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Testing the neutrality of money, labor, and capital in Pakistan's agriculture sector

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Abstract

This study investigates the neutrality of money in Pakistan's agriculture sector by analyzing semi-annual data from 1991S1 to 2019S2. We employ the impulse response function, variance decomposition, Johansen cointegration, VECM, and the Granger causality test. The Johansen cointegration approach demonstrates a continuous relationship between the variables over time. The Granger causality test indicates no short-term causal relationship between agricultural productivity and the broad money supply. On the other hand, agricultural production has a short-term causal relationship with inflation and capital. Long-term outcomes corroborate the empirical findings of the cointegration test, suggesting the existence of a cointegration connection. The impulse-response and variance decomposition tests indicate that the broad money supply has a statistically significant positive effect on short- and long-term agricultural productivity. On the other hand, inflation has both short-term and long-term detrimental effects on agricultural productivity. Meanwhile, short-term and long-term labor and capital shocks symmetrically affect agricultural productivity. Consequently, our results refute the long-term money neutrality hypothesis. The results of this paper will assist policymakers and researchers in gaining a more comprehensive understanding of the impact of inflation, labor, capital, and the broad money supply on Pakistan's emerging economy.

Keywords: Agricultural, Capital shocks, Labor, Pakistan, Money supply, VECM.
JEL Classification: E41; F66.

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Contents

Contribution of this paper to literature
Implementing Pakistani monetary policy raises questions about the impact of money supply on agricultural productivity. The study investigates the monetary neutrality of Pakistan's agriculture sector, aiming to identify solutions and answer these questions. It examines the effects of money supply on agricultural productivity and evaluates the long-term market neutrality (LMN) in the sector.

1. Introduction

In macroeconomics, selecting the right policies and methods to reduce inequality, ensure stability, and enhance economic growth and development is essential. The central bank uses monetary policies to attain objectives such as controlling inflation, providing an environment favorable to increasing output and employment to maximum levels, and sustaining the currency's value. By changing the money supply and interest rate, these policies can achieve various economic goals, including enhancing economic growth, creating employment, and maintaining price levels (Arani, Ghasemi, & Safakish, 2017). However, one of the most contentious economic issues is the effectiveness or ineffectiveness of monetary approaches in actual variables (also known as the neutrality of money in the economy). The two main hypotheses that explain this association are long-run money neutrality (LMN) and long-run super money neutrality (LSMN). According to the LMN hypothesis, a permanent change in the money supply has no long-term effect on the level of actual variables. In contrast, the LSMN hypothesis argues that a permanent change in the money supply growth rate has no long-term impact on the level of actual variables (Ekomie, 2013). Diverse schools of thought, including classical, Keynesian, and monetarist, have different perspectives on the function of money in the economy.

The Irving-Fisher Quantity Theory of Money supports the classical monetary theory, the first theory of monetary policy that most people agreed on, by demonstrating the link between economic data and monetary policy. Increasing the money supply does not affect real prices, jobless rates, or the real economy. Instead, it raises all prices and wages in the same way. In the past, money neutrality was an important part of classical economics. However, a new study shows that it doesn't always hold (Ahmed & Suliman, 2011). However, the new Keynesian argues that because of imperfect market information transmission and price rigidity (price stickiness), money supply changes appear to have a short-term influence on actual variables such as gross domestic product (GDP) and employment levels (Ahmed & Mortaza, 2010). Milton Friedman, the leader of the monetarist school, argued that the classical theory, which allows money to change real variables in the short run but only nominal magnitudes in the long run, is more accurate than the Keynesian theory.

The notion of monetary neutrality has been the subject of extensive research over the years. However, the results have been mixed and inconclusive, with some supporting the long-run money neutrality hypothesis and others rejecting it (see, for example, (Ekomie, 2013; Fasanya, Onakoya, & Agboluaje, 2013; Kamaan & Nyamongo, 2014; Khieu, 2014; Onyeiwu, 2012; Sulku, 2011).

However, Pakistan's economy has grown by 3.94 percent in FY2021, a significantly higher rate than in the preceding two years (-0.47 percent in FY2020 and 2.08 percent in FY2019). Agriculture is the largest sector, adding 19.2% to Pakistan's GDP and employing 38.5 percent of the country's labor force. Agriculture is the primary source of income for more than 65-70 percent of the population. However, some studies have revealed that monetary policy plays a significant role in the agricultural sector, for example, Hassen and Hamdi (2020). Discovered that interest rate changes had the most significant impact on the manufacturing and services sectors. In contrast, inflation had the most significant negative impact on the agriculture industry in the context of the Tunisian economy. Additionally, macroeconomic policy changes influence interest rates and inflation, thereby impacting the agricultural economy. Changes in interest rates influence variables such as variable production costs, long-term capital investments, cash flow, land prices, and exchange rates.

