Mapping the Causal Connections between Exchange Rate Fluctuations and Agriculture Production: New Evidence from Pakistan Utilizing Cointegration Analysis

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Abstract

This study is on the foreign exchange rate and export sector and its impact on macroeconomic variables. The objective is to research the experiential association between the rate of exchange and the export sectors of Pakistan. The time series data has been used which covered 1980- 2021. In this study, we used three major sectors that have been selected for this research with the Agricultural sector as the dependent variable. Rate of exchange, foreign direct investment, rate of inflation, and interest rate are being used as explanatory variables in this study. For the long run and short run estimation among variables; we used the Auto regressive distributed lag model (ARDL). The long-run findings of this study illustrated that in the model, the exchange rate is a positive and significant impact on agriculture production. Foreign direct investment, money supply (M2). Trade openness has a positive and significant impact on agriculture.

Key Words: Foreign Exchange rate, Agricultural Sector, Pakistan, Autoregressive Distributed Lag Model
JEL Codes: F31, Q17, C50

1   Introduction

Agriculture is a backbone of food security, a key source of raw materials for a variety of businesses, and a significant contributor to exports. Agriculture, food security, and economic growth are all intertwined in the development process and mutually beneficial. Because Pakistan is an agrarian country,

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increasing agricultural productivity is a must for achieving food security (Rahman & Khan 2019). Agriculture generates 19.3% of Pakistan's GDP, employs 42 percent of the workforce, accounts for 65 percent of export earnings, and supports 62 percent of the country's population (Government of Pakistan, 2019). Pakistan's agriculture sector has encountered numerous key obstacles in the last decade, including exchange rate volatility. The agriculture sector, like any other, is heavily influenced by exchange rate movements, both directly and indirectly (Frieden 2014; Bahmani and Xu, 2012). This is typically the case for the sector's import of raw materials and other sophisticated farm equipment, as well as the export of their output (Mustafa et al., 2004). Pakistan imports oil, which is utilized in agriculture as a raw resource. The agriculture sector's performance in 2020-21 is generally positive, with a growth of 2.77 percent versus a target of 2.8 percent.

The exchange rate is a key macroeconomic indicator and the foundation of international trade. Exchange rate fluctuations have played a significant impact in determining the trade balance. A volatile exchange rate delays commerce destabilizes capital flows and undermines investor confidence in a country with high exchange rate volatility, all of which slows GDP (Kemal & Qadir 2005). The rate of exchange between two coinages is the pace at which a single legal tender has been toggled for further. The rate of exchange has a significant collision on the revenue of global management. The transformation in rate exchange as well influences the value of abroad reserves detained by corpse sponsors. If Pakistan's rate exchange is Rupees 100 to $1, consequently it acquires 100 Rupees to get a buck or a dollar's charge of services and goods. From the conflicting standpoint, a dollar purchases 100 Rupees, utilize to give for Pakistani services and goods. A state is extra tending to include a deficit in its accessible description the prominent its price level, the superior it's Gross National Product the sophisticated its rate of interest, the easier its limitations to trade in, and the extra appealing its conjecture opportunity all difference and situations in diverse states and the superior its rate of exchange. The effects of alter in one of these features on the present balance account insincerity be predictable lacking arrogant the shock on the further informal fundamentals, if the organization increases duty, the public will acquire less import; consequently, decrease the account of the

current deficit. Thus far this diminishing will occur now if one of the swap features alters to attain a decrease in the capital account excess. In the occasion that nothing of these dissimilar features transform, the tapering import since the task increase will reason reduce the demand for abroad coinage, which therefore will elevate the value of the dollar. The growth in the value of the dollar will make exports extra expensive and imports cheaper to offset the bang of the duty addition (Hassan & Aljarrallah 2021).

