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DO REAL EFFECTIVE EXCHANGE RATE AND ITS VOLATILITY REALLY MATTER FOR TRADE BALANCE IN PAKISTAN? AN EMPIRICAL INVESTIGATION BY DYNAMIC CAUSAL CONNECTION

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Abstract:

This study is an empirical assessment of the presumption that real effective exchange rate and its volatility matter for trade balance in Pakistan. It explores the dynamic causal connection amongst series covering time span of 1976 to 2017. For the purpose, ARDL approach to co-integration is employed and to investigate the direction of causal connection between the variables, Granger-causality within VECM is applied on two types of models. Type-I incorporated the real effective exchange rate, while Type-II included the volatility in real effective exchange rate. The results revealed the existence of long-run association for both models only in the cases where trade balances are regressand. In short-run and long-run, trade balance is positively associated with real effective exchange rate which depicts that devaluation in real effective exchange rate deteriorates trade balance in short-run and in the long-run. However, increase in real effective exchange rate volatility is favorable in short-run but hurts the trade balance in long-run. The Granger-causality results imply that short-run unidirectional causality runs from real exchange rate to trade balance and volatility in exchange rate to trade balance. The findings of the study propose that Government of Pakistan should undertake exchange rate reforms for managing long-run stability in real exchange rates. Furthermore, exchange rate devaluation should not be policy option for improvement in trade balance.

Keywords: Real effective exchange rate, Exchange rate volatility, Trade balance, Pakistan, ARDL, VECM, Causality.

JEL Classification: FI7, F31, F47.

1. INTRODUCTION

In the era of economic integration and globalization the prompt internationalization of markets for goods and assets has enhanced the importance of exchange rate of the economies for international trade. It is the relative price that controls the trade flows amongst countries. The open-economy macroeconomists, from the theoretical realm and empirical work strive to demonstrate that exchange rate is the integral part of international economy as it works as a driving force of international trade. The exchange rate of a country has variations due to movements in exchange rates of her trading partners. The management of exchange rate is one of the major responsibilities of central banks of the countries.

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The management of exchange rate and choice of exchange rate policy is linked with motive to regulate the trade flow of a country. In this regard, real effective exchange rate is considered appropriate measure to analyze variations in international trade. It has advantages over other measures as it includes weighted average of basket of major currencies which incorporates fluctuations in relative prices and thus provides actual value of traded goods and services. The fluctuations in underlying relative prices, and hence in real effective exchange rate directly affect the behavior of traders due to increased uncertainty and risk, therefore, influencing the trade balance of a country. A number of studies have analyzed the impact of exchange rate on balance of trade confirming the short as well as long-run association between them but encompassing huge ambiguity in nature and lacking persistence in findings.

In order to elaborate the influence of exchange rate movements on trade balance, the channels based on theoretical underpinnings are: (i) standard theory of international trade (ii) j-curve theory (iii) Keynesian absorption approach and (iv) Monetary Approach. The former theory merely emphasized the free trade using the concepts of absolute advantage of Adam Smith and comparative advantage of David Ricardo. It rarely discussed the influence of exchange rate on balance of trade. The j-curve theory has microeconomic view that is a traditional concept in international trade showing that any depreciation in exchange rate worsens the trade in short-run and improves it in the long-run. However, Keynesian and monetary approaches focused on macroeconomic connections.

Pakistan switched to unified floating exchange rate regime in 1999. The motivation behind adaptation of this system was that it allows the macroeconomic fundamentals of countries to affect the exchange rate in international markets, thus, influencing the trade flows between countries and enhancing the market efficiency (Parveen *et.al.* 2012). On the contrary, the property of exchange rate being extremely volatile enhances the risk associated with flexible exchange rate for the contributors of financial markets. In this situation, they must dispense extensive resources in order to foresee the behavior of exchange rate attaining maximum exposure to risk associated with exchange rate. Therefore, this volatility may have dramatic role in determining variations in trade balance. A bulk of studies have investigated the relationship between exchange rate and trade balance. However, the existing literature is impregnated with disagreement whether exchange rate devaluation and exchange rate volatility are favorable for trade balance. Some of the studies are in favor of the presumption while others concluded against it.

The existing body of literature contains a number of studies that have explored the relationship between exchange rate and balance of trade. Among them some recent work includes Hassan *et.al.* (2016), Wondemo and Potts (2016), Genemo (2017), Kurtovic (2017), Bari and Togba (2017), Bussiere *et.al.* (2017), Dzanan and Masih (2017), Meniago and Eita (2017) and Immaculate and Kwadzo (2018). Almost all these studies confirmed the long-run relationship between exchange rate (either real or nominal) and the trade balance. Besides these studies, a few researches tested and failed to find the existence of j-curve theory. However, those studies found currency depreciation having positive relationship with the balance of trade for various economies worldwide (see, *inter alia*, Vural, 2016; Begovic and Kreso, 2017; Michael and Emeka, 2017 and Cardoso and Duarte, 2017). In this regard, the studies exploring the exchange rate-trade balance nexus in the case of Pakistan include, Rehman and Afzal (2003); Aftab and Khan (2008); Hameed and Kanwal (2009); Khan *et.al.*(2012); Shaheen (2013) and Afshan and Batul (2014). All of these studies, with exception of Aftab and Khan (2008) and Shaheen (2013) found the existence of long-run association between exchange rate and trade balance of Pakistan.

