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Climate Change, Government Agricultural Expenditure, and Agricultural Growth Nexus in Afghanistan: An Investigation with FMOLS and DOLS Approaches

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ABSTRACT

Agriculture is one of the main providers to Afghanistan's economy. Since 2002, the government, in collaboration with donor organizations and the private sector, has undertaken various projects in the agricultural industry. However, a notable upsurge in atmospheric CO2 emissions has resulted in significant climate change influences in contemporary decades. Therefore, this article examines the causal association between climate change, government agricultural expenditure, and agricultural growth in Afghanistan from 2002 to 2020. Despite evidence that climate change may be a primary driver of Afghanistan's agricultural production decline, no specific studies have addressed this matter comprehensively. This article's empirical investigation reveals a negative association between CO2 emissions and agricultural production, indicating that rising emissions are linked to decreased agricultural output, subsequently impacting Afghanistan's agricultural growth. Both theoretical considerations and empirical findings highlight the importance of adopting clean and green energy solutions and technologies to mitigate pollution in Afghanistan.
Furthermore, the research underscores that the impacts of carbon dioxide emissions on agriculture production exhibit robust long-term dynamics, contributing to the heterogeneity of the findings. Additionally, the study establishes a positive correlation between government agricultural expenditure and agricultural production. Consequently, it is strongly recommended that the Afghan government take proactive initiatives to enhance the agricultural sector. This can be accomplished by allocating more financial resources and implementing projects that promise long-term benefits for the country's agricultural development.

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Introduction

The worldwide challenge of climate change necessitates a comprehensive, cross-sectoral approach encompassing agrion systems. This approach should be linked with international agreements and consider the viable development's economic, social, and environmental measurements of viable . To expedite progress towards the 2030 agenda for sustainable expansion and its commonly agreed sustainable development goals (SDGs), the Rio Declaration on environment and development and the Paris Agreement, the FAO has formulated a new 10-year strategy on climate change, with a focus on enhancing food security and resilience (FAO, 2022). Rising global temperatures pose a growing threat to agriculture, impacting farmers, foresters, and fishermen worldwide. Without operative action against CO_2 emissions, agricultural production will decline, endangering food safety and leading to poverty among vulnerable populations. Agriculture's contribution to greenhouse gas emissions worsens the situation, particularly affecting regions already facing food insecurity, notably in Asia. Climate-related extremes like droughts, heatwaves, unpredictable and intense rainfall, storms, floods, and insect pests have significantly harmed farmers' livelihoods. Future climate predictions indicate higher temperatures and more erratic, heavy rainfall, although exact extreme patterns remain variable. In essence, the overall trend points to a challenging future for agriculture due to climate change, and the concern of CO_2 emission will escalate progressively unless immediate action is taken to curtail emissions of greenhouse gases, which are accountable for global warming. Substantial reductions in emissions are imperative to effectively mitigate climate change and maintain the global temperature increase within the range of 1.5°C to 2°C relative to pre-industrial levels (FAO, 2016).

The global connection between CO_2 emission and agriculture is evident through various impacts such as temperature shifts, altered precipitation patterns, life-threatening weather events, and changes in pests and diseases. These changes also affect atmospheric CO_2, food quality, and sea levels. The projected climate trends point to further challenges, including uncertain growing conditions and more variable weather patterns. Agricultural risk management (ARM) plays a dynamic role in helping stakeholders adapt to these threats in the short and medium periods. It helps as a vital platform for discussions on transitioning to a climate-resilient agriculture system. Prioritizing short-term risk reduction through ARM can generate urgent stakeholder involvement and pave the way for broader conversations on climate-smart agriculture .

The Asia-Pacific agriculture sector significantly contributes to climate change through substantial greenhouse gas (GHG) emissions, primarily from agricultural activities. Being a major rice-producing area, the region generates significant methane emissions from rice cultivation. To address food security for the rising population, there has been a notable increase in adopting energy-intensive practices and synthetic fertilizers, leading to elevated nitrous oxide emissions (from fertilizer use) and carbon dioxide (from irrigation energy). The expansion of livestock farming to meet meat and dairy demands has further amplified methane emissions alongside other environmental issues . South Asia stands as one of the most vulnerable regions to the magnitudes of climate change. Amongst the livelihoods reliant on this region, agriculture is particularly at risk. Projections suggest that the influence of global warming could lead to a loss of 10 percent to 50 percent in crop production by the close of this century. Over a quarter of the globe's undernourished population resides in South Asia, heavily dependent on agriculture. The region may need to double its food output to accommodate its growing populace, predicted to reach 2.68 billion by 2050. The region had the world's swiftest expanding economy before the appearance of the COVID-19 pandemic, but this crisis has introduced numerous challenges .

