. Other theories (Franke, 1991; Broll and Eckwert, 1999) argue that exchange rate volatility boost trade if firms respond timely to market changes. De-Vita and Abbott (2004) advance that exchange rate fluctuation reduce trade due to risk adverse trades. Higher swings lead to relative higher costs for risk averse traders and would decrease trade. Nicita (2013) notes that exchange rate volatility reduces trade due to associated transaction costs and uncertainties. Subjected data availability, the models have been empirical explore achieving different and inconsistent result for countries in emerging markets, Europe and the US (Bahmani-Oskooee et al., 2016; Thuy and Thuy, 2019; Bao and

Le, 2021; Bahmani-Oskooee and Arize, 2022; Lee et al, 2022; Li et al., 2022).

The volatility of the exchange rate is routine for Nigeria and has often elicit policy interventions. The country operates an open economy that relies on trades to advance sustainable growth (Adekunle et al., 2022). Since the 1980's, Nigeria has engaged in several reforms to liberalise the economy. As some point, regulators pursue to transform the regulated economy into a significant open one. This has resulted into increase in volume of imports and exports for over four decades. Successive exchange rate intervention by the Central Bank of Nigeria (CBN) have been a prominent component of foreign exchange policies. Despite such stabilisation response, there has been excessive swings in the exchange over two decades. The economy is confronted with incessant unstable exchange rates threatening trade gains. Examining the effects of exchange rate swings on trade is important because such could have significant impact on the reforms. If exchange rate volatility hurts trade, the export promotion will be endangered. Therefore, trade liberalization would lead to balance of payment crisis.

Some studies have examine the impact of exchange rate volatility on trade in Nigeria (Adubi and Okunmadewa, 1999; Alegwu et al., 2017; Ajinaja et al., 2017). Adubi and Okunmadewa (1999) show that exchange rate volatility affects agricultural trade flows. They argue that although exchange rates swings increase the prices of export crops, the overall effects would be a decline in exports. Ajinaja et al. (2017) examine the impact of exchange rate fluctuations on exports. The study finds that exchange rate volatility has positive impact on export performance. Alegwu et al. (2017) explore asymmetric effects of exchange rate volatility on agricultural exports. The study finds significantly different effects of real exchange rate volatility shock on export of cocoa, coffee, and rubber, except for cotton. These studies has limitations, and hence open gap for further investigations: they focus only on export and consider asymmetric effects by measuring exchange rates volatility based on generic heteroscedasticity models. In addition, they use exchange rate in its normal form.

Unlike previous studies, the study examines the effects of exchange rate volatility both exports and imports demands. The study deflects both trade measures by the consumer prices index in order to explore real exports and imports. This study therefore contributes to literature and closes identified gaps. In addition, the backward-looking or historical volatility measure is applied rather than the asymmetric measures. Historical volatility is obtained using the standard deviation of quarterly log return of exchange rates (Boyte-White, 2020). The study considers the long-run relation between trade and exchange rate volatility. Reminder part is organized as follows: Section II presents empirical literature. Section III describes the methodology and specify the models. Section IV presents the results. Section V concludes.

2. LITERATURE REVIEW

Different research have assess the impact of exchange rate volatility on trade flows. Some, including Sauer and Bohara (2001), Bahmani-Oskooee and Gelan (2007), Bahmani-Oskooee and Mitra (2008), Hooy and Choong (2010), Palamalai and Kalaivani (2013), Serenis and Tsounis (2014), Yanamandra (2015), Bahmani-Oskooee et al. (2016), Chaudhry and Yuce (2019), Thuy and Thuy (2019), Bao and Le (2021), Bahmani-Oskooee and Arize (2022), Lee et al. (2022) and Li et al. (2022), apply aggregates firm-level trade or cross-countries trade and the results of their investigations is mixed, and sometimes inconsistent with sample adjustments.

Sauer and Bohara (2001) use panel approach to examine 25 countries and find a negative and significant effect of exchange rate volatility on trade performance. Bahmani-Oskooee and Gelan (2007) studies the how exchange rate volatility impacts imports of member countries of the West African Monetary Union. Using pooled import volume, the findings establish adverse but insignificant effect of volatility on imports. Bahmani-Oskooee and Mitra (2008) disaggregate trade flows based on industry, and consider how volatility affect trade relationship between India and the U.S. They examine how both exports and imports of 40 industries respond to exchange rate volatility. The study identify both negative and positive implication of volatility in 40% of the sampled industries only in the short run.

Hooy and Choong (2010) concentrate on trade flows between India and Asian partners. They reveal that for each trading partner, the exchange rate volatility has positive effects on exports. Musila and Al-Zyoud (2012) access the links between trades and exchange rates volatility in Africa for the period 1998-2007. The elasticities from the estimated gravity model indicates little responsiveness of trade to fluctuation in the exchange rate volatility. They argue that eliminating exchange rates change would have only small increments effects on trade flow. Palamalai and Kalaivani (2013) examine how exchange rate volatility affects real exports in India between 1970 and 2011. The findings show that exchange rate volatility has adverse and significant impacts on real exports in the short-run. There is long-run equilibrium between real exports and exchange rate volatility, real exchange rate, Gross Domestic Product (GDP) and foreign economic activity. Serenis and Tsounis (2014) investigate how exports of Malawi, Morocco, and South Africa respond to exchange rate volatility from 1973 to 1990. The study confirms negative and significant effects for all three countries.

Chamunorwa and Choga (2015) examine relationship between exchange rate volatility and export in South Africa from 2000 to 2014 using the GARCH. The result reveals that exchange rate volatility wields negative but significant impact on exports. Yusoff and Sabit (2015) use the Generalized Method of Moments (GMM) to examine how real exchange rates, exchange rate volatility and real GDP affect ASEAN's member bilateral exports to China from 1992 to 2011. The results show exchange rate volatility has a negative effect on ASEAN exports to China and the real exchange rate has positive impact on the exports to China. Safuan (2017) uses both aggregate and disaggregated data to investigate exchange rate volatility influence on exports of Indonesia to China, Japan and the US. Using the seemingly unrelated regression on data from 1996 to 2014. The results reveal that exchange rate volatility wields a negative impacts on exports. Senadza and Diaba (2017) use dynamic heterogeneous panel technique to examine 11 African economies. The study finds that volatility has no significant effect on African imports, but find volatility hurts trade in the short-run, but boost trade over the long-run.

Chaudhry and Yuce (2019) examine the effect of exchange rate volatility on trade relationship US and Canada, exports to (USA) using use the ARDL cointegration approach. The findings indicate that exchange rate volatility had significant adverse impact on total exports, total imports and exports to the USA, but insignificant effects with Canadian imports from the USA. The results also reveal the absence of long-run relationship between exchange rate volatility and exports from the USA, exports of Canada, total imports from and imports to the USA. Thuy and Thuy (2019) reveal that exchange rate volatility negatively affects total exports volume of in Vietnam in the long run. Consistent with the J-curve effect, while exchange rate depreciation has positive influence on export in the long-run, the real foreign income and exchange rate volatility exerts a negative impact on exports in the short-run.