In context of impact of exchange rate volatility on trade balance, bunch of the studies [Mahmood *et.al.* (2011), Saqib and Sana (2012) and Khan *et.al.* (2014)] reinforced the idea that exchange rate volatility hurts the trade balance in Pakistan. In the rest of the world, several studies like Clark *et.al.* (2004), Stucka (2004), Petrovic and Gligoric (2010), Auboin and Ruta (2011), Broda and Ramalis (2011), Bakhromov (2011) and Immaculate and Kwadzo (2018) have supported the negative impact of exchange rate volatility on trade balance in their respective samples of analyses. Their findings support the idea that volatile behavior of exchange rate decelerates the process of international trade, undermines the capital movements and shakes the confidence of investors which makes the process of growth and trade flow sluggish. Nevertheless, a few of the studies [Kemal (2005) for Pakistan, Bristy (2013) for Bangladesh, Lotfalipour and Bazargan (2014) for Iran] have concluded against this behavior. These studies have ended up with the findings that exchange rate volatility influences trade balance neither in the short-run nor in the long-run.

In view of the commentary on existing literature, it is obvious that there is a lot of disagreement on the issue of exchange rate and its volatility in terms of their impact on trade flows from theoretical as well as empirical side. In this regard, the existing literature offers following gaps to be bridged by the current study. First, in view of the current developments in the literature on exchange rate-trade balance nexus, there is no updated research conducted in case of Pakistan. Second, the previous studies did not empirically test the impact of both exchange rate and its volatility simultaneously on balance of trade. Third, previous one of the studies has calculated real effective exchange rate volatility using exponential weighted moving average (EWMA). The existing studies used GARCH based volatility (Kemal, 2005; Mahmood *et.al.*, 2011; Lotfalipour and Bazargan, 2014 and Khan *et.al.*, 2014). Finally, most of the previous studies examined the relationship between exchange rate and trade balance in bivariate framework, however, very few studies utilized multivariate framework for empirical testing.

The objective of the current study is to analyze the dynamic causal connection between trade balance and exchange rate along with its volatility and to explore whether these factors matter for trade balance. For the purpose, the time series ARDL approach to co-integration has been employed. The Granger approach is used to explore the direction of causal connection in Vector Error Correction Model (VECM). According to Engle and Granger (1987) if a given set of variables is co-integrated, it implies that they must be represented in error correction form in which error correction term (ECT) must be part of the model. Similarly, the inclusion of lost information in the differencing process of time series is the advantage of VECM. It is the fundamental part of procedure to explore the short-run dynamics of model as well as long-run equilibrium relationship. The current study uses the updated data spanning from 1976 to 2017 for Pakistan economy. Moreover, this study incorporates the variables of trade balance, real effective exchange rate, real effective exchange rate volatility, industrial development, economic growth and inflation rate in the models. The exchange rate volatility has been calculated by using EWMA method.

2. DATA AND ESTIMATIONS

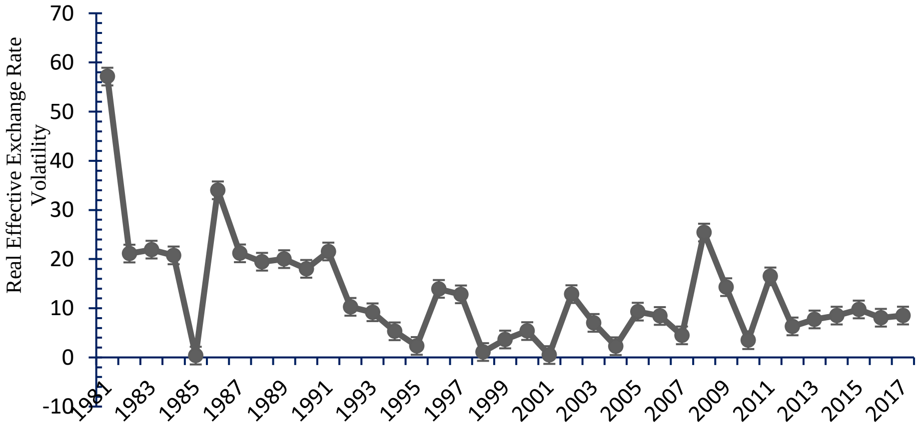
This study uses the annual time series data on trade balance, real effective exchange rate, industrial development, inflation rate and economic growth covering time span from 1976 to 2017.The data have been taken from various sources including Economic Survey of Pakistan, International Financial Statistics (IFS), World Development Indicators (WDI) and State Bank of Pakistan (SBP). The variable of trade balance is constructed dividing exports to imports and then applying the natural logarithmic transformation to this ratio.

The real effective exchange rate (R_{ER}), that is the average of real exchange rate of Pakistan with her major trade partners, is taken as the aggregate measure for real exchange rate. The industrial value is used as proxy for the industrial development (ID), Per capita Gross Domestic Product is taken as proxy for economic growth and is denoted by G_{GR}, whereas, consumer price index is used as a proxy for inflation rate (Π). Besides, real effective exchange rate volatility (VOL_{ER}) series is calculated by employing the Exponential Weighted Moving Average (EWMA) method, instead of GARCH based method used by Kemal (2005); Mahmood *et.al.* (2011);Lotfalipour and Bazargan (2014) and Khan *et.al.* (2014). All the variables are transformed into natural logarithmic form for empirical analysis. The generalized form of the EWMA formula is given as:

$$\mathrm{VOL_{ER}} = \lambda + (1 - \lambda) * G\mathrm{R}^2_{ER_{n-1}}$$

The volatility in real effective exchange rate has been presented in Figure 1.