Considering the above facts, two questions arise within the context of the economy's monetary policy implementation. Does the Pakistani economy's money supply affect agricultural productivity? Is the long-term impact of money on Pakistan's agricultural sector neutral? The study's main objective is to investigate Pakistan's agriculture sector's monetary neutrality to identify a solution and find an answer to the abovementioned questions. Therefore, this study makes a two-fold contribution to literature. On the one hand, it examines the effects of money supply on agricultural productivity. On the other hand, it evaluates the LMN in Pakistan's agriculture sector. The sections are organized as follows: The relationship between inflation, economic growth, and monetary policy is the primary focus of the literature review in Section 2. Section 3 provides information about the study's data and methodology. Section 4 discusses empirical data and analysis to achieve the objectives. Finally, the study summarizes the findings in the last section and presents policy recommendations.

2. Literature Review

This section offers a comprehensive review of the literature on the impacts of monetary policy on economic growth in the short and long run. The available literature shows that different econometric approaches, eras, and proxy variables have been used in various studies, and it also focuses on other nations and country groups. To examine the LMN, numerous empirical studies have highlighted the relationship between monetary policy and economic growth. For instance, Jawaid, Qadri, and Ali (2011) analyzed annual data from 1981 to 2009 to investigate how Pakistan's monetary, fiscal, and trade policies impacted the country's economic growth. Their findings, based on cointegration and the error correction model (ECM), revealed a direct correlation between money supply and economic growth in the short and long run. Similarly, Chaudhry, Qamber, and Farooq (2012) studied the short- and long-term relationships among monetary policy, inflation, and economic growth in Pakistan from 1972 to 2010. Their results indicated that the monetary policy variable of call money had a significant long-term impact. However, utilizing the cointegration method and ECM was insignificant in the short run. Additionally, Kareem, Afolabi, Raheem, and Bashir (2013) examined the influences of fiscal and monetary policies on Nigeria's economic growth from 1998 to 2008 using the ordinary least squares (OLS) method and a correlation matrix. Their research found that monetary factors, particularly narrow and broad money, primarily drive the growth of Nigeria's economy, as indicated by the real GDP growth rate.

Havi and Enu (2014) examined the relative effects of monetary and fiscal policies on Ghana's economic growth from 1980 to 2012, employing the Ordinary Least Squares (OLS) methodology. The findings demonstrate that money supply serves as an indicator of monetary policy, exhibiting a positive and statistically significant impact on Ghana's economy. Carare, De Resende, Levin, and Zhang (2021) conducted an empirical study using a cross-country panel dataset of 79 low-income countries (LICs) from 1990 to 2015 to assess the impact of external shocks on real GDP growth. The study identified significant differences between low-income countries with fixed normal exchange rates and those where the central bank targets monetary aggregates or inflation. An event study was conducted to analyze the output growth of the Central African Franc (CFA) compared to 18 analogous countries outside the CFA zone. The study decisively rejected the monetary neutrality hypothesis, providing substantial evidence that monetary policy frameworks enhance price and macroeconomic stability in LICs. Unexpected devaluation occurred in January 1994; the results indicate it was significant. Cyrus (2014) employed the recursive vector auto regressive (VAR) method to analyze the effects of monetary and fiscal policy shocks on Kenyan economic development, utilizing time series data from 1997 to 2010, which differs from prior research approaches. Monetary policy does not impact actual output, encompassing money supply and short-term interest rates. Nevertheless, the authors identified several factors contributing to weak links, including the absence of a structural, institutional, and regulatory framework. Lashkary and Kashani (2011) assessed the influence of monetary variables on economic growth in Iran. An econometric regression model analysis utilized a monetary approach to secondary data from 1959 to 2008. The findings indicate no significant relationship among employment, economic growth, real economic indicators, and money volume. Singh, Das, and Baig (2015) conducted a study examining the relationship between India's money supply, production, and pricing in both the short and long terms, employing the Johansen test for cointegration and the Granger causality test for causation. The findings underscored the importance of variable selection in analyzing the relationship between money, output, and price. Also, they found no long-term correlation between the money supply and production using quarterly or monthly data in India.

