THE EFFECTS OF ECONOMIC GROWTH, INFLATION RATE, TRADE OPENNESS, AND UNEMPLOYMENT RATE ON POVERTY: PROSPECTS AND CHALLENGES IN PAKISTAN

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ABSTRACT

Poverty is a prevailing issue that is now being deliberated and analysed in numerous industrialised and developing nations, including Pakistan. The present study aims to investigate the primary factors that contribute to poverty in the context of Pakistan. This study employed time series data for the goal at hand. In order to assess the stationarity of the data Unit root tests, specifically the Augmented Dickey-Fuller and Phillips-Perron tests, was utilised in order to ascertain the level of integration. In addition, a Bound test was undertaken to assess the long-term relationship. The outcomes of the Bound test revealed that long-run relationship exist between dependent and independent variables in the presence of poverty. The study employed the Autoregressive Distributed Lag (ARDL) modelling approach to examine the short and long-term effects of poverty variables. Furthermore, the Johansen co-integration test shows that long-term relationship between the endogenous and exogenous variables prevailed. A series of diagnostic tests was conducted to assess the quality and appropriateness of the model. In conclusion, the use of forecast error variance decomposition and impulse response function was employed to provide support and enhance the analysis of the ARDL model.

1. INTRODUCTION

Globally, poverty represents a significant concern that affects individuals across all socioeconomic backgrounds. Hence, the elimination of this chronic condition from the Earth's surface is imperative for the facilitation of development (Akerele et al., 2012). Poverty is characterised by a state of deprivation in overall well-being and the limited ability to generate sufficient money, resulting in an inability to access essential commodities and services required for a dignified existence (Ahmad & Riaz, 2009). Poverty is a multifaceted phenomenon that includes not only a scarcity of financial resources, but also a dearth of access to proper healthcare and education, limited availability of clean water and sanitation facilities, inadequate physical safety, a lack of agency and

representation, as well as insufficient opportunities and resources for personal and socioeconomic advancement (The World Bank, 2008).

Poverty is a complex and multifaceted phenomena that represents the most significant global concern. Nevertheless, the strength of the phenomenon varies across different geographical areas. According to the measurement standards established by the World Bank, global poverty can be classified into two categories: extreme poverty and those living in poverty. In addition, according to the World Bank's estimation, a significant portion of the global population, ranging from 950 million to 1.3 billion individuals, resides in circumstances characterised by severe poverty, defined as living on less than one dollar per day and lacking the means to fulfil their fundamental human necessities. Furthermore, an additional 1.7 billion people are classified as poor (The World Bank, 2008).

Indeed, alternative estimations of the global impoverished population are far greater, potentially reaching twice the reported figures. However, according to the World Bank's conservative proxy measure of extreme poverty, it is evident that around 800 million individuals experience insufficient access to food on a daily basis, while approximately 500 million people suffer from chronic malnutrition. Malnutrition can be attributed to factors beyond mere insufficiency of dietary energy. Food insufficiency can manifest when the quality or diversity of food is inadequate, despite a plenty in terms of quantity. Malnutrition can also be attributed to infections, diseases, and inadequate water and sanitation conditions. Hunger is a physiological sensation that signifies the body's requirement for additional nourishment. The severity of malnutrition in developing regions is considerable. In the most underdeveloped nations, approximately 35% of children aged 0-5 years exhibit moderate to severe underweight conditions. Within the region of Sub-Saharan Africa, a notable proportion of children, namely 38% within the specified age range, exhibit moderate to severe levels of stunting. In the region of South Asia, the percentage stands at 47%. The prevalence of moderate or severe wasting on a global scale stands at 11%, however in South Asia, this figure is notably higher at 18%. Moreover, according to Veltmeyer and Shafer (2010), a significant proportion of infants, specifically 29%, are born with low birth weight in the South Asian region.

Hunger may be perceived as a facet of severe poverty. It is commonly referred to as the most severe and critical symptom of poverty. Based on estimates provided by the United Nations (UN), about one billion individuals experience food insecurity and face the risk of life-threatening illnesses, malnutrition, and hunger on a nightly basis. The correlation between poverty and hunger is such that while not every individual living in poverty experiences hunger, a significant majority of those who suffer from hunger are indeed impoverished. A significant portion of the global population experiences hunger and malnourishment due to financial constraints that prevent them from purchasing an adequate quantity of food, hinder their ability to purchase nutritious food options, or impede their access to farming resources necessary for cultivating sufficient quantities of high-quality food. Moreover, as per the World Bank, almost 50% of the global child population resides in affluent environments, yet experiences the harsh realities of poverty, while over 33% suffer from malnutrition. In 2003, a total of 10.6 million children succumbed to mortality before attaining the age of five, which equates to an approximate daily average of 29,000 children. These unfortunate deaths were primarily attributed to hunger. Based on data provided by UNICEF, it is estimated that a daily average of 24,000 children succumb to mortality as a result of impoverished conditions. Consequently, poverty gives rise to the occurrence of hunger and inadequate sustenance. According to the Food and Agriculture Organization's estimation in 2009, approximately 15 percent of the global population was reported to be experiencing hunger.

