



## Exchange Rate Volatility and Trade Deficit in Pakistan: A Time Series Analysis

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### ABSTRACT

This paper inspected the exchange rate volatility in Pakistan within the time of 1981m07 to 2017m04 at that point discover its impacts on trade deficit. ARCH and GARCH models are developed for catching the unpredictable impact of exchange rate volatility on trade in Pakistan. Exchange rate standard volatility was figured in numerous past investigations by taking the standard deviation of the moving average of the logarithm of exchange rate. In any case, in this paper exchange rate unpredictability is estimated by ARMA (0, 1) and ARCH/GARCH (2, 1) models and asymmetrical information is utilized as dummy variable. Exchange rate volatility is utilized as independent variable and trade deficit as dependent variable. Money supply, private investment and gross domestic product are utilized as control variable. Augmented Dickey-Fuller (ADF) test used to check the stationary of the information the aftereffects of ADF demonstrates that a few factors are stationary at first contrast have request of joining I(1) and a few factors are stationary at level have request of reconciliation I(0). We utilize autoregressive distributed lag model to break down the impact of exchange rate volatility on trade deficit. The outcomes appeared there is negative and massive long run connection between exchange rate volatility and trade deficit yet in short run it is noteworthy and positive.

**Keywords:** Volatility, ARCH effect, Trade deficit, Autoregressive distributed lag model

**JEL Classifications:** E52, E58, F31

### 1. INTRODUCTION

The landing of the adaptable exchange rate framework in 1973 created a noteworthy instability and vulnerability in return rates. This began an open deliberation among approach producers and scientists found the effect of exchange rate instability on trade streams. Be that as it may, both the hypothetical and exact examinations yielded clashing outcomes about the connection between exchange rate changeability and global trade flows. Although most of the exchange models contend that unpredictability builds vulnerability, chance and consequently impedes the exchange flows, some different investigations recommend something else (Khan et al. 2014). Likewise, the issue is for the most part analyzed for coming researchers.

Parveen et al. (2012) broke down the elements cause exchange rate fluctuations in Pakistan. The central point of the examination

was to add to exchange rate unpredictability and their relative significance. The auxiliary information was utilized to finish up the discoveries. The information was gathered or taken from financial overview of Pakistan and universal measurements. Yearly information was gathered amid the period 1975-2010. Afzal (2007) clarified the conversion standard reaction of imports demand in Pakistan. The fundamental goal of the investigation was the genuine and powerful exchange rate reaction of imports demand in Pakistan. The outcome closed devaluation of household money debilitates imports however builds the aggressiveness of the fares. An expansion in remote trade hold was normal a beneficial outcome on import demand yet don't have a pivotal significance. Ahmad et al., (2014) portrayed in his paper the effect of exchange rate on adjust of balance of payment in Pakistan and was inferred that the dependability of conversion standard may make a positive situation for support the venture and enhance the balance of payment. The results demonstrate the huge and positive

relationship. As indicated by Vergil (2009) gauge the exchange rate instability and trade in euro and Mexico and discover the effect of exchange rate unpredictability on trade. The exchange rate instability has a positive and exceptionally noteworthy impact in the exchange rate of just a single of the ten assessed item gatherings. Zweig et al. (2008) inferred that impacts of exchange rate unpredictability on exchange were under psyche. In spite of the fact that appreciation can decrease trade surplus in short run, in a more drawn out skyline, there is no steady relationship. Jalil and Feridun (2010) explained the foreign exchange rate uncertainty in Pakistan by using the micro structure approach. Impact of Euro-Dollar exchange rate on macroeconomic indicators like real output, price level, and money supply for Pakistan has been evaluated by Muhammad (2010).

In the previous literature exchange rate volatility has been captured through the standard deviation of the moving average of the logarithm of exchange rate, but in the current study exchange rate volatility is estimated by ARMA (0, 1) and ARCH/GARCH (2, 1) models. And then find out the impact of exchange rate volatility on Trade Balance and results of the study has answer the question about How Exchange Rate Volatility disturb the Trade Balance of a Country? And reject the null hypothesis that there is no association between exchange volatility and trade deficit and accept the alternative hypothesis that there is association between exchange volatility and trade deficit.

## 2. DATA AND METHODOLOGY

The dependent variable is trade deficit while exchange rate volatility, inflation, Private Investment, money supply and GDP growth rate are taken as independent variables (Table 1).

### 2.1. Unit Root Test

Stationary of the factors are checked under the progression of unit root. In the event that mean, fluctuation and auto covariance of a variable stays same regardless of when we register them, at that point variable is called stationary.

