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Do Climate Change Matter for Agricultural Production in an era of Globalization? Empirical Insights from Pakistan

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ABSTRACT

The purpose of current research is to examine the “sunspot theory” of business cycles in the case of Pakistan in the globalization scenario. The current research uses time-series data from 1980 to 2021. To find out the impact of Climatic variation on agricultural Production, the NARDL technique is used for the estimation of results. Results confirmed that CO_2 emissions and mean temperature show an asymmetric effect on Agricultural production. Variations in CO_2 emissions and mean temperature pose mixed results about agricultural production both in the long-run and short-run in different globalization scenarios. Further, through discussion, it is confirmed that this decrease in agricultural production due to climatic variation has slowed down the economic activity in an economy. Based on the results, it is recommended that government must expand tree planting projects and maintain greenery at all costs. The problem is expected to worsen as the temperature rises and the population grows. Agriculture producers must be taught new and sophisticated agricultural and cultivation practices. To address the issue of water scarcity, the government of Pakistan must construct more dams and reservoirs to give farmers greater access to water. The last but not least, this research confirmed the validity of the sunspot theory in the case of Pakistan.

Keywords: Sunspot Business Cycle, Agricultural Production, Economic Activity, CO_2 Emissions, Mean Temperature
JEL Classifications: E32, F43, F47, J43

1. INTRODUCTION

Globalization has increased the interdependence of countries and different economies upon each other due to a significant increase in cross-border trade of goods and services (Shangquan, 2000; Molefe et al., 2018). Globalization has had a profound effect on our way of life. It has improved communication, expanded access to technology, and encouraged innovation (Xia et al., 2022). It has ushered in a new era of economic prosperity, opened up huge development channels, and played a critical role in bringing people of different cultures together. Globalization, on the other side, has caused a slew of issues, the most prominent of which is the environmental effect (Song et al., 2020; Abubakar and Dano, 2020). In environmental circles, globalization has been a heated topic, with environmentalists emphasizing its far-reaching repercussions. However, as affluence grows, so does ecological consciousness, making it the principal reason for preventing environmental harm in later stages of economic development (Chen et al., 2019; Aswani et al., 2018). As a result of globalization and industry, many chemicals have been introduced into the soil, resulting in a proliferation of noxious weeds and plants. By messing with plant genetic makeup, this toxic substance has caused severe harm (Shahzad et al., 2022). This one has put a pressure on readily available land and water supplies. Mountains are being chiseled away in various locations to make space for a passing tunnel or motorway. Huge tracts of undeveloped land have been encroached upon in order to build new structures (Guo et al., 2021).

Figure 1: Pakistan's mean annual temperature projections during 21st century using two different emission scenarios

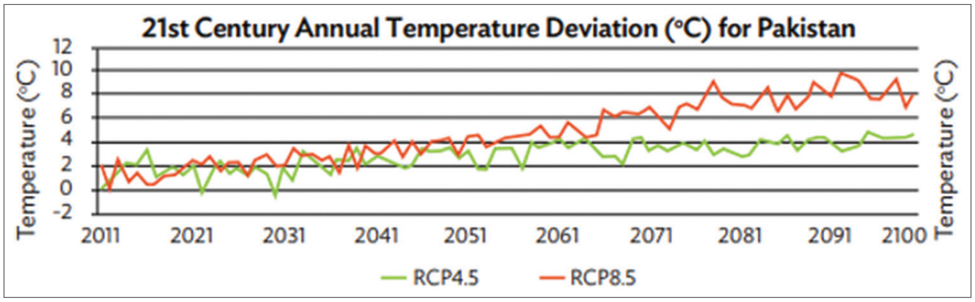
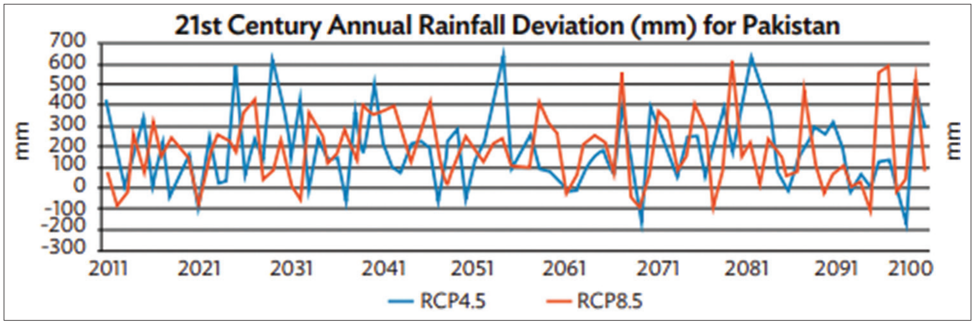