Pakistan is currently confronted with a multitude of issues, including but not limited to inflation, corruption, budget deficit, unemployment, poverty, energy crises, and low economic growth. The estimation of poverty is subject to significant sensitivity due to a multitude of factors, with the establishment of a poverty line being the most challenging aspect in the practical assessment of

poverty. This study employs the widely utilised food energy intake technique approach. This methodology involves graphing the caloric food supply per capita per day in order to ascertain the threshold at which a household attains sufficient food through either expenditure or income. According to official data from the Government of Pakistan (2015), it was determined that 9.3 percent of the population in Pakistan fell below the poverty line during the period of 2013-14. This equates to an estimated 17 million individuals living in poverty.

Previous scholars have conducted study on the impact of poverty alleviation at both the national and worldwide levels. The majority of the aforementioned studies employed diverse econometric approaches in order to assess the impacts of poverty. Nevertheless, the findings exhibit conflicting and inconclusive outcomes. The study conducted by Amjad and Kemal (1997) examined the primary factors influencing poverty at a macro level throughout the time frame spanning from 1963 to 1994. This study examines the significant impact of several factors on poverty, including economic growth, agricultural growth, terms of trade in the agriculture sector, industrial production, inflation rate, employment, wages, remittances, and the tax structure. In their study, Akhtar and Ahmad (1999) examined the primary determinants of poverty, identifying the food price index, real remittances per capita, human capital index, and open unemployment as the key factors influencing poverty levels. According to Osinub (2005), a negative correlation was found between poverty and unemployment. In a study conducted by Jamal (2006), an examination was made of the association between poverty, economic growth, and inequality in Pakistan from 1979 to 2002. The findings of the study indicated a positive correlation between per capita GDP and income disparity. Additionally, the research revealed that a reduced level of income inequality had a beneficial effect on the mitigation of poverty. In their study, Bakhshoodeh and Zibaei (2007) conducted an analysis on the correlation between agricultural trade openness and the alleviation of poverty. By utilising cross-country data, the researchers arrived at the conclusion that economic freedom exerts a favourable influence on income levels, while the presence of sound institutions contributes to the reduction of poverty. In their study conducted in 2008, Qayyum et al. investigated the effects of remittance on both economic growth and poverty levels throughout the span of 1973 to 2007. Their findings indicated that remittances exerted a positive and statistically significant influence on both economic growth and the decrease of poverty.

Similarly, Ahmad and Riaz (2009) conducted an investigation into the relationship between poverty and various macroeconomic factors, namely education, economic growth, inflation, and unemployment, within the context of Pakistan. The researchers utilised time series data spanning from 1974 to 2009 in order to analyse this nexus. The research findings indicate a positive correlation between education and poverty reduction. Nevertheless, it is important to note that both economic development and unemployment can have adverse effects on poverty levels. The study conducted by Pervez and Rizvi (2014) examined the correlation between poverty and many factors including agricultural growth, trade openness, inflation, labour in agriculture, remittances, and foreign direct investment (FDI). The research findings indicate that, with the exception of inflation, all the variables examined exhibit a detrimental effect on poverty.

Although there have been several studies conducted on various aspects of poverty, there has been limited empirical research exploring the relationship between poverty and macroeconomic variables. Within the confines of this particular environment, our research endeavours to investigate the influence of macroeconomic factors, namely economic growth, inflation, trade openness, and unemployment, on the state of poverty in Pakistan. The subsequent sections of this article are structured in the following manner: The subsequent section delineates the data and methodology employed in the investigation. The subsequent part presents the empirical findings and subsequent analysis. The fourth section of the paper contains the concluding observations.

2. METHODOLOGY

2.1 Data Description

In this study, annual data from 1998 to 2016 was collected. The study consisted of an analysis of five distinct macroeconomic factors. The dependent variable in our study is poverty, which is measured using the food energy intake technique approach. It is expressed in kilocalories per capita per day. The independent variables included in this study encompassed the inflation rate, trade openness, unemployment rate, and GDP growth, which were utilised as proxies for measuring economic growth. The factors under consideration are measured in terms of percentages. The data pertaining to yearly economic growth, inflation rate, trade openness, and unemployment rate has been sourced from the World Bank Development Indicator (WDI) website. The annual poverty statistics is obtained from the official website of the Food and Agriculture Organisation (FAO). The data processing and econometric analysis were conducted using EViews software version 9. The subsequent econometric methodologies employed for the analysis of time series data are as follows:

2.2 Stationary Test

A unit root test was employed to examine the stationarity of the time series data. The term "stationary" is used to describe data that exhibits constant variance, covariance, and mean throughout a given period of time. There are three primary cases, which are as follows:

Case: 1. Ø < 1 the data is stationary.
Case: 2. Ø > 1 the series explodes.
Case: 3. Ø=1 the series contains the unit root and is non-stationary.