In South Asia, Afghanistan, a landlocked country, is currently handling one of the most severe droughts it has experienced in the past twenty years, with severe conditions particularly affecting the southern, western, and northwestern regions. This has significantly reduced water resources, pushing around 19 million people, almost half the population, into acute food insecurity and poverty (Masood et al., 2022). While droughts have been a frequent issue in Afghanistan, climate change exacerbates their frequency and severity. The current drought is more extensive and severe than what happened in 2018. Due to the Afghanistan drought risk management strategy, the country is predicted to experience regular annual droughts to many extents by 2030, with climate models indicating ongoing drought conditions through 2022 . With its main reliance on agriculture and a varied climatic range, Afghanistan has experienced notable effects from climate variations, particularly impacting the wheat, rice, and corn growing periods. Alterations in temperature and rainfall have led to an elevated occurrence of droughts in the country. Compared to other semi-arid and arid nations, Afghanistan's water scarcity due to low annual rainfall and high evaporation rates intensifies its susceptibility to shifting climate patterns. As projected by climate models, Afghanistan is poised to confront a range of emerging and heightened climatic risks. The ongoing progression of climate change, which exerts diverse impacts on numerous biological processes, necessitates serious attention in Afghanistan.

Afghanistan's National Environmental Protection Agency (ANEPA) was established in 2005 to decrease the influences of climate change in the country. For this, Afghanistan drafted its inaugural environmental law, which subsequently underwent amendments by the national assembly. The final version was ultimately promulgated in early 2007. The organization formulated several policies related to environmental and social impact assessments, pollution control and reduction, national water quality monitoring, and national waste management. However, there are currently no policies to safeguard the environment through agricultural areas. ANEPA and the Ministry of Agriculture must collaborate in developing policies designed to mitigate the adverse environmental impacts of the agricultural sector in the country. Notably, many policies and procedures have not been properly implemented due to insufficient resources. The government is grappling with a shortage of technical expertise and financial support .

Based on my knowledge and understanding, there have been no studies precisely conducted on the impact of CO2 emission and government expenditure on agricultural growth in Afghanistan. The study concentrates on implementing inclusive policies to reduce carbon dioxide emissions and ecological contamination. Given that the country's economy heavily relies on agricultural production and output, our experimental and econometric analysis begins with calculating summary statistics and creating a correlation matrix for all variables. Additionally, the stationarity of these variables through the Augmented Dickey-Fuller (ADF) unit root test is checked accordingly. The Granger causality test also applies to ascertain causal relationships between the variables. To explore these relationships further, I employ the Johansen cointegration test using trace and max-eigenvalue statistics. Moreover, The Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Least Squares (DOLS) models to examine the associations and impacts of climate changes and agricultural Expenditure on agricultural growth, which is mostly done in the past study (Khan, Bin, & Hassan (2019).

For the enhancement and strengthening of outcomes, apply Canonical Cointegrating Regression (CCR) for the primary purpose of the study, to regulate the impact and relationships between climate changes, agricultural Expenditure, and agricultural growth in Afghanistan over the period 2002–2020, using FMOLS and DOLS models. It is important to note that no previous study has scrutinized the influence of climate change, government expenditure, and agricultural growth in Afghanistan. Our existing study fills this break and donates to the growing literature.

Objectives of the Study

- To analyze the impact of climate change and government agricultural expenditure on agricultural growth.
- Examine the relationship between climate change, government expenditure, and agricultural growth.
- To analyze the causal relationship between climate change, government expenditure, and agricultural growth.

Literature Review

Several studies have scrutinized the association between climate change, government agricultural expenditure, and agricultural growth. Some of them are given as follows.