Figure 2: Pakistan's precipitation deviation projections during 21st century using two different emission scenarios[1]



These inventions may enchant people while possibly damaging the environment and causing climate change (Sharma et al., 2021; Syam et al., 2024). Because of tonnes of dangerous chemicals (known as greenhouse gases – [GHGs]) created by industry, transportation, agriculture, and consumer behavior, the composition of the Earth's atmosphere is changing. The atmosphere is gradually warming because of this growing layer of gases. Climate change and its repercussions, such as increasing droughts and floods, rising sea levels, more severe temperatures, and so on, will have far-reaching implications. Pakistan is geologically located in a region where the effects of climate change are being felt strongly. Pakistan has also been impacted by this phenomenon of global warming and climate change, the country has witnessed severe changes in temperature and seasons over the past few years. Pakistan typically experiences warm weather. Hence, the geographical location of the country also puts it at risk of experiencing temperature rises more than the average temperature. Figure 1 shows the projections of mean annual temperature and rainfall until the 2100 year which clearly shows the drastic variations in climate in Pakistan if CO_2 emissions will not stable. Under RCP8.5, the average temperature trend suggests a 4°C-6°C rise by the end of the century, with a rapid increase after 2050.

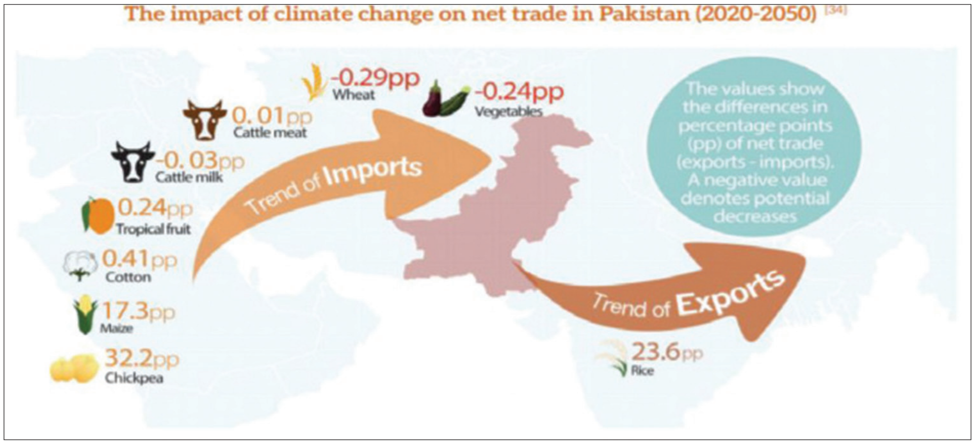
The land of Pakistan is generally arid and semi-arid (about 60% of the area receives <250 mm of rain per annum and 24% receives between 250 and 500 mm); the glaciers in the upper regions of Hindu Kush and Karakoram supply the water to the rivers but due to the increasing temperatures these glaciers are melting rapidly. Rainfall varies widely across geographic and temporal boundaries. In Pakistan, rainfall varies greatly from year to year. Peaks that rise sharply suggest substantial precipitation occurrences, whereas negative peaks indicate droughts. Figure 2 depicts RCP4.5 and 8.5 CMIP5 multimodal mean estimates of annual average temperature and precipitation increases compared to 1986-2005 for 2046-2065 and 2081-20100, respectively.

Natural disasters such as floods and drought have also started to occur more frequently. As of now, only 245 million acre-feet of water resources are available for farming and agriculture. Pakistan has a high demand for wheat and to produce wheat a lot more water resources are required, approximately water resources are less in the country to be able to produce the desired amount of wheat by 28.6% according to a report by Intergovernmental Panel on Climate Change (IPCC). According to the 4th report of IPCC, it has been predicted that agriculture production in the south Asian region will significantly reduce by the year 2050 and there will also be a severe shortage of drinking water. The Figure 3 below displays the expected agricultural trade loss due to climatic variation until 2050 in Pakistan. Therefore, food security, water security, energy security, food security and the development of the agriculture sector are at an alarming risk due to the mentioned reasons (Boone et al., 2018, Mohamed et al. 2024).