The financial crisis has been faced by experienced economics, but international trade declined in the crisis of 2008. Hence, then the world economy has a way to recover. In the report of WTO (World trade organization 2010), 9.5 percent of world trade has grown, following the depression of 2009 international trade faced a sharper decline during the period of a further 70 years. The reclamation of 2008/2009 has been an inspiring signal for global trade, and it investigated that the world economy was fast recovering. Since World War II the huge decline in world trade found and experienced a contraction of about 12.2 percent. So, the various developed economies like the USA, EU, and Japan experienced a decline in trade volume. While the oil exporting economies had experienced a less decline in trade volume to the connection of large industrialization economies like the Middle East at 4.9 percent, South and Central America at 5.7 percent, Africa at 5.6 percent, and Asia at 11.1 percent and China at 10.5 percent.

2   Literature Review

A three-stage least square technique was used to analyze quarterly data from 1982-I to 1996-IV, Akhtar and Malik (2000) investigated large movements in Pakistan's exchange policy. Four sectors textile, export, commodity and manufacturing sector were used in research and applied the cobb-Douglas production function in paper. The dependent variable was real gross domestic product and the Consumer price index, nominal exchange rate, and wholesale price index were independent variables. The study's findings described the impact of bilateral pricing and income on Pakistan's commerce.

Wang and Barret (2002) used annual time series data from 1989 to 1998 to estimate trade degree effects of real exchange rate risk. The dependent variable was export volume, whereas the

explanatory factors were real exchange rate and real exchange volatility. The findings suggest that actual exchange risk had little impact on most sectors of the economy, however, the agriculture sector was the most responsive and had an inverse impact on trade volume.

Irfan (2011) discussed the rate of exchange volatility and export expansion in the economy of SAARC ASEAN countries like Pakistan and regional markets, quarterly data from 1991: Q3-2004: Q2 was utilized in estimation. For analysis, econometric approaches such as ECM and co-integration were used. Results exhibit mixed findings like trade had inverse and significant smack in long as well as short run-in case of US, UK and Australia while less effective on Pakistan and no result found to observe these relationships in case of Malaysia and New- Zealand. Shirazi et al. (2004) looked at the impact of exports on Pakistan's economic growth by using time sequence data from 1960 to 2003 and variables Gross domestic product, real exports and imports were used. The Granger causality test, autoregressive model (VAR), and Johannes approaches were used, and the results revealed that three variables were linked. In long run, imports and exports had a strong relationship, whereas exports and imports did not. With 120 observations and annual time series data from 1973 to 2003, Azid et al., (2005) studied exchange rate volatility's impact on economic growth. Real money, exchange rate, export, import, Consumer price index, and real exchange rate were the variables studied using econometric approaches ARCH and GRACH models. As a result, the exchange rate and economic growth had a negative and non-significant relationship.

Kamil (2006) investigated the flexibility of exchange rate that caused misbalance in firms' balance sheets spanning data from 1992-2005 used for this estimation. Total foreign currency Denominated liabilities over total liabilities worked as the dependent variable while FLEX (floating exchange rate) exported as independent variables. Outturn manifested that adoption of floating rate of exchange regime pushes currency upward in the balance sheet. Firms must be risk takers for the achievement of higher returns. Chimnani et al. (2006) explored the consequences of the exchange rate on unemployment in 10 Asian countries spanning panel data taken from 1995-2005 for estimation. Econometric techniques co-efficient and OLS (ordinary least

square) approach applied for analysis. Unemployment worked as the dependent variable and exchange rate, net exports, real interest rate, Gross domestic product, and labor productivity were independent variables. Ramification showed a positive and significant bond between unemployment and exchange rate in the case of Asian economies.

Musonda (2008) used annual data from 1965 to 1999 to validate the Zambian economy's exchange rate volatility and non-traditional export activities. The dependent variable was nontraditional export, foreign income, terms of trade, the real effective rate of exchange, and real effective volatility exchange rate were explanatory factors. For measurement, GARCH, ECM, and unit root tests were used. Results showed that the volatility exchange rate had an inverse impact on exports in both the long and short run. Raddataz (2008) employed autoregressive distributed lag (ARDL), as well as ARCH and GRACH models, to evaluate exchange rate and trade exports in South Africa from 1980 to 2004. The exchange rate was a dependent variable, whereas trade and GDP were independent variables. Exchange rate fluctuation had a negative impact on trade and exports, according to the findings.