The condition utilized for leading augmented Dickey-Fuller (ADF) test has the accompanying structure:

To check the ADF unit root, the accompanying speculations were produced:

$$H_0: (P-1) = 0 \text{ or } P = 1$$

$$H_a: (P-1) < 0 \text{ or } P < 1$$

**Table 1: Descriptions of dependent and independent variables**

Variables	Descriptions
Dependent variable	
TB	Trade balance (exports-imports)
Independent variables	
PI	Private investment
VOL	Volatility in nominal exchange rate
M2	Money supply
GDP	Growth rate of gross domestic product (annual %)

### 2.2. ARCH/GARCH Model

We used monthly data and data set is from July 1981 to April 2017, giving a total of 430 observations. Thus, we have enough observations to carry out time series in the monthly case. ARCH/GARCH models for exchange rate returns at the monthly base measures exchange rate volatility was employed in this paper.

Mean equation:

$$EXR = \beta_0 + \beta_1 \times @SQRT (GARCH) + \beta_3 MA \quad (1)$$

Risk premium = @SQRT (GARCH)

Variance equation:

$$ARCH = \beta_4 + \beta_5 \times ARCH(-1)^2 + \beta_7 \times ARCH(-2)^2 + \beta_8 \times GARCH(-1) + \beta_6 \times RESID(-1)^2 \times (RESID(-1) < 0) \quad (2)$$

Asymmetrical information = RESID (-1)<sup>2</sup> × (RESID(-1) < 0)

Asymmetrical information is taking as dummy variable. When there is asymmetrical information in the market it is 1 otherwise it is zero.

### 2.3. Autoregressive Distributed Lag Model (ARDL) Approach

We utilized autoregressive dispersed slack model to discover the short run and long run co mix between conversion scale unpredictability and exchange adjust.

The ARDL system gives steady and sound parameter gauges for both the short run and long run. Besides, the ARDL strategy does not require pretesting of the factors. That is to say, this technique can be utilized regardless of the request of incorporation of factors. We can utilize it when all variables are simply I(0) or I(1) or a blend of both.

The ECM raises the short-run flow with the long-run stable harmony without losing long-run data.

$$\Delta (TB)_{i,t} = a + \sum_{k=1}^n b_k \Delta TB_{i,t-k} + \sum_{k=0}^n c_k \Delta PI_{i,t-k} + \sum_{k=0}^n d_k \Delta M2_{i,t-k} + \sum_{k=0}^n d_k \Delta VOL_{i,t-k} + \sum_{k=0}^n d_k \Delta GDP_{i,t-k} + w \{TB_{i,t-1} - (\beta_0 + \beta_1 PI_{i,t-1} + \beta_2 M2_{i,t-1} + \beta_3 VOL_{i,t-1} + \beta_4 Ln GDP_{i,t-1})\} + \mu t \quad (3)$$

Here the term in bracket can be defined as the error occurred in earlier time period and the parameter “w” has two mode interpretations. Its sign displays convergence/divergence of the error term and its magnitude portrays speed of divergence/convergence. On the other hand the parameters of the variables existed in differenced forms (having sign are short term estimates of the variables that describe short term impact on exports growth.

After replacing the in-bracket term in equation (3) by error term we get;

$$\Delta(TB)_t = a + \sum_{i=1}^p bk\Delta(TB)_{t-i} + \sum_{i=0}^q ck\Delta(PI)_{t-i} + \sum_{i=0}^r dk\Delta(M2)_{t-i} + \sum_{i=0}^s dk\Delta(VOL)_{t-i} + \sum_{i=0}^s dk\Delta(GDP)_{t-i} + \lambda iECM(-1)Eq - 3 \quad (4)$$

Where, ECM is named as Error correction term. Now by estimation of equation (3) using OLS, will provide the key instance to identifying the coefficients of equation (2).

We will estimate above ARDL model for both panel as well as individual data set of the developing countries.

### 3. RESULTS AND DISCUSSIONS

#### 3.1. Unit Root Test

Stationary of variables has been checked by ADF test. It is augmented form of Dickey Fuller and is augmented by adding the lagged values of the dependent variable  $\Delta Y_t$ . It was ensured

**Table 2: Test for unit root (augmented Dickey-Fuller)**

Variables	At level		At first difference		Results
	ADF stats	Probability	ADF stats	Probability	
EXR	6.1797	0.0000*	-6.404759	0.0000	I(0)
VOL	-6.179738	0.0000*	-6.404759	0.0000	I(0)
TB	-2.027386	0.2743	-6.230308	0.0000*	I(1)
M2	3.413021	0.0179**	-5.184211	0.0002*	I(0)
GDP	0.930246	0.9947	-5.121124	0.0002*	I(1)
PI	-1.330867	0.6034	-6.049161	0.0000*	I(1)

\*\*Indicate significance at 5 percent level. \*Indicate significant at 1 percent level