Agriculture production and the business cycle have a very strong link. The poor/lower class of the economy will have access to cheaper food and will eventually spend less on food items. This means the reduction in food prices will ultimately decrease the income of the agriculture sector. However, the purchasing power of the industrial sector will improve in the long run. Finally, as the economy swings toward manufacturing, the larger economy will benefit and thrive. The link between agricultural production

1 mm = millimeter, RCP4.5 and RCP8.5= Representative Concentration Pathways (RCPs) are emission IPCC AR5 scenarios. RCP4.5 is a stabilization scenario where greenhouse gas emissions stabilize by 2100. In RCP8.5 radiative forcing does not peak by year 2100. Source: Pakistan Meteorological Department. 2015. High Resolution Climate Scenarios. http://www.pmd. gov.pk/rnd/rndweb/rnd_new/climchange_ar5.php

Figure 3: Climate knowledge portal (Chaudhary, 2017)



efficiency and lowering food costs in comparison to the industry. This well-established phenomenon resulted in rapid economic expansion. The importance of the agricultural sector in business cycles shows that business cycles are very much dependent on agricultural activities in economies. According to the general economic growth hypothesis, this process causes the total economy to grow. Reduced agriculture incomes result in lower demand for industrial goods and hence the economy falls. This relationship still needs worth attention and research in the case of Pakistan's economy. There has been less research that highlight the impacts of climate change on the agriculture sector of Pakistan and concludes the consequences of this phenomenon on the rest of the economy as well. From the critical analysis of the literature that currently exists on this particular topic, it has been observed that most studies present regarding the impact of the climatic changes on agriculture are based upon the Ricardian model and the following studies neglect the relationship of business cycles with the changes in the environmental conditions. Moreover, there was no specific research found that used the Sunspot theory to highlight the relationship between climate change and its adverse effects on agriculture production. Thus, this research aims to fill this stated gap and aims to contribute to the progress of the agriculture sector of Pakistan. After going through a lot of literature and investigating this topic, it can be said that this study is unique and the first to interlink the Sunspot theory of business cycle and the impact of climate change on the agriculture sector of Pakistan.

2. LITERATURE REVIEW

Literature review holds a significance importance in any research, it helps in linking the study to the work of previous and more experienced researchers. The following literature review contains the summary of all articles and research papers that focus on the same agenda.

Elias et al. (2019) studied changes in variable components to explain the agricultural pressure and adaptive response of the United States as a result of severe temperatures in the southwest of the United States. The statistics showed that the water deficit in the semi-arid southwest of the United States was growing increasingly severe, resulting in agricultural output losses. Olen et al. (2015) investigated the influence of water shortage and climate on irrigation decisions made by agricultural crop farmers in the United States. Water scarcity and harsh weather had a substantial influence on producers' irrigation decisions, according to the statistics. Producers should employ spray irrigation technology or additional water to lessen the danger of crop damage caused by intense weather, and then boost water consumption. Markovic et al. (2015) investigated the efficiency of irrigation scheduling for maize production in Croatia and discovered that determining the optimum water level for the soil water sensor, as well as the relationship between the water table and root depth, were the most important factors influencing irrigation efficiency under extreme weather conditions. Eggen et al. (2019) examined sorghum crop model development. According to the data, the incidence of sub seasonal precipitation failures rose in the early rainy season, reducing sorghum output. Olesen and Bindi (2002) investigated the impact of global warming on agricultural production in Europe and discovered that in the south, adverse factors such as water scarcity and the possibility of increasing extreme weather events will dominate, resulting in lower harvests and a reduction in suitable agricultural planting area. Huong et al. (2019) researched to quantifying the total impact of the changes that contribute to the formulation of sustainable living in Vietnam. The area of northwest Vietnam has experienced a significant change in the temperature and the amount of rainfall per year. Arora (2019) explains that one of the biggest global concerns in today's era is the rapidly changing earth's ecosystem. The climatic conditions are changing worldwide, and it has been a constant process but in the last century, the speed of the variations in the climate has increased significantly. Pollution and other irresponsible activities by humans have resulted in a temperature rise of 0.9°C since the 19^{th} century and it is mainly due to GHG. Ahmad et al. (2011) conducted a study to evaluate the impacts of climate change on the agriculture sector in India. India is one of the biggest contributors to the Asian economy, most of India's GDP is based on its agriculture sector. According to the statistics around 55% of India's total population demands on the agriculture sector for their income. India has also the highest amount of pollution in the region, it has been evaluated that India is experiencing the worst climatic changes in the region. The excessive and ineffective use of land and the emission of gas produced by the burning of fossil fuels contribute to the increase in air and water pollution.