Figure 1: Series of Real Effective Exchange Rate Volatility



2.1 Stationarity Analysis

The stationary of a series implies that the series should be mean reverting and must have inertia less than unity. It explains that mean, variance and covariance of the series are time invariant over the sample. The unit root analysis is pre-requisite to test the causal connection of time series. In order to ensure the reliability and robustness of unit root test results, three kinds of unit root tests are employed. These tests include, Augmented Dicky Fuller (onward ADF) (1979) test, Phillips-Perron (onward PP) (1988) test, and Kwiatkowski Phillips Schmidt and Shin (onward KPSS) (1992) test. Different from ADF and PP test, the null hypothesis of stationarity against alternative of non-stationarity is tested in KPSS. Each of these tests has some peculiar points which declare them appropriate to be used for stationarity analysis. First, ADF is conventional unit root test which improves on Dicky-Fuller test in terms of statistical power. Second, PP test is a non-parametric model-based test therefore it avoids serial correlation and heteroskedasticity in the time series. Third, KPSS offers even more statistical power to account for the autocorrelation of macroeconomic time series [Stock and Watson (1998)]. Hence, inclusion of the three types of unit root tests has substantially increased the statistical reliability of the unit root analysis.

The famous natural logarithmic transformation is done for all the variables. The results of unit root tests on level variables are reported in Table 1 and on first differenced variables are reported in Table 2.

Table 1: Unit root ADF, PP and KPSS test on level variables in natural logarithmic form

	Augmented Dicky-Fuller test			Phillips-Peron test			Kwiatkowski Phillips Schmidt Shin test	
Variables	Lags Selected by AIC	Test statistic	Tabulated value at 5%	Lags Selected by AIC	Test statistic	Tabulated value at 5%	Test statistic	Tabulated value at 5%
Ln(TB)	1	-1.418	-2.939	1	-1.839	-2.939	0.538	0.463
Ln(R_{ER})	1	-1.571	-2.939	1	-1.107	-2.939	0.599	0.463
Ln(Π)	1	-3.201	-2.939	1	-3.592	-2.939	0.281	0.463
Ln(G_{GR})	1	-2.192	-2.941	1	-3.461	-2.939	0.813	0.463
Ln(ID)	1	-4.283	-2.939	1	-3.710	-2.939	0.291	0.463
Ln(VOL_{ER})	3	-4.735	-1.952	1	-4.006	-2.939	0.045	0.463

The results in Table 1 show that the variables of Π, ID and VOL_{ER} are stationary at level. However, variables of TB, R_{ER} and G_{GR} were non-stationary at level but became stationary at first difference. It is shown by rejecting the null hypothesis of unit root in the case of ADF and PP tests. It is further demonstrated by retention of the null hypothesis of stationary in the case of KPSS test (Table 2). Hence, it can be concluded that the variables which have become stationary at first difference are integrated of first order or I(1). Since in presence of some non-stationary series, the standard ordinary least square is not applicable because it gives spurious estimates. Furthermore, all of the series are not integrated of the same order, hence ruling out the applicability of Johnson co-integration technique. The variables are of mixed order of integration, i.e., I(0) and I(1), while none of the variables is integrated of order I(2). If any of the series is having second order of integration, then it is not feasible to interpret the F-Statistics values constructed by Pesaran *et.al.* (2001). Hence, the current situation confirms the suitability of ARDL bounds testing approach to be employed due to mixed order of integration and absence of second order integration.

Table 2: Unit root ADF, PP and KPSS test on first difference of level variables in natural log form

	Augmented Dicky-Fuller test			Phillips-Peron test			Kwiatkowski Phillips Schmidt Shin test	
Variables	Lags Selected by AIC	Test statistic	Tabulated value at 5%	Lags Selected by AIC	Test statistic	Tabulated value at 5%	Test statistic	Tabulated value at 5%
Ln(TB)	1	-4.805	-2.941	1	-5.384	-2.941	0.069	0.463
Ln(R_{ER})	1	-7.413	-2.941	1	-4.751	-2.941	0.173	0.463
Ln(G_{GR})	1	-5.629	-2.941	1	-3.211	-2.941	0.206	0.463

2.2. Autoregressive Distributed Lag (ARDL) Bounds testing approach to co-integration

The ARDL bounds testing approach to co-integration proposed by Pesaran and Shin (1999) and later on by Pesaran *et.al.* (2001) has been employed to empirically analyze the long-run relationship and short-run dynamics amongst the variables of interest (trade balance, real effective exchange rate, economic growth, inflation rate and industrial development). In this regard, ARDL is used as general Vector Autoregressive Model with order p, denoted by a pair of column vectors (Y_t and X_t respectively) each comprising of five variables, i.e. Y_t= [TB_t, R_{ERt}, G_{GRt}, Π_t, ID_t] and X_t= [TB_t, VOL_{ERt}, G_{GRt}, Π_t, ID_t]. The bounds testing approach has three striking advantages over traditional co-integration frameworks. First, the ARDL is applied to the series with mixed order of integration, i.e. I(0), I(1) and fractional order of integration. Second, it yields more efficient estimates than traditional tests, even for small samples. Third and last, it gives unbiased estimates in model of long-run. This study employs following ARDL model specifications:

$$\Delta Y_t = \Phi_{i,j} + \Sigma_{i=1}^{p}\tau_{i,j}\Delta Y_{t-i,j} + \Sigma_{i=1}^{q}\psi_{i,j}Y_{t-i,j} + \varepsilon_{i,j} \ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$\Delta X_t = \Phi_{i,j} + \Sigma_{i=1}^{p}\tau_{i,j}\Delta X_{t-i,j} + \Sigma_{i=1}^{q}\psi_{i,j}X_{t-i,j} + \varepsilon_{i,j} \ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where, ΔY_t is a column vector with dimension (5x1) which is the first difference of variable $Y_t = [\mathrm{TB}_t, \mathrm{R}_{ERt}, \mathrm{G}_{GRt}, \Pi_t, \mathrm{ID}_t]^T$ and ΔX_t is a column vector (5x1), the difference form of variable $X_t = [\mathrm{TB}_t, \mathrm{VOL}_{ERt}, \mathrm{G}_{GRt}, \Pi_t, \mathrm{ID}_t]^T$. Moreover, $\Phi_{i,j}$ is the column vector of drift coefficients and $\varepsilon_{i,j}$ is the column vector of residuals[1].