This study employs the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit root tests to assess the degree of integration (Dickey and Fuller, 1981; Phillips and Perron, 1988). The application of PP techniques extends to the determination of unit roots as an alternative to the ADF unit root test, as they are capable of calculating a residual variance that accounts for auto-correlation. In practical application, the ADF test can be categorised into three distinct versions.

$$\Delta S_t = \alpha S_{t-1} + \sum_{j=1}^{p} \beta_i \Delta S_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta S_t = \gamma_0 + \alpha S_{t-1} + \sum_{j=1}^{p} \beta_i \Delta S_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta S_t = \gamma_0 + \gamma_0 t + \alpha S_{t-1} + \sum_{j=1}^{p} \beta_i \Delta S_{t-1} + \varepsilon_t \quad (4)$$

The variables ϒ0 and ϒ1 represent the intercept term and the coefficient of the trend variable, respectively. The symbol "εt" is used to denote the error term. The residual term demonstrates statistical evidence of possessing a constant variance and independence. The symbol Σ represents the summation sign, where the lag duration begins at j=1 and extends up to "p". Various criteria exist for selecting the ideal lag, such as the Akaike Information Criterion (AIC), the Schwarz Bayesian Criterion (SBC), and the Hannan-Quinn Criterion (HQ). When doing the ADF test, the selection of an adequate lag duration is determined by the Akaike Information Criterion (AIC). Equation 5 presents the formal mathematical representation of the PP test.

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_0 t + u_t \quad (4)$$

In the given context, $ß_0$ represents a constant, t denotes a trend, and ut represents the error term. In the event that the series exhibits a unit root, it follows that the coefficient ß1 will be equal to zero. Consequently, the Phillips-Perron (PP) test serves as a means to assess the hypothesis that ß1 equals zero. The primary objective of the Phillips-Perron (PP) test is to enhance the statistical properties of the Augmented Dickey-Fuller (ADF) test when used to limited samples.

2.3 Johansen's Co-Integration Test

The Johansen co-integration test is employed to analyse the presence of a long-term relationship between variables and determine the number of co-integrating vectors (Kapusuzoglu and Ulusoy, 2015; Lajdova et al., 2016).

Following Mukhtar and Rasheed (2010) the Johansen co-integration test is based on two likelihood ratio tests: The Trace test (λ_{trace}) and the maximum eigenvalue test (λ_{max}). The research is focused on the two Johansen tests: the trace test for the hypothesis and the λ-max test for a hypothesis on the individual eigenvalues in order to determine the number "r", co-integrating vector. This test is based on the following equations (8) and (9) respectively:

$$J_{trce}\,(K) = -T\sum_{j=k+1}^{n}\ln\,(1-\lambda_i) \qquad (7)$$

$$J_{max}(K+1) = -Tln(1-\lambda_{k+1}) \qquad (8)$$

The variable k represents the quantity of cointegration vectors, while λ represents the jth ordered value. The presentation provides information regarding the size of the sample. The coefficient matrix $\boldsymbol{\pi}$ yields the eigenvalues. The J_{Trace} test (k) is performed in order to evaluate the hypothesis H_0: the rank of $\boldsymbol{\pi}$ is less than or equal to k, as compared to the alternative hypothesis H_1: the rank of $\boldsymbol{\pi}$ is greater than k. The inclusion of J_{Max} (k + 1) in this context serves the purpose of evaluating the hypothesis H_0, which states that the rank of $\boldsymbol{\pi}$ is less than or equal to k, in comparison to the alternative hypothesis H1, which posits that the rank of $\boldsymbol{\pi}$ is equal to k + 1.

2.4 Autoregressive Distributed Lag (ARDL) Model

In this work, the ARDL modelling approach was employed to examine the existence of a long-run relationship between the variables of interest. The limits test for co-integration was utilised for this purpose. The model presented in this study was established by Pesaran et al. (2001) and is applicable regardless of the variables' order of integration. The inquiry pertains to the categorization of repressors as either exclusively integrated of order zero (I(0)), exclusively integrated of order one (I(1)), or mutually co-integrated. The ARDL model can be formulated in the following manner to examine the relationship between poverty, economic growth, inflation rate, trade openness, and unemployment rate.

$$\Delta lnPO_t = \alpha_0 + \alpha_1 lnPO_{t-1} + \beta_1 lnEG_t + \beta_2 IR_{t-1} + \beta_3 lnTO_{t-1} + \beta_4 UREG_{t-1} + \sum_{i-1}^{p}\lambda_i \Delta lnPO_{t-i} + \sum_{i-0}^{q}\theta_i \Delta lnEG_{t-i} + \sum_{i-0}^{r}\phi_i \Delta IR_{t-i} + \sum_{i-0}^{s}\varphi_i \Delta lnTO_{t-i} + \sum_{i-0}^{t}\xi_i \Delta UR_{t-i} + \varepsilon_t \qquad (9)$$

In Equation (9), the symbol Δ represents the difference operator, whereas ln PO denotes the natural logarithm of poverty. Similarly, the natural logarithms of economic growth, inflation rate, trade openness, and unemployment rate are denoted as ln(EG), ln(TO), ln(IO), and ln(UR) accordingly. The mistakes, denoted as εt, are characterised by being serially independent, having a mean of zero, and a constant variance. To derive the long-run coefficients, the Autoregressive Distributed Lag (ARDL) model is estimated according to the following specification:

$$\left(1- \alpha_1 L- \ldots- \alpha_u L^u\right)PO_t = \beta_0 + \left(1- \beta_1 L- \ldots \beta_v L^v\right)EG_t + \left(1- \gamma_1 L- \ldots \gamma_x L^x\right)IR_t + \left(1- \lambda_1 L- \ldots \lambda_y L^y\right)TO_t + \left(1- \xi_1 L- \ldots \xi_z L^z\right)UR_t \quad (10)$$

