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Article

Does Energy-Growth and Environment Quality Matter for Agriculture Sector in Pakistan or not? An Application of Cointegration Approach

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Abstract: The main objective of this paper is to examine the long-term effects of financial development, economic growth, energy consumption (electricity consumption in the agriculture sector), foreign direct investment (FDI), and population on the environmental quality in Pakistan during the period of 1980 to 2016. We use CO_2 emissions from the agriculture sector as a proxy indicator for environmental quality. We employ various unit root tests (e.g., ADF, PP, ERS, KPSS) and structural break unit root tests (Z&A, CMR) to check the stationarity and structural break in the data series. Cointegration tests, i.e., Johansen, Engle-Granger, and ARDL cointegration approaches are used to ensure their robustness. Results showed that significant long-term cointegration exists among the variables. Findings also indicated that an increase in financial development and foreign direct investment (FDI) improves environmental quality, whereas the increase in economic growth and electricity consumption in the agriculture sector degrades environmental quality in Pakistan. Based on the findings, we suggest policymakers should provide a conducive environment for foreign investment. Moreover, it is also suggested that a reliance on fossil fuels be reduced and a transition to renewable energy sources be encouraged to decrease the environmental pollution in the country.

Keywords: financial development; carbon emissions; energy consumption; environment quality cointegration; Pakistan

1. Introduction

The Food and Agriculture Organization (FAO) of the United Nations [1] examined the main factors of greenhouse gas (GHG) emissions with respect to agriculture, fishery and forestry sectors which had doubled their emissions in the past 50 years and could increase by as much as 30% in the future. Agriculture-related emissions from livestock and crops increased from 4.7 billion tons of carbon dioxide equivalent in 2001 to more than 5.3 billion tons in 2011, an increase of 14%. The increase is largely due to the increase in total agricultural output of developing countries [1]. The agriculture sector performs a vital role in the economy of Pakistan, functioning as the backbone of the country's economy. The farming sector not only provides food and raw materials but also creates employment opportunities for a large proportion of the population and provides food, fiber, (fuel from plants) and other products used to sustain and improve their living standards.

According to Pakistani statistics [2], agriculture accounted for 18.9% of the gross domestic product (GDP) and it is a source of livelihood for almost 42% of the rural population. The agriculture sector of Pakistan is made up of five subsectors including major crops, minor crops, livestock, fishing, and forestry, respectively. The major crops (e.g., wheat, rice, sugarcane, maize, and cotton) accounted for a 23.60% value addition in the agriculture sector and a 4.45% contribution to the gross domestic product (GDP). Likewise, the minor crops accounted for 10.80% of agriculture value addition and 2.04% of GDP. Similarly, livestock, fishing and forestry accounted for shares of 58.92%, 2.10% and 2.09% in the agriculture sector respectively, and 11.11%, 0.40% and 0.39% of GDP [2]. Accordingly, the enormous input from these subsectors to the agriculture segment may responsible for producing carbon dioxide (CO_2) in Pakistan. The negative effects of carbon dioxide (CO_2) emission from the agricultural sector, especially from fossil fuels, as well as the increase of greenhouse gases (GHGs) on the earth's surface, pose challenges for all countries of the world, regardless of economy size and the volume of population. Hence, all countries are responsible for the accumulation of such greenhouse gases (GHGs).

The earthquake in Haiti, floods in Pakistan and Australia, the tsunami in Japan and wildfires in Russia were among the most recent past major disasters that could be the consequence of environmental degradation. These conditions have caused damage to natural resources such as forests and wildlife, land and agricultural output, infrastructure and, above all, to human life. Economists and environmental experts believe that these catastrophic events are the main source of disruption to economic and financial development and have a significant impact on the environment [3].

Most developing countries started to work towards environmentally sustainable financial activities. However, economic growth activities often lead to an increase in the use of energy, which in turn contributes to the burning of fossil fuels and subsequently a rise in carbon dioxide (CO_2). This toxic substance increases the amount greenhouse gases (GHGs) and contributes to global warming. The hazards and consequences of climate change and global warming have led to the establishment of environmental friendly advocacy organizations. These organizations have made a significant contribution to the global green movement, promoting conditions in which human beings and the natural environment can come together to meet socio-economic and environmental needs [4]. Furthermore, financial development is seen as an alternative to achieving a quality environment, the challenge remains that carbon dioxide emissions are linked to the consumption of energy as a catalyst for the development and economic growth. In this case, reducing carbon dioxide emissions necessarily means slowing down the growth of the economy, while the country will not be keen to insist on economic growth. This requires innovative solutions through which the twin goals of better economic growth and a sustainable environment can be achieved. As stated in [3] this issue has been in existence since 1960, and since then there has been increased consciousness of the degradation of the environment and its more harmful influences on climate change and the environment among policymakers, ecological activists, and economists both at national and international levels. Several countries initially proposed regulatory policies and rules to address environmental pollution and degradation in pursuing of economic development.

The present study is different from previous studies in various aspects, and it has four contributions to the emerging economic literature, which is related to the studies of environmental quality: (1) we considered carbon emissions from the agriculture sector with reference to some further economic indicators in Pakistan, where its economy is enormously based on its agriculture output. (2) We used various unit root tests such as the Augmented Dickey–Fuller (ADF), the Phillips–Perron (PP), the Elliot, Rothenberg and Stock point optimal (ERS), the Kwiatkowski, Phillips, Schmidt and Shin (KPSS), Zovit Andrews and the clemente montanes reyes (CMR) tests are also utilized to consider the structural breaks. (3) For a long-term relationship, the ARDL approach is employed to check the short-term and long-term relationships between financial development, economic growth, energy consumption (electricity consumption in the agriculture sector), FDI, population and CO_2 emissions in

Pakistan. (4) For the purpose of robustness, cointegration tests (Johansen and Engle-Granger tests) are applied for approving the long term cointegrating combinations among the variables.

The purpose of this paper is to analyze the long-term cointegrating association between financial development and CO_2 emissions in Pakistan over the period 1980–2016 by using the Johansen cointegration test, Engle-Granger cointegration and autoregressive distributed lag (ARDL) bounds testing cointegration approaches. Only a few studies in the past have investigated the impact of financial development on CO_2 emissions from the agriculture sector as an indicator of environmental quality. Because of the scarcity of the study, the study can fill this gap and contribute to the growing literature.

The remainder of this paper is organized in this manner: the literature review is stated in Section 2, and materials and econometric methods are portrayed in Section 3. Moreover, the empirical results and discussion are enclosed in Section 4, whereas Section 5 concludes the recent study and grants some policy implications along with future recommendations.