Colaccelli (2009) used sector data from 1981 to 1997 to analyze export retaliation to real-time volatility. Estimating approach used the ordinal least square (OLS) econometric technique and the dependent variable was trade, together with the gross domestic product, real exchange rate, and GDP deflators. Results revealed sectorial export elasticity, with the discrimination sector having higher elasticity than the homogeneous sector. Javed and Farooq (2009) from 1982 to 2007, Auto Regressive Distributed Lag (ARDL) model was used to investigate the impact of economic development and the rate of exchange volatility in Pakistan. Economic growth was a dependent variable, with volatility in imports, real exports, revered money, and manufacturing products serving as independent factors. According to the study's findings, exchange rate volatility reveres money, and exports had a beneficial effect on economic growth in the long run, although the statistical value of imports and exports was low. In the short run, the volatility of the exchange rate between manufacturing exports and imports had a detrimental impact on economic growth. Ozturk and Kalyoncu

(2009) used quarterly data from 1980 to 2005 to estimate volatility in exchange rates and trade, as well as cross-country comparisons and repercussions on Pakistan's economy. For analysis, econometric techniques ADF and a regression model were used. Foreign activity, real exchange rate, relative price, and volatility exchange rate were dependent variables, whereas real export was an independent variable. Data indicated that real exchange rate volatility had an opposing and considerable impact on trade in South Korea, Pakistan, Poland, and South Africa, whereas it had a positive impact on Hungary and Turkey in the long run. The relationship between exchange rate and macroeconomic variables in Pakistan's agriculture industry is investigated empirically. In this part, we estimated one sector statistically and also give the findings during the apply diverse method, techniques and tests. And apply the Autoregressive distributed lag (ARDL) technique to estimate the model. The exchange rate is the important independent series that use in this model.

The uneven impact of the currency rate on the agriculture sector was neglected in a study by Fiaz et al. in 2021. A nonlinear autoregressive distributed lag (NARDL) framework is being used in the current study to look into the potential asymmetry of the impact of exchange rate changes on the agriculture sector. The data set spans the years 1970 to 2019, and it was compiled using information from the State Bank of Pakistan's manual and the Ministry of Finance. Real effective exchange rate, agricultural production, inflation, main export, government investment, terms of trade, imports, and exports are the variables considered in the study. The research series' mix of stationary and non-stationary variables was validated using the ADF unit root test. The study employs the ARDL strategy as a result, but since the NARDL technique is also used, the emphasis is on exploring the asymmetric effect. According to the NARDL data, both short- and long-term consequences of positive exchange rate changes on the agricultural sector are less significant than those of negative ones.

3   Results and Discussion

In this section, we examine the exchange rate and agricultural sector analysis of descriptive and matrix of correlation. In this study, the tendency of central analysis of descriptive is revealed in table one and to verify the association

between the particular model the correlation of matrix used that expresses the association among the series in table two.

3.1   Descriptive Analysis

The first part of this section explains the descriptive statistics for each series that we are using in our study. All data series are intended for the State Bank of Pakistan and the world development indicator (WDI). This section displays each series' median, standard deviation, mean, kurtosis, and skewness. Although exchange rate, foreign direct investment, inflation rate, and interest rate were employed as explanatory variables in our study, agriculture was used as a dependent variable. This table depicts the mean term, which is the average term in statistics, and the standard deviation value, which represents the variances and oscillations in statistics. The value of kurtosis illustrates the Peakness of the series.