The selection of the optimal delays for the ARDL model is determined by employing the Schwarz information criteria. The Bound test, proposed by Pesaran et al. (2001), utilises an F-test to evaluate the joint null hypothesis. The null hypothesis is defined as H0: α1 = β1 = β2 = β3 = β4 = 0, while the alternative hypothesis is stated as H1: α1 ≠ β1 ≠ β2 ≠ β3 ≠ β4 ≠ 0. The null hypothesis (H0) is rejected when the computed test statistic surpasses the upper critical value. When the F-statistic value falls inside the specified bounds, the results of the co-integration test are inconclusive. If the value of the F-statistic is smaller than the lower limits value, the null hypothesis of no co-integration cannot be rejected, regardless of whether the series are integrated of order 0 or 1.

2.5 The Residual Diagnostic Tests

In order to assess the dependability of the ARDL model, we employed five residual diagnostic tests. The ARCH test, proposed by Engle (1982), is used to examine the presence of autoregressive conditional heteroscedasticity (ARCH) in the residuals. The Lagrange multiplier (LM) test is employed to address autocorrelation issues within the model. The Regression Specification Error Test, also referred to as Ramsey RESET, was introduced by Ramsey in 1969. The applicability of the Ramsey RESET test is limited to equations that have been calculated using certain methodologies. The CUSUM test utilises the cumulative sum of the recursive residuals, as proposed by Brown et al. in 1975. The Jarque-Bera Test, developed in 1987, is a statistical test used to assess the normality of a given model's distribution. Hence, the utilisation of these diagnostic procedures will enable us to ascertain the accuracy of the results, ensuring their independence from autocorrelation and confirming the normal distribution of the residuals. Furthermore, these tests also provide evidence that the functional form of the model is accurate and that the overall model is stable and conforms to normality.

Furthermore, the VAR model was employed to obtain insights into the interplay of the variables. The most effective methodology is analysing the interplay of the variables through the utilisation of the impulse response function. This method is also included in the VAR model (Equation 5). The impulse response function represents the response of a vector autoregressive (VAR) system to a shock or innovation. The purpose of this function is to assess the degree of responsiveness exhibited by the endogenous variables in a Vector Autoregression (VAR) model when a shock or innovation is introduced to the error term, denoted as εt in Equation 5. This approach involves the application of a unit shock to each variable inside the VAR system in order to observe its impact. Nevertheless, in order to accomplish the research goal, the study solely focuses on examining the relationship between poverty and several factors such as economic growth, inflation rate, trade openness, and unemployment rate. This implies that a one standard deviation shock to the residual will impact the variables of economic growth, inflation rate, trade openness, and unemployment rate, and therefore influence poverty levels. This analysis also incorporates the Cholesky decomposition technique, as observed in the study. This methodology elucidates the extent to which endogenous and exogenous variables diverge in the future subsequent to their reciprocal influence throughout a certain time frame.

3. RESULTS AND DISCUSSIONS

3.1 Descriptive Statistics

The descriptive statistics of all variables in the study are presented in Table 1. The mean value of Poverty was calculated to be 2386.72 kilocalories per capita per day, with a range of 2255 to 2440. The standard deviation for this data set was determined to be 52.32. The average economic growth

rate was found to be 3.85, with a range spanning from 1.01 to 7.67. The standard deviation for this dataset was calculated to be 1.90. Additionally, the average inflation rate was found to be 8.61, with a range of 2.91 to 20.29 and a standard deviation of 4.54. Similarly, the mean trade openness and unemployment rate were recorded as 33.18 and 6.35 percent correspondingly. Figure 1 depicts the temporal dynamics of poverty in Pakistan from 1998 to 2016, with data presented on a yearly basis. In a comparable manner, the yearly percentage fluctuations in economic growth, inflation rate, trade openness, and unemployment rate in Pakistan from 1998 to 2016 have been graphically represented (Figure 2-4).

Table 1. Descriptive statistics of the variables.

Variables	Mean	Median	Maximum	Minimum	Std. Dev.
Poverty	2386.72	2404	2440	2255	52.32
Economic Growth	3.85	3.58	7.67	1.01	1.90
Inflation Rate	8.61	7.81	20.29	2.91	4.54
Trade Openness	33.18	32.90	38.33	28.13	2.52
Unemployment Rate	6.35	5.97	8.30	4.98	1.05

Source: Author(s) calculation.

3.2 Results of Unit Root Test

The stationarity of the five series, namely Poverty, Economic Growth, Inflation Rate, Trade Openness, and Unemployment Rate, was assessed in this study using the ADF and PP unit root tests. Table 3 displays the projected outcomes of the Augmented Dickey-Fuller (ADF) test, whereas Table 4 presents the expected results of the Phillips-Perron (PP) test. The ADF test values presented in Table 3 demonstrate that all of the variables exhibit stationarity at the first difference, indicating an integrated order of one, I(1). Additionally, the PP test indicates that all of the variables exhibit non-stationarity at their levels, but become stationary when differenced once. Hence, it can be concluded that they are similarly characterised by being integrated of order one, denoted as I(1).

Table 3. ADF test for unit root.