Numerous studies have also found a limited link between economic growth and the money supply, for example, Coibion (2012). While comparing the standard VAR versus the most significant impacts, the impact on the US economy of monetary shocks from 1970 to 1996 was assessed using Romer and Romer (2004) technique (R and R). Using the usual VAR approach, the researchers discovered that monetary policy shocks explained a tiny portion of the real-economy changes assessed by industrial production or unemployment. Additionally, the researchers demonstrated the ineffectiveness of the standard VAR in explaining the recessions of 1980–1982 and 1990. Smets and Wouters (2007) developed a model for the medium-sized effects of monetary shocks on actual variables, such as Dynamic Stochastic General Equilibrium (DSGE). Milani and Treadwell (2012) used a small-scale DSGE model. Assessed the consequences of unanticipated and anticipated monetary policy shocks (2012). For US data from 1960Q1 to 2009Q1, likelihood-based techniques were utilized to estimate observable variables, including inflation, federal funds rate, and output gap. They also establish that unexpected shocks from monetary had a more minor and shorter-lasting influence on output than anticipated policy shocks, which have a significant, delayed, and long-lasting effect. The percentage of economic growth related to monetary policy has stayed relatively low. In (2015), researchers used the vector error correction model (VECM) and quarterly data from 1996 to 2014 in Malaysia to examine the long-term trend of monetary aggregates. Their findings revealed that there was minimal evidence to back up Malaysia's monetary neutrality perspective.

Hassen and Hamdi (2020) It is one of the few research studies that explored how the monetary policy of the Tunisian central bank affected sectoral and overall economic growth, particularly during times of crisis. They used quarterly data from 2000 to 2018 to conduct an empirical VECM analysis. Over time, overall and sector economic growth is positively associated with the primary interest rate and negatively related to inflation. When they examined the effects on each activity sector independently, they found that changes in the primary interest rate highly affect manufacturing and services. Moreover, inflation has a highly negative impact on the agriculture sector.

Most studies find the link between monetary policy and economic growth and focus on this relationship. However, this study employed an empirical technique called VECM modeling to examine the effect of money supply on agricultural productivity. This allows us to accept or reject the LMN hypothesis in the Pakistani economy. Furthermore, no study has yet explored this relationship in Pakistan using various control factors.

3. Materials and Methods

3.1. Data and Description of Variables

This research aims to examine the LMN in Pakistan's agricultural sector. Semi-annual time series data from 1991S1 to 2019S2 for the variables are gathered from WB (2021). Hassen and Hamdi (2020) used the control variables, such as inflation, labor, and capital, in their study. To examine the connection between monetary policy and the sectoral economy's growth. The table presents a list of parameters that were used in the examination:

Table 1. Description of data.

Variables	Symbols	Description	Units
Dependent variable			
Agricultural productivity	AGR	Agriculture, forestry, and fishing, value added per worker	Constant 2010 US$
Independent variables			
Money supply	M2	Broad money (Monetary policy tool)	% of GDP
Inflation	INF	Consumer prices	Semi-annual %
Labor	LFPR	Labor force participation rate	% of the total population, ages 15-64
Capital	GFCF	Gross fixed capital formation	% of GDP

Table 1 presents key variables related to agricultural productivity, distinguishing between one dependent variable and several independent variables. The dependent variable, agricultural productivity, is measured by the value added per worker in the agriculture, forestry, and fishing sectors, expressed in constant 2010 US dollars. The independent variables include money supply, inflation, labor force participation rate, and gross fixed capital formation, each evaluated as a percentage of GDP or the population, providing insight into factors influencing agricultural productivity.

3.2. Model

The study methodology begins with a test of traditional linear cointegration using the VECM model based on Johansen's technique, which employs the likelihood maximum (LM) to the VAR model, assuming that errors are allocated uniformly across samples. In its simplest form, the VAR model looks like this:

$$y_t = A_o + A_1 y_{t-1} + \cdots + A_k y_{t-k} + \varepsilon_t \quad (1)$$

Where t=1…., T, A_o is the vector of constants from A_1 to A_k be coefficients of matrices and ε_t is the vector of disturbances that have serially no mutual relationship disturbances, and 0 means variances of homoscedasticity. The vector of endogenous variable is the y_t.