Dongbei Bai (2023) investigated the influence of carbon dioxide emissions on agricultural productivity in China from 2000 to 2019 by using a combination of spatial Durbin models and entropy approaches. The result revealed a noteworthy detrimental influence of climate change on agricultural output. This effect remained robust in various tests, such as substituting indices, implementing quantile regression, and minimizing extreme values. The study's results also pointed out that annual precipitation had an insignificant influence on agricultural productivity growth when dissecting different climatic elements. In contrast, other climate-related factors like temperature and wind speed had a substantial adverse impact. An assessment of heterogeneity indicated that alterations in climate significantly impeded agricultural productivity growth exclusively in China's western region. Climate variations in both the eastern and central regions demonstrated no discernible impact. And also Chandio, Jiang, Rehman, & Rauf (2020) studied the short and long-run effects of CO_2 emissions on agriculture in China from 1982 to 2014. The research outcomes indicate that the emissions of CO_2 exert a noteworthy influence on agricultural productivity, both in the short term and over an extended period. Conversely, temperature and rainfall negatively affect agricultural output in the long run. Notably, factors such as the land area dedicated to cereal crops, energy consumption, and fertilizer usage demonstrate a favorable and substantial correlation with agricultural output, evident in both short-term and long-term perspectives.

Ayinde, Muchie, & Olatunji (2017) scrutinize the influence of CO_2 emissions on agricultural productivity in Nigeria between 1980 and 2005. The findings demonstrated that shifts in temperature were linked to a decrease in agricultural productivity, whereas changes in rainfall positively influenced it. Nevertheless, it was found that rainfall in the preceding year had a detrimental association with agricultural efficiency in the current year. In Pakistan, Khan, Bin, & Hassan (2019) investigated the impact of climate change on agriculture export trade from 1975 to 2017. The study's findings revealed that the agricultural output of crops like wheat, rice, cotton, maize, and tobacco has been remarkably influenced by worldwide warming and climate change. The economic consequences of these climate changes have led to a significant decrease in the agricultural sector's productivity. Additionally, the research indicated that the rise in environmental pollution and climate change is closely linked to the substantial contributions from transportation and industrial activities. This is exacerbated by the absence of effective measures within the country to reduce CO_2 emissions and tackle environmental pollution.

Timothy et al. (2015) investigated the comparative impact of public Expenditure on agricultural growth using time series data. The research found that capital expenditure in both countries is positively associated. However, both countries allocated more of their budget to recurrent rather than capital expenditure. The study also found that non-agriculture Expenditure has positive and negative impacts on agricultural growth, depending on the country's economy. A similar survey by Chandio, Yuansheng, Rehman, & Jingdong (2016) studied government expenditure on agriculture, agricultural outputs, and economic development in Pakistan from 1983 to 2011. The study's outcome presented that the agricultural outputs and public Expenditure in the agricultural sector positively influence economic and agricultural growth.

For the African region, Jambo (2017) examined the influence of government spending on agricultural growth in Zambia, Malawi, South Africa, and Tanzania from 2000 to 2014. The outcome of the study reveals that in a different country, agriculture spending has a distinct impact on agriculture GDP growth; in Zambia, the public Expenditure funded the price support programs (PSP) and input subsidy programs (ISP), which the empirical analysis showed that infrastructure development has more impact on growth and the result also indicated that Expenditure on SIPs, PSPs, and agriculture research has a negative relationship with agricultural growth in Zambia, However In Malawi, the results of the empirical analysis found that expensing on agricultural research has a higher impact on growth, and have a positive relationship between agricultural growth and expensing on PSPs. However, infrastructure development in Tanzania received more budgetary provisions; the regression outcomes indicate a negative relationship between expensing on infrastructure and long-run economic growth.

Table 1. Summary of Previous Literature Reviewed

County	Methods	Outcomes	References
India	Reproduction models	Climate change negatively impacts the agriculture sector	Mall, Singh, Gupta, & Srinivasan (2006)
China	Ricardian Model	CO_2 emissions negatively affect the agriculture sector in the country	Mendelsohn (2014)
Iran	Conceptual model	Environmental pollution negatively impacts hydrology and agriculture in the country.	Karimi, Karami, & Keshavarz (2018)
Vietnam	Ricardian model	Climate change negatively affects the agriculture sector	Huong, Nguyet, Hung, Duc, & Chuong (2022)
Nigeria	Ordinary Least Square (OLS) technique	Government expenditure has a positive and significant influence on the agriculture sector.	Idoko (2018)
Pakistan	Error Correction Model (ECM)	Public spending on education, health, and road length positively influences the addition of agricultural value.	Saeed (2019)
India	Autoregressive distributive lag (ARDL) model	Public investment is more productive than input subsidies for the agricultural sector.	Zafar & Tarique (2023)
China	Autoregressive distributive lag (ARDL) model	The study analysis initiates a positive relationship between the output of agriculture and agricultural Expenditure in the short and long run.	Zeraibi & Mivumbi (2019)