Bahmani-Oskooee and Saha (2020) examine impact of exchange rate volatility on India's bilateral exports to and imports from 14 largest trading partners. The study finds short-run asymmetric effects that transform into the long-run asymmetric effects in about half of the sample. The increase volatility has positive and significant effects on India's exports to China but the decrease in real rupee-yuan volatility has no effects. The increase in rupee-dollar volatility has positive long-run effects on both the export to and imports from the US but decrease in volatility is inconsequential. Bao and Le (2021) Note that USD/VND movements affect not only Vietnam-USA but also Vietnam-UK and Vietnam-EU trades. They investigate how bilateral and vehicle currency exchange rates asymmetrically impact bilateral trade of Vietnam with the UK and EU-27 countries. The results indicate the significant of both short-run and long-run coefficients, hence suppose the importance of USD as vehicle currency.

Bahmani-Oskooee and Arize (2022) explore the symmetric and asymmetric effects of exchange rate volatility on trade flows between the U.S and African countries. The results confirmed long-run asymmetric impact of exchange rate swings of U.S. exports to 15 countries and U.S. imports from 12, as well as discovered significant asymmetric short-run impact of exchange rate fluctuation on U.S. exports to and imports from 20 of the countries. Lee et al. (2022) apply nonlinear ARDL on disaggregated to examine the influence of exchange rate volatility on trade of United States and China, during 2003 to 2020. The result confirms that increase volatility motivates U.S. exports to and imports from China. Li et al. (2022) supposes that exchange rate volatility hurts the Chinese import trade from 2000 to 2006. The result identify indicates that volatility has negative impacts on intermediate inputs imports, which is particularly adverse for with greater financial vulnerability.

3. METHODOLOGY

3.1. Methods

The cointegration bound tests and autoregressive distributed lag (ARDL) models are employed (Palamalai and Kalaivani, 2013; Chaudhry and Yuce, 2019; Thuy and Thuy, 2019; Subanti et al., 2019). The Bound test is admissible under the log transformation of the variables (Mills, 2019). Assume y_t (x_t) is the dependent (independent) variables, the study completes the Augmented-Dickey-Fuller (ADF)'s unit root test under the null of non-stationarity, to verify the stochastic property of the data generating process. If d is order of integration, each variable is denoted as I(0), I(1) and I(d) for level, first difference and d-difference order of stationarity.

Before conducting cointegration test, the study initially imposed a maximum of eight lags on each log transformed variable and select an optimum model based on the Akaike's Information Criterion (AIC). Bound test (Pesaran et al., 2001) confirms cointegration relationship among variables. Under the null of no cointegration, the test linearly combines the $l(0)$ and $l(1)$ series and estimate the convergence (ECM) based on a reparameterised model. The test computes F-statistic [F_m], which is compared with critical value bound (C.V.B.). Pesaran et al. (2001) propose Upper [U_b] and lower [L_b] C.V.B. consistent to polar cases of purely $l(0)$ or $l(d)$ variables. The null is rejected if $F_m > U_b$.

The study presents the over-parameterised ARDL (i.e., short run) and ECM or cointegrating convergence (i.e., long run) models. The general $ARDL\ (p,s_1,\ldots,s_m)$ model that shows how, y_t is explained by its own pasts y_{t-i} and current, x_t and past, x_{t-i} of regressors:

$$y_t = \beta_0 + \sum_{j}^{m}\beta_j x_{j,t} + \sum_{i=1}^{p}\varphi_i y_{t-i} + \sum_{j}^{m}\tilde{\beta}_{j,i} x_{j,t-i} + a_t \qquad (1)$$

$\tilde{\beta}_{j,i}$ is polynomial lag $\tilde{\beta}_j(B) = -\sum_{l=i+1}^{S_j}\beta_{j,l}$; $\hat{\beta}_j = \hat{\beta}_{j,0} + \ldots + \hat{\beta}_{j,s_j}$

$\hat{\beta}_j = \hat{\beta}_{j,0} + \ldots + \hat{\beta}_{j,s_j}$ and $\varepsilon_t = \varphi^{-1}(B)\,a_t$. The study eliminates most non-significant variables and present the parsimonious model. Both Wald (under null of insignificant variables) and redundant variables LR tests are conducted to reduce the over-parameterised to parsimonious model. The ARDL is transformed to add the ECM $ec_t = y_t - \theta_0 - \sum_{j=1}^{m}\theta_j x_{j,t}]$ for the cointegrating regression.

$$\Delta y_t = \beta_0 + \sum_{j=1}^{m}\varphi_i^{*}\Delta y_{t-i} + \sum_{j=1}^{m}\beta_j x_{j,t-i} + \sum_{j=0}^{m}\gamma_{j,i}\Delta x_{j,t-i} - \mu ECM_{t-1} + \varepsilon_t \qquad (2)$$

Equation (2) expresses the current change in the endogenous variable (Δy_t) as a linear function of current change in exogenous variable (Δx_t) and a proportion of the previous error from the long-run "equilibrium" (ECM_{t-1}). The absolute value of μ indicates the speed of adjustment. The estimator ($\hat{\theta}_j = \hat{\beta}_j / \left(1 - \Sigma_{i=1}^{p}\hat{\varphi}_i\right)$] gives the coefficients of the long-run relationship of the parsimonious ARDL. Lastly, since ARDL comprises of $l(1)$ variable(s), it is required to check for model diagnostic heteroscedasticity, serial correlation, normality and Stability of long-run estimates using

Table 1: Basic statistics and unit root tests

Variable	Statistics		Jarque-Bera		Correlation coefficients									Stationarity tests		
Z_t	μ	σ	*JB*	*Prob.*	$EXPT_t$	$IMPT_t$	ERV_t	$RESV_t$	GDP_t	$M2_t$	$OILP_t$	INF_t	ASL_t	Level	Diff.	Remark
$EXPT_t$	1.540	0.292	11.40*	0.003	1									−2.36	−9.10	I (1)
$IMPT_t$	1.515	0.296	49.25*	0.000	0.84	1								−3.32	−18.0	I (1)
ERV_t	0.002	0.001	26.53*	0.000	0.38	0.46	1							−3.28	−10.2	I (1)
$RESV_t$	0.000	0.001	1263*	0.000	−0.19	−0.18	−0.04	1						−7.30	−10.3	I (0)
GDP_t	2.120	0.181	2.440	0.295	−0.73	−0.86	−0.51	0.10	1					−2.86	−4.98	I (1)
$M2_t$	6.957	0.498	12.63*	0.000	−0.71	−0.87	−0.54	0.11	0.98	1				−1.59	−10.3	I (1)
$OILP_t$	1.778	0.217	14.88	0.003	0.04	−0.33	−0.27	−0.07	0.55	0.60	1			−2.26	−8.98	I (1)
INF_t	1.079	0.151	44.16	0.000	−0.23	−0.17	−0.07	0.16	0.04	0.01	−0.27	1		−3.99	−7.04	I (0)
ASI_t	4.416	0.205	12.85*	0.002	−0.33	−0.55	−0.13	0.00	0.67	0.69	0.70	−0.27	1	−2.68	−8.34	I (1)