3.3. Methodology

The empirical estimation of the study methods is outlined below. To start, the Jarque-Bera test and descriptive analysis are used to make sure the distribution is normal. After that, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used to determine the existence of the unit root. Unlike the ADF test, the PP test corrects the t-statistics of the coefficients of the lagged variables rather than adding the different terms of the lagged variables to account for serial correlations. The intercept and the trend have been submitted to the unit root test. The cointegration test, which was created by Johansen and Juselius (1990) is used to find cointegrating vectors in a set of non-stationary time series data and to look into the long-term relationship between the variables once it has been established that the variables are stationary. The null hypothesis states that there are only r cointegrating vectors, as opposed to the alternative of (r+1) cointegrating vectors. The following formula is used to compute the maximum eigenvalue statistic:

$$\lambda_{maxi} = -Tln(1 - \lambda_{r+1})$$

A rare statistic tests the null hypothesis of r co-integrating vector against the alternative of r or more co-integrating vectors. It is given by.

$$\lambda_{trace} = -T\sum ln(1 - \lambda_i)$$

If one or more cointegrating vectors are found, the basic VAR approach only generates the expected outcomes if an error-correcting term is included in the model. Consequently, a VECM takes the following form:

$$\Delta AGR = \alpha_1 + \sum_{i=0}^{m} \theta_1 \Delta AGR_{t-i} + \sum_{i=0}^{n} \theta_1 \Delta LR_{t-i} + \sum_{i=0}^{o} \theta_1 \Delta INF_{t-i} + \sum_{i=0}^{p} \theta_1 \Delta LFPR_{t-i} + \sum_{i=0}^{q} \theta_1 \Delta GFCF + \lambda_1 ECT_{t-1} + \varepsilon_t \quad (2)$$

Under these specifications, the parameter (λ) of the lagged error correction term (ECT_{t-1}) represents the long-run relation in the variables being evaluated at the equilibrium point. The Akaike information criteria (AIC) has been used to identify the optimal lag length for the variables to protect them from over/under parameterization problems, which can lead to bias and inefficiency in estimations. To validate the long-run equilibrium relationship in the variables, the parameter of the error correction term must be negative, statistically significant in terms of its related t-value, and smaller than one. Furthermore, it analyzes the short- and long-run causal directions between the variables by using the VECM framework and the Granger causality test. However, to ensure the stability of the VECM and uncover further information, several diagnostic tests are applied, including impulse response analysis and variance decomposition analysis.

4. Estimation Technique and Empirical Results

4.1. Descriptive Analysis

Table 2 provides an overview of all variables' statistics. According to the table, all mean values of the variables represent the average level seen in the data set. LFPR has the highest mean value (1723.04), whereas INF has the lowest (8.38). Each series' mean-over-median ratio is approximately 1. Furthermore, a range of variance between each series' maximum and minimum is proven to be adequate compared to the mean. The standard deviation illustrates how data differs from the mean. A low standard deviation shows that the data points are close to the meaning of the data set. A high standard deviation shows that the data points are spread over a broader range of values. AGR, INF, and GFCF are positively skewed, while M2 is negatively skewed regarding the skewness of the variables. The kurtosis statistics of the variables show that only AGR and INF exhibit leptokurtic behavior, while all other variables exhibit platykurtic behavior. Combine the skewness and kurtosis measures to determine if a random variable has a normal distribution. The Jarque-Bera test for normality generally distributes the residuals of all the study's variables.

Table 2. Summary statistics.

Variable	AGR	M2	INF	LFPR	GFCF
Mean	1723.048	48.623	8.387	52.902	15.607
Median	1723.759	48.100	7.921	52.67	15.742
Maximum	1927.92	59.036	20.286	55.08	19.129
Minimum	1553.845	34.799	2.529	50.5	12.520
Std. dev.	83.952	6.687	4.104	1.214	1.758
Skewness	0.279	-0.154	0.601	0.102	0.189
Kurtosis	3.757	2.173	3.420	2.052	2.017
Jarque-Bera	2.140	1.882	3.921	2.273	2.681
Probability	0.342	0.390	0.140	0.320	0.261

On the other hand, correlation refers to the degree of linkage interrelation between two variables. Table 3 summarizes the results of the correlation matrix. The correlation coefficients are small among all explanatory variables, ranging from 0.12 to 0.37, except for 0.67 for GFCF and LFPR.

Table 3. Results of the correlation matrix.