2. Literature Review

In Pakistan, several studies have been done in the past to see the impact of financial development, power and economic on CO_2 emissions. Some of the major studies in this regard done by [5–12]. An investigation has been conducted by in [6] that investigated the long-run cointegration association between monetary instability and ecological degradation in Pakistan for the period 1971–2009 using time-series analysis. The study found that financial instability increase environmental pollution in Pakistan. The study in [11] inspected the effect of financial development, growth, trade, and energy on CO_2 emissions in Pakistan between 1980 and 2015. It was reported that financial development, economic growth, consumption of power and skills are the increasing factors of CO_2 emissions. Furthermore, it was obtained that there is a long-run association between CO_2 emissions, financial development, energy consumption, capital, trade and economic growth in case of Pakistan. In the existing literature, some researchers found the insignificant impact of financial development on CO_2 emissions [13–15]. A research has been conducted by [3] examined the impact of growth, coal, financial development and trade on environmental quality in South Africa by using time-series data (1965–2008). Hence, results indicated that a rise in economic growth raises energy emissions, whereas financial development reduces it. Their findings also revealed that consumption of coal has a significant contribution to decline environment in the South African economy. By reducing the growth of energy pollutants, trade openness improves environmental quality for the case of South Africa.

Applying time-series analysis, [15] studied Turkey by using financial development, energy use, economic growth, trade openness, and CO_2 emissions data from the period 1960–2007. The results of the analysis revealed that economic growth and trade openness have significant effects causing environmental pollution but financial development has no significant impact on environmental quality. Using time-series analysis, [16] examined the impact of financial and economic development as well as energy on CO_2 emissions in China. They found the inverse effect of financial development on environmental pollution telling that the development of the financial sector has not taken place at the expense of environmental pollution in China. Additionally, an investigation has been conducted by [17] investigated the relations between economic growth, energy consumption, financial development, trade openness and CO_2 emissions over the period of 1975–2011 in case of Indonesia. They accomplished that energy use and economic growth increase CO_2 emissions, whereas trade openness and financial development compact it. As studied by the [18] examined the interplay between financial development, energy use and GDP on CO_2 emissions. Using time-series data for Turkey for the period 1976–1986, results of the analysis revealed that financial development develops environmental quality while energy use and economic growth reduce it. The study of [19] has investigated the interplay between energy consumption, economic growth, and CO_2 emissions by applying time-series data for eight Asian countries covering the period 1991–2013. The study proved that the growth of economic and consumption of energy have affected environmental degradation.

Inspecting the five western provinces of China, [20] established that the effect of tourism on the environment is negative for Gansu, Shanxi, Qinghai, and Ningxia. Overall, the negative impact of economic growth and energy consumption is more significant than tourism on CO_2 emission in the long run. According to [21,22] investigated an interrelationship between economic growth, level of energy consumption, financial development and oil prices in context of Italy for 1960 to 2014, where he found a long run cointegration among the variables under ARDL approach, and elaborated that estimators for oil prices and real economic growth have a noteworthy impact on level of energy usage. However, in short run results under the VAR technique, only real economic growth is an impacting factor for energy consumption. Furthermore, [23] broadened the literature with respect to Belt and Road Initiative countries for 1980–2016, where a panel of 47 nations acknowledged that financial development, energy consumption, capital formation, economic output and urbanization detrimentally fronting to the environmental abatement excluding trade openness which has a favorable link with CO_2 emissions. Similarly, [24] explored an EKC hypothesis considering to BRI 65 countries, results offered that mean group model authenticate it in all six regions. Likewise, the pooled mean group only confirmed the EKC hypothesis in developed European region but unacceptable for others.

Indeed, developing, emerging and advanced economies are converging to diminish the scale of CO_2 emissions without disturbing to the pace of sustainable progression. After reforms and open up the economy in China, the structure of its economic development has been transformed very swiftly, the operational segments of growth, i.e., agriculture, industry and service sectors tremendously sponsor to bolster the degree of economic progress in this age of competitiveness. The revealed estimates enlightened that agriculture, industry, services sectors, energy consumption, and trade detrimentally deflate to the natural environment of China [25]. Next, an exploration has been conducted [26] considering industrial growth, energy usage, services sector output and CO_2 emissions in China over the period of 1971–2016. The estimations divulged that industrial growth, services sector and level of energy utilization have an adverse effect on ecology, whereas the economic output is effectual for the environmental quality in the long run for China. However, in short-term industrial growth, the service sector and economic output harmfully effect on the environment. In addition, scrutiny has been warranted for Pakistan over the time range of 1984–2016, where a long-run interconnection was found between the variables. As per testified outcomes, gas and electricity consumption have a positive influence on the agriculture sector proportion of GDP in Pakistan [27].

Some important knowledge has been analyzed and a contribution to the existing body of literature made by distinguishing our current study and using CO_2 emissions from the agricultural sector as a substitute for environmental quality, the inclusion of population and money market financial indicators in simulating the association between financial development and environmental quality for the case of Pakistan.

3. Material and Econometric Methods

The theoretical basis of the present study comes from the expanded theory of production, which considers energy use to be an additional productive input in addition to workforce and capital. Once energy use is included in the production function, there is a case for it to be directly related to carbon dioxide emissions (CO_2). The expanded production doctrine also provides a framework for the use of development of the financial sector as a model of technological progress. This is based on greater financial development that can increase output and economic growth. Recent empirical works have employed expanded production theory to simulate the association amongst financial development, consumption of energy and carbon dioxide emissions (CO_2) [28–31]. However, the use of emissions from the agricultural sector makes the study very different from the available literature. In addition, modeling the log–log model specification compared to a simple linear-linear specification would reduce the sharpness of time series data and thus provide efficient results [32].

The empirical model specifications of this current study followed the emerging literature related to financial development and carbon dioxide emissions (CO_2), which provide empirical evidence to explore the links between growth, energy, financial development and carbon dioxide emissions (CO_2). In addition to the use of agricultural emissions, the study has added the population to further distinguish our empirical work from earlier studies [3,16,25]. These authors have included financial development in their empirical analysis. Following them, the functional form for carbon dioxide emissions (CO_2) in Pakistan can be specified as follows:

$$CO_{2t} = f(Y_t, EC_t, FD_t, FDI_t, POP_t) \quad (1)$$

The study used the log-linear specification in order to examine the interplay amongst dependent variable and independent variables. This study has formulated the log-linear model and it is specified as follows:

$$lnCO_{2t} = \lambda_0 + \lambda_1 lnY_t + \lambda_2 lnEC_t + \lambda_3 lnFD_t + \lambda_4 lnFDI_t + \lambda_5 lnPOP_t + \varepsilon_t \quad (2)$$

where $lnCO_2$ is the usual log of carbon dioxide (CO_2) from the agriculture sector, lnY stands for the natural log of economic growth, $lnEC$ represents the natural log of energy consumption (electricity consumption in agriculture sector), $lnFD$ symbolizes natural log of financial development, $lnFDI$ indicates natural log of foreign direct investment net inflows, $lnPOP$ represents natural log of population, $\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5$ are coefficients to be estimated, λ_0 represents the constant term and ε_t denotes the stochastic error term, respectively. The present empirical work is based on the annual time series data to examine the effects of financial development and economic growth on agricultural CO_2 emissions in Pakistan. Data over the period 1980 to 2016 have been taken from the World Development Indicators (WDI, 2016), Food and Agriculture Organization (FAO, 2014) and Pakistan economic survey (GOP, 2016). Table 1 reports the description of the selected study variables.