Methods and Materials

This research paper is based on secondary data, mainly sourced from the world development indicators reported by the World Bank and Afghanistan statistical yearbook reports from 2002 to 2020. Agricultural gross domestic product is used as a proxy for agricultural growth as a dependent variable (Y), and CO_2 emissions (C), agricultural expenditure (A), and official exchange rate (E) are independent variables in the model. This paper investigates climate change, government agricultural expenditure, and agricultural growth in the geographical context of Afghanistan. As a result, selecting suitable proxies to quantify the phenomena described above is critical, as only the relevant proxies will explain the study's aims. However, the current analysis is based on 19 observations for each variable from 2002 to 2020, totaling

76 observations, to achieve the aims of this research. The explanation of the variables studied, along with their respective source, is mentioned in Table 2.

Table 2: Data Description and Sources

Nomenclature of Variables	Description	Data Source
Agricultural GDP (*Y*)	Agricultural GDP is used as a proxy for agricultural growth	The data is obtained from the World Development Indicators (WDI) and the Afghanistan Statistical Yearbook Reports (NSIA)
CO_2 emissions (*C*)	CO_2 emissions (metric tons per capita)	
Agricultural Expenditure (A)	Agricultural Expenditure is the total government expenditure in the agricultural sector.	
Exchange rate (*E*)	Official exchange rate (LCU per US$, period average)	

Results & Discussion

Model Specification

A multiple regression model is used to scrutinize the empirical relationship between CO_2 emissions, agricultural expenditure, official exchange rate, and agricultural growth for the Afghanistan economy, as follows . Specifically, the variables are stated in Equation 1.

$$Y = \beta_0 + \beta_1 C + \beta_2 A + \beta_3 E + \mu \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

Y: Agricultural Gross Domestic Product.

C: CO_2 emissions.

A: Agricultural expenditure.

E: Exchange rate

β_0 is intercept, and β_1, β_2, and β_3 are the elasticity coefficients of Y with respect to C, A, and E, respectively, and "μ" is the white noise error term.

Ⅳ. Empirical Analysis

Descriptive Test

Table 3 shows the descriptive statistics. It is perceived that Y, C, A, and E are narrowly range with their mean value greater than the related standard deviation. The skewness results depict that the series has skewness ranges between −0.2725 and 0.776, indicating that variables, that is, Y, C, and A have long tails to the lift except for E, with a longer tail to the right. However, The Jarque-Bera statistics result specified that all variables had a matching probability value larger than 0.05; therefore, we do not reject the null hypothesis and accomplish that the time-series variables are normally distributed.

Table 3: Descriptive Statistics

	Y	C	A	E
Mean	19.18462	0.219869	14.87039	4.019371
Median	19.30339	0.268359	15.19675	3.918502
Maximum	19.83225	0.408965	16.29265	4.353344
Minimum	18.31347	0.054867	12.692	3.838429
Std. Dev.	0.453227	0.109266	1.190552	0.177564
Skewness	-0.46742	-0.27251	-0.49349	0.776817
Kurtosis	2.064618	1.755697	1.852223	2.07571
Jarque-Bera	1.384527	1.460884	1.814109	2.587239
Probability	0.500442	0.481696	0.403712	0.274276
Sum	364.5078	4.177508	282.5375	76.36806
Sum Sq. Dev.	3.697457	0.214903	25.51346	0.567523
Observations	19	19	19	19

Correlation Statistics

The correlation outcomes are shown in Table 4. We observe that CO2 emissions, agricultural Expenditure, and exchange rates exhibit statistically significant and robust positive correlations with agricultural gross domestic product. It is important to note that no evidence of multicollinearity was detected among our variables.

Table 4: Correlation matrix of variables

Probability	Y	C	A	E
Y	1			
C	0.975493	1		
A	0.807716	0.832885	1	
E	0.775586	0.767816	0.386977	1

Tests for Stationary

Table 5 offers the results of the ADF unit root test of variables. The results revealed that the variables Y, C, A, and E are non-stationary. However, all these variables are stationary after first differencing. These results show that Y, C, A, and E are integrated in order one, and the test for stationarity is used to regulate the maximum order of integration in the model.