The part of the ARDL model having coefficients ψ's shows the long-run part of the model. On the contrary, the part in the difference form and with coefficients τ's represents the short-run dynamics of the model. Moreover, ϕ's show the component of drift of the models. Whereas, ε's the white noise error terms and D denotes the first difference. The null hypotheses of the long-run co-integration relationship denoted as $\psi_{1j} = \psi_{2j} = \psi_{3j} = \psi_{4j} = \psi_{5j}=0$ are tested against the alternative hypotheses of $\psi_{1j} \neq \psi_{2j} \neq \psi_{3j} \neq \psi_{4j} \neq \psi_{5j} \neq 0$ via Wald test of restrictions providing F-statistic. The critical bound test values constructed by Pesaran *et.al.* (2001) are used. The lower bound critical value is constructed on the assumption that all five variables in the ARDL model are I(0) while, the upper bound critical value is constructed based on assumption that all five variables are I(1). Decision rule is such that the F-statistic exceeds the upper bound critical value implies rejection of null hypothesis of no co-integration. On the other hand, if the F-statistic is less than lower bound critical value, the null hypothesis of no co-integration cannot be rejected. Otherwise, the bounds test remains inconclusive.

The F-statistic values obtained from Wald test are reported in Table 3 and Table 4 for the models without real effective exchange rate volatility series (Type-I Model) and those with real effective exchange rate volatility series (Type-II Model), respectively. In addition, the bounds values at 5%, for our models from Pesaran *et.al.* (2001) are given in the same table. The optimal lag order is considered based on Akaike Information Criteria. The calculated F-statistic values of ARDL regressions, normalized for the regress and of the models, are also reported in the same tables.

Table 3: Bound test results of Type-I Models

Outcome variables	Lags by AIC	Wald F-statistic	Result
F_{TB} (TB\ R_{ER}, G_{GR}, Π, ID)	3	12.35	Co-integration
F_{RER}(R_{ER}\TB, G_{GR}, Π, ID)	2	1.99	No co-integration
F_{GGR}(G_{GR}\TB, R_{ER}, Π, ID)	2	2.95	Inconclusive
F_{Π}(Π\TB, R_{ER}, G_{GR}, ID)	3	3.24	Inconclusive
F_{ID}(ID\TB, R_{ER},G_{GR}, Π)	2	2.86	Inconclusive
Lower bound critical value at 5%	2.62		
Upper bound critical value at 5%	3.79		

Bounds critical values are taken from Pesaran, et.al.(2001), Table CI (iii) Case (III)

[1]Note: if dependent variable is used as regressor its lag(s) start from 1+0q. Where j = 1, 2,3,4,5 which is the number of equations.

Table 4: Bound test results of Type-II Models

Outcome variables	Lags by AIC	Wald F-statistic	Result
F_{TB} (TB\\VOL_{ER}, G_{GR}, Π, ID)	3	10.72	Co-integration
F_{VOLER}(VOL_{ER}\TB, G_{GR}, Π, ID)	3	2.86	Inconclusive
F_{GGR}(G_{GR}\TB, VOL_{ER}, Π, ID)	2	3.22	Inconclusive
F_{Π}(Π\TB, VOL_{ER}, G_{GR}, ID)	3	3.15	Inconclusive
F_{ID}(ID\TB, VOL_{ER}, G_{GR}, Π)	3	2.79	Inconclusive
Lower bound critical value at 5%	2.62		
Upper bound critical value at 5%	3.79		

Bounds critical values are taken from Pesaran, et.al. (2001), Table CI (iii) Case (III)
In case of specifications without exchange rate volatility, the results reveal that there is co-integrating relationship (long-run association) amongst the variables of interest when TB is taken as regressand. This is exhibited from the Wald F-statistic (12.35) which exceeds the upper bound critical value at 5% (3.79). It implies that the null hypothesis of no co-integration in equation (1) is rejected. There is no co-integrating association when R_{ER} is the explained variable because the Wald F-statistic (1.99) is less than the lower bound critical value at 5% (2.62). In this way, the null hypothesis of no co-integration is not rejected. However, the results are inconclusive for the specifications with explained variables G_{GR}, Π and ID respectively, with Wald F-statistic (2.95, 3.24 and 2.86 respectively) between upper and lower bound critical values at 5%, in the case where models are without exchange rate volatility.

Moreover, when the specifications are including exchange rate volatility instead of real effective exchange rate, the results show that there is co-integrating association among the variables of interest when TB is regressand. This is because the Wald F-statistic (10.72) exceeds the upper bound critical value at 5% (3.79). Whereas, the results are inconclusive for the specifications with explained variables VOL_{ER}, G_{GR}, Π and ID respectively, with Wald F-statistic (2.86, 3.22, 3.15 and 2.79 respectively) between upper and lower bound critical values at 5%. This is the case of specifications containing the series of exchange rate volatility.