Table 1. Study variables name, symbols, measurement and data sources.

Variable Name	Symbol	Variable Measurement	Data Source
CO_2 emissions	CO_2	CO_2 emissions from the agriculture sector (Gg)	(FAO, 2014)
Economic growth	Y	In constant 2010 US$	(WDI, 2016)
Electricity consumption	EC	Electricity consumption in agriculture sector (Gwh)	(GOP, 2016)
Financial development of the private sector	FD	Domestic credit to the private sector (% of GDP)	(WDI, 2016)
Foreign direct investment	FDI	Net inflows (% of GDP)	(WDI, 2016)
Population	POP	Total population (million)	(GOP, 2016)

Notes: GOP = Government of Pakistan; FAO = The Food and Agriculture Organization of the United Nations; WDI = World development Indicators.

Estimation Technique

Autoregressive Distributed Lag (ARDL)

The ARDL modelling approach proposed by [33] is used to check whether a long-run cointegration exists amongst the selected study variables or not. The autoregressive distributed lag (ARDL) modelling technique has some advantages over the traditional methods [34,35]. First, both the short-run and long-run parameters can be assessed at the same time. Second, this method can be employed even if the selected study variables are stationary at I(0), I(1) or a combination of both. Third, the ARDL modelling approach has been found much more efficient when dealing with a small sample size [29]. The ARDL-bound test cointegrations equations are given by:

$$
\begin{aligned}
\Delta lnCO2_t \;=\;& \delta_0+\delta_1\sum_{i=1}^{p}\Delta lnCO2_{t-1}+\delta_2\sum_{i=1}^{p}\Delta lnY_{t-1}+\delta_3\sum_{i=1}^{p}\Delta lnEC_{t-1}\\
&+\delta_4\sum_{i=1}^{p}\Delta lnFD_{t-1}+\delta_5\sum_{i=1}^{p}\Delta lnFDI_{t-1}+\delta_6\sum_{i=1}^{p}\Delta lnPOP_{t-1}\\
&+\phi_1 lnCO2_{t-i}+\phi_2 lnY_{t-i}+\phi_3 lnEC_{t-i}+\phi_4 lnFD_{t-i}+\phi_5 lnFDI_{t-i}\\
&+\phi_6 lnPOP_{t-i}+\mu_t\\
\Delta lnY_t \;=\;& \delta_0+\delta_1\sum_{i=1}^{p}\Delta lnY_{t-1}+\delta_2\sum_{i=1}^{p}\Delta lnCO2_{t-1}+\delta_3\sum_{i=1}^{p}\Delta lnEC_{t-1}+\delta_4\sum_{i=1}^{p}\Delta lnFD_{t-1}\\
&+\delta_5\sum_{i=1}^{p}\Delta lnFDI_{t-1}+\delta_6\sum_{i=1}^{p}\Delta lnPOP_{t-1}+\phi_1 lnY_{t-i}+\phi_2 lnCO2_{t-i}\\
&+\phi_3 lnEC_{t-i}+\phi_4 lnFD_{t-i}+\phi_5 lnFDI_{t-i}+\phi_6 lnPOP_{t-i}+\mu_t\\
\Delta lnEC_t \;=\;& \delta_0+\delta_1\sum_{i=1}^{p}\Delta lnEC_{t-1}+\delta_2\sum_{i=1}^{p}\Delta lnY_{t-1}+\delta_3\sum_{i=1}^{p}\Delta lnCO2_{t-1}.\\
&+\delta_4\sum_{i=1}^{p}\Delta lnFD_{t-1}+\delta_5\sum_{i=1}^{p}\Delta lnFDI_{t-1}+\delta_6\sum_{i=1}^{p}\Delta lnPOP_{t-1}.\\
&+\phi_1 lnEC_{t-i}+\phi_2 lnY_{t-i}+\phi_3 lnCO2_{t-i}+\phi_4 lnFD_{t-i}+\phi_5 lnFDI_{t-i}\\
&+\phi_6 lnPOP_{t-i}+\mu_t\\
\Delta lnFD_t \;=\;& \delta_0+\delta_1\sum_{i=1}^{p}\Delta lnFD_{t-1}+\delta_2\sum_{i=1}^{p}\Delta lnEC_{t-1}+\delta_3\sum_{i=1}^{p}\Delta lnY_{t-1}\\
&+\delta_4\sum_{i=1}^{p}\Delta lnCO2_{t-1}+\delta_5\sum_{i=1}^{p}\Delta lnFDI_{t-1}+\delta_6\sum_{i=1}^{p}\Delta lnPOP_{t-1}\\
&+\phi_1 lnFD_{t-i}+\phi_2 lnEC_{t-i}+\phi_3 lnY_{t-i}+\phi_4 lnCO2_{t-i}+\phi_5 lnFDI_{t-i}.\\
&+\phi_6 lnPOP_{t-i}+\mu_t\\
\Delta lnFDI_t \;=\;& \delta_0+\delta_1\sum_{i=1}^{p}\Delta lnFDI_{t-1}+\delta_2\sum_{i=1}^{p}\Delta lnFD_{t-1}+\delta_3\sum_{i=1}^{p}\Delta lnEC_{t-1}.\\
&+\delta_4\sum_{i=1}^{p}\Delta lnY_{t-1}+\delta_5\sum_{i=1}^{p}\Delta lnCO2_{t-1}+\delta_6\sum_{i=1}^{p}\Delta lnPOP_{t-1}.\\
&+\phi_1 lnFDI_{t-i}+\phi_2 lnFD_{t-i}+\phi_3 lnEC_{t-i}+\phi_4 lnY_{t-i}+\phi_5 lnCO2_{t-i}\\
&+\phi_6 lnPOP_{t-i}+\mu_t\\
\Delta lnPOP_t \;=\;& \delta_0+\delta_1\sum_{i=1}^{p}\Delta lnPOP_{t-1}+\delta_2\sum_{i=1}^{p}\Delta lnFDI_{t-1}+\delta_3\sum_{i=1}^{p}\Delta lnFD_{t-1}.\\
&+\delta_4\sum_{i=1}^{p}\Delta lnEC_{t-1}+\delta_5\sum_{i=1}^{p}\Delta lnY_{t-1}+\delta_6\sum_{i=1}^{p}\Delta lnCO2_{t-1}\\
&+\phi_1 lnPOP_{t-i}+\phi_2 lnFDI_{t-i}+\phi_3 lnFD_{t-i}+\phi_4 lnEC_{t-i}+\phi_5 lnY_{t-i}\\
&+\phi_6 lnCO2_{t-i}+\mu_t
\end{aligned}
\tag{3}
$$