μ ≡ Mean, σ ≡ Standard deviation, Diff: First Difference of each Z_t. The Pearson ordinary correlation coefficients (r_{z1z2}) accruals quality and their components pairs Z_i and Z_j having n-set …, ($z_{1,n}$, $z_{2,n}$)] with $r_{z1\,z2} = \sum_i^n (z_{1,t} - \bar{z}_1)(z_{2,t} - z)\left[\sqrt{(z_{1,t} - \bar{z}_1)^2}\sqrt{(z_{2,t} - z)^2}\right]^{-1}$, which lie between –1 and+1. *,**,*** indicates statistical significance using probability, $P|t|=0$, at 1%, 5% or 10% levels. The test statistics (τ^{μ}) indicate that rejection of the null of non stationarity for *RESVt* and *INFLt* [τ^{μ} >ADFα] at level, for the test equation. All other series are stationary trend at first difference

the cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ).

3.2. Empirical Models

The study analyses how trade is explained by erratic swings in exchange rate. The volatility effects is examined on real export, $EXPT_t$ (3) and real import, $IMPT_t$ (4) functions. Some studies (Yanamandra, 2015; Bahmani-Oskooee et al., 2016; Chaudhry and Yuce, 2019; Thuy and Thuy, 2019; Bao and Le, 2021; Bahmani-Oskooee and Arize, 2022), use variables including ($EXPT_t$) exchange rate volatility (ERV_t), foreign reserve volatility (*RESVt*), real GDP (*GDPt*), broad money supply ($M2_t$), oil price ($OILP_t$), inflation rate (INF_t) and shares price index (ASI_t), each of which is in its log scaled form.

$$EXPT_t = f(ERV_t, RESV_t, GDP_t, M2_t, OILP_t, INF_t, ASI_t) \quad (3)$$

$$IMPT_t = f(ERV_t, RESV_t, GDP_t, M2_t, OILP_t, INF_t, ASI_t) \quad (4)$$

Like the regressors, $EXPT_t$ and $IMPT_t$, hence (3) and (4) are double log equations supposing the estimates are interpreted as percent change. In computing the volatility measures (ERV_t and $RESV_t$), the study applies the backward-looking approach. Such volatility measures that serve as guide for investors and analysts (Adkins, 2019; Boyte-White, 2020) compute historical volatility for the variable using the standard deviation of its daily returns. Because daily data are reported for both variables, computing quarterly estimates of volatility from the daily high-frequency data limits approximation errors. The exchange rate volatility for each quarter (ERV_t) is then defined:

$$XV_t = \sum_{t=1}^{n}\left[(XR_t - \overline{XR})/n\right]^2 \quad (5)$$

Where $XR_t = (XR_{d,t}/XR_{d,t-1})$] and $[\overline{XR} = \sum_{t=1}^{m} XR_{d,t}/m]$, respectively, are the returns and mean returns of $X_{d,t}$ [i.e., exchange rates, ($EXR_{d,t}$) and foreign reserves ($RES_{d,t}$)] based on the daily values. Where *m* is 63 day horizon for each quarter, and *n* = 90 is the number of quarters in the sample periods.

3.3. Data

The study use quarterly data from 2000Q2 to 2022Q3. Because of the need to log transform the variables, the year 2000Q, a period of negative inflation, is avoided. The data are sourced from CBN database. The exchange rate used is the nominal USD/NGN rate that averages the reported buying and selling rates. The exports and imports values are deflated with the corresponding reported composite consumer price index (November 2010 = 100) to compute the real exports and real imports ($IMPT_t$). The shares price index is employed to proxy for business sentiments. The Inflation rates (based on the 12 months average change) for all items is used.

4. RESULTS

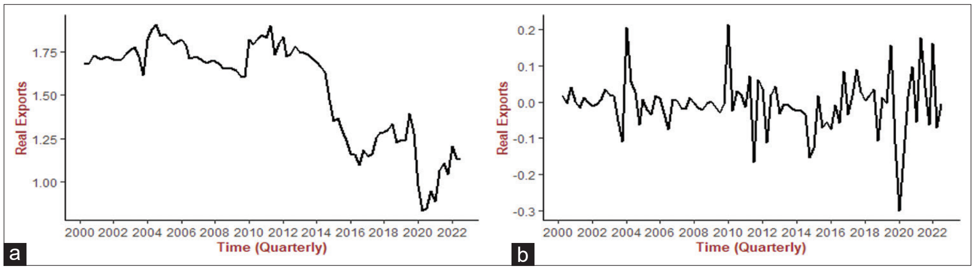
4.1. Preliminary Information

Table 1 presents the preliminary information of the variables, including the basic statistics, Pearson correlation coefficients and unit toot test results. Exchange rate volatility signifies a high correlation with both real exports and imports. Except for real GDP, the Jarque-Bera (J-B) value is significant for all, rejecting the normality null for each series. There is high correlation between real exports and real GDP as well as between real import and real GDP, real import and shares price index. (Figures 1a-9a and 1b-9b) depict the times series plots of the log transformation (log difference) for the variables.

4.1.1. Time Series Plots of Models' Variables

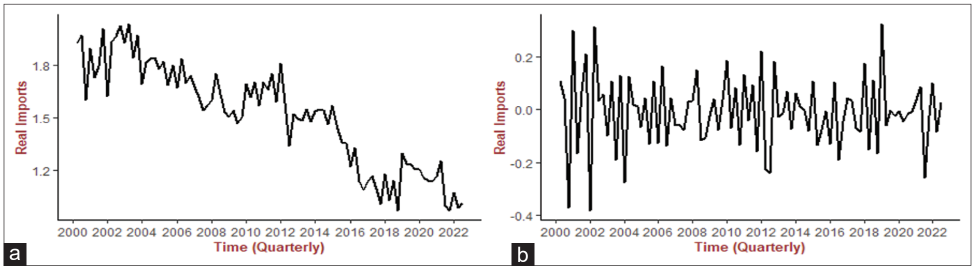
According to the ADF tests, only reserve and inflation rates are stationary, others are differenced stationary. Because the variables are integrated of different order, cointegration bound test is conducted to confirm existence of equilibrium relation. The AIC selects an optimal lag of 3 (Table 2). The bound tests (Table 3) reject the null of no cointegration at 5% significance in real exports and imports test equations. Since equilibrium relationship exists between export and the regressors as well as between real imports and regressors, (Tables 4 and 5) presents estimates of the ARDL model for real Exports (Imports). Panel A reports the over parameterised regression based on the optimal lag, Panel B presents the Wald and Redundant