2.3. Long and short-run Granger causality tests

As the co-integration is established, we have estimated the conditional-ARDL models which are given below:

$$\Delta TB_t = \Phi_1 + \Sigma_{i=1}^{q} \psi_{i,j} Y_{t-i} + \varepsilon_{1t} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

$$\Delta TB_t = \Phi_2 + \Sigma_{i=1}^{q} \psi_{i,j} X_{t-i,j} + \varepsilon_{2t} \ldots\ldots\ldots\ldots (4)$$

Where, all the variables in specifications (3) and (4) have been defined earlier. Akaike Information Criterion has been used to identify the order of ARDL (p, q1, q2, q3, q4) of all the five variables in vectors Y_t and X_t.The equations (3) and (4) have been estimated using the ARDL of order (1, 0, 0, 0, 0). The results of the estimated models normalized for the TB are reported in Tables 5 and 6, respectively.

Table 5: Long-run estimates by ARDL: Type-I Model

Variables	Coefficient	t-ratio	p-value
C	-1.76	-6.08	0.00
$Ln(R_{ER})$	0.09	4.17	0.00
$Ln(\Pi)$	-0.07	-0.14	0.86
$Ln(G_{GR})$	0.53	4.39	0.00
Ln(ID)	0.14	3.82	0.00

Table 6: Long-run estimates by ARDL: Type-II Model

Variables	Coefficient	t-ratio	p-value
C	2.38	5.10	0.00
$Ln(VOL_{ER})$	-6.32	-4.92	0.00
$Ln(\Pi)$	-0.11	-0.19	0.81
$Ln(G_{GR})$	0.68	3.76	0.00
Ln(ID)	0.20	3.45	0.00

In case of Type-I model, the estimated long-run coefficients for real effective exchange rate, economic growth and industrial development are highly significant. Real effective exchange rate has positive impact on balance of trade. It means any depreciation in Pakistani rupee will deteriorate her trade balance in the long-run. It implies that Pakistan's demand for imports is inelastic to currency depreciation, therefore currency depreciation leads the imports to become more expensive. On the other way around, Pakistan's exports are not much expensive, thus exports receipts are not much increased because of the stated depreciation of Pakistani rupee. As a result, the said depreciation makes the trade balance of Pakistan further worse-off rather than improving it. Hence, Marshall-Learner condition fails to hold in case of Pakistan.

The variable of economic growth also has positive impact on trade balance which indicates that as the economy grows, its balance of trade improves. It implicates that high economic growth in Pakistan is likely to improve the trade balance through boost in domestic production and hence by enhancement of its exports. The industrial development variable has positive sign which indicates that industrial development may lead towards improvement in trade balance of Pakistan. As the domestic industry grows, exports will be promoted and import substitutes will be made available discouraging the imports, hence improving the balance of trade. However, inflation rate has a negative but insignificant effect on balance of trade. In case of Type-II model, the variable of exchange rate volatility has a negative impact on balance of trade. It shows that if the volatility of exchange rate rises, it will deteriorate the trade balance. On the contrary, if the fluctuations in exchange rate becomes stable then the trade balance will be improved. It implies that high exchange rate volatility increases the risk for domestic investments. Therefore, it reduces the domestic production and as a result leads to decline in exports and thus trade balance is deteriorated. This is insightful in case of Pakistan because many factors like external debt, terms of trade, inflation differential and interest rate differential help in increased volatility of exchange rate in Pakistan [Bashir and Luqman (2014)]. Therefore, it leads to worsening-off the balance of trade. The other variables in this model like economic growth and industrial development have positive and significant coefficients.

It is conventional in time series literature to obtain parameters of short-run dynamics, in this view, the error-correction model associated with long-run can be estimated [Narayan and Smith (2008), Odhiambo (2009)]. The confirmation of long-run association among the variables of interest is the indication of the presence of Granger Causality (at least unidirectional). Its existence is to be found by F-statistic value and lagged error correction term of the model.

$$\Delta Y_t = \Phi_{i,j} + \Sigma_{i=1}^{p}\tau_{i,j}\Delta Y_{t-i,j} + \varphi ECT_{t-1} + \varepsilon_{i,j} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$\Delta X_t = \Phi_{i,j} + \Sigma_{i=1}^{p}\tau_{i,j}\Delta X_{t-i,j} + \varphi ECT_{t-1} + \varepsilon_{i,j} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where τ_{1i} , τ_{2i} , τ_{3i} , τ_{4i} *and* $\tau_{5i}$are the short-run coefficients that show the dynamics for convergence to equilibrium level of the model and φ is the parameter of speed of adjustment. The set of equations, 5 and 6, are estimated by ordinary least square method. The estimated coefficients in equations 5 and6, representing short-run dynamics and those linked with the long-run relationships, are reported in tables7 and 8, respectively.

Table 7: Type-I Model: Short-run VECM results of ARDL(1,1,0,1,0) chosen based on AIC

Variables	Coefficients	t-ratio	p-value
C	-0.23	-5.93	0.00
D(Ln(R_{ER}))	0.04	3.71	0.00
D(Ln(Π))	-0.07	-0.32	0.68
D(Ln(G_{GR}))	0.83	4.12	0.00
D(Ln(ID))	0.05	0.23	0.77
ECM(-1)	-0.52	-3.58	0.00
R^2 = 0.84			
F statistic = 9.12			0.03
DW statistic = 1.99			

Starting with the long-run results, the coefficient of lagged error correction term has been revealed highly significant with negative sign in case of Type-I model. It is the confirmation of the co-integration results from bounds testing approach. Its estimated value -0.52 shows that after a shock of real effective exchange rate, there will be high speed of adjustment to approach the equilibrium level of trade balance. If there is disequilibrium in trade balance because of the shock of real effective exchange rate in previous year, then approximately 52% of the shock will converge back to the long-run equilibrium level in the current year. Similarly, the estimated coefficient value of lagged error correction term for the Type-II model is -0.39 which is moderately high.