Variables		ADF test	P value	Lag	Conclusion
PO	Intercept	-2.06	0.26	(1)	I(1)
	Difference	-3.72	0.01**	(1)	
	Intercept and Trend	-2.35	0.39	(1)	
	Difference	-5.52	0.00*	(1)	
EG	Intercept	-2.54	0.12	(1)	I(1)
	Difference	-3.89	0.01**	(1)	
	Intercept and Trend	-2.58	0.29	(1)	
	Difference	-3.82	0.04**	(1)	
IR	Intercept	-1.60	0.46	(1)	I(1)
	Difference	-3.44	0.02**	(1)	
	Intercept and Trend	-1.56	0.77	(1)	
	Difference	-5.58	0.00*	(0)	
TO	Intercept	-0.72	0.82	(1)	I(1)
	Difference	-4.74	0.00*	(0)	
	Intercept and Trend	-1.16	0.89	(1)	
	Difference with Trend	-4.79	0.01**	(0)	
UR	Intercept	-1.91	0.32	(1)	I(1)
	Difference	-3.71	0.01**	(0)	
	Intercept and Trend	-1.99	0.57	(1)	

	Difference with Trend	-3.72	0.04**	(0)	

Note: *Significant at 1%, ** Significant at 5%

Table 4. PP test for unit root.

Variables		PP test	P Value	Lag	Conclusion
AGD	Intercept	-0.89	0.78	(1)	I(1)
	Difference	-9.17	0.00*	(1)	
	Intercept and Trend	-2.69	0.24	(1)	
	Difference	-9.25	0.00*	(1)	
MAN	Intercept	-2.02	0.28	(2)	I(1)
	Difference	-9.96	0.00*	(2)	
	Intercept and Trend	-4.25	0.01*	(2)	
	Difference	-	-	-	
APP	Intercept	-2.59	0.10	(1)	I(1)
	Difference	-13.71	0.00*	(1)	
	Intercept and Trend	-1.74	0.72	(1)	
	Difference	-16.02	0.00*	(1)	
PEA	Intercept	-1.68	0.44	(1)	I(1)
	Difference	-7.13	0.00*	(1)	
	Intercept and Trend	-3.13	0.11	(1)	
	Difference	-7.06	0.00*	(1)	

Note: *Significant at 1% level

3.3 Results of Johansen Test for Co-Integration

The examination of the hypothesis of co-integration is conducted using the Johansen co-integration test, as all the variables are integrated of the same order, namely I(1). The approach utilised for co-integration in this study is founded upon two statistical tests, namely trace statistics and maximal eigenvalues. The predicted outcomes of Johansen's co-integration tests are displayed in Tables 5 and 6. At a significance level of 5%, the trace statistics value exceeds the critical value for a maximum of one co-integrating vector. Hence, based on the results obtained from the Trace statistics (Table 5), the null hypothesis H0: $r \leq 1$, indicating the absence of a co-integrating vector, is rejected in favour of the alternative hypothesis Ha: $r = 2$. At a significance level of 5%, it can be observed that the Max-Eigen value exceeds the critical value, indicating the presence of at most one co-integrating vector. Therefore, based on the results presented in Table 6, we may conclude that the null hypothesis H0: $r = 1$, which assumes the absence of an integrating vector, cannot be rejected in favour of the alternative hypothesis Ha: $r = 2$, when considering the Max-Eigen statistics. The co-existence of co-integration among poverty, economic growth, inflation rate, trade openness, and unemployment rate suggests that these variables exhibit a simultaneous movement and possess enduring associations in the long term.

Table 5. Johansen co-integration test using trace statistics.

Null Hypothesis	Alternative Hypothesis	Eigenvalue	Trace Statistic	5% Critical value	Prob.**	Hypothesized No. of CE(s)
$H_0: r = 0$	$H_a: r = 1$	0.97	132.83	69.82	0.00	None*
$H_0: r \leq 1$	$H_a: r = 2$	0.80	56.28	47.86	0.01	At most 1*
$H_0: r \leq 2$	$H_a: r = 3$	0.46	22.91	29.80	0.25	At most 2
$H_0: r \leq 3$	$H_a: r = 4$	0.38	10.15	15.49	0.27	At most 3

Source: Author(s) calculation

Table 6. Johansen co-integration test using max-Eigen statistics.

Null Hypothesis	Alternative Hypothesis	Eigenvalue	Max-Eigen Statistic	5% Critical value	Prob.**	Hypothesized No. of CE(s)
$H_0 : r = 0$	$H_a : r = 1$	0.97	76.55	33.88	0.00	None*
$H_0 : r \leq 1$	$H_a : r = 2$	0.80	33.36	27.58	0.01	At most 1*
$H_0 : r \leq 2$	$H_a : r = 3$	0.46	12.77	21.13	0.47	At most 2
$H_0 : r \leq 3$	$H_a : r = 4$	0.38	9.92	14.26	0.22	At most 3