Ivanic and Martin (2018) researched to examine the impact of agriculture production on the business cycle and economic growth. The research also proves that the growth in the agriculture sector also impacts the poverty and unemployment in countries. This fact can be used for policy making. Many agricultural products are used in the industrial sector as raw materials. Hence, the fluctuations in the price level and availability of these products can cause significant changes in the manufacturing process of the industrial sector. The rate of poverty and unemployment within a country depends upon the labour intensity of different sectors. When considering the supply side linkages the increase in the agricultural sector may reduce the price of food and other necessary manufactured goods for the poor. Hence, the business cycle within the economy is strongly impacted by the production in the agriculture sector (Ramakgasha et al., 2024).

Canter (2017) studied the impact of climate change on the business cycles in different economies. The researcher discussed that the industrial sector is also impacted when there is a fluctuation in the climatic conditions, this is due to many different factors. One of the most significant causes of reduction in industrial production due to climate change is the decrease in the availability of resources that come from the agriculture sector. All the sectors within the economy are closely linked together and any fluctuation in one can upset the dynamics of the other sector. The industrial sector requires input from the agriculture sector in the form of food and raw material and return, the industrial sector supplies technological gadgets and advanced machinery to the agriculture sector.

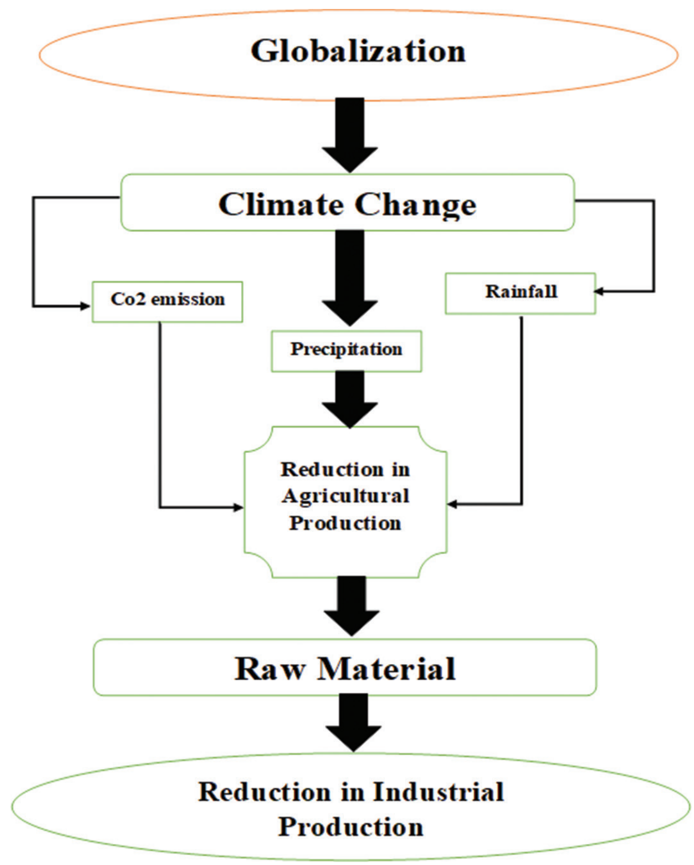
Charania and Li (2020) studied that since there has been an increase in the demand for agriculture products due to an increase in the population, there has also been a significant increase in the technological advancements that have helped the agriculture sector to grow and produce more. The industrial sector supplies and demands various goods to and from the agriculture sector and there is a very close relationship between both the sectors. the study also concluded that due to the increase in agriculture production the condition of the soil has depreciated and there has been a negative impact on the environment. Hence, the growth of both the industrial and agriculture sector can have a negative impact on the environment if sustainable means and methods are not used.