Table: 1
Variable Descriptive Statistics Results

Variables	Mean	Median	Std. Dev	Skewness	Kurtosis
AGRI	6.471118	2.726850	6.168580	0.915703	2.394634
EXR	48.01054	45.04667	30.42669	0.444102	1.938143
FDI	141483.6	24327.10	508882.6	5.589829	33.13545
INF	8.401607	7.921084	3.802016	0.662377	3.805356
M2	44.02126	43.25191	6.245616	2.589990	10.96149
TO	83.52392	88.93000	19.08421	-0.146672	2.167083

Source: Author's calculation's E-views 9.0

Descriptive statistics analyze the essential characteristics of data, such as the data sequence's Minimum, Maximum, Mean, and Standard Deviations values. The average value of the Interest rate is 12.03 and the standard deviation is 1.96 which presents the volatility of variable Interest rates. The average value of Money supply (M2) is 44.02 and its standard deviation is 6.24 which measures the mean of speed in Money supply (M2). The average value of Trade openness is 83.52 and its standard deviation is 19.08 which illustrates the lower variation in Trade openness. If the skewness number is less than zero, the distribution is negatively skewed. If the value of skewness is equal to zero, then the distribution will be symmetric. In this table we examine the value of skewness of these variables that explain all the variables are positive skewness but the Interest rate and Trade openness.

Kurtoses determine both tails and Peakness. Such as the Agriculture Exchange rate, Inflation rate, and Trade openness are platykurtic distribution while the kurtosis is greater than 3 than its means leptokurtic like foreign direct investment, Money supply (M2). The slanting alignment certain validates the duo sage correlation of chosen series to dimensions sculpts for that research.

Table: 2
Results of Correlation Analysis of Variables

	AGRI	EXR	FDI	INF	M2	TOT
AGRI	1					
EXR	-0.7774	1				
FDI	-0.2291	0.1797	1			
INF	-0.0331	0.0457	0.4562	1		
M2	-0.2948	0.3495	0.0893	1		
TO	0.4412	0.7086	0.3024	0.1532	1	

Source: Author's calculations

In this table, we explicate the correlation investigation. Table 2 explains the correlation between variables. Although to matrix Agricultural is strongly correlated with, Rate of exchange, foreign direct investment, Rate of inflation, M2 and trade openness wherever it is negatively correlated among, Exchange rate, foreign direct investment, Inflation rate, and Money supply (M2). Interest and M2 and trade openness are negatively moderate correlate with the foreign direct investment are -0.30.

The method a generally used by investigators to verify the non-stationary and stationary data. Fuller-Dickey (1979, 1981) describes a set of steps to investigate the time series for stationary and non-stationary.

This table summarizes the results of the ADF unit root test. Outcomes of a few of the study's series are revealed in their levels of stationary, while others will differ. All subsequent variables twisted to stationary once the first difference was made. Because the probability value is bigger and there is no substantial, the agricultural value at the level is not stationary. The agricultural difference is substantial in the first case, with a probability value of less than 0.05. So, our concern for agriculture is based on the first distinction I made (1). Because there is no substantial and the

probability value is bigger, the value of the exchange rate is not stationary at the level. The exchange rate is significant in the first difference, and the likelihood is smaller than 0.05. The first difference is where the exchange rate is found (1).

Table: 3
Unit Root Test Results Using the ADF Method

Variables	Test for a unit root in	By including	t- Stat	Prob.	Remarks
AGRI	Level	Intercept	-1.37148	0.5845	I(1)
	Level	Trend & intercept	-3.40368	0.6667	
	Level	None	-2.407924	0.1745	
	1st difference	Intercept	-9.35874	0.0000	
EXR	Level	Intercept	1.90605	0.9997	I(1)
	Level	Trend & intercept	-1.64605	0.7497	
	Level	None	2.92369	0.9986	
	1st difference	Intercept	-3.676730	0.0098	
	1st difference	Trend & intercept	-4.49864	0.00062	
	1st difference	None	-0.88376	0.3247	
FDI	Level	Trend	-5.10963	0.0002	I(0)
M2	Level	Intercept &Trend	-3.18378	0.1051	I(1)
	Level	None	0.821284	0.8846	
	1st difference	Intercept	-4.20797	0.0022	
	1st difference	Trend & intercept	-4.36776	0.0074	
INF	Level	Trend	-3.72789	0.9004	I(0)
	Level	Intercept &Trend	-3.590076	0.0497	
TO	Level	Intercept	-1.832818	0.3592	I(1)
	Level	Trend & intercept	-1.72605	0.7188	
	Level	None	-0.93916	0.30333	
	1st difference	Trend	-4.557209	0.0009	
	1st difference	Intercept & trend	-4.49528	0.0053	