where δ_0 represents the constant term, μ_t stands for the error term, the dynamics for error correction in the short run are denoted by δ whereas the long-run links is presented in the next half of the equation symbolized by ϕ. The ARDL modeling approach employees F-statistics test to decide the presence of a long-run cointegration amongst the constructed study variables. The null hypothesis suggests the there is no a long-run cointegration against the alternative hypothesis of there exists a long-run cointegration among the variables. [33,36] proposed LCB (Lower Critical Bound) and the UCB (Upper Critical Bound) for large samples and small samples and large samples. A long-run cointegration among the variables exists if the computed F-statistics is greater than UCB value than the null hypothesis can be rejected and accepted the alternative hypothesis that a long-run cointegration exist. Furthermore, the null hypothesis cannot be rejected if the calculated F value is lower than LCB value and suggested that a long-run cointegration does not exist. However, if the calculated F value lies between the UCB and LCB, the result is inconclusive. In the present empirical study, we used the AIC (Akaike Information Criterion) for selection of the lag length. After the optimal lag length selections and model estimation, if there exists the long-run cointegration association so the short and long-run ARDL model equations are the following:

$$
\begin{aligned}
\Delta lnCO2_t &= \delta_0 + \delta_1 \sum_{i=1}^{p} \Delta lnCO2_{t-1} + \delta_2 \sum_{i=1}^{p} \Delta lnY_{t-1} + \delta_3 \sum_{i=1}^{p} \Delta lnEC_{t-1} \\
&+ \delta_4 \sum_{i=1}^{p} \Delta lnFD_{t-1} + \delta_5 \sum_{i=1}^{p} \Delta lnFDI_{t-1} + \delta_6 \sum_{i=1}^{p} \Delta lnPOP_{t-1} \\
&+ \psi_1 ECT_{t-1} + \varepsilon_t \\
\Delta lnY_t &= \delta_0 + \delta_1 \sum_{i=1}^{p} \Delta lnY_{t-1} + \delta_2 \sum_{i=1}^{p} \Delta lnCO2_{t-1} + \delta_3 \sum_{i=1}^{p} \Delta lnEC_{t-1} \\
&+ \delta_4 \sum_{i=1}^{p} \Delta lnFD_{t-1} + \delta_5 \sum_{i=1}^{p} \Delta lnFDI_{t-1} + \delta_6 \sum_{i=1}^{p} \Delta lnPOP_{t-1} \\
&+ \psi_2 ECT_{t-1} + \varepsilon_t \\
\Delta lnEC_t &= \delta_0 + \delta_1 \sum_{i=1}^{p} \Delta lnEC_{t-1} + \delta_2 \sum_{i=1}^{p} \Delta lnY_{t-1} + \delta_3 \sum_{i=1}^{p} \Delta lnCO2_{t-1} + \delta_4 \sum_{i=1}^{p} \Delta lnFD_{t-1} \\
&+ \delta_5 \sum_{i=1}^{p} \Delta lnFDI_{t-1} + \delta_6 \sum_{i=1}^{p} \Delta lnPOP_{t-1} + \psi_3 ECT_{t-1} \\
&+ \varepsilon_t \\
\Delta lnFD_t &= \delta_0 + \delta_1 \sum_{i=1}^{p} \Delta lnFD_{t-1} + \delta_2 \sum_{i=1}^{p} \Delta lnEC_{t-1} + \delta_3 \sum_{i=1}^{p} \Delta lnY_{t-1} + \delta_4 \sum_{i=1}^{p} \Delta lnCO2_{t-1} \\
&+ \delta_5 \sum_{i=1}^{p} \Delta lnFDI_{t-1} + \delta_6 \sum_{i=1}^{p} \Delta lnPOP_{t-1} + \psi_4 ECT_{t-1} + \varepsilon_t \\
\Delta lnFDI_t &= \delta_0 + \delta_1 \sum_{i=1}^{p} \Delta lnFDI_{t-1} + \delta_2 \sum_{i=1}^{p} \Delta lnFD_{t-1} + \delta_3 \sum_{i=1}^{p} \Delta lnEC_{t-1} + \delta_4 \sum_{i=1}^{p} \Delta lnY_{t-1} \\
&+ \delta_5 \sum_{i=1}^{p} \Delta lnCO2_{t-1} + \delta_6 \sum_{i=1}^{p} \Delta lnPOP_{t-1} + \psi_5 ECT_{t-1} + \varepsilon_t \\
\Delta lnPOP_t &= \delta_0 + \delta_1 \sum_{i=1}^{p} \Delta lnPOP_{t-1} + \delta_2 \sum_{i=1}^{p} \Delta lnFDI_{t-1} + \delta_3 \sum_{i=1}^{p} \Delta lnFD_{t-1} \\
&+ \delta_4 \sum_{i=1}^{p} \Delta lnEC_{t-1} + \delta_5 \sum_{i=1}^{p} \Delta lnY_{t-1} + \delta_6 \sum_{i=1}^{p} \Delta lnCO2_{t-1} + \psi_6 ECT_{t-1}. \\
&+ \varepsilon_t.
\end{aligned}
\tag{4}
$$

where ECT_{t-1} represents the error correction term and it is denoted for the long-run equilibrium speed of adjustment. To check the good fitness of the empirical model, this study used the various diagnostic tests, including the serial correlation and heteroskedasticity test, while CUSUM (Cumulative Sum of Recursive Residuals) and CUSUMSQ (Cumulative Sum of Squares of Recursive Residuals) are also applied to check the stability of the model over the period.

4. Results and Discussions

4.1. Descriptive Statistics, Correlation Matrix, and Unit Root Test Analysis

Table 2 reports the basic statistical description of the study variables and results show that $lnCO_2$, lnY, lnEC, lnFDI, lnPOP are normally distributed but lnFD does not follow a normal distribution as suggested by Jarque-Bera test. Though, ARDL approach can solve the problem of non-normality. Likewise, the results of the correlation matrix are also shown in Table 2 and reveal that economic growth, electricity consumption in the agriculture sector, FDI and population have a strong positive and significant correlation with CO_2 emissions while financial development has negative and significant relation with CO_2 emissions, respectively.

Table 2. Descriptive summary and correlation matrix.

	$LNCO_2$	LNY	LNEC	LNFD	LNFDI	LNPOP
Mean	10.9673	25.4007	8.6769	3.2039	−0.2858	18.6722
Median	11.0014	25.4125	8.6736	3.2065	−0.3683	18.7000
Maximum	11.5157	26.1520	10.0508	4.2008	1.2997	19.0790
Minimum	10.4369	24.4944	7.6333	1.8048	−2.2762	18.1730
Std. Dev.	0.3192	0.4733	0.5872	0.4699	0.8055	0.2674
Skewness	−0.0674	−0.2236	0.3443	−0.2623	−0.1500	−0.2489
Kurtosis	1.7805	1.9846	3.3054	5.2553	2.8962	1.9112
Jarque-Bera	2.3206	1.8977	0.87517	8.2663	0.1554	2.2098
Probability	0.3133	0.3871	0.6455	0.0160	0.9252	0.3312
Observations	37	37	37	37	37	37
$LNCO_2$	1.0000					
	——					
LNY	0.9940 ***	1.0000				
	(0.0000)	——				
LNEC	0.9062 ***	0.9183 ***	1.0000			
	(0.0000)	(0.0000)	——			
LNFD	−0.3920 ***	−0.3376 **	−0.3541 **	1.0000		
	(0.0164)	(0.0410)	(0.0315)	——		
LNFDI	0.6928 ***	0.7132 ***	0.6334 ***	−0.0485	1.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.7755)	——	
LNPOP	0.9955 ***	0.9981 ***	0.9082 ***	−0.3401 **	0.7022 ***	1.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0394)	(0.0000)	——

Source: Authors' computation. **Note:** ***, ** Significant at 1% and 5% levels, respectively.

