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Article: **Remittances-Exchange Rate Nexus: Evidence from Pakistan**

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# Remittances-Exchange Rate Nexus: Evidence from Pakistan

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## Abstract

The major goal of this study was to estimate the remittances-exchange rate nexus in Pakistan. For this purpose, it adopted a two-step procedure to examine the short-run and long-run nexus between exchange rate and remittances in Pakistan from January 1980 to April 2018. In the first step, an ARMA-GARCH model was utilized along with the generated conditional variance as the measure of the volatility of remittances and rate of exchange, respectively. In the second step, ARDL framework was utilized to check both the long- and short-run nexus between rate of exchange and inflation. The result revealed that past remittances and exchange rate affected current remittances and rate of exchange, significantly. Furthermore, it was also shown that exchange rate has a significant and positive effect on remittances and the volatility of rate of exchange has a significant and positive effect on exchange rate in the long-run. The test of causality showed that a bidirectional causality exists between remittances and the volatility of remittances, as well as between rate of exchange and the volatility of rate of exchange. Thus, it is suggested that the government needs to formulate policies to maintain the stability of exchange rate. Moreover, strong capital and financial markets are required to mitigate the risk of exchange rate.

**Keywords:** exchange rate, remittances, volatility

## Introduction

Remittances, over the course of time, have become a significant source of foreign capital inflows in emerging as well as in developed economies. In emerging economies, official development assistance (ODA), portfolio investment, foreign direct investment (FDI), and remittances of workers are

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major sources of capital inflows. Remittances, however, do not impose any political and economic conditions in comparison with other forms of capital inflows. For the last two decades, remittance inflows have been continuously increasing in Pakistan. It should be noted that remittances have played a significant role in stabilizing and developing Pakistan's external sector as they largely compensate for the trade deficit. Many economists argue that various necessities of life, as well as basic goods and services, are purchased through remittances in Pakistan. Increased remittances are directly proportional to the increase in purchasing power parity, which eventually leads to a rising demand for services and goods. Remittances also cause the exchange rate to fluctuate (increase or decrease). The size of remittances in emerging economies is thrice that of ODA; furthermore, remittances constitute a more stable financial inflow than any other source (Ratha & Shaw, [2007](#)). Mexico, China, and India receive approximately forty percent of total remittances (World Bank, [2011](#)). Acosta et al. ([2007](#)) argued that remittances act as private aid to households and lead to better health and education for individuals at household level.

Volatility in remittances causes fluctuation in the exchange rate in developing economies. Increased remittances also raise the rate of exchange. The increased exchange rate causes adverse effects on the tradable part of the economy. On the other hand, remittances expand the non-tradable part due to which both exports and imports are adversely affected. As a result, there is a rise in the real effective exchange rate (REER) which causes the loss of international competitiveness. Generally, three main channels of remittances affect the rate of exchange. Initially, by increasing the net foreign asset in the economy, remittances affect the real sector. Secondly, remittances affect the equilibrium of the economy internally where domestic labor and capital are efficiently utilized. Lastly, remittances and exchange rate affect the growth of economy and the prosperity of an emerging and developing country.

Various researchers have analyzed the association between remittances and exchange rate. (Rehman, [2017](#); Jehan & Hamid, [2017](#)) argued that there is a positive link between exchange rate and remittances. (Barajas et al., [2011](#); Amuedo-Dorantes & Pozo, [2004](#); Acosta et al., [2009](#); Lartey et al., [2012](#); Lopez et al., [2007](#)) showed that the flow of remittances increases the

real exchange rate. During the last two decades, controlling remittances and the volatility of exchange rate has gained notable attention of policymakers. Consequently, there is a bulk of literature available that talks about the relationship of exchange rate with remittances in developed economies, but there is little to no literature available about the workings of this relationship in Pakistan. This study fills this gap by providing an empirical estimation of the association between remittances and rate of exchange in the Pakistani context.