Figure 1: (a and b) Real exports



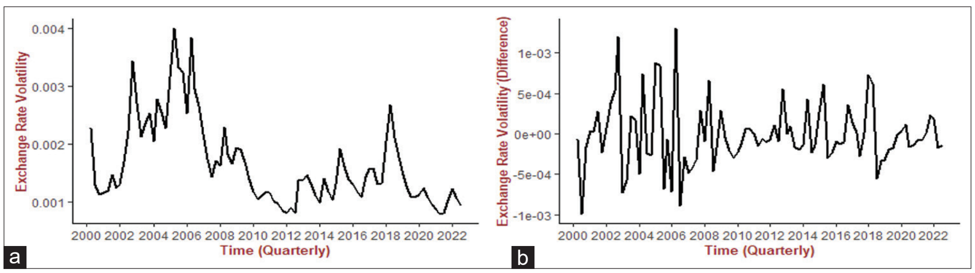
Source: Author (2022)

Figure 2: (a and b) Real imports



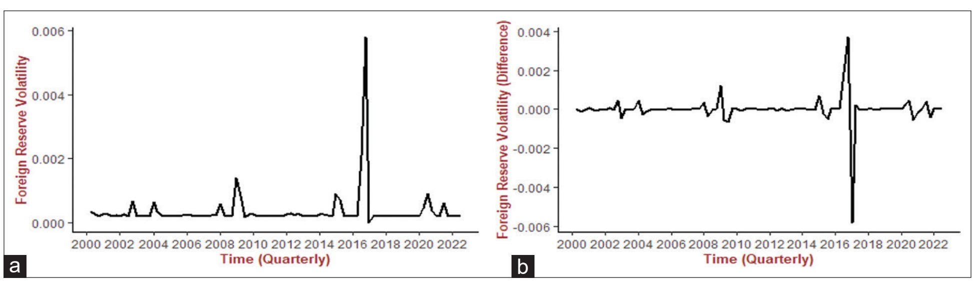
Source: Author (2022)

Figure 3: (a and b) Exchange rate volatility



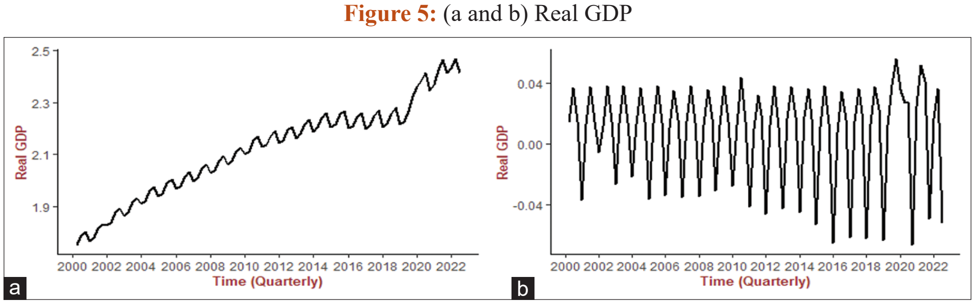
Source: Author (2022)

Figure 4: (a and b) Foreign reserve volatility



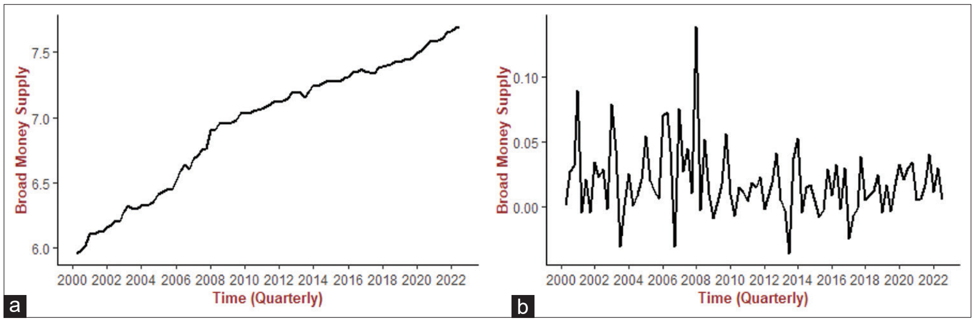
Source: Author (2022)

Figure 5: (a and b) Real GDP



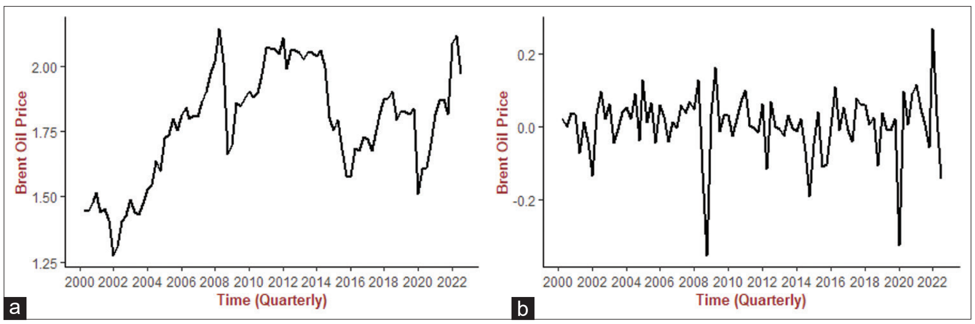
Source: Author (2022)

Figure 6: (a and b) Broad money supply



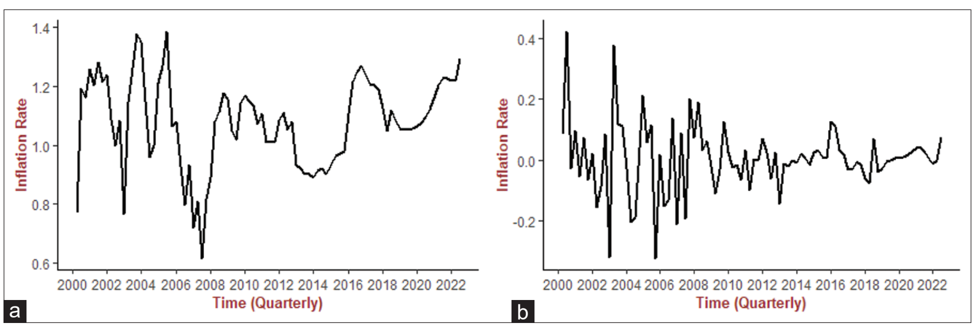
Source: Author (2022)