**Table 3: Descriptive analysis**

Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.*
0.005817	0.014677	0.287972	17.52562	3354.789	<0.0001

**Table 4: ARCH LM test on ARMA (0, 1) residuals**

F-statistic	119.0472	Prob. F(1,378)	0.0000
Obs*R-squared	91.01335	Prob. Chi-square(1)	0.0000

**Table 5: Estimation Result of GARCH (1, 2) model**

Variable	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	-0.622716	0.101452	-6.138020	0.0000
C	0.000885	0.000702	1.260683	0.2074
MA(1)	0.127066	0.042540	2.987006	0.0028
Variance equation				
C	2.53E-05	2.06E-06	12.25616	0.0000
RESID(-1) <sup>2</sup>	0.302504	0.113867	2.656655	0.0079
RESID(-1) <sup>2</sup> × (RESID(-1) < 0)	0.816753	0.194302	4.203530	0.0000
RESID(-2) <sup>2</sup>	-0.107704	0.036431	-2.956355	0.0031
GARCH(-1)	0.161580	0.056799	2.844787	0.0044
R-squared	0.080477	Mean dependent var		-0.005817
Adjusted R-squared	0.075611	S.D. dependent var		0.014677
S.E. of regression	0.014111	Akaike info criterion		-6.609098
Sum squared resid	0.075268	Schwarz criterion		-6.526310
og likelihood	1267.033	Hannan-Quinn criter		-6.576251
Durbin-Watson stat	2.322303			

that error term is free from the problem of serial correlation. The results are shown in Table 2.

#### 3.2. Descriptive Statistics for ARCH-GARCH Model

Descriptive statistics is reported in Table 3.

#### 3.3. Model Fitting

Table 4 shows that the distribution of number of exchange rates does not follow a normal distribution; mean that there is a grouping of volatility. Model is starting with the conditional mean process by autoregressive process AR(0) and moving average MA(1) as shown in Table 5. The estimated coefficient of both conditional mean equation and conditional variance equation of GARCH (1, 2) model are highly significant as shown in Table 6.

After testing the heteroscedasticity by using GARCH model, GARCH (1, 2) has effectively seized the fluctuation in volatility and there is no ARCH effect left in the residuals from the selected model and checked by ARCH LM test are shown in Table 6 (appendix) indicated that the residuals do not show any ARCH effect.

#### 3.4. Bound Test Co-Integration Technique

Results of bound test have been shown in Table 7.

#### 3.5. Short Run Co-integration From ARDL (4, 4, 4, 2, 3) Selected Based on Akaike Info Criterion

Our estimated findings revealed that the foreign exchange rate fluctuations have statistically significant but negative effect on foreign trade deficit at its 1<sup>st</sup> lag in short run. At second and third lag exchange rate have insignificant impact on trade deficit. For the fitness of model ECM should be negative and significant (Table 8). The above model fulfills the certain criteria. The value of ECM is shows that the disequilibrium removes from the model at the speed of -0.918883.

According to the result of Table 9 exchange rate uncertainty or volatility has negatively related but has significant effect on international trade deficit, while Money supply and GDP

**Table 6: ARCH LM test on GARCH (1, 2) residuals**

F-statistic	0.400988	Prob. F(1,378)	0.5270
Obs×R-squared	0.402682	Prob. Chi-Square(1)	0.5257

**Table 7: Testing for existence of a level relationship among the variables in the ARDL model**

F-statistic	Significant at 10%	Significant at 5%	Significant at 2.5%	Significant at 1%
6.848761	2.2	3.09	2.56	3.49
	2.88	3.87	3.29	4.37

F statistic is significant at 1%. It means co integration exists at one percent in this model.

**Table 8: Estimation of equation no.3 and ECM**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TB(-1))	0.494765	0.082122	6.024789	0.0003*
D(TB(-2))	0.719697	0.096087	7.490083	0.0001*
D(TB(-3))	0.124797	0.107565	1.160203	0.2794
D(LVOL)	-1.395984	0.274492	5.085699	0.0009*
D(LVOL(-1))	2.016782	0.508407	3.966868	0.0041**
D(LVOL(-2))	0.406103	0.356617	-1.138766	0.2878
D(LVOL(-3))	-0.394598	0.221614	-1.780564	0.1129
D(M2)	-0.017251	0.082981	-0.207897	0.8405
D(M2(-1))	-0.869783	0.147303	-5.904720	0.0004*
D(M2(-2))	-0.500456	0.114993	-4.352060	0.0024*
D(M2(-3))	-0.237405	0.092523	-2.565900	0.0333**
D(LPI)	-6.552417	1.307681	-5.010717	0.0010*
D(LPI(-1))	-5.942596	1.505104	-3.948297	0.0042*
D(LGDP)	-0.636709	3.311340	-0.192281	0.8523
D(LGDP(-1))	0.564574	3.896101	0.144907	0.8884
D(LGDP(-2))	15.049680	3.801905	3.958457	0.0042*
ECT(-1)	-0.918883	0.112448	-8.171623	0.0000*
R-squared	0.956593			
Adjusted R-squared	0.842649			
Durbin-Watson stat	2.601994			