This paper aims to analyze the remittances-exchange rate nexus in Pakistan. The aims of this study are as follows: firstly, to estimate how rate of exchange as well as the volatility of rate of exchange and remittances affect remittances; secondly, to analyze how remittances as well as the volatility of remittances and exchange rate affect the exchange rate. The study is important as it delivers better understanding, information, and necessary evidence to policymakers, individuals, and researchers. Furthermore, this study is beneficial for government officials and central banks while formulating the macroeconomic policy, which is essential to maintain a stable rate of exchange and economic growth.

The study is organized as follows: Section 2 discusses the review of the related literature. It is followed by a discussion on data and methodology in Section 3. The findings of the study are described in Section 4, while policy recommendations and conclusion are discussed in Section 5.

### Literature Review

Lopez et al. (2007) analyzed the link between the real effective rate of exchange and remittances. They found that remittances raise the real rate of exchange. Barajas et al. (2011) analyzed the relationship of rate of exchange in equilibrium and remittances using a small open economy model. The results depicted that rate of exchange increased less than remittances. Lartey et al. (2012) examined the behavior of remittances under different exchange rate regimes in 109 emerging economies from 1990-2003. The results showed that a rise in remittances leads to a boost in spending, which in turn causes the appreciation of exchange rate. Barrett (2013) investigated how remittances affected exchange rate appreciation in Jamaica from 1995-

2010. The findings of their study showed an inverse association of remittances and exchange rate.

Hassan and Holmes (2013) analyzed the long-run association between exchange rate and remittances in underdeveloped economies from 1987-2010. The findings showed the existence of a short-run relationship and unidirectional causality from remittances to exchange rate as well as the existence of the Dutch diseases. Nyan et al. (2013) analyzed the association between Dutch diseases and remittances in Philippines from 1980-2010. The results verified the existence of Dutch diseases as well as a positive relationship of the real effective exchange rate with GDP in the Philippines. Sweidan (2013) investigated how rate of exchange affected remittances and the balance of trade in Jordan from 1976-2009. The results revealed that rate of exchange affected the balance of trade in the short-run, whereas remittances exhibited a similar impact through Dutch diseases by increasing the living cost and reducing export competitiveness.

Ahmed and Martinez-Zarzoso (2014) explored the internal and external factors of remittances flow in Pakistan from 2001-2011. The results depicted political instability, economic conditions, and financial development as major internal factors affecting the flow of remittances, while a major external factor was the stock of migrant in the host country. Kamran et al. (2014) examined the major determinants of remittances from 1990-2010 in Pakistan. The results manifested exchange rate, FDI, and GDP as the major determinants of remittances in Pakistan. Tuuli (2015) investigated how remittances affected the exchange rate in Ghana's economy from 1987-2010. The results depicted that in the long-run, a rise in capital inflow causes a rise in the real rate of exchange.

Khan et al. (2016) studied the link between the real exchange rate and remittances in Pakistan from 1980-2014. They found that a rise in remittances leads to an appreciation of the real rate of exchange in Pakistan. Alam et al. (2017) analyzed the determinants of remittances from 1975-2016 in Pakistan. They found exchange rate, political stability, interest rate, gold prices, real GDP, stock market performance, and development expenditure as the major determinants of remittances for the aid period. The results also revealed that exchange rate depreciation leads to an increase in remittances. Jehan and Hamid (2017) analyzed the association between

capital inflows and exchange rate volatility in emerging economies from 1980-2013. The results indicated that financial development is very important for reducing the damaging effects of exchange rate volatility on the inflows of capital. The researchers concluded that financial sector development is important for emerging economies to attract more capital inflows.

Khurshid et al. (2017) investigated how remittances affected exports and exchange rate in Pakistan from 1992-2015. The findings determined that a bidirectional causality exists between exchange rate and remittances. Lartey (2017) studied the effect of remittances on GDP in 135 emerging and transition countries from 1970-2007. The results showed that a boost in economic growth and remittances is directly linked with a more flexible exchange rate. Rahman (2017) examined the nexus between REER and remittances through the mediating role played by financial development for thirty-seven countries from 2000-2015. The results revealed a positive association between exchange rate and remittances. Additionally, it was also found that the existence of Dutch diseases can worsen the recipient country's trade competitiveness in the global market.