Source: Author(s) calculation

3.4 Results of ARDL Model and Bound Test

The ARDL model was employed in this investigation due to the fulfilment of the preconditions, specifically the absence of any variable exhibiting I(2) characteristics. Hence, this study examines the co-integration relationship between poverty and various economic indicators, including economic growth, inflation rate, trade openness, and unemployment rate. The limits test for co-integration is employed within the framework of the autoregressive distributed lag (ARDL) model, which incorporates both restricted intercept and unconstrained trend. However, in order to assess the long-term estimates bound test (F statistics), it is necessary for the value to be statistically significant. Therefore, the F-statistics was used to check the long-run co-integration between the endogenous variable poverty and exogenous variables economic growth, inflation rate, trade openness and unemployment rate. Additionally, Table 7 displays the outcomes of the Bound test for co-integration, namely the projected value of the F statistics. The F-Critical values presented in Table 7 were sourced from Pesaran et al. (2001). The findings of this study indicate that a lag order of k=1 was deemed suitable for co-integration. The findings from the boundaries test (F-Statistics) conducted by the ARDL modelling approach, as presented in Table 6, indicate a strong indication of the presence of a long-term association between poverty and many factors including economic growth, inflation rate, trade openness, and unemployment rate in the context of Pakistan. As a result, the bounds test is unable to accept the null hypothesis H0: α1 = Β1 = Β2 = Β3 = Β4 = 0, which suggests no co-integration between poverty and economic growth, inflation rate, trade openness, and unemployment rate. Instead, it supports the alternative hypotheses H1: α1 ≠ Β1 ≠ Β2 ≠ Β3 ≠ Β4 ≠ 0, indicating the presence of co-integration between poverty and economic growth, inflation rate, trade openness, and unemployment rate.

Table 6. The Bounds test for co-integrating relationship.

	90% confidence level		95% confidence level		99% confidence level	
K	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	3.80	3.80	4.60	4.60	6.44	6.44
1	3.02	3.51	3.62	4.16	4.94	5.58
2	2.63	3.35	3.10	3.87	4.13	5.00
3	2.37	3.20	2.79	3.67	3.65	34.66
4	2.20	3.09	2.56	3.49	3.29	4.37
5	2.08	3.00	2.39	3.38	3.06	4.15
F-statistic	6.36					

A significant correlation exists between poverty and economic growth, inflation rate, trade openness, and unemployment rate when poverty is considered as the dependent variable in the long run. The maximum values of variables v, x, y, and z in equation (11) are constrained to 1 due to the use of a substantial sample size and the inclusion of annual data in this study. The values chosen for the variables v, x, y, and z are 1, 1, 1, and 1, respectively. The findings of the estimated short and long-run ARDL co-integration model are presented in Table 8. The specification of the

deterministic element in the model was derived from the principles of economic theory and the statistical relevance of the model. Hence, the model incorporated both the restricted intercept and the unrestricted trend. According to the findings presented in Table 8, the estimated constant term exhibits a positive and statistically significant relationship at a significance level of 5%. In the short-run context, it is theoretically anticipated that the coefficients of economic growth and trade openness would have a positive sign. However, their statistical significance is not established. Similarly, in the short-run, it is theoretically expected that the inflation rate and unemployment rate will have a negative sign, but their statistical significance is inconclusive. The estimates obtained from the nonlinear model indicate that alterations in the exogenous variables do not exhibit statistically significant asymmetric impacts on poverty in the short term. The persistence of unequal impacts is shown in the long-term. This finding suggests that there is a positive correlation between poverty reduction and economic growth, specifically in relation to trade openness. In the near term, the poverty levels in Pakistan are adversely affected by both inflation and unemployment rates.

Subsequently, the discourse is expanded by considering the outcomes of a long-term autoregressive distributed lag (ARDL) co-integration analysis involving poverty, economic growth, inflation rate, trade openness, and unemployment rate. As evidenced by the data presented in Table 8, poverty exhibits a statistically significant beneficial impact on all three exogenous factors in the long term. These findings provide more evidence that economic growth, inflation rate, trade openness, and unemployment rate will continue to have a significant impact on the agriculture value added of Pakistan over an extended period of time.

Table 8. The ARDL co-integration model.

Variable	Coefficient	Standard error	t-Statistics	P value
Constant	6.66	2.36	2.82	0.02
Short-run form				
ΔEG	0.02	0.01	1.81	0.11
ΔIR	-0.00	0.00	-0.32	0.76
ΔTO	0.05	0.06	0.90	0.39
ΔUR	-0.01	0.01	-0.90	0.40
Long-run form				
LEG	0.02	0.01	1.88	0.10
LIR	0.00	0.00	0.17	0.87
LTO	0.01	0.07	0.11	0.92
LUR	-0.02	0.01	-2.88	0.02
Akaike Information Criterion (AIC)		-6.11		
Schwartz Information Criteria (SIC)		-5.56		
Hannan-Quinn Criteria (HQ)		-6.01		
Durbin-Watson stat		1.94		

Source: Author(s) calculation

3.5 Results of Diagnostic Tests

Various diagnostic tests were conducted to assess the validity and dependability of the findings. The reliability of the analytical results is supported by the findings of the residual diagnostic tests, namely the Lagrange multiplier (LM) and Engle's ARCH tests. These tests indicate that the residuals of the estimations do not exhibit any autocorrelation issues, as shown in Table 9. The adequacy of the model's specification was assessed through the application of the Ramsey RESET test. The test results indicate that the functionality of the model is accurate. Furthermore, a normality test was conducted on the residuals in order to assess their distribution for normality. Hence, the Jarque-Bera normalcy test was performed. The null hypothesis posits that the residuals

have a normal distribution. Therefore, based on the p-value, there is insufficient evidence to reject the null hypothesis. According to Table 9, the Jarque-Bera value, along with its accompanying P value, indicates that the residuals exhibit a normal distribution. The stability of the parameters was assessed through the utilisation of the CUSUM test. The CUSUM test relies on the cumulative sum of the recursive residuals. Figure 5 displays the plot of the cumulative sum, accompanied by the 5% critical lines and the outcomes of this particular test. The results of this test indicate that the parameters exhibit stability, as evidenced by the cumulative sum remaining within the bounds defined by the two critical lines.