Variable	AGR	M2	INF	LFPR	GFCF
AGR	1				
M2	0.283	1			
INF	-0.372	0.127	1		
LFPR	0.275	0.626	-0.287	1	
GFCF	-0.269	-0.236	0.365	-0.677	1

4.2. Results of Unit Root Test

The current study is an attempt to use the ADF test. Dickey and Fuller (1979) and the PP test (Phillips & Perron, 1988). To goal is to determine whether the chosen variables are stationary and to pinpoint their level of integration. Table 4, which presents the tests, explains that all the variables are non-stationary at their levels but are stationary at the first difference or integrated of order me (1).

Table 4. Unit-root test PP and ADF.

Unit-root test (ADF)		
	At level	**At first difference**
Variable	**With intercept and trend**	**With intercept and trend**
AGR	-2.371	-6.485*
M2	-2.759	-7.422*
INF	-2.298	-6.147*
LFPR	-3.112	-7.475*
GFCF	-2.288	-7.324*
Unit-root test (PP)		
	At level	At first difference
Variable	With intercept and trend	With intercept and trend
AGR	-2.450	-7.550*
M2	-2.508	-7.436*
INF	-2.298	-7.379*
LFPR	-3.127	-7.519*
GFCF	-2.530	-7.324*

Note: (*) indicate significance at the 1% levels, respectively. Leg length is based on AIC, and probability is based on MacKinnon (1996) a one-sided p-value.

4.3. Results of the Cointegration Test

Formulating the ideal lag number is essential to applying the Johansen method. With a randomly chosen lag interval, a VAR model was first established with the endogenous variables AGR, M2, INF, LFPR, and GFCF. The appropriate lag interval for the study was then determined by applying a lag interval determination test to the residuals. Table 5 summarizes the results of this test. The order of optimal lag length is decided by using AIC.

Table 5. Lag intervals test.

Information criteria for selection						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-770.204	NA	3483	29.252	29.438	29.324
1	-566.313	361.618	4096.417*	22.502	23.617*	22.931*
2	-558.799	11.909	8130.903	23.162	25.206	23.948
3	-517.644	57.461*	4723.407	22.552	25.526	23.696
4	-496.108	26.005	6144.502	22.683	26.586	24.184
5	-464.646	32.055	6078.337	22.439*	27.272	24.297

Note: The criterion's chosen lag order is indicated by a *. FPE: Final prediction error, LR: Sequential modified LR test statistic (Each test at 5% level), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ).

In addition, the autocorrelation LM test was used to see if there was any autocorrelation in the error terms of the VAR model. The LM tests H_o show that there is no autocorrelation problem. The probability value of the fifth lag is more significant than 0.05, which means that H_o cannot be rejected, indicating no autocorrelation problem. Table 6 explains the results of the test. Furthermore, AR roots must be smaller than 1 for the VAR to be stable. Figure 1 illustrates the placement of all inverse roots within the unit circle. As a result of this circumstance, it was determined that the VAR meets the stability criteria. Also, the White test was employed to see if the model had a problem of heteroscedasticity. The null hypothesis explains the homoscedasticity in the test. Table 7 also presents the result of this test. The probability value is more significant than 0.05, indicating that we cannot reject the null hypothesis. In other words, it was found that there was no heteroscedasticity problem in this model. However, the cointegration relationship was tested using the Johansen cointegration approach. The findings are shown in Table 8. The trace and maximum eigenvalue tests give three cointegrating equations at the 5% significance level. As a result, this study attempts the vector error correction model.

Table 6. LM test.

Lag	**LM statistics**	**p-value**
1	15.942	0.916
2	38.373	0.042
3	16.072	0.912
4	78.418	0.000
5	9.535	0.997
6	26.735	0.369
7	7.136	0.999
8	49.903	0.002
9	5.117	1.000
10	33.421	0.120

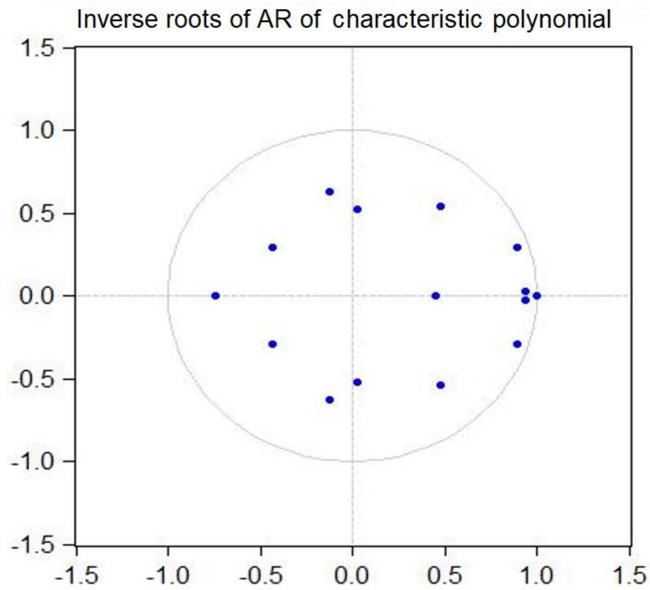

Figure 1. VAR stability test.

