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EXCHANGE RATE VARIATION AND THE AGRICULTURAL OUTPUT IN PAKISTAN: A TIME SERIES ANALYSIS

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ABSTRACT

This study investigates the impact of the real effective exchange rate on the agricultural sector in Pakistan. For empirical analysis, quarterly data covering the period 2007Q1-2021Q4 is used. Based on the unit root test, the long-term relationship between the real effective exchange rate, agricultural output, agricultural imports, and agricultural exports is estimated through the Johansen cointegration approach. A Vector Error Correction Mechanism (VECM) is used for short-term relationships between the real effective exchange rate, agricultural output, agricultural imports, and agricultural exports. Study findings reveal that the real effective exchange rate (REER) and agricultural exports have positive impacts on Pakistani agricultural output in the long run. While there is a negative relationship between agricultural output and agricultural imports in Pakistan. The State Bank of Pakistan should focus on the most appropriate exchange rate policy so that agricultural output thereby boosting agriculture exports. An increase in agriculture exports would raise the national output on one hand and it is a source of foreign exchange earnings on the other.

Keywords: Exchange Rate; Agriculture Sector, Cointegration

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1. INTRODUCTION

The agriculture industry plays a critical role in raising living standards and propelling economic growth forward. The agriculture industry, particularly in emerging countries, playss a vital role in their economic development. Because agriculture provides a large portion of GDP in developing countries, it is critical to expand and prioritize the agricultural sector for GDP to rise at a quicker rate. Pakistan has an agro-based economy, with agriculture accounting for a large portion of the country's GDP growing by 2.77 percent during the year 2019-20 (Economic Survey of Pakistan Report 2020-2021).

Apart from contributing to the GDP, it employs 70% of Pakistan's population. Even though industrialization has occurred, the agriculture sector plays a significant role in transforming people's socioeconomic circumstances. It satisfies local food demands and gives input to various local businesses. It also contributes to foreign exchange earnings by exporting agricultural raw materials, semi-finished goods, and finished items. As a result, the agriculture sector in Pakistan is crucial to the economy, and actions must be done to ensure its long-term development to continue to thrive and contribute to the country's prosperity. It is crucial to understand the critical variables that may contribute to the agriculture sector's sustainable development in Pakistan. Effective policies in this area can be established, and the agriculture sector may remain on track to achieve national prosperity.

2. LITERATURE REVIEW

The key goal of the monetary policy is to stabilize the currency and build up foreign exchange reserves are now driving monetary policy (Svensson, 2018). A solid and stable monetary policy makes it feasible to promote economic growth. The exchange rate system is a critical component of a country's economic development (Rodrik, 2008). The exchange rate is the value of a country's currency to other currencies (Krugman, 2001). Fixed and flexible exchange rates are the two types of exchange rates available (Rajan, 2012). The governing body determines the fixed rate, whereas the market decides the flexible rate without government pressure to stabilize money circulation. Although the country's excellent economic development rate exhibited suitable export growth, the exchange rate value increased owing to significant demand for the country's currency (Nurina, 2016). The steady exchange rate helps sustain capital market liquidity and attract investors, resulting in the desired economic growth (Wong, et al., 2005). On the other hand, a weaker currency would boost exports and make local producers more competitive. In the commodities futures markets, this causation may be shown more clearly. The exchange rate regime is critical for high international commerce, price stability, and appropriate monetary policy (Frieden, 2010). If the exchange rate and the gross domestic product have a positive relationship, farm export products will increase. Policymakers' principal aim is economic growth (Sokolov, 2011).