Table 9. Residual diagnostic tests.

Tests	Prob. x^2	Tests		Value	P value
LM	0.85>0.05%	Ramsey RESET	F statistic	1.07	0.34
Engle's ARCH	0.56>0.05%	Jarque-Bera	JB	1.22	0.54

Source: Author(s) calculation

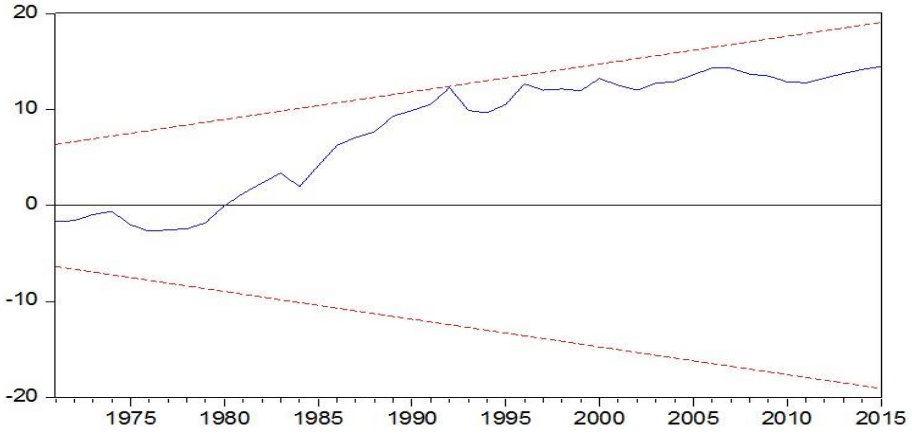

Figure 5. CUSUM test at 5% significance level.

Forecast error variance decomposition

The findings of variance decomposition are presented in Table 10. The standard error encompasses the prediction error of the variable at the specified forecast horizon for periods ranging from one to ten years in the future. The error variance decomposition provides insight into the extent to which changes in a variable may be attributed to its own exogenous shock versus shocks originating from other variables. Hence, the underlying cause of this discrepancy in the forecast can be attributed to the fluctuations in the present and future values of the innovations associated with each endogenous variable inside the Vector Autoregressive (VAR) system. The remaining variables represent the proportion of the forecast variance attributed to each innovation, where each row totals 100. The decomposition of the first variable in the VAR ordering during the first period is solely attributable to its own innovation. In this particular scenario, it is observed that as the forecast horizon expands, the standard errors exhibit an anticipated increase. However, they eventually reach a plateau, indicating that the system under consideration is stable. Moreover, the second horizon shock to AGD is responsible for 97.01% of the observed variation in AGD fluctuations. This implies that the aforementioned shock is exclusive to the AGD entity. In a similar vein, it is shown that shocks to poverty, economic growth, inflation rate, trade openness, and unemployment rate have the potential to induce fluctuations of 2.02%, 0.42%, and 0.53% in the aggregate gross domestic product (AGD), respectively. Based on the findings shown in Table 10, it can be inferred that poverty, economic growth, inflation rate, trade openness, and unemployment rate are

considered exogenous variables. However, it is noteworthy that poverty exhibits a greater impact on the variables of APP and PEA for prediction horizons beyond four years. It is noteworthy that poverty estimates are subject to the influence of various economic factors, including economic growth, inflation rate, trade openness, and unemployment rate. The impact of APP on AGD projections is significant, with PEA also exerting a considerable influence. MAN, while to a lesser level, also contributes to the overall forecast timeframes. According to Enders (2004), it is customary in applied research for a variable to account for a significant amount of its forecast error variance at shorter horizons, while exhibiting lesser proportions at longer horizons.

Table 10. Forecast error variance decomposition.

Periods	S. E	ln AGD	ln MAN	ln APP	ln PEA
1	0.32	100.00	0.00	0.00	0.00
2	0.39	97.01	2.02	0.42	0.53
3	0.45	88.75	1.99	7.21	2.04
4	0.50	82.42	3.71	8.88	4.97
5	0.56	79.16	3.06	11.40	6.32
6	0.61	79.23	2.58	11.20	6.94
7	0.65	78.67	2.29	12.50	6.48
8	0.69	78.72	2.11	13.20	5.91
9	0.72	78.69	1.92	13.90	5.46
10	0.76	78.18	1.76	14.90	5.14

Source: Author(s) calculation

Impulse response function

This function examines the impact of a singular exogenous shock on the present and future values of the endogenous variables. This study investigates the reaction of the dependent variable in the vector autoregressive (VAR) model to exogenous disturbances in the error terms. The function examines the impact of a singular disturbance to one of the innovations on present and future values of the endogenous variables. The impulse response function examines the potential impact of poverty, economic growth, inflation rate, trade openness, and unemployment rate on the increase in the aggregate gross domestic product (AGD) of Pakistan. The analysis of impulse response functions in the context of AGD reveals a discernible pattern of behaviour. While the rate of AGD increment is declining, the remaining three variables have a consistent upward trajectory, as depicted in Figure 6-9. This implies that there exists a positive correlation between poverty, economic growth, inflation rate, trade openness, and unemployment rate. The persistent upward trend observed in the expansion of this exogenous variable indicates a lack of imminent risk associated with a potential bubble.