Figure 7: (a and b) Brent oil price



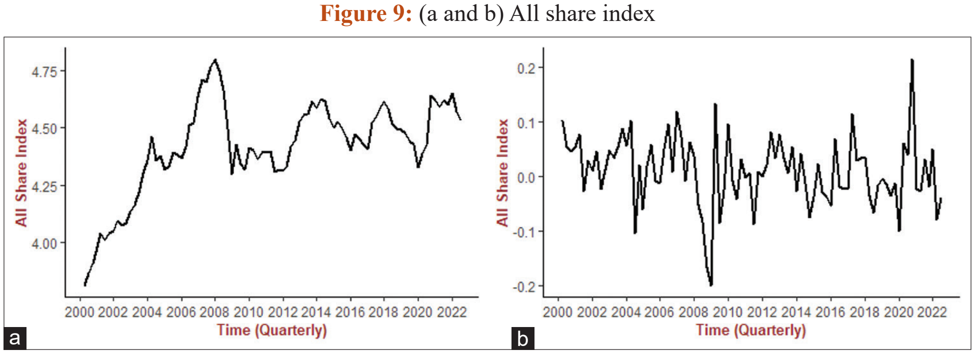
Source: Author (2022)

Figure 8: (a and b) Inflation rate



Source: Author (2022)

Figure 9: (a and b) All share index



Source: Author (2022)

Variable LR tests, and Panel C reports the Parsimonious short run estimates.

Based on the AIC optimal lag, the study estimates the over-parameterised model and conduct the coefficient restrictions tests for the non-significant coefficients. The result shows that only reserve volatility, money supply lags and share price index are insignificant. Using Wald test, the study fails to reject the null that all insignificant estimates equal zeros [i.e., $H_0 : \beta_2 = \tilde{\beta}_{4,1} = \tilde{\beta}_{4,2} = \beta_7 = 0$] for real exports function. The null

[$H_0 = \tilde{\beta}_{4,2} = \tilde{\beta}_{4,3} = \tilde{\beta}_{5,1} = \tilde{\beta}_{7,1} = 0$] is rejected as well for the real imports ARDL model. The redundant variable LM tests indicate that the null cannot be rejected for the real exports and imports models, supposing to modify the over-parameterised model (Panel A) to a parsimonious one (Panel C).

Table 2: Lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
$EXPT_t$						
0	1321.2	NA	0.000	−32.03	−31.80	−31.94
1	1812.9	875.41	0.000	−42.46	−40.34*	−41.61
2	1855.9	68.20	0.000	−41.95	−37.96	−40.35
3	1927.5	99.52	0.000	−42.13	−36.26	−39.78
4	2007.9	76.58	1.9e−9*	−47.69*	−32.72	−41.18*
$IMPT_t$						
1	1746.2	NA	0.000	−41.03	−39.1*	−46.2*
2	1811.2	104.59	0.000	−41.05	−37.30	−39.54
3	1883.1	101.71	0.000	−41.25	−35.61	−38.98
4	1969.2	104.99	0.000	−45.3*	−30.34	−39.33

Table 3: Cointegration bound tests

Dependent	Test statistics	C.V.	Significance		
Variable [y_t]	F-stat.	Bounds	10%	5%	1%
*EXPT*t	3.567	I (0) Bound	2.03	2.32	2.96
		I (1) Bound	3.13**	3.50**	4.26
$IMPT_t$	3.805	I (0) Bound	2.03	2.32	2.96
		I (1) Bound	3.13**	3.50*’	4.26

*, **, *** indicates statistical significance at 1%, 5% or 10%. Since 3.567 [3.805] > Upper C.V.B, the test rejects the null of no cointegration between real Exports [Imports] and regressors at 5% significance. Source: Author (2022)

4.2. Short-and Long-Run Volatility Impacts

The models confirm the existence of a negative and significant short run effect volatility effects. Consistent with previous studies (Chaudhry and Yuce, 2019; Subanti et al., 2019), the parsimonious model indicates that exchange rate swings depresses real trades. The volatility clustering transmit their effect in past and current periods causing instability in the real exports and imports. The magnitude of percent decline would be higher for the real exports (−5.25) relative to the real import imports (−2.64). Except for foreign reserve volatility, the current and pasts influence of all variables of the parsimonious short-run model for the real export are rightly signed and significant, causing short run deviation in real export. The persimmons real import models indicates that except for the current and pasts of foreign reserves volatility, as well as money supply, all regressors significantly explain real imports. All variables are significant at 5% level, except for business condition which is weakly significant at 10%.

Tables 6 and 7 presents the export [import] cointegrating form estimates, while Table 8 presents the long run coefficients for the exports [Panel A] and imports [Panel B]. Consistent with previous studies (Thuy and Thuy, 2019), the convergence real exports and

Table 4: Short run EXPT models

Variable	Panel A: Over parameterised model				Panel C: Parsimonious model			
y_t	Est.	Coeff.	S.e.	Prob.	Est.	Coeff.	S.e.	Prob.
$EXPT_{t-1}$	φ_1	0.606	0.065	0.000	φ_1	0.663	0.059	0.000*
ERV_t	β_1	−6.571	2.063	0.000	β_1	−5.250	1.076	0.000*
$RESV_t$	β_2	10.39	10.52	0.327	β_2	8.939	10.75	0.408
GDP_t	β_3	−0.336	0.172	0.055	β_3	−0.315	0.176	0.078***
$M2_t$	β_4	−0.684	0.281	0.017	β_4	−0.607	0.224	0.008*
$M2_{t-1}$	$\tilde{\beta}_{4,1}$	−0.158	0.339	0.643				
$M2_{t-2}$	$\tilde{\beta}_{4,2}$	−0.099	0.336	0.770	$\tilde{\beta}_{4,2}$	0.443	0.207	0.036**
$M2_{t-3}$	$\tilde{\beta}_{4,3}$	0.733	0.261	0.006				
$OILP_t$	β_5	0.463	0.077	0.000	β_5	0.394	0.065	0.000*
INF_t	β_6	0.180	0.057	0.003	β_6	0.193	0.052	0.000*
ASI_t	β_7	−0.013	0.068	0.846				
Const.	β_0	2.018	0.457	0.000	β_0	1.610	0.333	0.000*
Test		Statistics						
$\bar{R}^2$		0.948				0.959		
F-stat.		176.7				229.5		
Prob (F-stat.)		0.000*				0.000*		
DW		1.980				1.983		
Panel B: Wald and redundant variable LR tests								
Wald test								
F-stat.			0.4941	0.8108				
x^2-stat.			2.9646	0.8133				
LR test								
F-stat.			0.2164	0.9285				
$\bar{R}^2$			0.9591					