Hashmi et al. (2009) used the Vector Error Correction Model to investigate agriculture export and exchange rate volatility in Iran's economy (VECM). The primary goal of this research is to determine the impact of changes in the Iranian currency rate on agricultural export commodities. The findings of this study reveal that changes in the Iranian exchange rate do not affect agricultural exports in the short term. Still, in the long run, changes in the exchange rate have a beneficial influence on agricultural exports. The effects of the real effective exchange rate on

Turkish farm trade were investigated by Fidan (2006). The dynamic relationship of real effective exchange agricultural export and imports was studied utilizing vector autoregressive vectors. According to this study, REER has a lesser impact on export and import in the short term than it does in the long run. Using the Johansons co-integration approach, Mushtaq et al. (2011) investigated Pakistani wheat prices' monetary impact and macroeconomic variables. The study's main goal is to demonstrate that the money supply and exchange rate have a long-term impact on Pakistani wheat prices. According to the study's conclusions, trade openness had an impact on wheat prices, and it took three to four years for prices to stabilize. Salman et al. (2012) investigated the relevance of Pakistan's agriculture sector. He used the Johansen technique and the Error Correction Mechanism (ECM) methodology for this investigation. This research aims to determine the importance of the agricultural sector and whether it is necessary for achieving a given level of GDP growth. The study's major results are that agriculture has a large long-term impact on Pakistan's GDP growth and is strongly associated with it. The agricultural sector and Pakistan's GDP growth have the same relationship in the short term. Using the Co-integration and VECM, Elijah and Salau (2010) investigated agriculture's response to prices and currency rates in Nigeria. The study aims to look at how agriculture reacts to changes in exchange rates and comparable prices. According to this study, agricultural output responds favorably to exchange rate hikes and adversely to increases in food costs in the long and short term.

In Pakistan, the value of imports has always been more than the value of exports. (Irshad & Xin, 2017). As a result, Pakistan's trade balance is negatively impacted. As a result, our currency's external value has been steadily declining, meaning a progressive increase in the exchange rate over time. The exchange rate is a macroeconomic variable that influences FDI, international trade, unemployment, inflation, and GDP. While it is well acknowledged that the exchange rate has a significant impact on export and import because currency exchange rates impact the pricing of agricultural goods, they can pGDP a significant role in a country's agriculture industry's competitiveness; that is, there is a negative link between currency value and the number of exports. Importers will pay more for exports if the exporting country's currency is strong, making them less competitive unless local producers accept a lower price for their products.

In Pakistan, Kemal (2005) investigated the volatility of the exchange rate and commerce. He employed 3SLS to discover the association between the variables for this aim. The primary goal of this research is to determine the nature of exchange rates and their level of instability. The main findings suggest that an unstable currency rate has a beneficial influence on Pakistani exports but negatively impacts Pakistani imports. Mosavi and Leelavathi (2013) investigated agricultural export and exchange rates in India. They looked at secondary data from 1980 to 2010. This study aimed to identify the long-run link between these variables through causality analysis to test the existence of causality between exchange rate and agricultural export. They discovered that these variables are not co-integrated. They suggest no correlation between the exchange rate and agricultural exports in India. Changes in the exchange rate do not affect India's agricultural exports in the long run. Victor and Dickson (2013) investigated the relationship between Nigeria's agricultural output and the Real Effective Exchange Rate (REER). The study's main goal was to examine the relationship between these variables using co-integration and the ECM econometric technique from 1980 to 2011. Using this technique, they discovered that the REER is intuitive and positively associated with Nigeria's agricultural output. The study's findings also reveal that the prices of Nigeria's exports and agricultural product exports have a

large and favorable impact on the country's agricultural output. As a result, the REER plays an important role in agricultural output, and REER depreciation benefits agricultural output.

DATA AND ECONOMETRIC METHODOLOGY

For the period 2007Q3 to 2021Q4, statistics on agricultural exports, agricultural imports, agricultural output, and the real effective exchange rate were collected. The information was gathered from the WDI and the State Bank of Pakistan.

THE MODEL

The short-run relationship was tested using the Vector Error Correction Mechanism (VECM). The Vector Error Correction Mechanism (VECM) provides data on the short-term dynamics and long-term relationships between variables. In comparison to other methodologies, it also provides more information regarding the existence and strength of such a relationship. The error correction model's defined equation is:

$$\Delta AY_t = \alpha_1 + \sum_{i=1}^{p} \theta_i \, \Delta AY_{t-i} + \sum_{i=1}^{P} \delta_i \, \Delta X_{t-i} + \beta_1 ECT_{t-i} + e_{1t} \qquad (1)$$

$$\Delta X_t = \alpha_2 + \sum_{i=1}^{p} \theta_i \, \Delta AY_{t-i} + \sum_{i=1}^{p} \Delta X_{t-i} + \beta_2 ECT_{t-1} + e_{2t} \qquad (2)$$

Where Y_t is a measure of aggregate agricultural output in year t. X_t are variables which includes REER, agriculture exports and agriculture imports in year t, Δ indicating the difference, P is the number of lags, ECT represent the error terms derived from the long run relationship and e_{it} (i = 1,2,3…..) is the error terms with zero mean and constant variance.