It implies that if there is shock of volatility in the real effective exchange rate to create disequilibrium in the trade balance, then this shock will dissipate with relatively less speed.

Table 8: Type-II Model: Short-run VECM results of ARDL (1,0,0,1,0) chosen based on AIC

Variables	Coefficients	t-ratio	p-value
C	-0.10	-3.26	0.00
D(Ln(VOL_{ER}))	0.15	4.49	0.00
D(Ln(II))	-0.05	-0.17	0.83
D(Ln(G_{GR}))	0.38	2.96	0.03
D(Ln(ID))	0.13	3.05	0.01
ECM(-1)	-0.39	-4.45	0.00
R^2 = 0.76			
F statistic = 12.97			0.05
DW statistic = 2.01			

The variables of real effective exchange rate, real effective exchange rate volatility, economic growth, inflation rate and industrial development Granger-cause trade balance in the long-run. It means that causality runs interactively from real effective exchange rate, economic growth, inflation rate and industrial development to trade balance via error correction term. Similarly, it runs from exchange rate volatility, economic growth, inflation rate and industrial development to balance of trade. Inflation rate has negative but insignificant effect whereas, industrial development has positive but insignificant impact on trade balance in Type-I model. However, merely inflation rate is insignificant with negative sign in Type-II model. The F-statistic values of the regressions based on ARDL equations (equations 5 and 6) show that the model without and with exchange rate volatility are best fit and globally significant at 5% level. These models pass the post estimation tests including White test of heteroskedasticity, Durbin-Watson, Breusch Godfrey LM test of serial correlation, Jarque-Bera (JB) test of normal errors and Ramsey-Reset test of functional form specification. The results of these diagnostics are reported in tables 9 and 10. The statistical findings of JB test on Type-I and Type-II models are presented in Figures 2 and 3, respectively. The probability values of JB test revealed that the residuals of both estimated models follow the normal distribution.

Figure 2: JB test on Type-I Model

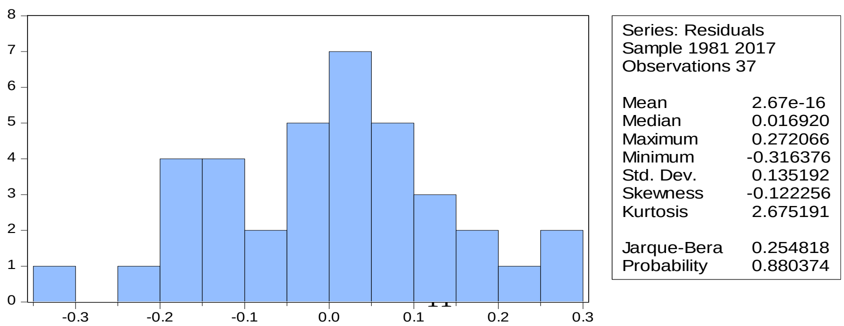


Figure 3: JB test on Type-II Model

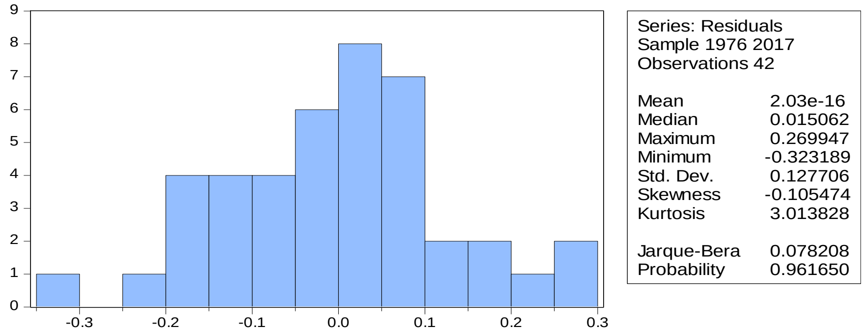


Table 9: Post-estimation diagnostic test results: Type-I Model

Test	Chi-square statistic	p-value
Breusch-Godfrey LM Serial Correlation test	2.30	0.14
Ramsey's RESET test of Functional Form	7.62	0.19
White test of Heteroscedasticity	0.21	0.51
Jarque-Bera Normality test	JB test value	0.90
	0.06	

Table 10: Post-estimation diagnostic test results: Type-II Model

Test	Chi-square statistic	p-value
Breusch-Godfrey LM Serial Correlation test	3.18	0.11
Ramsey's RESET test of Functional Form	4.91	0.14
White test of Heteroscedasticity	0.32	0.59
Jarque-Bera Normality test	JB test value	0.63
	0.87	

The stability of coefficients in the long-run is verified via testing the dynamics in the short run which is pre-requisite condition for ARDL model (Pesaran and Shin, 1999). The cumulative sum of recursive residuals (CUSUM) and CUSUM square tests are executed to check the stability of the parameters obtained after estimating equations 5 and 6 with error correction terms. The Figures4to7show the graphic representation of these tests. The results confirm the structural stability of the ARDL models as the lines of plots of CUSUM and CUSUM square are within the critical region of 5 % significance shown via bands of the plot.