4.2. Empirical Results and Discussion

Before testing the cointegration association amongst the study variables, our first step is to examine their integration order. Although, if the variable is integrated in a dissimilar order, i.e., I(1) or I(0), the ARDL approach can be used. In doing so, the present empirical study uses several renowned unit root methods, for instance, ADF, PP, DF-GLS (ESR) and KPSS in order to firstly check the stationarity of data. Table 3 reports the outcomes of these renowned unit root approaches exhibits that all the study variables are stationary at the combination of I(0) and I(1). This validates the use of autoregressive distributed lag (ARDL) bound test approach suggested by [33,37].

Similarly, the results of the Z&A and CMR breakpoint unit root tests are summarized in Table 4. The results indicated that most of the variables had a unit root problem at level but became stationary at 1st difference as the test statistics are significant at the given level of significance. On the other hand, DLNY is stationary at level. Therefore, the estimations confirmed that our variables were stationary at the required levels, even in the existence of structural breaks, and the bounds testing method could be employed. The ARDL bounds test is employed to explore the presence of a long-run cointegration. In this study we have checked the cointegration of all variables and outcomes are described in Table 5. The ARDL cointegration test outcomes of first equation F_{CO2} (CO_2/Y, EC, FD, FDI, POP) disclose that there exists significant (at 5% level) a long-run cointegrating association between variables when CO_2 emissions was used as the dependent variable. Likewise, in both equations second and third F_Y (Y/CO_2, EC, FD, FDI, POP) and F_{EC} (EC/Y, CO_2, FD, FDI, POP) indicate that there no-cointegration exist amongst variables when economic growth and electricity consumption in agriculture sector were used as the dependent variables. Moreover, in the fourth equation of ARDL bounds test, we used financial development as a dependent variable F_{FD} (FD/EC, Y, CO_2, FDI, POP), results display that there exist a long-run cointegrating link between the variables. Similarly, the results of the fifth equation of ARDL bounds test F_{FDI} (FDI/FD, EC, Y, CO_2, POP) show that there is no long-run cointegration exist among variables when the foreign direct investment was used as the dependent variable.

Table 3. Results of unit root tests.

Intercept/Trend	Variables	ADF	PP	ERS	KPSS
At level					
Intercept	$LNCO_2$	0.067279	0.067279	1.086835	0.732173 **
	LNY	−1.306952	−2.373318	0.591036	0.731082 **
	LNEC	0.151339	−0.449389	0.444442	0.691326 **
	LNFD	−1.247226	−0.989193	−3.126253 ***	0.389965 *
	LNFDI	−2.165385	−2.054144	−1.807425	0.567661 **
	LNPOP	−1.735334	−3.504824 **	1.725230	0.729719 **
Intercept and trend	$LNCO_2$	−2.896777	−3.012182	−3.000342	0.132629 **
	LNY	−3.415602 *	5.743567 **	−1.718915	0.160034 **
	LNEC	−2.083088	−4.010968 ***	−2.103183	0.126498 **
	LNFD	−2.068319	−1.851540	−3.816892 ***	0.148328 *
	LNFDI	−2.649033	−2.773817	−2.746427	0.135530 *
	LNPOP	−5.104828 ***	−4.291706 ***	−3.335802 ***	0.193353 **
At first difference					
Intercept	$DLNCO_2$	−5.909376 ***	−5.909376 ***	−5.982860 ***	0.058512
	DLNY	−3.575677 ***	−3.544302 ***	−2.811139 ***	0.374628 *
	DLNEC	−11.77023 ***	−11.89641 ***	−2.487519 **	0.119807
	DLNFD	−4.612180 ***	−4.612180 ***	−8.962681 ***	0.367610 *
	DLNFDI	−5.824703 ***	−6.420425 ***	−5.737412 ***	0.176450
	DLNPOP	−2.052846	−1.275548	−0.432306	0.650474 **
Intercept and trend	$DLNCO_2$	−5.811907 ***	−5.811907 ***	−5.905037 ***	0.058439
	DLNY	−3.658144 **	−3.659494 **	−3.668914 ***	0.112724
	DLNEC	−11.69367 ***	−11.79462 ***	−2.569443	0.101405
	DLFD	−4.661032 ***	−4.661032 ***	−8.997397 ***	0.359870 ***
	DLNFDI	−5.741518 ***	−6.786958 ***	−5.799335 ***	0.150092 **
	DLNPOP	−0.300854	−0.674946	−1.556024	0.168522 **

Source: Authors' computation. **Notes:** ADF; PP; ERS and KPSS indicate the Augmented Dickey–Fuller test; the Phillips–Perron test; the Elliot, Rothenberg and Stock point optimal test and the Kwiatkowski, Phillips, Schmidt and Shin test, respectively. ***, ** and * Significant at 1%, 5% and 10% levels, respectively.

Table 4. Results of Zivot-Andrews and CMR structure break unit root tests.

	Zivot-Andrews Structure Break Unit Root Test				CMR Structure Break Unit Root Test			
Variables	Level		1st difference		Level		1st difference	
	T-statistics	Breaks	T-statistics	Breaks	T-statistics	Breaks	T-statistics	Breaks
$LNCO_2$	−1.07	1995	−9.81	1996	10.487	1997	0.691	1994
LNY	−5.74	2004	-	-	7.119	2005	−3.389	1990
LNEC	−1.81	2012	−12.28	2011	5.021	2012	0.741	2010
LNFD	−3.41	2011	−9.71	1993	−3.389	2013	−0.259	1991
LNFDI	−2.85	1992	−6.03	2009	5.962	1989	−0.398	2009
LNPOP	−3.09	2009	−6.28	2010	8.943	2000	−12.107	1993

Notes1: Z&A test produced critical values are as; −4.58, −4.93, and −5.34 at 1%, 5%, and 10% respectively. **Notes2:** CMR denotes for "Clemente Montanes Reyes" structure break unit root test, where it produced a critical value −3.560 at 5%.

Table 5. Results of cointegration bounds test.

Model for Estimation		F-Statistics	Decision
F_{CO2} (CO_2/Y,EC,FD,FDI,POP)	ARDL(1, 1, 0, 0, 1, 1)	4.949047 **	Cointegration exist
F_Y (Y/CO_2,EC,FD,FDI,POP)	ARDL(1, 1, 0, 0, 0, 0)	1.778916	No-cointegration exist
F_{EC} (EC/Y,CO_2,FD,FDI,POP)	ARDL(1, 0, 0, 0, 0, 0)	3.348705	No-cointegration exist
F_{FD} (FD/EC,Y,CO_2,FDI,POP)	ARDL(1, 0, 0, 1, 1, 0)	8.578359 ***	Cointegration exist
F_{FDI} (FDI/FD,EC,Y,CO_2,POP)	ARDL(1, 0, 0, 0, 0, 1)	2.887597	No-cointegration exist
F_{POP} (POP/FDI,FD,EC,Y,CO_2)	ARDL(1, 1, 0, 0, 1, 0)	19.73612 ***	Cointegration exist
Critical Value Bounds	I0 Bound	I1 Bound	
1%	3.15	5.23	
5%	3.12	4.25	
10%	3.93	3.79	

Source: Authors' computation. **Note:** ***, ** Significant at 1% and 5% levels, respectively.