UNIT ROOT TEST

The Augmented Ducky Fuller (ADF) test is commonly used to determine stationarity. We define stationarity as a series having a constant mean and variance. This study employed the Augmented Ducky Fuller Test (ADF) to check the unit root problem for time series stationarity.

$$\Delta Y_t = \alpha_t + \beta_t + \rho Y_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta Y_{t-1} + \varepsilon_t \qquad (3)$$

$$H_0 : \rho = 0 and \beta = 0$$
$$H_1 : \rho \leq 0 and \beta \neq 0$$

Where Y_t is the time series under investigation, Δ indicates the first difference, ε_t is the error term with zero mean and constant variance, t is a time trend, $\propto_t$, β_t , ρ and γ_i are the parameters. The acceptance of null hypothesis:

H: ρ= 0 implies that Y_t is nonstationary

The rejection of null hypothesis:

H: $\rho \neq 0$ implies that Y_t is stationary.

3. Empirical Results

TESTING DATA STATIONARITY

To test stationarity of this time series data used the standard Augmented Dickey Fuller test. The Augmented Dickey Fuller test results are presented in the Table 1

Table 1 UNIT ROOT TEST

Variables	Trend	Lags	ADF-statistics	Diagnosis
LA_Y	no	1	-1.93	I(1)
ΔLA_Y	no	12	-11.2*	I(0)
LE_RATE	yes	0	-1.47	I(1)
ΔLE_RATE	yes	2	-5.59*	I(0)
AGRI_XP	yes	1	-0.64	I(1)
ΔAGRI_XP	no	9	-11.26*	I(0)
LA_PM	yes	2	-2.87*	I(1)
ΔLA_PM	no	0	-11.17*	I(0)

Hints: * determined that the null hypothesis is to be rejected of non- staionarity of the given variables at 1% and level of significance

OPTIMAL LAG SELECTION

The ideal lag length must be chosen to examine the impact of exchange rate flexibility on Pakistan's agriculture sector. LR, FPE, AIC, SC, and other factors are utilized to determine the best lag length. When the sample size is small, the Schwartz Information Criterion (SIC) is acceptable; however, when the sample size is large, the Akaike Information Criterion (AIC) is more appropriate. This study uses quarterly data for analysis, which has a value of 140, which is low when compared to other criteria values, hence this study would choose Akaike Information (AIC). Table 2 table summarizes the results of these lag selection criteria.

Table 2 Optimal Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	309.5614	NA	4.54E-08	-5.555661	-5.457462	-5.515831
1	**885.0175**	**1098.598**	**1.74e-12***	**-15.72759***	**-15.23659***	**-15.52844***
2	888.1728	5.794368	2.20E-12	-15.49405	-14.61026	-15.13558
3	892.8815	8.304478	2.71E-12	-15.28876	-14.01216	-14.77096
4	900.8796	13.52395	3.15E-12	-15.14327	-13.47388	-14.46615
5	938.0061	60.07744	2.16E-12	-15.52738	-13.4652	-14.69095
6	941.664	5.653105	2.74E-12	-15.30298	-12.848	-14.30723
7	944.84	4.677401	3.53E-12	-15.06982	-12.22204	-13.91474
8	949.7287	6.844119	4.43E-12	-14.86779	-11.62722	-13.5534
9	982.0396	42.88539*	3.40E-12	-15.16436	-11.53098	-13.69064

It is clear from the given analysis that our optimal lag length is 1.