Figure 4: CUSUM test on Type-I Model

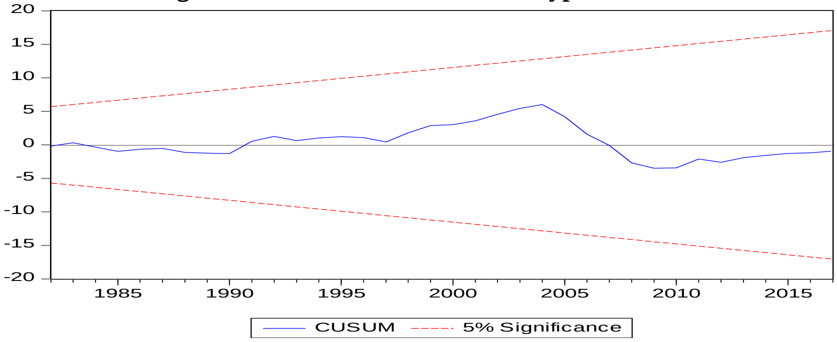


Figure 5: CUSUM test on Type-II Model

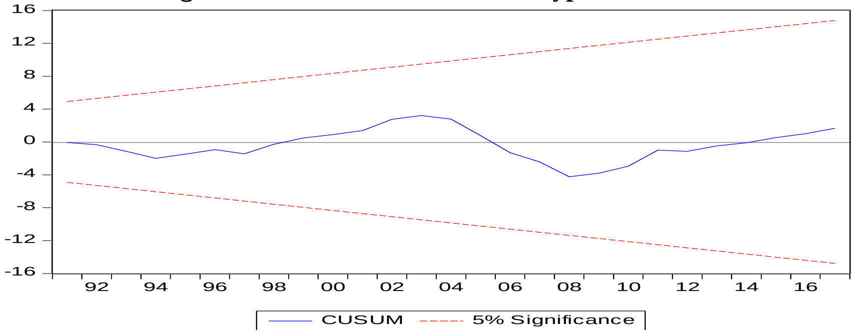


Figure 6: CUSUM-square test on Type-I Model

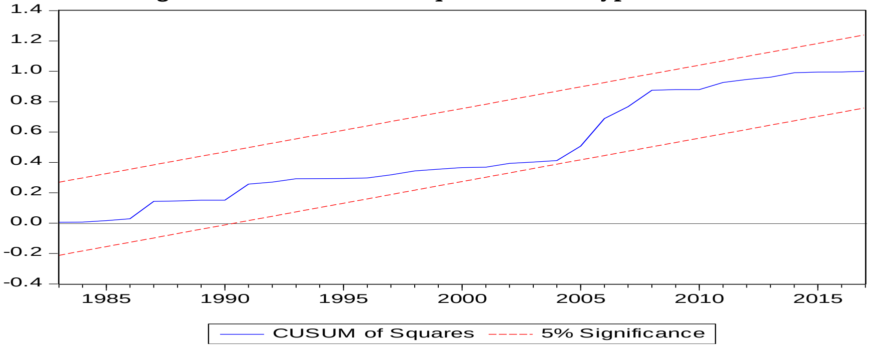
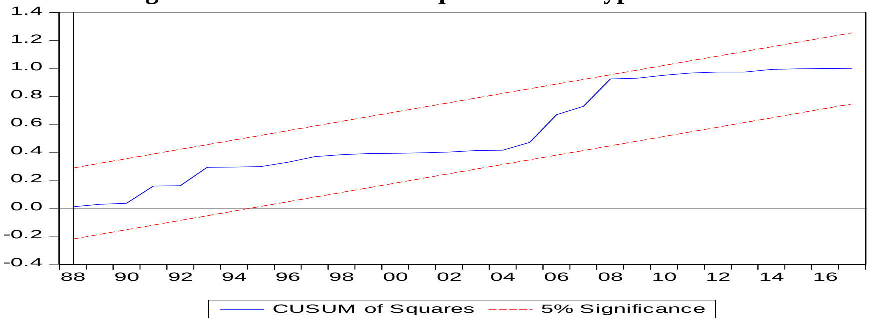


Figure 7: CUSUM-square test on Type-II Model



During the period of 1998 to 2000, political instability embarked because of economic sanctions by western world in response to the nuclear experiment by Pakistan. In order to insulate the foreign exchange reserves, the foreign currency accounts were frozen by Government of Pakistan. This situation shattered the confidence of investors and traders. Meanwhile, the economy suffered from considerable reduction in exports. Later on, floating exchange rate was implemented spanning 2000 to 2009. In order to analyze the significant structural break in 2000 and over the post dirty float regime (from 2000 to 2009), the stability tests of Chow Break-point and Chow Forecast are applied. The results of Log-likelihood and values of F-statistic do not confirm any structural break in both models. The model without and with real exchange rate volatility are shown in tables 11 and 12, respectively.

Table 11: Statistical results for stability tests: Type-I Model

Test	Breakpoint, Forecast Period	F-stat	p-value of F-stat	Log likelihood ratio (LLR)	p-value of LLR
Chow Breakpoint test	2000	0.64	0.25	23.19	0.19
Chow Forecast test	2000, 2009	0.79	0.32	33.27	0.07

Table 12: Statistical results for stability tests: Type-II Model

Test	Breakpoint, Forecast Period	F-stat	p-value of F-stat	Log likelihood ratio (LLR)	p-value of LLR
Chow Breakpoint test	2000	2.41	0.08	18.11	0.07
Chow Forecast test	2000, 2009	2.03	0.06	37.67	0.12

Table 13: Short-run Granger Causality results: Type-I Model

	F-statistic					
Outcome Variables	D(Ln(TB))	D(Ln(R_{ER}))	D(Ln(Π))	D(Ln(G_{GR}))	D(Ln(ID))	Causality direction
D(Ln(TB))	-	3.18**	2.53	5.91*	0.62	R_{ER} to TB G_{GR} to TB
D(Ln(R_{ER}))	0.47	-	0.20	0.27	0.34	No causality
D(Ln(Π))	0.71	1.24	-	0.22	3.02*	ID to Π
D(Ln(G_{GR}))	0.59	1.09	1.28	-	1.25	No causality
D(Ln(ID))	1.02	0.56	1.69	0.87	-	No causality