Table 5: Unit Root Test (Augmented Dickey-Fuller test)

Variable	t-Statistic	Probability	Order of Integration
Y	-5.3969 ***	0.001	I(I)
C	-2.5837**	0.013	I(I)
A	-5.7811***	0.000	I(I)
E	-2.4961**	0.016	I(I)

Note: *** and** denote significance levels at 1% and 5%, respectively.

Consequently, the Johansen cointegration test was conducted utilizing both max-eigenvalue and trace statistics. The results obtained from the estimation of max-eigenvalue and trace statistics are presented in Table 6. It was observed that the values of both max-eigenvalue and trace statistics surpassed the critical value at a 5 percent significance level. This indicates the presence of a long-term cointegration association among the variables under consideration.

Table 6: Johansen cointegration test using trace statistics and max-eigenvalue statistics

Cointegration rank test (trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical value	Prob.**
None*	0.967993	118.5332	69.81889	0.000
At most 1 *	0.856651	60.02288	47.85613	0.002
At most 2	0.602764	27.00088	29.79707	0.102
At most 3	0.46373	11.30608	15.49471	0.193
At most 4	0.041078	0.713077	3.841466	0.398
Cointegration rank test (maximum eigenvalue)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical value	Prob.**
None *	0.967993	58.51036	33.87687	0.000
At most 1 *	0.856651	33.022	27.58434	0.009
At most 2	0.602764	15.6948	21.13162	0.243
At most 3	0.46373	10.593	14.2646	0.176
At most 4	0.041078	0.713077	3.841466	0.398

Note: Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level.

*denotes rejection of the hypothesis at the 0.05 level.

**MacKinnon-Haug-Michelis (1999) p-values.

Fully modified OLS and Dynamic OLS estimation analysis

This article employs fully modified OLS and dynamic OLS regression analyses as the primary econometric models. The outcomes in Table 7 showcase the results of FMOLS and DOLS. The coefficients associated with the CO2 emission variable in FMOLS (-1.045876) and DOLS (-3.725726) indicate a negative correlation between CO2 emissions and agricultural gross domestic product in Afghanistan. Our empirical investigation highlights a significant adverse impact of environmental pollution and carbon emissions on agricultural gross domestic product. Conversely, the coefficient related to agricultural Expenditure reveals a positive correlation with agricultural gross domestic product. Additionally, negative relations are observed between CO2 emissions, exchange rates, and agricultural gross domestic product. The R-squared values stand at 0.95 for the FMOLS model and 0.99 for the DOLS model, signifying robust residuals for all data observations and suggesting a well-fitted model.

Table 7: FMOLS and DOLS regression analysis

Variable	Coefficient	t-Statistic	Coefficient	t-Statistic
C	-1.045876***	-4.793264	-3.725726*	-3.012933
A	0.243563***	6.928717	-0.237602	-0.805086
E	-1.284671***	-6.060403	-4.694253*	-3.491006
C	20.22209	18.96839	39.50139	4.825526
R^2	0.953922		0.998063	
SE of regression	0.101322		0.043581	
Long-run variance	0.000896		0.00102	

*** Significant at 1%.
*Significant at 10%, respectively.

Long-run Granger Causality Test

The long-run Granger causality test outcomes are presented in Table 8, indicating the existence of long-run causality in all the examined variables with statistically significant probabilities. In time series analysis, the Granger causality test is a crucial statistical tool for exploring causal relationships between two variables. However, the vector error correction Granger causality test unveils that CO2 emissions substantially influence agricultural gross domestic product over the long term. Additionally, our findings suggest that CO2 emissions have a significant and adverse impact on agricultural production, resulting in a decrease in the country's overall agricultural gross domestic product. In contrast, agrarian Expenditure demonstrates a noteworthy positive effect on agricultural production, contributing to an upturn in Afghanistan's gross agricultural output.

Table 8: VEC Granger Causality/Block Exogeneity Wald Tests

Dependent Variable	Excluded	Chi-square Statistics	Degrees of Freedom	p-value

Δ Ln Y	*Δ C*	5.781653*	2	0.0555
	Δ Ln A	7.326604**	2	0.0256
	Δ Ln E	5.75402*	2	0.0563
	ALL	12.96846**	6	0.0435
Δ C	*Δ LnY*	0.565924	2	0.7535
Δ Ln A	*Δ Ln Y*	11.84037***	2	0.0027
Δ Ln E	*Δ Ln Y*	6.167462**	2	0.0458

Note: *** indicates significance at 1%.
**indicate significance at 5%.
* indicate significance at the 10% critical value levels.