Table 7. White test results.

Chi-sq	Df	Prob.
429.696	450	0.747

Table 8. Johansen cointegration test result.

Result of the cointegration test							
Trace statistic				Max-eigen statistic			
Null hypothesis	Value	C.V (0.05)	Prob.	Null hypothesis	Value	C.V (0.05)	Prob.
None *	169.511	69.818	0.000	None *	94.735	33.876	0.000
At most 1 *	74.776	47.856	0.000	At most 1*	35.821	27.584	0.003
At most 2*	38.954	29.797	0.003	At most 2*	30.029	21.131	0.002
At most 3	8.925	15.494	0.372	At most 3	7.296	14.264	0.454
At most 4	1.629	3.841	0.201	At most 4	1.629	3.841	0.201

Note: The rejection of the null hypothesis is denoted *at the 0.05 level. (*) indicates significance at the 1% levels, respectively.

Based on the above results, the study used three cointegration equations on the VECM. Then, the Granger causality test was run to find the variables' short- and long-term causality relationships. The result in Table 9 indicates that M2 and AGR, about our interest factors, had no significant short-run correlation. However, short-run causality exists when moving from INF and GFCF to AGR. In the long run, these findings support empirical findings from the cointegration test, indicating the existence of a cointegration relation. When the AGR is the dependent variable, the parameter of the error correction term is negative, less than one, and significant at 1 percent, suggesting that there is long-run causation extending from the broad money supply, inflation, labor, and capital to agricultural production. The coefficient (-0.7317) indicates a correction of approximately 73 percent every six months for any deviation from the long-run equilibrium between the variables.

Table 9. Granger causality results based on VECM.

DV	Chi-square statistics of lagged, 1st difference term (P-value)				
	$\Delta(\boldsymbol{AGR})$	$\Delta(\boldsymbol{M2})$	$\Delta(\boldsymbol{INF})$	$\Delta(\boldsymbol{LFPR})$	$\Delta(\boldsymbol{GFCF})$
$\Delta(AGR)$	--	8.643 (0.124)	25.680* (0.000)	3.829 (0.574)	9.796*** (0.081)
$\Delta(M2)$	4.655 (0.459)	--	15.319* (0.009)	17.900* (0.003)	4.611 (0.465)
$\Delta(INF)$	1.654 (0.894)	4.778 (0.443)	--	1.481 (0.915)	4.473 (0.483)
$\Delta(LFPR)$	32.195* (0.000)	6.211 (0.286)	17.511* 0.003	--	23.606* (0.000)
$\Delta(GFCF)$	4.156 (0.527)	5.179 (0.394)	4.404 (0.492)	4.160 (0.526)	--
The coefficients of error correction terms [t-statistic]					
DV	ECT1	ECT2	ECT3		
$\Delta(AGR)$	-0.731* [-3.785]	8.576** [2.659]	-15.949* [-3.831]		
$\Delta(M2)$	0.022*** [2.023]	-0.708* [-3.840]	0.546** [2.292]		
$\Delta(INF)$	-0.002 [-0.152]	-0.127 [-0.545]	0.012 [0.040]		
$\Delta(LFPR)$	-5.163 [-0.038]	0.019 [0.881]	-0.020 [-0.714]		
$\Delta(GFCF)$	-0.003 [-0.906]	0.050 [0.716]	-0.125 [-1.385]		

Note: (*), (**), (***) significant at the 1%, 5%, and 10% respectively.

We also used diagnostic testing on VECM residuals. Table 10 shows the outcomes of these tests. The table shows that the VECM residuals have no serial correlation or heteroscedasticity issues. In conclusion, the residuals of the estimated specifications pass the residual diagnostics tests, indicating the robustness of the estimation findings.

Table 10. Residual diagnostics test results of VECM.