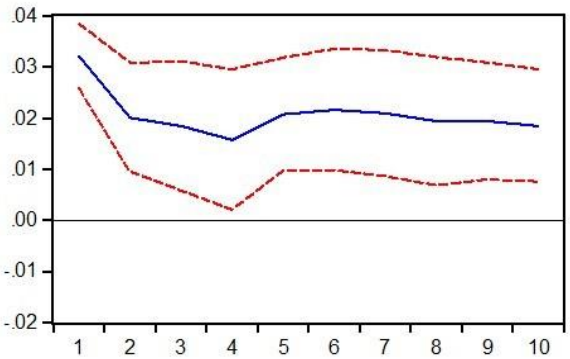

Figure 6. The response of ln AGD to ln AGD.

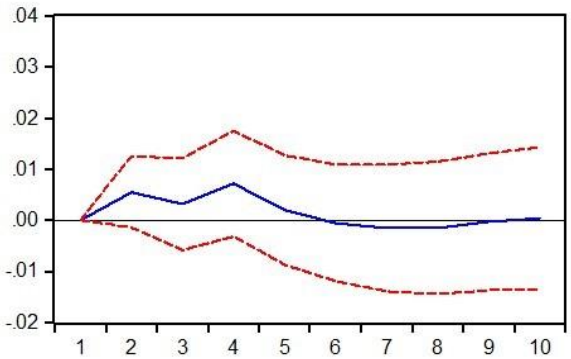

Figure 7. The response of ln AGD to ln MAN.

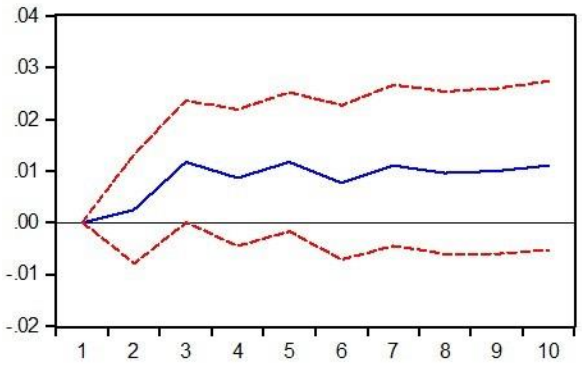

Figure 8. The response of ln AGD to ln APP.

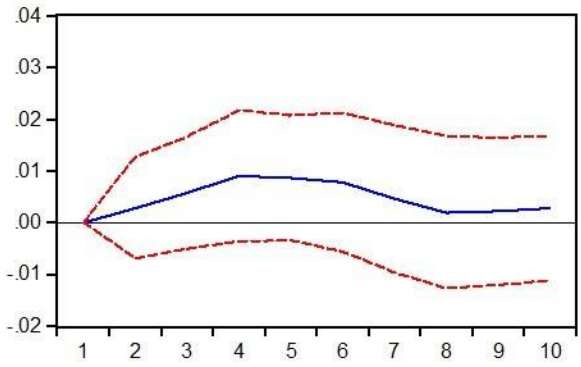

Figure 9. The response of ln AGD to ln PEA.

4. CONCLUSIONS

This study primarily aimed to conduct an investigative analysis of the relationship between average growing degree days (AGD) and the production of three selected fruits (mangoes, apples, and pears) using a nonlinear autoregressive distributed lag (ARDL) model. The Bound test was utilised in order to validate the presence of a long-term connection. The findings of the Bound test indicate the presence of a durable association between the exogenous variables (MAN, APP, and PEA) and the endogenous variable (AGD) in the research. The coefficients of the autoregressive distributed lag (ARDL) model indicate a statistically significant positive link between agricultural gross domestic product (AGD) and the production of the selected fruits in the long-run. However, in the short run, the coefficients yielded results that were supportive of economic theory, although they were positive in nature, they did not reach statistical significance. Moreover, the findings from the Johansen co-integration analysis suggest the presence of a sustained association between the production of specific fruits and the agricultural gross domestic product (AGD) of Pakistan in the long term.

Based on the findings presented, several significant policy implications can be discerned. Initially, in the immediate term, the production of MAN, APP, and PEA exhibits a favourable impact on the Aggregate Gross Domestic Product (AGD) of Pakistan. It is imperative for policy makers, researchers, and government workers to prioritise the cultivation and development of fruit crops. Furthermore, it is advisable to establish a robust correlation between fruit output and the Agricultural Development Goals (AGD) of Pakistan. Hence, it is imperative to allocate additional focus towards sustaining long-term relationships in the future. In summary, this study suggests that in order to enhance the country's export capabilities, the government of Pakistan should initiate new initiatives aimed at fostering the growth of the agricultural sector as a whole, with a specific focus on the horticulture industry.

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