JOHANSEN COINTEGRATION TEST

The identification of the integrating vectors analysis is the next stage. If no co-integrated variables are found, we cannot proceed with the analysis; however, if at least one or more co-integrated equations are found, the study can proceed with the analysis. Normally, two separate criteria are utilized for co-integrating analysis. The Trace statistics and the Maximum EigenValue test are two examples. The cointegration relationship between the variables is determined using the trace statistics criterion in this study. The results of the Trace statistics test are presented in Table 3.

Table 3 Johansen Co-integration Test Based On Trace Statistics

Null Hypothesis No of CE(s)	Alternative hypothesis	Trace Statistics	Critical values	P Value
r=0*	**r=1**	**57.38814***	**53.07904**	**0.0196**
r≤1	r=2	33.13809	34.19275	0.0647
r≤2	r=3	14.19970	19.26184	0.3481
r≤3	r=4	4.53005	9.264546	0.3261

Hints: Trace test indicates 1 co-integrating equation at the 0.05 level* shows that the null hypothesis is rejected at the 0.05 level

The study's empirical results show that there is one co-integrating equation in this study's analysis as shown in table 3

CO-INTEGRATION EQUATION NORMALIZED

According to our analysis' cointegration test, there is just one cointegrating equation. Here, normalizes the co-integrating vector on agricultural production by assessing the long term relationship between the remaining indices and agricultural output (AY). The normalized co-integration, which is shown in Table 4, indicates a consistent link between agricultural output, real effective exchange rate, agricultural exports, and agricultural imports.

Table 4 Johansen Cointegration Results

Lag Variables	Coint-Eq	Standard Error	T-value
LA_Y(-1)	1.00000	-----	----
LE_RATE(-1)	-6.377103	1.13752	-5.60617**
AGRI_XP(-1)	-4.100805	0.91407	-4.48632**
LA_PM(-1)	3.514062	0.63423	5.54066**
C	13.37207		

Hints ** indicates the variables are significant at 5% level of significance

A reduced form equation between agricultural output and all of the other variables can be used to show the above long-term relationship, which is normalized. Long-run can be stated in the following equation form:

$$LA\_Y = 13.37 - 3.51LA\_MP ** + 4.1AGRI\_XP ** + 6.37LE\_Rate **$$

The long-run link between agricultural output, agricultural imports, agricultural exports, and the real exchange rate in Pakistan is depicted by this cointegration relationship. According to the equation above, a 1% increase in agricultural imports causes a 3.51 percent decline in agricultural output, whereas a 3.51 percent rise in agricultural output causes a 1% decrease in agricultural imports. Furthermore, a 4.1-unit increase in agricultural exports will result in a 6.37-percent gain in agricultural production, whereas a one-percent increase in the real exchange rate will result in a 6.37-percent increase in agricultural output. In Pakistan, agricultural output and agricultural imports have an inverse relationship in the long run, whereas agricultural output has a positive association in the long run with agricultural exports and real exchange.

VECTOR ERROR CORRECTION ESTIMATION

Using the VECM, the findings of Pakistan's exchange rate and agriculture sector in long-run correlations can be enhanced. Some exogenous shocks cause the long-run relationship between the variables to be disrupted. According to the Granger theorem, the presence of cointegration implies the presence of error correction. The quest to comprehend the short-run adjustment in the long-run correlations between agricultural output and exchange rate has led to the development of this mechanism. The ECM is reported in the table below 5 in this analysis.

Table 5 Vector Error Correction Estimation

Vector Correction	ΔGDP
C	0.017827**
LA_Y(-1)	-0.015026
LE_RATE(-1)	-0.219166
AGRI_XP(-1)	0.127692
LA_MP(-1)	0 .043995**
ECT	**-0.075178****
R-squred	0.608879
Adj R-squared	0.546275
Standared Error of Regression	0.093502
F-statistics	9.922299