The last equation for ARDL bounds test F_{POP} (POP/FDI, FD, EC, Y, CO_2) indicates a long-run cointegration exists among variables when the population is used as the dependent variable. To check the robustness of our long-run cointegrating results, we employed the Johansen cointegration test by using trace statistics and max–eigenvalue statistics. The estimated outcomes of (trace and max–eigenvalue) test are shown in Table 6. The trace and max–eigenvalue statistics values are greater than the critical value at 5% significance level; showing a long-run co-integration relationship among the variables. Additionally, the Engle-Granger (EG) cointegration test [38] is utilized to measure the further robustness of Johansen cointegration test outcomes. It is a dual-step errors-based test, so initially, dependent variable ($LNCO_2$) is regressed on explanatory variables (Y, EC, FD, FDI, POP) and computed the residuals from the equation. At that time, calculated residuals are further analyzed by the ADF unit root test in Table 7, where residuals are stationary at their level. It is an indication for at the first stage that variables are cointegrated. Moreover, the validation through the second step will be guaranteed the long run cointegration among the variables effectually. Next, the 1st difference of the residuals is regressed on its lagged based residuals in simple OLS approach in Table 8. The estimates of calculated residuals (New-1) in OLS regression results is statistically significant at 5%, which ensured that there is long-run cointegration among the set of variables. Hence, rejecting the null hypothesis instead of the alternative is evidence the dataset series are certainly cointegrated.

Table 6. Johansen cointegration test using Trace statistics and Max–Eigenvalue statistics.

Hypothesized		**Trace**	**0.05**	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob
None *	0.896802	184.6633	95.75366	0.0000
At most 1 *	0.743880	107.4457	69.81889	0.0000
At most 2 *	0.474210	61.13391	47.85613	0.0018
At most 3 *	0.449581	39.27687	29.79707	0.0030
At most 4 *	0.392142	18.97631	15.49471	0.0143
At most 5	0.058530	2.050617	3.841466	0.1521
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob
None *	0.896802	77.21766	40.07757	0.0000
At most 1 *	0.743880	46.31176	33.87687	0.0010
At most 2	0.474210	21.85705	27.58434	0.2278
At most 3	0.449581	20.30056	21.13162	0.0650
At most 4 *	0.392142	16.92569	14.26460	0.0185
At most 5	0.058530	2.050617	3.841466	0.1521

Source: Authors' computation. **Note:** * 5% level, statistical significance.

Table 7. First step in Engle-Granger cointegration test to calculating the residuals unit root.

ADF Test Statistic at a Level for (Calculated Residuals)	
t-Statistic	Prob.*
−4.032361	0.0035 ***
Test critical values:	
1% level	−3.626784
5% level	−2.945842
10% level	−2.611531

Source: Authors' computation; ***, * Significant at 1%, 5% and 10% levels, respectively.

Table 8. Second step in Engle Granger cointegration test for significance evaluation.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNEC)	0.002775	0.0108	0.256973	0.799
D(LNFD)	−0.02262	0.007154	−3.16153	0.0037 ***
D(LNFDI)	−0.00632	0.006445	−0.98062	0.3349
D(LNPOP)	−0.27731	0.696161	−0.39834	0.6933
D(LNY)	0.402064	0.187295	2.146686	0.0403 **
NEW(-1)	−0.40261	0.152648	−2.63748	0.0133 **
C	0.017448	0.01602	1.08916	0.2851

Source: Authors' computation. **Note:** ***, ** Significant at 1% and 5% levels, respectively.

Table 9 displays the estimated outcomes of both long and short-run of ARDL approach. The CO_2 emissions from the agricultural sector is used as a dependent variable while economic growth, electricity consumption in the agriculture sector, financial development, FDI and population have been used as independent variables in this empirical study. The estimated outcomes show that economic growth is significant and inversely linked to CO_2 emissions from the agricultural sector at 1% significance level in the long run. The estimated coefficient of economic growth shows that a 1% increase in economic growth reduces CO_2 emissions from agriculture by 0.45%; this means that economic growth improves the environmental quality in Pakistan. The empirical outcomes of this study support the theoretical arguments in the literature that the adoption of cleaner energy sources boosts up the economic growth that improves environmental quality. Our estimated findings are in line with the results of previous studies. Reference [39] found that the economic growth and electricity consumption degrade environmental quality in belt and road initiative (BRI) countries. Reference [40] revealed that economic growth is inversely associated with CO_2 emissions, indicating that economic growth improves environmental quality in Nigeria. But, our findings are contrary to the results of [21] who reported that economic growth has a positive and significant effect on CO_2 emissions. The long-run coefficient of the agricultural electricity consumption is positive but it is non-significant. The result of the positive effect of electricity consumption in the agriculture sector on CO_2 emissions is in line with, and supports the results of earlier research [41,42]. The result shows that presently electricity is a critical factor for the level of CO_2 emissions, which is highly alarming in Pakistan. High-level use of energy causes high environmental degradation [43]. The carbon-free sources of energy such as nuclear and wind, related innovative technology is also favorable to improve the quality of the environment [44]. Likewise, the coefficient of financial development is negative and highly significant at a 1% significance level in the long run. Financial development coefficient outcomes show that a 1% rise in financial development has the capacity to reduce the CO_2 emissions from the agricultural sector and improve the environmental quality almost 0.02%. The findings of financial development are in line with the results of earlier researchers. [24] revealed that financial development significantly enhances the environmental degradation in the One Belt and One Road region. [18,43] reported that financial development improves environmental quality in Turkey. Similarly, FDI coefficient results indicate a positive significant and dominant effect on CO_2 in the long run in Pakistan. FDI results indicated that FDI contributes to environmental degradation. Additionally, the population coefficient is positive and significantly associated with CO_2 emissions in the long run, showing that a 1% increase in population could increase environmental pollution by 1.42%. The population growth will increase the land openness for residential construction, agriculture, and other related economic activities.

The finding of this paper is intuitive with the previous study of [45]. Table 9 reports the estimated outcomes of the short run ARDL technique. Outcomes of the short-run cointegration show that economic growth has a positive but statistically non-significant effect on CO_2 emissions, indicating that economic growth does not have any statistical influence to cause environmental degradation in Pakistan. Whereas, financial development has a strong negative association (–0.023) with CO_2 in the short-run analysis. Results of financial development indicate that a 1% increase in financial development reduces the CO_2 emissions from the agricultural sector and improves environmental quality. FDI has a positive and non-significant effect on CO_2 emissions in Pakistan in the short run. The findings of this study are consistent with the outcomes of [38] Saud et al. (2018) which stated that an increase in financial development and FDI improve the quality of the environment. Additionally, the results display a strong positive association (9.022) among the population and CO_2 emissions in Pakistan in the short-run. Results of the population indicate that a 1% increase in population will increase CO_2 emissions by 9.02% in the short-run.