### Methodology and Data

Time series model was used in this study to estimate the link between rate of exchange and remittances as well as their respective volatilities. The first model measured how rate of exchange, volatility of rate of exchange, and volatility of remittances affect remittances. It is stated as follows:

$$REM = f(VREM, REER, VREER) \quad (1)$$

where REM denotes remittances, VREM denotes the volatility of remittances, REER denotes real effective rate of exchange, and VREER denotes the volatility of real effective rate of exchange.

The second model measured the effect of remittances, volatility of remittances, and volatility of exchange rate on exchange rate. It is stated as follows:

$$REER = f(REM, VREM, VREER) \quad (2)$$

Where REER denotes real effective exchange rate, REM denotes remittances, VREM denotes volatility of remittances, and VREER denotes volatility of real effective exchange rate.

Time series data must be dealt with proper care to get rid of spurious regression. Hence, to avoid the non-stationarity issue, PP and ADF tests were used. Dickey and Fuller (1981) prescribed the Augmented Dickey Fuller (ADF) test that follows the assumption of uncorrelated error terms. The problem of serial correlation leads to the use of the ADF test in which the unit root test is augmented as per the lag value of the dependent variable. Phillips and Perron (1988) introduced the non-parametric statistical method to get rid of the problem of serial correlation.

After Engle (1982) used the Autoregressive Conditional Heteroskedasticity (ARCH) model. Several researchers have used its other form to model volatility. Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model is extensively used to model the volatility which is time varying (Engle, 1982; Bollerslev, 1986). In this research, a two-step procedure was used to find out the link between the volatility of remittances and inflation. In the first step, ARMA-GARCH model was used in which conditional variance was generated as a volatility measure. The second step comprised the estimation of the regression equation.

Autoregressive Moving Average (ARMA) (p, q) was used to model the mean equation of remittances. It is stated as follows:

$$\pi_t = \alpha_0 + \sum_{i=1}^p \alpha_i \pi_{t-i} + \sum_{j=1}^q \beta_j \varepsilon_{t-j} + \varepsilon_t \quad (3)$$

where  $E(\varepsilon_t | \alpha_{t-1}) = 0$  and  $\text{Var}(\varepsilon_t | \alpha_{t-1}) = \delta_t^2$

The length of lag for the mean equation was chosen using AIC and SIC. It is necessary to analyze whether the error term with conditional variance in the mean equation has an ARCH effect and that there is no serial correlation in the error terms before modeling the uncertainty of variables. Mean equation was used to augment the variances (time varying) in the residuals using the ARMA-GARCH model stated as follows:

$$\pi_t = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \pi_{t-i} + \sum_{j=1}^q \beta_1 \varepsilon_{t-j} + \varepsilon_{1t} \quad (4)$$

$$\delta_t^2 = \gamma_0 + \sum_{i=1}^p \gamma_i \delta_{t-i}^2 + \sum_{j=1}^k \eta_j \varepsilon_{t-j}^2 + \varepsilon_{2t} \quad (5)$$

The volatility of inflation and the volatility of remittances were measured using conditional variance  $\delta_t^2$ , separately. ARCH ( $\eta$ ) and GARCH ( $\gamma$ ) coefficients' sum was determined by the persistence of volatility. Cointegration between the variables was determined using the ARDL model.

There are different methodologies used to determine cointegration among the variables, but with the assumption that the same order of integration exists among them (Johansen & Juselius, 1990; Engle & Granger, 1987). For example, Pesaran et al. (2001) introduced Autoregressive Distributive Lag (ARDL) test, which is only applicable when the variables have a mixed integration order. ARDL bound testing technique is considered to be more efficient than other techniques, while pre-testing of the variables is not required.