The null for the Wald test is that the insignificant coefficients equal zeros $[H_0: \beta_2 = \tilde{\beta}_{4,1} = \beta_7 = 0]$. The test is non-significant [Prob (F) = 0.8108>0.05], indicating the null holds. The null for the Redundant Variable LR Test is that the insignificant variables are redundant, hence, do not contribute to the exploratory power ($\bar{R}^2$) of the models. Since $\bar{R}^2$ (=0.9591) of the test equation is higher than that ($\bar{R}^2$ =0.948) of the over-parameterised model [and Prob (F) = 0.9285>0.05], the test is insignificant and the null holds. *, **, *** indicates statistical significance at 1%, 5% or 10%.Source: Author (2022)

Table 5: Short run IMPT models

Variable	Panel A: Over parameterised model				Panel C: Parsimonious Model			
y_t	Est.	Coeff.	S.e.	Prob.	E_{st}.	Coeff.	S.e.	Prob.
$IMPT_{t-1}$	φ_1	0.222	0.099	0.028	φ_1	0.204	0.091	0.029**
$IMPT_{t-2}$	φ_2	0.502	0.092	0.000	φ_2	0.515	0.088	0.000*
ERV_t	β_1	−4.606	2.230	0.021	β_1	−2.641	1.232	0.024**
$RESV_t$	β_2	−17.67	16.23	0.280	β_2	−19.70	15.53	0.210
$RESV_{t-1}$	$\tilde{\beta}_{2,1}$	−37.32	17.11	0.033	$\tilde{\beta}_{2,1}$	−36.30	16.46	0.031**
$RESV_{t-2}$	$\tilde{\beta}_{2,2}$	28.84	16.96	0.094	$\tilde{\beta}_{2,2}$	25.47	16.05	0.117
GDP_t	β_3	−1.158	0.382	0.004	β_3	−1.186	0.353	0.001*
GDP_{t-1}	$\tilde{\beta}_{3,1}$	0.826	0.384	0.035	$\tilde{\beta}_{3,1}$	0.847	0.360	0.022**
$M2_t$	β_4	−0.565	0.465	0.229	β_4	−0.633	0.437	0.152
$M2_{t-1}$	$\tilde{\beta}_{4,1}$	1.472	0.520	0.006	$\tilde{\beta}_{4,1}$	1.372	0.436	0.003*
$M2_{t-2}$	$\tilde{\beta}_{4,2}$	−0.432	0.514	0.404				
$M2_{t-3}$	$\tilde{\beta}_{4,3}$	0.366	0.519	0.483				
$M2_{t-4}$	$\tilde{\beta}_{4,4}$	−0.821	0.409	0.049	$\tilde{\beta}_{4,4}$	−0.721	0.247	0.005*
$OILP_t$	β_5	0.457	0.131	0.001	β_5	0.450	0.098	0.000*
$OILP_{t-1}$	$\tilde{\beta}_{5,1}$	−0.011	0.177	0.951				
$OILP_{t-2}$	$\tilde{\beta}_{5,2}$	−0.572	0.183	0.003	$\tilde{\beta}_{5,2}$	−0.555	0.148	0.000*
$OILP_{t-3}$	$\tilde{\beta}_{5,3}$	0.251	0.144	0.087	$\tilde{\beta}_{5,3}$	0.223	0.133	0.099***
INF_t	β_6	−0.215	0.086	0.016	β_6	−0.220	0.083	0.010**
ASI_t	β_7	−0.554	0.190	0.005	β_7	−0.516	0.140	0.000*
ASI_{t-1}	$\tilde{\beta}_{7,1}$	0.066	0.245	0.790				
ASI_{t-2}	$\tilde{\beta}_{7,2}$	0.517	0.239	0.034	$\tilde{\beta}_{7,2}$	0.522	0.215	0.018**
ASI_{t-3}	$\tilde{\beta}_{7,3}$	−0.359	0.192	0.067	$\tilde{\beta}_{7,3}$	−0.329	0.183	0.07***6
Const.	β_0	2.407	0.743	0.002	β_0	2.447	0.717	0.001*
Test			Statistics					
$\bar{R}^2$		0.911				0.915		
F-stat.		40.49				51.85		
Prob (F-stat.)		0.000*				0.000*		
DW		1.998				1.997		
Panel B: Wald and redundant variable LR tests								
Wald Test								
F-stat.		0.836		0.546				
x^2-stat.		5.019		0.541				
LR test								
F-stat.		0.836		0.546				
$\bar{R}^2$		0.915						

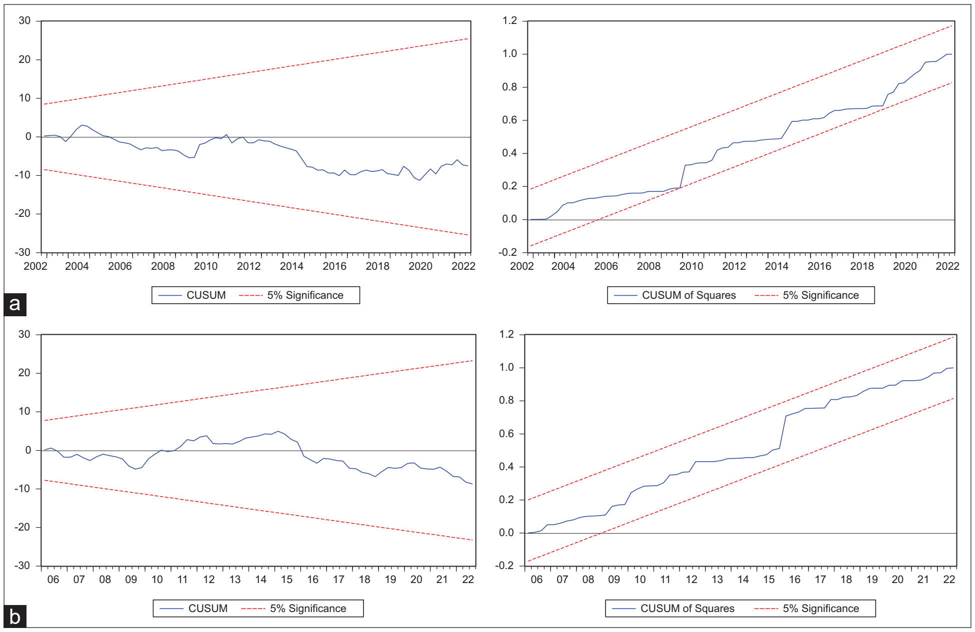
The null for the Wald test is that the insignificant coefficients equal zeros [$H_0:\tilde{\beta}_{4,2}=\tilde{\beta}_{4,3}=\tilde{\beta}_{5,1}=\tilde{\beta}_{7,1}=0$] . The test is non-significant [Prob (F) = 0.546 > 0.05], indicating the null holds. The null for the Redundant Variable LR Test is that the insignificant variables are redundant, hence, do not contribute to the exploratory power ($\bar{R}^2=0.911$) of the models. Since $\bar{R}^2$ (= 0.915) of the test equation is higher than that of the over-parameterised model [and Prob (F) = 0.546 > 0.05], the test is insignificant and the null holds. *, **, *** indicates statistical significance at 1%, 5% or 10%. Coeff. – Coefficient; Est. – Estimate; S.e. – Standard error of estimate, and Prob.-Probability value. Source: Author (2022)