Source: Author's calculations

The part symbolizes the aspect analysis in the long run and explicates the affiliation among macroeconomic variables and exchange rate in feature. It explains the coefficient in the long run of the ARDL model. Agriculture is a dependent variable in the original model, The exchange rate, trade openness, foreign direct investment, broad money M2, and inflation, on the other hand, are all independent variables.

Table: 4

Long-run Estimation of ARDL Models, Model-I

Variables	Agricultural sector Model D:V: AGRI, ARDL (1,0,3,2,1,2)
EXR	0.22176
	(0.0000)
FDI	0.00001
	(0.0572)
INF	0.4567
	(0.0081)
M2	0.216319
	(0.0174)
TO	0.163731
	(0.00084)

Source: Author's calculation

This research illustrates the findings of our initial model. The Exchange Rate is the first explanatory variable. The coefficient of the Exchange rate shows it had an impact positive on Agricultural in Pakistan. The exchange rate is significant for agriculture, demonstrating that a 1% increase in the exchange rate has a major impact on Agricultural to 0.21%. The possible reason is the increase in IM function mostly during the price channel, coinage reduction influences IM.

The findings are linked with Ali (2017). The second independent variable is Foreign direct investment, and the coefficient is 0.0001, which is statistically significant. The value of FDI is a 1% increase in FDI that will increase the independent variable by 0.0001. Our result supports Anwar et al. (2013). The third independent variable is trade openness, and its coefficient value is 0.16371 and there is statistically positive significance. The value of trade openness is a 1% increase that will increase Agricultural by 0.16371. If the value of trade openness will boost it also expand agricultural exports. The findings correlated with Anwar et al. (2013). The fourth independent variable is money supply (M2), and the value is 0.126319 and it's statistically

positively significant. The value of M2 is a 1% increase in M2 that will increase in agriculture by 0.126319. With the application of monetary policy, the agricultural cost raises the income of farmers is elevated. Our findings will support Haye (2009). The acute value taking was presented by Pesaran et al. (2001) by two alteration levels; upper bound and lower bound level. If F-value is surpassing the upper perilous value, then the null hypothesis of no cointegration is forbidden. If the value of a lower F-value, then we cannot discard the null hypothesis and if the value of F-statistics is under the upper and lower bound then the trial develops unfounded.

Null Hypothesis: $\alpha_1 = \alpha_2 = \alpha_3 \ldots \ldots \ldots \ldots .. = \alpha_8 = 0 \, (No Cointegration)$

Alternative Hypothesis: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \ldots \ldots \ldots \ldots \alpha_8 \neq 0 \, (Co-integration \, exists)$

Table: 5
Bound Test for Long Run Relationship

Models	F-Statistic	At 5% Significance level		At 10% Significance level	
		Lower bound	Upper bound	Lower bound	Upper bound
	3.53629	2.39	3.38	2.08	3

Source: Author's calculations with the help of E-Views 9

The bound test results are shown in this table. The F-statistic value in model 1 is 3.53629, which is substantial, and the significant value is 3.38 and 3, indicating that the F-statistic value is greater than the bound upper at 5% and 10%. As a result, the null hypothesis will be rejected, which states that the model lacks co-integration, and admit the alternative hypothesis. As a result, the model is tested to see if the variables have a long-term relationship with co-integration.

Various diagnostic tests were employed to assess the Autocorrelation, heteroskedasticity models miss specification in the functional form, and the test that the residuals in the current study's models are normally distributed to determine the model's goodness.