Diagnostic tests	Obs.*R-squared	P-values
LM_{SC}	2.780	0.249
x^2_{HET}	0.537	0.463

Note: LM_{SC} and x^2_{HET} represent the Breusch-Godfrey serial correlation LM test, and the ARCH test, respectively.

4.5. Impulse Response and Variance Decomposition

Results Granger causality further illuminate the information that impulse response functions (IRFs) provide. IRFs help explain the direction of a relationship, as well as how long it takes for these effects to manifest. You can use IRFs to demonstrate a dependent variable's response to an independent variable shock. As a result, Figure 2 shows the AGR responses to M2, INF, LFPR, and capital across 10 semi-annual time horizons. Each deviation shock to the M2 appears to trigger a positive and consistent reaction in the AGR, both the short and long term. This positive influence rises until the seventh period, abruptly declining. On the other hand, INF has an inverse impact on AGR in both the long and short run. Until the second period, the plotted impulses demonstrate that AGR begins to decline. Following that, it rises during period three but then begins to fall until the seventh period; after that, it suddenly rises. In response to a one-standard-deviation impulse to the LFPR, the AGR decreases up to the second period and then begins to increase until the fifth period. It then begins to decline until the seventh period, then begins to rise until it reaches a stable level up to the ninth period, then it begins to rise again. Similarly, a one standard deviation impulse to LFPR causes AGR to decline from period two to period three, then grow until the seventh period, then fall until it reaches a stable level until the ninth period, after which it rises again. Therefore, in both cases, negative and positive responses exist. As a result, the shocks to LFPR and GFCF have a symmetric impact on AGR in both the short and long run.

Finally, we used a variance decomposition test to see how monetary policy and other factors affected agricultural productivity. Variance decomposition enables us to determine the extent to which the volatility of the dependent variable explains its variability. It also illustrates the extent to which each independent factor explains the variance in the dependent variable. Table 11 displays a forecasted variance decomposition of AGR over 10 semi-annual time horizons. In the short term, or period two, the shock to AGR accounts for 98.69% of the variance in AGR (own shock). The shock to M2, INF, LFPR, and GFCF can cause 0.07, 1.08, 0.11, and 0.02 percent variations in AGR, respectively. While in the long run, that is, period ten, a shock to AGR accounts for 65.65% of the variation of the fluctuation in AGR (own shock), M2, INF, LFPR, and GFCF can cause 3.05%, 13.43%, 3.5%, and 12.27% fluctuation to AGR, respectively.

Broad money supply positively impacts agricultural production (measured in constant price), but the analysis disproves the LMN hypothesis in both the short and long runs. This finding is consistent with that of Carare et al. (2021); Havi and Enu (2014) and Muhammad, Wasti, Hussain, and Lal (2009) who proved that long-term monetary policy is not neutral. In contrast, inflation has adverse short- and long-term effects on agricultural productivity. This result agrees with Hassen and Hamdi (2020). Input prices, commodity prices, and land values impact inflation. Consequently, inflation leads to a fall in agricultural productivity, whereas labor and capital have a symmetric impact.