ARDL model is specified as follows:

$$\Delta \ln Y_t = C + \sum_{i=1}^p \alpha_i \Delta \ln Y_{t-i} + \sum_{i=1}^p \beta_i \Delta \ln X_{t-i} + \varphi_1 \ln Y_{t-1} + \varphi_2 \ln X_{t-1} + \varepsilon_t \quad (6)$$

Where the first difference of variables is represented by  $\Delta$ . Short-run dynamics are represented by  $\alpha$  and  $\beta$ , while  $\varphi_1$  and  $\varphi_2$  depict the coefficients of long-run. Following hypothesis was used to test cointegration:

$$H_0: \varphi_1 = \varphi_2 = 0 \text{ (No cointegration)}$$

$$H_1: \varphi_1 \neq \varphi_2 \neq 0$$

The null hypothesis depicting the absence of cointegration is rejected if the value of F-statistics is more than the upper bound value. On the other hand, if the lower value is bigger than the value of F-statistics then there would be no cointegration between the variables. Inconclusive results would be obtained if the F-statistics lies between the limit of lower and upper values. Short-run values are measured by converting the ARDL model into the error correction model (ECM). The rate of adjustment of the variable into the equilibrium is shown by ECT (error correction term), while convergence in the short-run is depicted by a negative sign. The presence of a long-run association between the variables is shown by the bound test,



while direction of causality is estimated using Granger causality test. Granger (1988) postulated that ECM can be used to determine causal association among the variables. Short-run dynamics are also used to capture the coefficient of the lagged term, while information about long-run causality is provided by ECT.

Monthly time series data of Pakistan from January 1980-April 2018 was used for estimation in this paper. Real effective exchange rate data was gathered from the various issues of Pakistan Economic Survey. The data of remittances (million US \$) was also collected from the Pakistan Economic Survey (various issues). Both the variables, that is, real effective exchange rate and remittances were converted into a standardized unit for a meaningful comparison. The estimated conditional variance of GARCH model was used to estimate remittances' volatility as well as the volatility of real effective exchange rate.

## Results

Table 1 reports the results of unit root tests. ADF test showed that there is integration of order I(1) for all variables except VREER, which has order I(0) integration. The results of ADF test were confirmed by Phillip-Perron (PP) unit root test. PP test showed that remittances and real effective rate of exchange have integration of order I(1), while the volatility of remittances and real effective rate of exchange volatility are order I(0) integrated.

**Table 1**

*Results of ADF and PP Unit Root Test*

| Var   | ADF Test |            | PP Test |            | Results |      |
|-------|----------|------------|---------|------------|---------|------|
|       | I(0)     | I(1)       | I(0)    | I(1)       | AD      | PP   |
| REM   | 1.589    | -3.716***  | .479    | -52.169*** | I(1)    | I(1) |
| VREM  | -.201    | -9.986***  | -       | -45.869*** | I(1)    | I(0) |
| REER  | -1.915   | -14.846*** | -1.815  | -14.754*** | I(1)    | I(1) |
| VREER | -        | -13.277*** | -       | -40.593*** | I(0)    | I(0) |

*Note.* \*\*, and\*\*\* shows significance at 5% and 1% level respectively.

The coefficients estimated by ARMA model for remittances and rate of exchange volatilities are shown in Table 2. The models of ARMA were

selected on the basis of SIC and AIC, while diagnostic tests (Ljung-Box Q-test) showed that serial correlation was not present in the residual at lag lengths of different levels. The test of LM depicted the existence of ARCH effect in both the models of remittances and exchange rate.

**Table 2***ARMA Model for Remittances and Exchange Rate*

| OLS Estimates of ARMA Model |                      |                   |
|-----------------------------|----------------------|-------------------|
| Coefficients                | Remittances          | Exchange Rate     |
| AR(1)                       | -1.045***<br>(0.041) | .014<br>(.094)    |
| AR(2)                       | -.420***<br>(0.033)  | ----              |
| AR(8)                       | -.208***<br>(.017)   | ----              |
| AR(12)                      | .219***<br>(.026)    | ----              |
| MA(1)                       | .499***<br>(.044)    | .375***<br>(.084) |
| MA(8)                       | .163***<br>(.044)    | ----              |
| MA(9)                       | -.073**<br>(.042)    | ----              |
| MA(12)                      | .181***<br>(.041)    | ----              |
| MA(13)                      | .111**<br>(.044)     | ----              |
| ARCH Effect                 |                      |                   |
| F-statistic                 | 17.846***            | 10.233***         |
| Presence of ARCH Effect     | Yes                  | Yes               |

*Note:* \*\*, and\*\*\* shows significance at 5% and 1% level respectively. Standard errors are in parathesis.