** and ** show the statistical significance at 1 and 5 percent level of significance, respectively.*

Table 14: Short-run Granger Causality results: Type-II Model

	F-statistic					
Outcome Variables	D(Ln(TB))	D(Ln(VOL$_{ER}$))	D(Ln(Π))	D(Ln(G$_{GR}$))	D(Ln(ID))	Causality direction
D(Ln(TB))	-	3.62**	2.80	0.81*	0.78	VOL$_{ER}$ to TB G$_{GR}$ to TB
D(Ln(VOL$_{ER}$))	0.57	-	0.57	1.12	0.24	No causality
D(Ln(Π))	0.61	0.09	-	0.34	2.59***	ID to Π
D(Ln(G$_{GR}$))	0.55	0.79	1.02	-	1.37	No causality
D(Ln(ID))	0.78	2.32***	1.13	0.89	-	VOL$_{ER}$ to ID

, and *** show the statistical significance at 1, 5 and 10 percent level of significance, respectively.*

The short-run Granger-causality test results for models without and with exchange rate volatility are reported in tables 13 and 14 respectively. In Type-I model, the F-statistic on regressors indicates that uni-directional Granger-causality runs from real effective exchange rate to trade balance, economic growth to trade balance and industrial development to inflation rate. On the other hand, none of the variables Granger causes to real effective exchange rate, economic growth and industrial development. The causality from real effective exchange rate to balance of trade confirms the results of Khan *et al,* (2012). Whereas, in case of Type-II model, the direction of the Granger-causality is from exchange rate volatility to trade balance, economic growth to trade balance, industrial development to inflation rate and exchange rate volatility to industrial development. However, the variables of exchange rate volatility and economic growth are not Granger caused by any of the variable. More interestingly, the Granger causality from exchange rate to trade balance supports the results of Kreso (2017) and Michael and Emeka (2017), while it opposes the results of Bristy (2013) and Lotfalipour and Bazargan (2014).

In the light of empirical findings, the increase in real effective exchange rate volatility leads to trade balance improvement in long-run. In fact, in presence of dominant income effect over the substitution effect is likely to lead real effective exchange rate to improve the trade balance. The underlying mechanism is that if exporters are sufficiently risk averse, then rise in real effective exchange rate volatility is likely to increase exports revenues. In this case, the exporters are expected to export more, thus improving the trade balance. This channel is confirmed by Khan *et.al.* (2014), Bussiere*et.al.* (2017) and Dzanan and Masih (2017).

Moreover, the currency depreciation, according to predominant notion, works via (i) making the exports cheaper and hence expanding the export volume, and (ii) making the imports expensive, and hence discouraging the imports. This process, on the whole, improves the trade balance. In Pakistan, the currency depreciation failed to improve the trade balance. The key reasons for this failure were (a) inelastic imports,

(b) inexpensive huge volume of exports, and (c) high inflation rates. First, Pakistan's imports largely consisted of fuels and manufacturing raw materials. There are no imports substitute available domestically. Therefore, currency depreciation failed to discourage inelastic imports of Pakistan and further deteriorated the trade balance. Second, Pakistan's exports have greater volume than imports but they are much cheap as compared to imports. In this way, currency depreciation did not increase the exports receipts of Pakistan. Third, currency depreciation in presence of high inflation rates failed to improve trade balance. The mechanism revealed that high inflation rates swallowed the gap of price differences for imports and exports, and thus hindered the promotion of exports. On the other hand, it enlarged the imports bills of Pakistan, therefore, it further deteriorated the trade balance of Pakistan. This finding is consistent with Wondemo and Potts (2016), Genemo (2017) and Nizamani *et.al.* (2017).

3. CONCLUSIONS

This study is an empirical assessment of the presumption whether real effective exchange rate and its volatility matter for trade balance of Pakistan exploring the dynamic causal connection amongst series spanning 1976 to 2017. In order to test the long-run association among trade balance, real effective exchange rate, real effective exchange rate volatility, inflation rate, economic growth and industrial development, the ARDL approach to co-integration is employed. And also, to investigate the direction of causal connection between the variables under analysis, Granger-causality within Vector Error Correction Model is applied.

The results interestingly show the existence of long-run association only in cases where trade balance is the regressand in both type of models, i.e. Type-I and Type-II models. In short and long-run, the real effective exchange rate is positively associated with the trade balance which depicts that any devaluation in real effective exchange rate will deteriorate trade balance in short-run and will continue to do so in long-run. It is perhaps either because the importers are bound in prior contracts or the nature of imports of Pakistan is necessity goods. Besides this, the volatility in exchange rate is favorable in short-run, but it hurts the trade balance in the long-run. The economic growth, in both type of models, reinforces trade balance in short as well as long-run. The industrial development improves trade balance in short and long-run in Type-II model, whereas in Type-I model, it has insignificant impact in short-run and significant in the long-run. The inflation is negatively related to trade balance but appears insignificant in both type of models. The Granger-causality results imply that short-run unidirectional causality runs from real effective exchange rate to trade balance, and volatility in real effective exchange rate to trade balance. Furthermore, there is one-way causality from economic growth to trade balance. On the other hand, there is no significant causality from industrial development and inflation to trade balance in either types of models. The findings of the study are advisable that Government of Pakistan should undertake exchange rate reforms, managing it in a way, to avoid major fluctuations in the long-run. Moreover, exchange rate devaluation should not be policy option for the improvement of trade balance.

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