Robust analysis

To enhance the robustness assessment of our findings derived from the FMOLS and DOLS models, we carried out a canonical cointegrating regression (CCR) examination. The outcomes of this rigorous analysis are showcased in Table 9, employing the CCR approach. Our resilient regression analysis results are consistent with those obtained from the FMOLS and DOLS models, strengthening and affirming our study's hypothesis.

Specifically, the coefficient for carbon emissions is -0.66105, indicating a negative relationship with the agricultural gross domestic product. Conversely, the coefficient for agricultural Expenditure is 0.35963, demonstrating a positive relationship with the agricultural gross domestic product. Additionally, the R-squared value in the CCR investigation is 0.95, indicating high residual and optimal fit, underscoring the robustness and accuracy of our study's findings.

Table 9: Robust analysis using CCR estimator

Variable	Fully modify OLS		Canonical cointegrating regression (CCR)	
	Coefficient	t-Statistic	Coefficient	t-Statistic
C	-1.045876***	-4.793264	-0.661057**	-2.215947
A	0.243563***	6.928717	0.359637***	7.363731
E	-1.284671***	-6.060403	-0.723921**	-2.345283
C	20.22209	18.96839	16.57687	10.04547
R^2	0.953922		0.941924	
SE of regression	0.101322		0.113751	
Long-run variance	0.000896		0.000896	

Note: **indicates significance at 5%.
*** indicate significance at the 1% critical value levels.

Residual Diagnostic Tests

Heteroscedasticity Test: Since the p-values of the Breusch–Pagan probability are more than 0.05, we can reject the presence of heteroscedasticity in the model (Table 10).

Table 10: Heteroskedasticity Test Result

Criteria	Prob.Value	Ho: Null Hypothesis	Interpretation
Heteroscedasticity test	0.6234	Accept	No-Heteroscedasticity

Serial Correlation LM Test: Serial correlation is a statistical concept that describes the link between the present value of a variable and the lag value of the same variable from earlier periods. Since the p-value of the Breusch–Godfrey serial correlation LM test is greater than 0.05, we conclude that there is no serial correlation in the model (Table 11).

Table 11: Serial Correlation LM Test: Breusch–Godfrey

Criteria	Prob.Value	Ho: Null Hypothesis	Interpretation
Breusch-Godfrey Serial Correlation LM test	0.5005	Accept	No Serial Correlation

CUSUM and CUSUM square tests

The stability of variance or measurement in the estimation analysis was assessed using the cusum and cusum of squares tests introduced by Brown, Durbin, & Evans (1975). The outcomes of these tests are shown in Figures 1 and 2. The CUSUM test indicates that the regression parameters of the model exhibit relative stability, supported by the critical line falling within the 5 percent crucial significance level. Conversely, the cusum of squares (CUSUMSQ) test affirms that the model is entirely stable. Since the cusum test has already established the stability of parameters, it is sufficient to draw inferences and conclude that the model is stable.