3. METHODOLOGY

3.1. Theoretical Background

A more commonly recognized (but still under investigation) idea concerns the works of William Stanley Jevons (Jevons, 1909) and his son H. Stanley Jevons (Jevons, 1910). The older Jevons, and later his son H. S., felt that fluctuations in agricultural productivity and hence overall economic activity were caused by the cyclical pattern of solar activity. This is known as the "sunspot" theory. Although it is sometimes considered strange, it is not too farfetched. Climate change would undoubtedly have a significant impact on agricultural productivity (and hence revenue) in non-irrigated agrarian communities. As a result, relatively considerable fluctuations in agricultural output would lead to variations in supporting industries (forward linkages), which would subsequently influence industrial output that uses agricultural raw materials (backward linkages), and finally total economic output. This theory is one of the first theories to explain business cycles. Stanley explained that due to the sunspots on the surface of the sun, the weather on the surface of the earth gets impacted and because in older times the economies and fulfillment of necessities of people were heavily dependent upon the agriculture sector alone, the climatic conditions would have a strong impact on the agricultural productivity. Households are predicted to decrease further by 17.7% due to the changes in climatic conditions of the region by the years 2050 and 2100. Countries all over the world are suffering economic losses due to insufficient production of crops which is directly linked to climatic conditions.

3.2. Conceptual Framework



Source: Authors' created

3.3. Variables and Econometric Model

The investigation on the relevant topics is conducted on the secondary data available for the year 1980 till the year 2021. The macroeconomic variables used for this research include agriculture production (AGPR), Call money rate (CMR), economic globalization (EGLOB), trade globalization (TGLOB), precipitation (PRE), fertilizer consumption (FTIM), CO_2 emissions (CO_2), Mean temperature (MEANT), KOF globalization (GLOB), employment in the agriculture sector (EMP) and population growth rate (POPG). Detail regarding different variables used in the current study is presented in Table 1 along with data sources.

3.4. Study Model and Estimation Techniques

Following model is used for current research.

$$AGPR\tau = \alpha_0 + \alpha_1 REER\tau + \alpha_2 EMP\tau + \alpha_3 POPG\tau + \alpha_4 FTIM\tau + \alpha_5 CMR\tau + \alpha_6 MEANT\tau + \alpha_7 PRE\tau + \alpha_8 CO2\tau + \alpha_9 GLOB\tau + \alpha_{10} EGLOB\tau + \alpha_{11} TGLOB\tau + \mu_\tau \quad (1)$$

3.4.1. Estimation techniques

The variables are mixed some are stationary and some are nonstationary and integrated of order one. As per theory apply the NARDL methodology in this situation. Following the sequence of estimation, we have checked the long-run relation view ARDL. The ARDL model is as follows:

$$AGPR_t = \eta_0 + \sum_{i=1}^{q}\eta_1 (AGPR)_{t-1} + \sum_{i=1}^{q}\eta_2 (REER)_{t-i} + \sum_{i=1}^{q}\eta_3 (EMP)_{t-i} + \sum_{i=1}^{q}\eta_4 (POPG)_{t-i} + \sum_{i=1}^{q}\eta_5 (FTIM)_{t-i} + \sum_{i=1}^{q}\eta_6 (CMR)_{t-i} + \sum_{i=1}^{q}\eta_7 (MEANT)_{t-i} + \sum_{i=1}^{q}\eta_8 (PRE)_{t-i} + \sum_{i=1}^{q}\eta_9 (CO_2)_{t-i} + \sum_{i=1}^{q}\eta_{10} (GLOB)_{t-i} + \sum_{i=1}^{q}\eta_{11} (EGLOB)_{t-i} + \sum_{i=1}^{q}\eta_{12} (TGLOB)_{t-i} + \mu_t \quad (2)$$