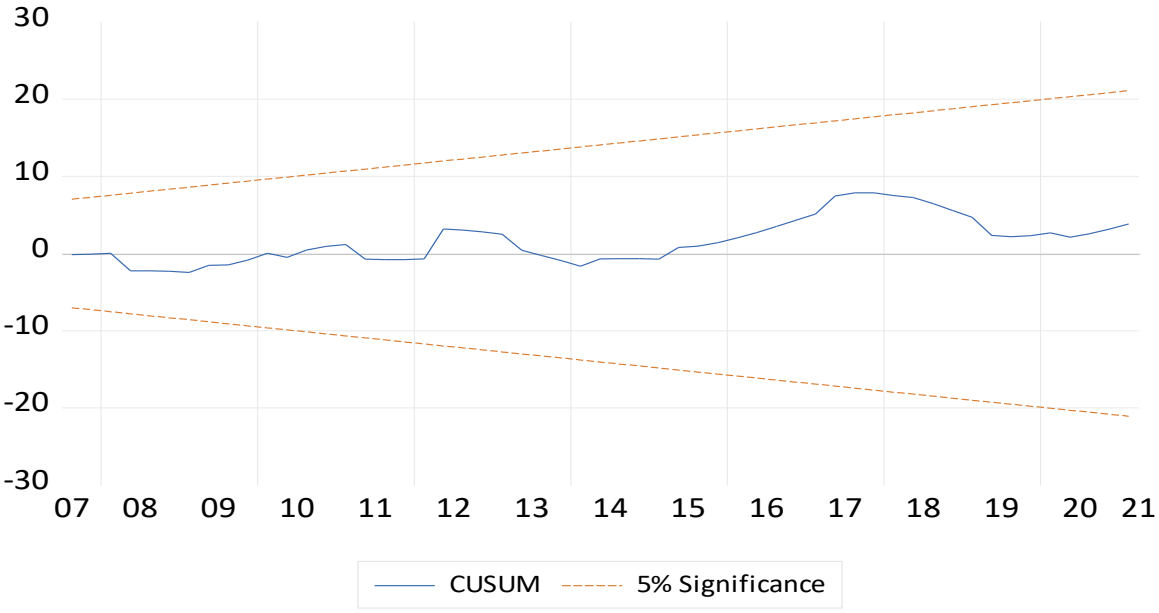
Hints : ** means variable is significance at 5% level

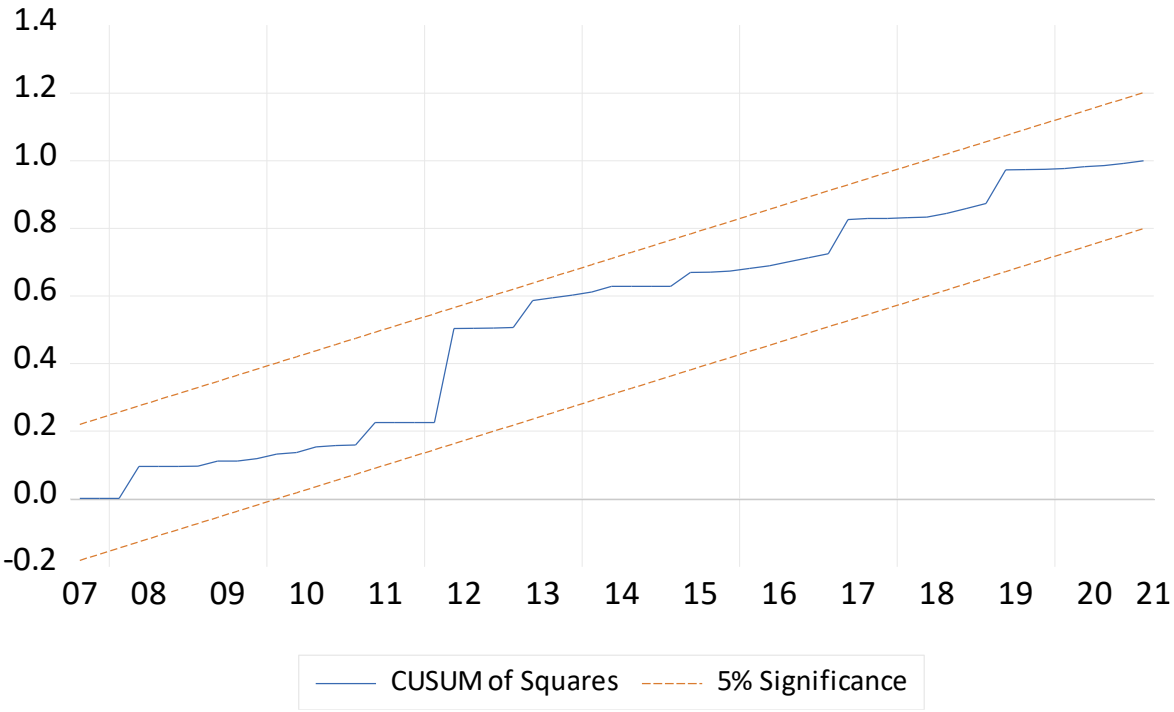
The speed of adjustment from short-run to long-run equilibrium is indicated by the error correction period. The error correction term is ECT, and its value is both statistically significant and has a negative sign. As a result, the long-term relationship is confirmed. This also demonstrates the rapidity with which the system adjusts from short-run disequilibrium to long-run equilibrium. The coefficient (short-term elasticities) of lag values in the ECM is shown in table 5. The coefficient for error correction (ECT) has a (-) sign with a significant t-statistics, indicating that the error reduces over time. According to the Granger theorem, a portion of the disequilibrium caused by the external shock can be adjusted over time (Engle and Granger 1987). The ECT directs the variables to re-establish equilibrium. In other words, it restores the system's equilibrium. In this study, the ECT coefficient is significant and has a negative sign, indicating that there is a long-run equilibrium relationship between the variables. According to this study's analysis, 7.4 percent error correction occurs in the co-integrating equation due to the negative sign of the error correction term (ECT). As a result of the preceding findings, it can be concluded that there is a short-term and long-term relationship between the agricultural sector (agricultural imports, agricultural exports, and agricultural output) and the exchange rate. The mistake correction terms are statistically significant, indicating that 7.4% of errors are corrected every quarter. The ECT sign is negative, indicating that the error is decreasing over time. The ECM's findings are also linked to multivariate Causality results.