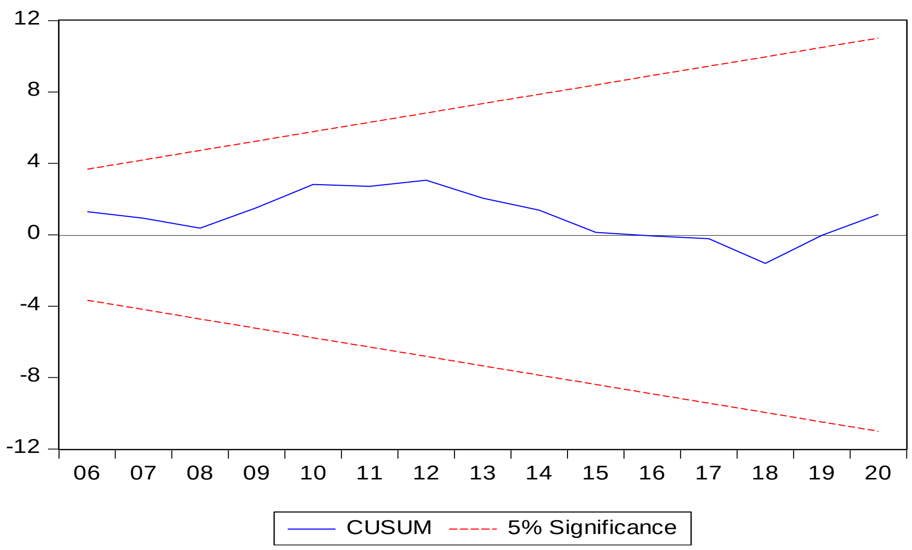

Figure 1: Plot of the cumulative sum of squares of recursive residuals of CUSUM

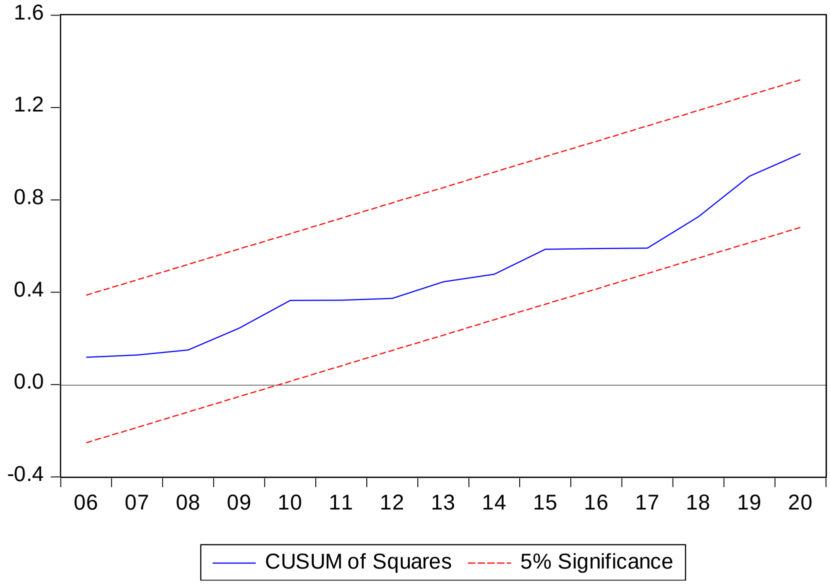

Figure 2: Plot of the cumulative sum of squares of recursive residuals of CUSUMsq

Conclusion

Agriculture and its association with climate change play a pivotal role in mitigating the impacts of climate change, ensuring food security, and promoting sustainable and resilient agricultural practices. The agricultural sector carries even greater significance for Afghanistan, a country consistently grappling with the challenges of climate change and periodic droughts.

In this paper, I investigate the effect of climate change and government expenditure on agricultural growth. My empirical findings from both FMOLS and DOLS models reveal a negative correlation between carbon emissions and Afghanistan's gross agricultural domestic product. This emphasizes that environmental pollution and CO_2 emissions significantly adversely impact the country's agricultural output. Conversely, the coefficient for agricultural Expenditure exhibits a positive association with agricultural gross domestic product, indicating that government investments in the agricultural sector have a constructive effect on boosting agricultural production and development within Afghanistan. Therefore, it is strongly recommended that the government allocate additional financial resources to strengthen its climate protection efforts, consequently mitigating the detrimental impacts on the agricultural sector. Behind the allocation of the sources, the government should formulate comprehensive policies and procedures. Furthermore, there is a pressing need to enhance the capabilities of government organizations responsible for implementing policies to safeguard the country's climate.

Moreover, the government should allocate financial resources to projects that, despite having short-term impacts, promise substantial long-term benefits for agricultural growth. This approach ensures the sustained increase in agricultural production and the fulfillment of domestic demand for agricultural and livestock products within the country. It is recommended that the government maintains a stable domestic currency exchange rate concerning foreign exchange. Additionally, it should pursue policies and programs to promote national products, particularly within Afghanistan's agricultural, industrial, and mining sectors. These initiatives will foster economic stability and the growth of domestic industries, contributing to the overall welfare of Afghanistan.

Finally, it can be mentioned that this study is not free from limitations. For instance, the study used FMOLS and DOLS models and Granger causality, which may not fully capture the complex relationship between CO2 emission, government agricultural expenditure, and agricultural growth. However, this study also adopted the latest technique to measure the link in the studied variables, which may provide an important basis for future research in Afghanistan.

Conflict of Interest: The author(s) declared no conflict of interest.

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