imports models indicate that exchange rate swings cause decline in trades in the long run. The first difference of real GDP, money supply and shares price index would exert negative and significant influence on export. The foreign reserves volatility has positive but insignificant effects. The exchange rate volatility wields a positive impact on the real import exports in the long-run. Ceteris paribus, a 1% increase in exchange rate volatility would cause around 9.5% decline in real exports, and about 4.5% increase in the real imports demand in the country. The error correction term is rightly signed and significant for the exports [imports] model. Approximately 39.4% (27.6) of shocks from the preceding year's perturbation converge to the long-run equilibrium in the contemporary year for the real for the exports (imports) model.

4.3. Diagnostic Tests

The diagnostic examination (Table 9) confirms adequacy of the real exports and imports models. Both models' residuals are not heteroscedastic as the Breusch-Pagan-Godfrey test is insignificant with P-values (0.386 and 0.763) >0.05 level. The Breusch-Godfrey test cannot reject the null of serially correlation for the residuals

Figure 10: (a) CUSUM and CUSUM of Squares for Real Export Model. (b) CUSUM and CUSUM of squares for real import model



Source: Author (2022)

Table 6: Export Cointegrating Form ($\Delta EXPT_t$)

Variable	Est.	Coeff.	S.e.	Prob.
ΔERV_t	$\gamma_{1,0}$	−6.571	2.063	0.000*
$\Delta RESV_t$	$\gamma_{2,0}$	10.387	10.519	0.327
ΔGDP_t	$\gamma_{3,0}$	−0.336	0.172	0.055**
$\Delta M2_t$	$\gamma_{4,0}$	−0.684	0.281	0.017**
$\Delta M2_{t-1}$	$\gamma_{4,1}$	0.099	0.336	0.770
$\Delta M2_{t-2}$	$\gamma_{4,2}$	−0.733	0.261	0.006*
$\Delta OILP_t$	$\gamma_{5,0}$	0.463	0.077	0.000*
ΔINF_t	$\gamma_{6,0}$	0.180	0.057	0.003
ΔASI_t	$\gamma_{7,0}$	−0.013	0.068	0.846
ECM_{t-1}	μ	−0.394	0.065	0.000*

*, **, *** indicates statistical significance at 1%, 5% or 10%. Coeff. – Coefficient; Est. – Estimate; S.e. – Standard error of estimate

Table 7: Import Cointegrating Form ($\Delta IMPT_t$)

Variable	Est.	Coeff.	S.e.	Prob.
$\Delta IMPT_{t-1}$	φ_1^*	−0.502	0.092	0.000*
ΔERV_t	$\gamma_{1,0}$	4.606	2.230	0.021*
$\Delta RESV_t$	$\gamma_{2,0}$	−17.67	16.23	0.280
ΔRESVt-1	$\gamma_{2,1}$	−28.83	16.96	0.094***
ΔGDP_t	$\gamma_{3,0}$	−1.158	0.382	0.004*
$\Delta M2_t$	$\gamma_{4,0}$	−0.565	0.465	0.229
$\Delta M2_{t-1}$	$\gamma_{4,1}$	0.432	0.514	0.404
$\Delta M2_{t-2}$	$\gamma_{4,2}$	−0.366	0.519	0.483
$\Delta M2_{t-3}$	$\gamma_{4,3}$	0.821	0.409	0.049**
$\Delta OILP_t$	$\gamma_{5,0}$	0.457	0.131	0.001*
$\Delta OILP_{t-1}$	$\gamma_{5,1}$	0.572	0.183	0.003*
$\Delta OILP_{t-2}$	$\gamma_{5,2}$	−0.251	0.144	0.087***
ΔINF_t	$\gamma_{6,0}$	−0.215	0.086	0.016**
ΔASI_t	$\gamma_{7,0}$	−0.554	0.190	0.005*
ΔASI_{t-1}	$\gamma_{7,1}$	−0.517	0.239	0.034**
ASI_{t-2}	$\gamma_{7,2}$	0.359	0.192	0.067***
ECM_{t-1}	μ	−0.276	0.103	0.009*

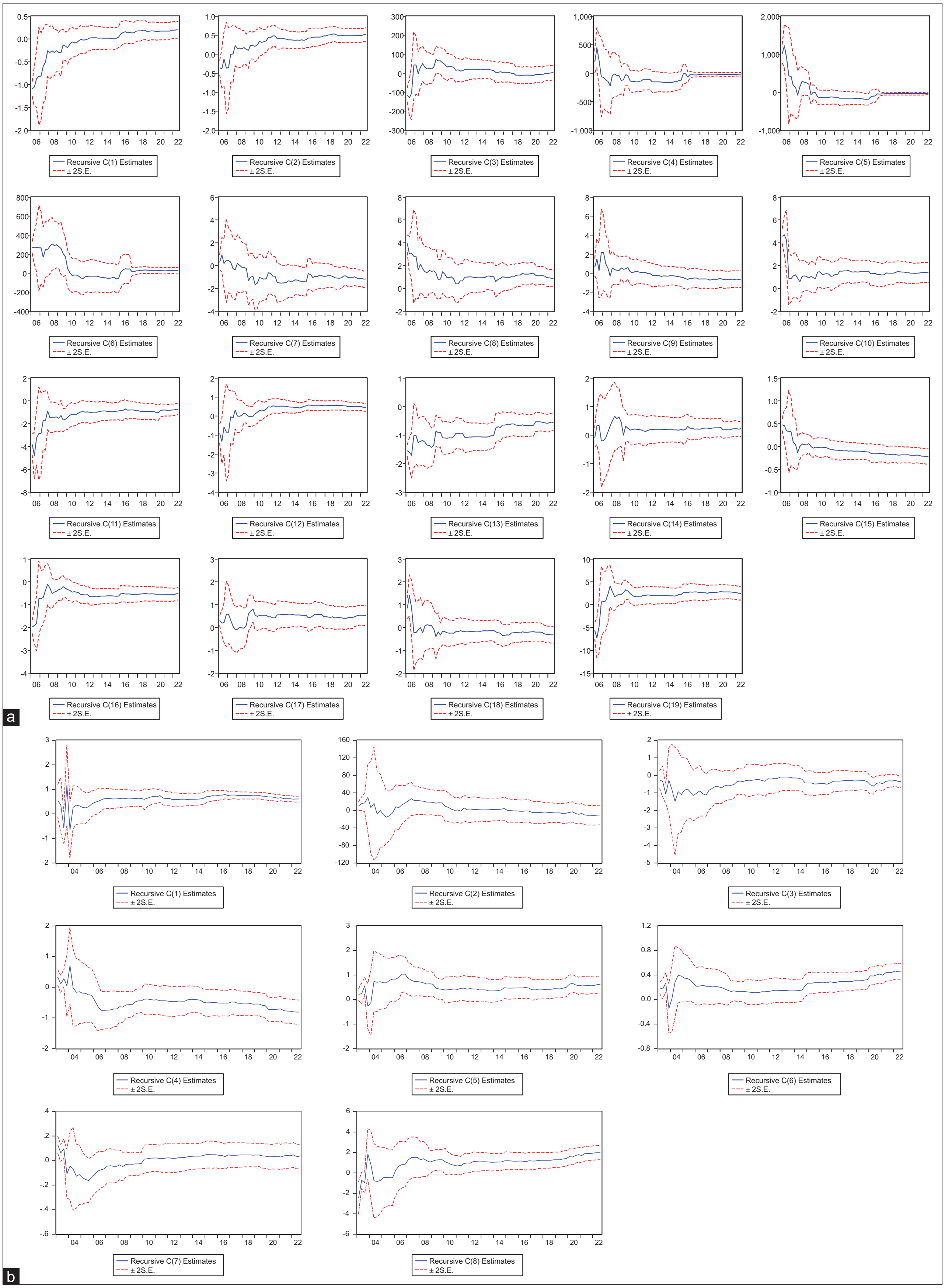
*, **, *** indicates statistical significance at 1%, 5% or 10%. Coeff. – Coefficient; Est. – Estimate; S.e. – Standard error