\*Significant at one percent. \*\*Significant at 5%

**Table 9: Long run co-integration from ARDL (4, 4, 4, 2, 3) selected based on Akaike info criterion**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LVOL	-5.240223	1.252036	4.185361	0.0031*
LM2	0.938726	0.462695	2.028825	0.0770**
LPI	-6.927928	1.243562	-5.571037	0.0005*
LGDP	10.198780	3.153773	3.233835	0.0120**
C	81.945990	27.558065	2.973576	0.0178**

\*Significant at one percent. \*\*Significant at 5%

have positively related with foreign trade deficit. Private Investment has adverse and statistically significant related with trade deficit.

**3.6. Diagnostic Tests**

Results of diagnostic shown in Table 10 indicates that there is no evidence of serial autocorrelation, accepted the Breusch-Godfrey with the null hypothesis of no autocorrelation.

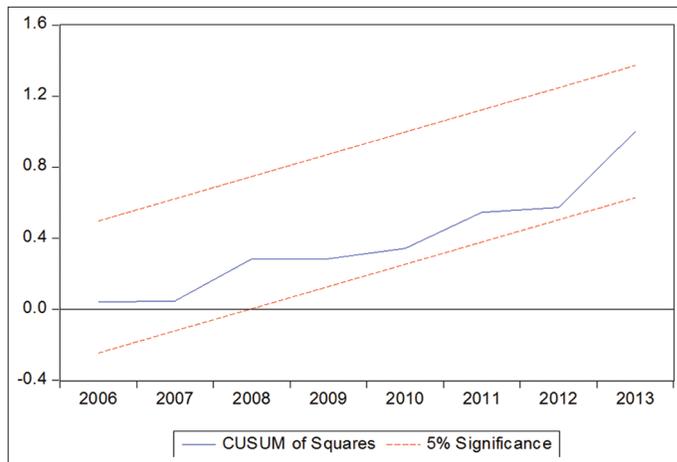
**3.7. Stability Test**

Graphical representations of the square CUSUM is shown in Figure 1 and model in the long term. According to Bahmani-Oskooee (2004b) the null hypothesis (i.e. that the regression equation is specified correctly) may not be refused if the texture of these statistics is kept within the critical limits of significance level of 5%.

**Table 10: Breusch-Godfrey serial correlation LM test**

F-statistic	1.521476	Prob. F(2,6)	0.2921
Obs×R-squared	10.09500	Prob. Chi-square(2)	0.0064
Heteroskedasticity test: ARCH			
F-statistic	0.004832	Prob. F(1,27)	0.9451
Obs×R-squared	0.005189	Prob. Chi-square(1)	0.9426

**Figure 1: CUSUM test**



**3.8. Robustness Check**

The co-integration test of Table 10 indicates the presence of two vectors of integration in the model that is in line with the results obtained with the technique of co-integration ARDL which also supports long-term relationships in the model.

**4. CONCLUSIONS AND SUGGESTIONS**

In this study trade deficit and exchange rate volatility are adversely related with each other as the more variation in exchange rate is diminishing trade deficit. In the meantime, exchange shortage, cash supply and gross domestic product are definitely related. Private Investment and exchange shortage are contrarily related. The observational investigations identifying with the connection between exchange rate inconstancy and its components are not conclusive. By the by, the ideal effect of exchange rate devaluation on trade deficit is uncertain in the previous studies. Be that as it may, observational aftereffects of this paper indicated very huge connection amongst trade deficit and exchange rate variations. Rose (1990) ponders the connection amongst devaluation and trade balance for an example of 30 nations and discovers that the effect of devaluation on the trade balance is unimportant for 28 nations, while one nation demonstrates a negative effect.

For creating nations, issues in regards to exchange intensify when, alongside swelling, outer components rise as “stuns” or “news” and exasperate the stream of worldwide costs paid for products or stocks. Such components disturb smooth and customary conversion scale streams and are frequently showed through money emergencies and securities exchange crashes (Schmidt-Hebbel and Tapia, 2002). The same number of times the connection between exchange shortfall and conversion scale unpredictability is uncertain so it is recommended that we can enhance our exchange adjust or limit

our exchange deficiency by different determinates of exchange shortages. In the paper there is negative connection between private speculation and exchange shortfall so we can likewise limit our exchange deficiency by expanding the private venture.

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