Most of the prior research suggests that the GARCH model is much better and more parsimonious than the ARCH model. The effect of an

infinite number of squared residuals of the ARCH model are parsimoniously captured by the GARCH model (Bollerslev, 1986). A symmetric response to the shocks (both positive and negative) of volatility remains the basic restriction of the GARCH model. The results of the GARCH model for remittances and rate of exchange are given in Table 3. The results of the mean equation of remittances and rate of exchange showed that past remittances and exchange rate have a significant effect on current remittances and rate of exchange as shown by the GARCH model. While the results of the variance equation of remittances and rate of exchange showed a high persistence of uncertainty in remittances and exchange rate.

**Table 3***GARCH Model for Remittances and Exchange Rate*

| Mean Equation     |             |               |
|-------------------|-------------|---------------|
| Coefficients      | Remittances | Exchange Rate |
| AR(1)             | .009        | -.108         |
| AR(2)             | .243***     | ----          |
| AR(8)             | -.147***    | ----          |
| AR(12)            | .705***     | ----          |
| MA(1)             | -.730***    | .485***       |
| MA(8)             | .142**      | ----          |
| MA(9)             | .064        | ----          |
| MA(12)            | -.540***    | ----          |
| MA(13)            | .219***     | ----          |
| Variance Equation |             |               |
| RESID(-1)^2       | .127***     | .148***       |
| GARCH(-1)         | .577***     | .598***       |

*Note.* \*\*, and\*\*\* shows significance at 5% and 1% level respectively. Standard errors are in parathesis.

Bound test was applied on the two models presented above and the results are reported in Table 4. SIC was used for selecting the lag length. The comparison of the value of F-statistics of (lower and upper) bound values is suggested by Pesaran et al. (2001). The results depicted that the

upper bound value was less than the value of F-statistics at 1% significance level in both the models, which argues for the rejection of the null hypothesis using both models.

**Table 4**

*Results of ARDL Bound Test*

| Model  | F-Statistics | 1% critical values |       | Co-integration Exist |
|--|--------------|--------------------|-------|----------------------|
|  |              | I(0)               | I(1)  |                      |
| Model I: Dependent Variable Remittances<br>$F_{(REM VREM, REER, VREER)}(5,0,3,0)$    | 4.603        | 3.380              | 4.230 | Yes                  |
| Model II: Dependent Variable Exchange Rate<br>$F_{(REER VREM, REM, VREER)}(4,3,1,0)$ | 5.489        | 3.230              | 4.350 | Yes                  |

The LM test for serial correlation of Breusch-Godfrey and the model specification test of Ramsey Reset were applied as diagnostic tests to validate the reliability of the results before the estimation of parameters in both short- and long-run. The results of these tests are given in Table 5. It indicates that the ARDL model is free from model misspecification and serial correlation.

**Table 5**

*Results of Diagnostic Tests*

| Model   | Diagnostic Test                              | F-statistics (p-value) | Results                      |
|---------|--|------------------------|------------------------------|
| Model I | Breusch-Godfrey LM Test (Serial Correlation) | .020 (.980)            | No Serial Correlation Exists |

| Model    | Diagnostic Test                              | F-statistics<br>(p-value) | Results                      |
|----------|--|---------------------------|------------------------------|
| Model II | Ramsey Reset Test<br>(Model Specifications)  | 2.150<br>(.321)           | No Misspecification error    |
|          | Breusch-Godfrey LM Test (Serial Correlation) | .984<br>(.322)            | No Serial Correlation exists |
|          | Ramsey Reset Test for (Model Specifications) | 1.607<br>(.246)           | No Misspecification error    |

*Note:* P-values are in parenthesis and show that the null hypothesis cannot be rejected.