Table 6 Diagnostic Tests

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	1.345088	Prob. F(2,71)	0.2671
Obs*R-squared	3.030046	Prob. Chi-Square(2)	0.2198
Harvey Test for Hetroskedasticty			
F-statistic	1.449060	Prob. F(9,73)	0.1836
Obs*R-squared	12.58052	Prob. Chi-Square(9)	0.1825
Scaled explained SS	15.04294	Prob. Chi-Square(9)	0.8908

The above tables show that p-values are greater than 5% so we accept the null hypothesis and conclude that there is no econometric problem. For the stability of our model, we are using the Cumulative Sum of Square test. The stability of model is indicated by Cumulative Sum of Square as shown below





The cumulative sum and the cumulative sum square (CUSUM) test results indicate that the model is stable because the CUSUM lines fall between the two five percent (5%) lines. So, our model is stable.

4. CONCLUSION

This research looks at the dynamic relationship between Pakistan's real effective exchange rate and its agriculture industry from 1980 to 2020. For empirical analysis, the Johansen Co-integration approach and the Vector Error Correction Mechanism (VECM) are utilized. To determine the causative relationship between agricultural output, agricultural imports, agricultural exports, and the real effective exchange rate, the simple Granger causality technique is applied. For data stationarity, the Augmented Ducky Fuller (ADF) econometric technique is applied. One cointegrating equation is found using the Johansen cointegration approach. It means that agricultural outputs, agricultural imports, the real effective exchange rate, and agricultural exports have a long-term relationship.

The empirical findings reveal that agricultural output, agricultural imports, agricultural exports, and the real effective exchange rate all have a substantial link. In Pakistan, there is a negative correlation between agricultural imports and agricultural output. This implies Pakistan imports more consumer goods such as cooking oil, veggies, and so on. As a result, its agricultural imports have a detrimental influence on output. In the long run, the real effective exchange rate (REER) and agricultural exports have a large positive impact on Pakistan's agricultural output, according to the study's second finding. The depreciation of Pakistan's real effective exchange rate showed a positive correlation with agricultural output. Agricultural exports increased when the REER depreciated, and agricultural output increased when agricultural exports increased. If a result, as agricultural exports rise, agricultural output rises as well, and vice versa.

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