Table 9. Estimated long-run and short-run coefficients of ARDL model.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long-run estimation				
LNY	−0.451404 ***	0.163762	−2.756465	0.0105
LNEC	0.008475	0.013542	0.625863	0.5369
LNFD	−0.027816 ***	0.007907	−3.517833	0.0016
LNFDI	0.044922 ***	0.009849	4.561101	0.0001
LNPOP	1.425103 ***	0.386299	3.689118	0.0010
Constant	−4.829268	4.283987	−1.127284	0.2699
Trend	0.015515 ***	0.004183	3.709142	0.0010
Short-run Dynamics				
D(LNY)	0.157755	0.182425	0.864770	0.3951
D(LNEC)	0.007047	0.011039	0.638382	0.5288
D(LNFD)	−0.023128 ***	0.007517	−3.076716	0.0049
D(LNFDI)	0.009470	0.006154	1.538790	0.1359
D(LNPOP)	9.022650 ***	3.144515	2.869329	0.0081
DTrend	0.012900 ***	0.004982	2.589351	0.0155
ECM (−1)	−0.831464 ***	0.155434	−5.349315	0.0000
R-squared	0.998298			
Adjusted R-squared	0.997730			
F-statistic	59.170			
Prob(F-statistic)	0.000000			
Durbin-Watson stat	1.873053			

Source: Authors' computation. **Note:** *** Significant at 1% level.

To test the stability of the ARDL model this study used various diagnostic tests, for example, Breusch-Godfrey for serial correlation, White for heteroscedasticity, CUSUM and CUSUMQS for the stability of the parameters, outcomes are described in Table 10. The diagnostic test results display that the ARDL model has successfully passed all diagnostic tests. Moreover, the results of CUSUM and CUSUMQS presented in Figures 1 and 2, indicating that the values of the parameters are stable over the period.

Table 10. Diagnostic tests for the stability of the ARDL model.

Breusch-Godfrey Serial Correlation LM Test: Serial Autocorrelation			
F-statistic	0.166770	Probability	0.8474
Obs*R-squared	0.507160	Probability	0.7760
White Heteroskedasticity Test:			
F-statistic	0.047588	Probability	0.8286
Obs*R-squared	0.050317	Probability	0.8225
Ramsey RESET Test: Model Misspecification			
F-statistic	1.270951	Probability	0.2703

Source: Authors' computation. **Note:** * Significant at 5% level.

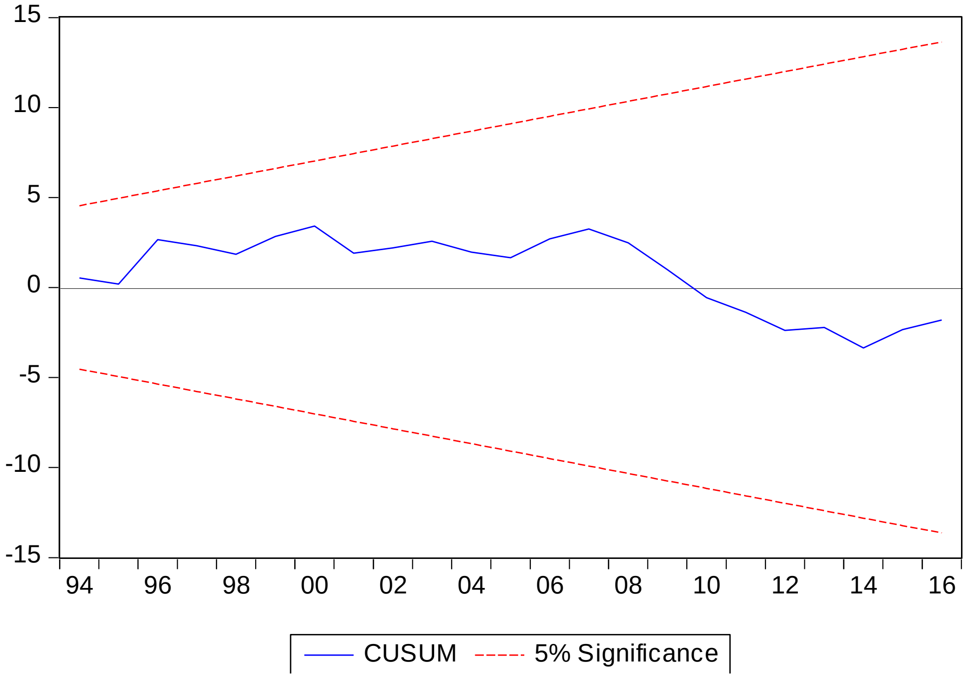

Figure 1. The plot of the cumulative sum of recursive residuals.

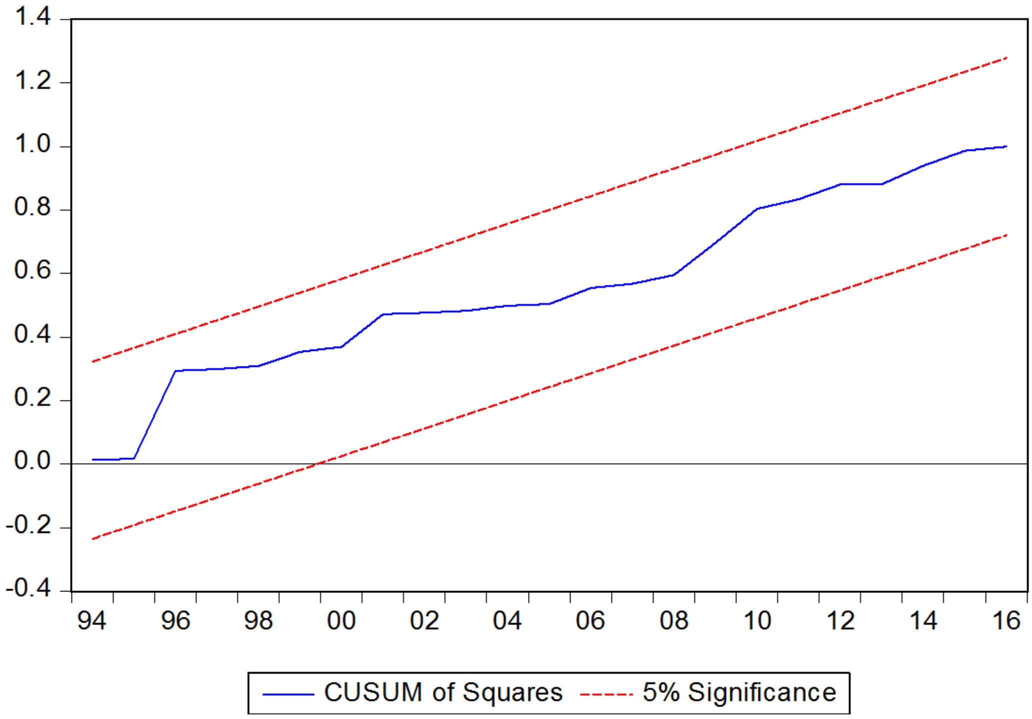

Figure 2. The plot of the cumulative sum of squares of recursive residuals.