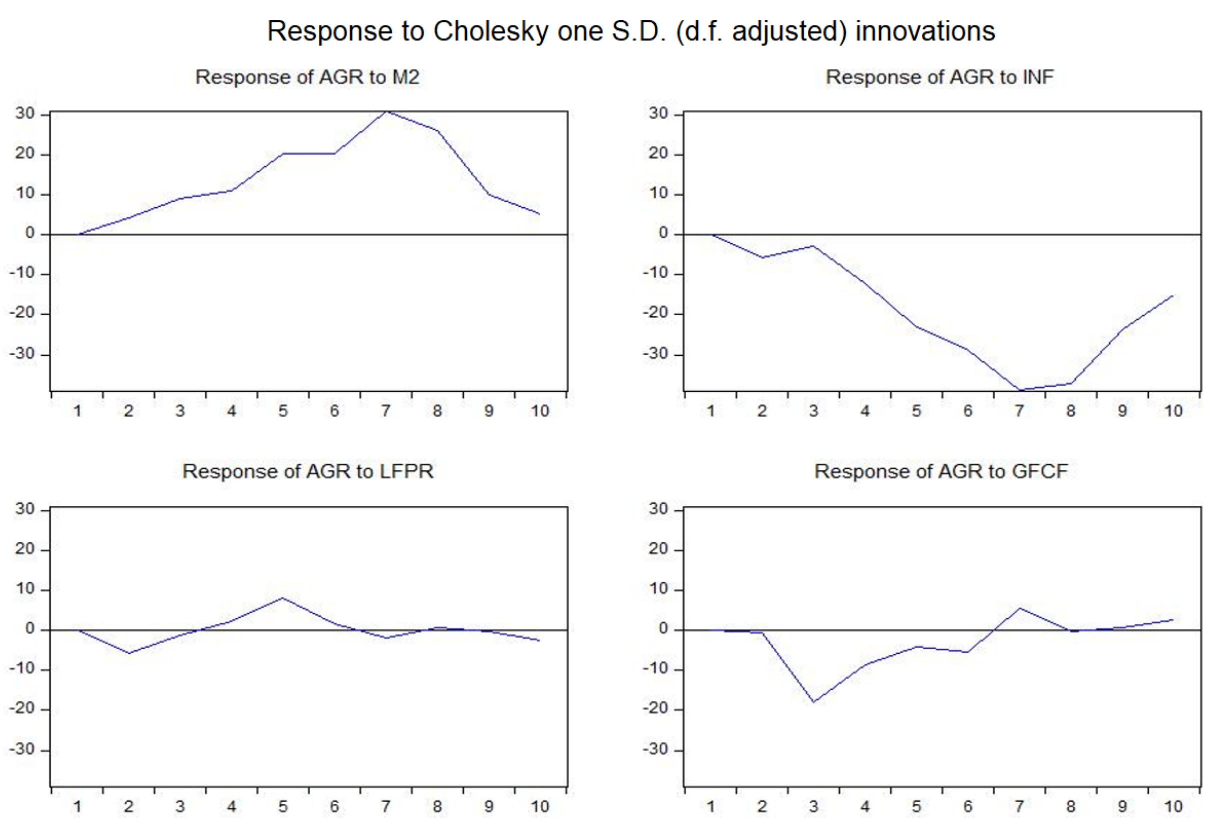

Figure 2. Impulse response of M2, INF, LFPR, and GFCF on AGR.

Table 11. Variance decomposition of agriculture per worker (APW).

Period	AGR	M2	INF	LFPR	GFCF
1	100	0.000	0.000	0.000	0.000
2	98.693	0.078	1.089	0.113	0.024
3	87.293	0.057	1.446	3.312	7.890
4	84.285	0.104	1.158	3.423	11.028
5	81.094	0.946	2.901	3.474	11.582
6	76.831	1.194	6.893	3.771	11.308
7	71.341	2.525	10.603	3.785	11.744
8	67.626	3.056	13.439	3.599	12.277
9	65.652	3.001	15.428	3.568	12.348
10	64.252	2.943	16.794	3.659	12.349

5. Conclusion and Policy Recommendations

The current study investigates money neutrality in Pakistan's agriculture sector using semi-annual data from 1991S1 to 2019S2 within the VECM framework. First, the study conducts unit root tests using ADF and PP. As a result, all the variables at the first difference level were stationary. Using the VAR technique, the study determined the optimal lag length for our equation model. We employed the Johansen cointegration test in the second phase to analyze the cointegration relationship between the variables, identifying three cointegrating equations. As a result, we decided to use VECM.

When agricultural productivity was the dependent variable, the coefficient of error correction term was statistically significant at 1% and had a negative sign. According to VECM analysis, equilibrium returned to normal at 73% every six months. We applied the Granger causality test, based on VECM modeling, in the third phase to examine causality between the short- and long-term variables. According to Granger's causality results, broad money and agricultural productivity had no short-run causal association. However, due to inflation and capital, there was short-term causality in the movement of agricultural productivity. The cointegration findings suggest and confirm that there is a long-run relationship. The present study attempts the last phase's impulse response and variance decomposition tests.

The results demonstrate a positive and consistent response in both short- and long-term agricultural productivity to a one-standard-deviation shock in broad money. On the other hand, inflation has a damaging long-term and short-term impact on agricultural production. However, labor and capital shocks had symmetric effects on agricultural production in both the short and long run. As a result, our findings refute the long-run money neutrality hypothesis.

The findings reveal that agricultural production is vulnerable to monetary, inflation, labor, and capital shocks. Policymakers in developing countries, such as Pakistan, should diversify the economy to reduce the impact of inflation shocks and boost the sector's share of GDP. As a result, the economy will be more resilient to unanticipated shocks and sustain stability for the long term.

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