Table: 6
Diagnostic Test for Model

Name of test	F-statistics value	Probability
Breush-Godfrey correlation LM test	0.36783	0.9640
Heteroskedasticity	0.912962	0.5742

Source: Author's calculations

The LM test tells us if the F-value is superior then the p-value is 0.05 so we cannot reject the null hypothesis and nope the alternative hypothesis. And F-value is less than the p-value of 0.05 so we accept the alternative hypothesis and reject the null hypothesis and serial correlation exists. The above table shows that model one Breush- Godfrey LM test is F-statistic is 0.3678, and the probability value is 0.3678. Model one probability is greater than 0.05. The null hypothesis is un-rejectable and there is no serial correlation in this model.

3.2   Error Correction result

The short period estimation illustrates that the variables are associated with the short run. The short period co-integration value has to be equally negative and must be significant. The disparity between real and actual values is described error correction model (ECM). While two situations are fulfilled then the short run exists. ECM must be negative and statistically significant.

Table: 7
Error Correction Result

Variables	Model I Agricultural export sector model D:V: Agri, ARDL(1,0,3,2,2)
D(EXR)	-0.132996 (0.2510)
D(EXR(-1))	----------
D(EXR(-2))	----------
D(TO)	0.119054 (0.0644)
D(TO(-1))	0.162434 (0.0193)
D(TO(-2))	0.22343 (0.0009)
D(FDI)	-0.0002 (0.0642)
D(FDI(-1))	-0.0002 (0.0482)
D(FDI(-2))	----------
D(INF)	0.128976 (0.5783)
D(INF(-1))	----------
D(INF(-2))	---------
D(M2)	-0.054928

	(0.5991)
D(M2(-1))	-0.417934
	(0.0109)
D(M2(-2))	-------
Coin Eq (-1)	-0.699120
	(0.0000)

Source: Author's calculations

      In this model, The Coint Eq (-1) coefficient is -0.699120 and the negative mark of the coefficient illuminate to it is going to converge across more than six months.

4   Conclusion

      This section is separated into two elements. The main element steady of the conclusion is that we will compress the outcomes of the investigation. The second element is policy commendations that we will deliver a little proposal on depending on these findings. At the present, we will provide aspect entirely the findings in a moment. The main drive of this investigation is to become the effect of the foreign exchange rate and the agricultural sector in Pakistan. In the current study, we have used time series which covered 1980-2021. In a time, series investigation, it is essential that the first illustration of the integration of order of the series below deliberation be verified to evade regression specious findings. The Augmented Dickey Fuller test was applied in this study for this drive. The findings illustrate that the series of this research have mixed integration order. Two variables are originated elect integrated of order zero and six variables are assimilated order one. In this condition, the appropriate methodology of time series to use is the Auto regressive distributed lag model (ARDL) method.

      According to the long run findings of the Autoregressive distributed lag approach, the rate of exchange has a positive and statistically significant association among the export sector of Pakistan and also its lag dependent variables of each sector that show and sustenance the amount of literature signifying the optimistic association on sector export and rate of exchange that means the devaluation in the state increase the exports. The results shown in model one are, that trade openness is positive and significant. Money supply (M2), the rate of exchange has positive and significant and foreign direct investment has negative and insignificant.

In the Diagnostic test as well, insignificant illustration of no occurrence of any Heteroskedasticity and autocorrelation. By showed formerly in the investigation of the research that sector export has a solid optimistic association with the rate of exchange, which proposes the value effectiveness of foremost Pakistan exports and there is an essential for the policy of rate of exchange that sustenance the sector export. By that, there is a vital necessity for the firmness of disaster of the energy and divergence of the whole export vile. In the country of Pakistan with little intercontinental trade alignment and divergence beside from shortage of financial souk growth by firms exporting might be nope mitigate the peril related with the rate of exchange activities, the government and exporters would drill a long tenure strategy to eradicate the lacks existing in financial organization and economic.

5   Policy Implication

The findings show that the government must take steps to increase the export sector's productivity. The government can grant product subsidies to increase exports and make these products more competitive in foreign markets. Pakistan may continue to import necessary raw materials for value addition as well as needed technologies to boost capacity and productivity. Pakistan's exports should be boosted to help the country's financial markets develop.

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