In order to test the direction of causality between the variables, the study conducted the pair-wise Granger causality test. The Granger causality approach has three categories such as bidirectional causality, unidirectional causality, and no causality. Table 11 reports the pair-wise Granger causality outcomes. The results of the pair-wise Granger causality test show that the null hypothesis that economic growth does not Granger cause CO_2 emissions is rejected at 10% significance level, implying that economic growth does Granger cause CO_2 emissions. However, the null hypothesis that CO_2 emissions do not Granger cause economic growth is not rejected, meaning that CO_2 emissions do not Granger cause economic growth. There is evidence of unidirectional causality running from LnY → $LnCO_2$ at the 10% significance level. The results of the Granger causality test failed to reject the null hypothesis that energy consumption (electricity consumption in the agriculture sector) does not Granger cause CO_2 emissions. However, CO_2 emissions Granger cause energy consumption (electricity consumption in the agriculture sector) at a 1% level of significance. There is evidence of unidirectional causality running from CO_2 → LnEC. The Granger causality test results display that the null hypothesis that financial development does not Granger cause CO_2 emissions is no rejected, implying financial development does not Granger-cause CO_2 emissions. However, the null hypothesis of CO_2 emissions does not Granger-cause financial development is rejected at a 5% level of significance, implying CO_2 emissions does Granger-cause financial development. Thus, a unidirectional causality has been identified from CO_2 → LnFD at the 5% significance level. Moreover, the null hypotheses that the population does not Granger-cause CO_2 emissions is rejected at 5% significance level. There is evidence of bidirectional causality between LnPOP ↔ $LnCO_2$.

Table 11. Granger causality between CO_2 and its determinants.

Null Hypothesis	F-statistic	Probability
LnY does not Granger Cause $LnCO_2$	3.34546	0.0764 *
$LnCO_2$ does not Granger Cause LnY	0.31787	0.5767
LnEC does not Granger Cause $LnCO_2$	1.70653	0.2005
$LnCO_2$ does not Granger Cause LnEC	10.3927	0.0028 ***
LnFD does not Granger Cause $LnCO_2$	2.79801	0.1038
$LnCO_2$ does not Granger Cause LnFD	4.14764	0.0498 **
LnFDI does not Granger Cause $LnCO_2$	0.32867	0.5703
$LnCO_2$ does not Granger Cause LnFDI	2.22259	0.1455
LnPOP does not Granger Cause $LnCO_2$	4.00315	0.0537 **
$LnCO_2$ does not Granger Cause LnPOP	5.69914	0.0229 **

Source: Authors' computation. **Note:** *, **, *** indicate rejection of null hypothesis at 10%, 5% and 1% levels of significance, respectively.

5. Conclusions, Recommendations and Future Implications

This paper examined the effects of financial development, economic growth, electricity consumption in the agriculture sector, FDI and population on the environmental quality in Pakistan for the period 1980 to 2016. We used CO_2 emissions from the agriculture sector as a proxy indicator for environmental quality. Several unit root tests (ADF, PP, ERS, KPSS) and structural break unit root tests (Z&A, CMR) are applied to test the stationarity and structural break in the dataset series. Cointegration approaches, i.e., Johansen cointegration, Engle-Granger, and ARDL cointegration approaches ensure their robustness.

The ARDL bounds method establish the long-run cointegration association between financial development, economic growth, electricity consumption in the agriculture sector, FDI, population and CO_2 emissions. The ARDL bounds method, Engle-Granger, and Johansen cointegration tests outcomes confirmed the presence of a long-term cointegrating connection among the variables. The long-run coefficients of economic growth and financial development have negative effects on CO_2 emissions. These findings indicate that a 1% increase in economic growth and financial development will reduce CO_2 emissions growth and improve the environmental quality in Pakistan by 0.45% and 0.02% respectively. Whereas, the results of the long-run coefficients of electricity consumption in the agriculture sector, FDI and population have positive impacts on CO_2 emissions. This indicates that a 1% increase in energy consumption (electricity consumption in the agriculture sector) and FDI net inflows will degrade environmental quality by 0.008% and 1.42% while a 1% increase in population could increase environmental pollution by 1.42% in the long-run in Pakistan. Furthermore, in order to check the direction of causality amongst the study variables, the study applied the pairwise Granger causality test. The Granger causality test results showed a unidirectional causality between economic growth and CO_2 emissions. However, there was a bi-directional causality between population and CO_2 emissions.

Based on the findings, our study suggested that the Government and policymakers should further increase financial development and economic growth, since such development may further improve the quality of environment in the country. Additionally, the use of energy and CO_2 emissions are directly associated with each other, therefore, our study also suggested that the efficient energy consumption from fossil sources and a conversion to renewable energy sources, so as to reduce environmental pollution in the country.

As perceived from the outcomes, the CO_2 mitigation guidelines grounded on energy usage and gross demotic product (income) unaccompanied may not determine to be productive as financial expansion is an essential fragment of the greenhouse gas (GHG) mitigation strategy. Consequently, financial growth is extracted to get better environmental quality with regard to the agriculture sector in Pakistan. Thus, the policy implications may retrieve from the recent study as, to utilize the financial segment across the banking system, and to reassure energy-efficient and green portfolio investments. Subsequently, monetary regulatory policy can be outlined to pose minor interest charges and other markdowns for environmentally friendly manufacturing practices by business corporations/organizations. However, in the recent time period, the Pakistani financial division and its various sectors have had a low volume portion and would have to experience an extremely stretched mode before attaining its optimal point.

In this respect, the state government can support the financial markets by launching a solid strategic agenda that generates enduring worth for (GHG) emissions cuts and constant provisions for the expansion of novel technological tools that may guide a low carbon-concentrated country. Additionally, well-organized capital and financial markets can be an alternative appreciated policy choice that might be accepted. Hence, this is due to which companies can shrink their liquidity perils and can activate the needed funds via portfolio divergence, that would be enormously advantageous in developing a wide-ranging technology foundation in the long run.

Lastly, this recent study spreads the room for future investigations, where the investigators can practice our methodological procedure to catch the greater awareness of economic development, energy usage and environmental quality interrelationships with regard to the agriculture sector in nations other than Pakistan. Supplementary, current ARDL approach may exchange with nonlinear ARDL (NARDL) or can be upgraded by building an index of financial development in place of exercising a sole element as a deputation for financial advancement. The on-hand study has employed the cumulative CO_2 emissions dataset for Pakistan; however, in future exploring the linkages between income, financial expansion and CO_2 emissions amount at a disaggregate scale (industry wise) may offer some improved understandings. Consequently, it may assist policy architects to articulate environment-friendly monetary and fiscal policies.

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