Table 8: Long run coefficients

Variable	Est.	Coeff.	S.e.	Prob.
Panel A: $EXPT_t$				
Const.	$\hat{\theta}_0$	5.123	0.604	0.000
ERV_t	$\hat{\theta}_1$	−24.30	11.82	0.035
$RESV_t$	$\hat{\theta}_2$	26.38	27.42	0.339
GDP_t	$\hat{\theta}_3$	−0.852	0.435	0.054
$M2_t$	$\hat{\theta}_4$	−0.528	0.169	0.003
$OILP_t$	$\hat{\theta}_5$	1.177	0.120	0.000
INF_t	$\hat{\theta}_6$	0.071	0.149	0.635
ASI_t	$\hat{\theta}_7$	−0.034	0.171	0.845
Panel B: $IMPT_t$				
Const.	$\hat{\theta}_0$	8.726	1.593	0.000
ERV_t	$\hat{\theta}_1$	16.70	74.76	0.824
$RESV_t$	$\hat{\theta}_2$	−94.80	101.1	0.352
GDP_t	$\hat{\theta}_3$	−1.206	1.287	0.353
$M2_t$	$\hat{\theta}_4$	0.077	0.577	0.895
$OILP_t$	$\hat{\theta}_5$	0.454	0.300	0.135
INF_t	$\hat{\theta}_6$	−0.778	0.389	0.050
ASI_t	$\hat{\theta}_7$	−1.193	0.563	0.038

The estimator, $\hat{\theta}_j$ $[= \hat{\beta}_j / \left(1 - \Sigma_{i=1}^{p} \hat{\varphi}_i\right)]$ provides the coefficients of the long-run relationship of the parsimonious ARDL. *, **, *** indicates statistical significance at 1%, 5% or 10%. Coeff. -Coefficient; Est.-Estimate; S.e.-Standard error of estimate, and Prob.-Probability value

Figure 11: (a) Recursive coefficients for Real Import Model. (b) Recursive coefficients for Real Export Model



Source: Author (2022)

Table 9: Robustness tests

Variable	Serial correlation Breusch-Godfrey LM		Heteroskedasticity breusch-pagan-godfrey		Normality Jarque-Bera
	F-stat.	Obs* R^2	F-stat.	Obs* R^2	JB-stat.
$EXPT_t$					
Stat.	0.171	0.407	1.084	11.93	2.381
	(0.843)	(0.816)	(0.386)	(0.369)	(0.218)**
$IMPT_t$					
	0.175	0.388	0.558	3.492	1.493
	(0.840)	(0.824)	(0.763)	(0.745)	(0.561)***

Breusch-Pagan-Godfrey test is insignificant with *P* values (0.386 and 0.763) >0.05. The Breusch-Godfrey test cannot reject the null of serially correlation for the residuals. Jarque-Bera test shows that the residual is normally distributed. *, **, *** indicates statistical significance at 1%, 5% or 10%. Obs*R^2 – Observed R-squares; JB-stat. -Jarque-Bera

of both models. The errors terms are white noise and normally distributed. All models' coefficients fall inside the critical bands (red lines) of the CUSUM and CUSUMSQ plots (Figure 10a and b) indicating stability of the long run coefficients of the parsimonious export and import models. In addition, the coefficients of each model are stables, as they fall within acceptable bands of the individual CUSUM and CUSUMSQ plots for the real export (Figure 11a) and real imports (Figure 11b) parsimonious model's regressors at 0.05 level. This is non-surprising since the short-run dynamic effects are sustained to the long-run, a significant *t*-test indicate that the long-run coefficients will be stable.

5. CONCLUSIONS

Depending on the risk tolerated by traders, exchange rate volatility have impacted negative or positive effects on trade flows since international monetary system moved from fixed to flexible exchange rates. Focusing on advanced economies, many apply aggregative countries trade and confirm mixed results of exchange rate volatility on trades. Unstable exchange rate has incessantly confronted the Nigerian economy, and threatens gains realisable from exports and imports. Unlike previous studies, the paper examines how exchange rate volatility, foreign reserve volatility, real GDP, broad money supply, oil price, inflation rates and shares price index affect real exports and imports demand functions.

The paper addresses the issue of how the exchange rate volatility impacts trades, and finds that, alongside the proponents of adverse effects, the volatility of the USD/NGN leads to significant decline Nigeria's real exports and imports in the short-run and long-run. Because this jeopardises fiscal objectives to maintain export led growth, pursuing a more consistent exchange rate stability would significantly increase Nigeria's bilateral trades. The regulators should sustain and strengthen policies to stabilise exchange rate should. This would prevent excessive swings and cause trade to improve trade in the future. Hence, authority can expand periodic exchange rate intervention to curtail excessive swings. This should be intuitively maintained and appraise regularly, to avoid risk of possible counter-productive response.

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