The short-run and long-run parameters were estimated as suggested by Pesaran et al. (2001) after applying the diagnostic tests. In Table 6, panel A and B report the results of long- and short-run dynamics, respectively.

**Table 6**

*Long Run and Short Run Dynamics*

| Dependent Variable     | Remittances<br>Model I | Exchange Rate<br>Model II |
|------------------------|------------------------|---------------------------|
| Panel A: Long-run      |                        |                           |
| VREM                   | -111.820               | -21.028                   |
| REER                   | 1.659**                | ----                      |
| VREER                  | -150.550               | 569.690***                |
| REM                    | ----                   | .509                      |
| Panel B: Short-run ECM |                        |                           |
| ECT(-1)                | -.026***               | -.013***                  |

*Note:* \*\*, and\*\*\* shows significance at 5% and 1% level respectively.

The results of Model I showed a significant positive association between remittances and the real effective rate of exchange. It means that whenever there is a rise in exchange rate (appreciation), it leads to a higher inflow of remittances. Consequently, a rise in remittances leads to a rise in foreign exchange earnings which boosts the economic growth and prosperity of the

country. These results are consistent with (Rehman, [2017](#); Nyan et al., [2013](#); Tuuli, [2005](#)). While the volatility of remittances and the volatility of rate of exchange both have a negative and insignificant effect on remittances in the long-run. The estimation of Model II showed that the volatility of the real effective exchange rate has a significant and positive impact on the real effective rate of exchange. Furthermore, remittances have a positive and insignificant effect on exchange rate, while the volatility of remittances has an insignificant and negative influence on rate of exchange in Pakistan in the long-run.

ECT demonstrates the adjustment rate of the variable towards the equilibrium, while convergence in the short-run is depicted by the negative sign. In Table 6, panel B reports the short-run dynamics and shows that a long-run link and convergence exist in both the models. Table 7 reports the Granger causality test results. Its results showed that a two-way causality is there between exchange rate and the short-run volatility of rate of exchange in Pakistan. Moreover, two-way causality also exists among remittances and the volatility of remittances in the short-run in Pakistan.

**Table 7**

*Results of Causality Test*

| Model  | F-Statistics | Causality |
|--|--------------|-----------|
| Volatility of Remittances → Volatility of ER | .225         | No        |
| Volatility of ER → Volatility of Remittances | .045         | No        |
| ER → Volatility of ER                        | 4.585***     | Yes       |
| Volatility of ER → Exchange Rate             | 2.761***     | Yes       |
| Remittances → Volatility of ER               | .150         | No        |
| Volatility of ER → Remittances               | .334         | No        |
| Exchange Rate → Volatility of Remittances    | .314         | No        |
| Volatility of Remittances → Exchange Rate    | .334         | No        |
| Remittances → Volatility of Remittances      | 15.419***    | Yes       |
| Volatility of Remittances → Remittances      | 5.212***     | Yes       |
| Remittances → Exchange Rate                  | .973         | No        |
| Exchange Rate → Remittances                  | .919         | No        |

*Note:* \*\*\*, \*\*, \* shows significance at 1%, 5% and 10% respectively.

## Conclusion

The results of the mean equation of remittances and exchange rate showed that past remittances and rate of exchange have a significant effect on current remittances and rate of exchange in the GARCH model, while the variance equation of remittances and rate of exchange showed a high persistence of uncertainty in remittances and exchange rate. The results of ARDL model showed that exchange rate has a positive and significant impact on remittances, while the volatility of remittances and rate of exchange volatility both have a negative and insignificant effect on remittances in the long-run. The rate of exchange volatility has a significant and positive effect on exchange rate, while remittances and the volatility of remittances have a negative and insignificant effect on rate of exchange in the long-run. The results of the Granger causality test depicted that two-way causality exists between exchange rate and rate of exchange volatility as well as between remittances and the volatility of remittances in the short-run in Pakistan.

The following policy recommendations are suggested on the basis of the above results: firstly, the government needs to formulate policies for the stability of the rate of exchange; secondly, strong capital and financial markets are required to mitigate the risk of exchange rate and to protect international competitiveness.

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