3.4.2. ARDL cointegration equation

$$AGPR_t = \eta_0 + \sum_{i=1}^{q}\eta_1 (AGPR)_{t-1} + \sum_{i=1}^{q}\eta_2 (REER)_{t-i} + \sum_{i=1}^{q}\eta_3 (üüü\ )_{t-i} + \sum_{i=1}^{q}\eta_4 (\quad)_{t-i} + \sum_{i=1}^{q}\eta_5 (üüü\ )_{t-i} + \sum_{i=1}^{q}\eta_6 (\quad)_{t-i} + \sum_{i=1}^{q}\eta_7 (MEANT)_{t-i} + \sum_{i=1}^{q}\eta_8 (PRE)_{t-i} + \sum_{i=1}^{q}\eta_9 (CO_2)_{t-i} + \sum_{i=1}^{q}\eta_{10} (GLOB)_{t-i} + \sum_{i=1}^{q}\eta_{11} (EGLOB)_{t-i} + \sum_{i=1}^{q}\eta_{12} (TGLOB)_{t-i} + \lambda_1 (AGPR)_t + \lambda_2 (REER)_t + \lambda_3 (EMP)_t + \lambda_4 (POPG)_t + \lambda_5 (FTIM)_t + \lambda_6 (CMR)_t + \lambda_7 (MEANT)_t + \lambda_8 (PRE)_t + \lambda_9 (CO_2)_t + \lambda_{10} (GLOB)_t + \lambda_{11} (EGLOB)_t + \lambda_{12} (TGLOB)_t + \mu_t$$

Where,
q=lag independent variables
n=short run
λ=long run (3)

Equations (2,3) are an error–correction specification which gives both the long-run and short-run coefficients. λ represents long-run coefficients, while differenced variables η depict short-run coefficients. However, Eq (2,3) depicts the symmetric relationship among explanatory variables. Considering the aspect of non-linearity, which is important to be concerned that both positive and negative changes in MEANT and CO_2 may affect differently. And to capture the asymmetric effect of these positive and negative changes the NARDL model is more appropriate (Shin et al. 2014). in the NARDL methodology of the decomposition of the exchange rate into MEANT_POS and MEANT_NEG, CO2_POS AND CO2_NEG. Therefore, the model is as follows

Decomposing variables MEANT

$$POS_t = \sum_{i=1}^{q} " MEANT_j^{+} = \sum_{i=1}^{q} max(" MEANT_j, 0) \quad (4)$$

$$NEG_t = \sum_{i=1}^{t} " MEANT_j^{-} = \sum_{i=1}^{t} \min(" MEANT_j, 0) \quad (5)$$

CO2

$$POS_t = \sum_{i=1}^{t} " CO_{2j}^{+} \sum_{i=1}^{t} max(" CO_{2j}, 0) \quad (6)$$

$$NEG_t = \sum_{i=1}^{t} " CO_{2j}^{-} = \sum_{i=1}^{t} min(" CO_{2j}, 0) \quad (7)$$

We have further decomposed the Globalization into Economic Globalization and Trade globalization for in depth study.

Model 1

$$AGPR_t = \eta_0 + \sum_{i=1}^{q}\eta_1 (AGPR)_{t-1} + \sum_{i=1}^{q}\eta_2 (REER)_{t-i} + \sum_{i=1}^{q}\eta_3 (EMP)_{t-i} + \sum_{i=1}^{q}\eta_4 (POPG)_{t-i} + \sum_{i=1}^{q}\eta_5 (FTIM)_{t-i} + \sum_{i=1}^{q}\eta_6 (CMR)_{t-i} + \sum_{i=1}^{q}\eta_7 (MEANT)^{+}_{t-i} + \sum_{i=1}^{q}\eta_8 (MEANT)^{-}_{t-i} + \sum_{i=1}^{q}\eta_9 (PRE)_{t-i} + \sum_{i=1}^{q}\eta_{10} (CO_2)^{+}_{t-i} + \sum_{i=1}^{q}\eta_{11} (CO_2)^{-}_{t-i} + \sum_{i=1}^{q}\eta_{12} (GLOB)_{t-i} + \lambda_1 (AGPR)_{t-i} + \lambda_2 (REER)_t + \lambda_3 (EMP)_t + \lambda_4 (POPG)_t + \lambda_5 (FTIM)_t + \lambda_6 (CMR)_t + \lambda_7 (MEANT)^{+}_{t-i} + \lambda_8 (MEANT)^{-}_{t-i} + \lambda_9 (PRE)_t + \lambda_{10} (CO_2)^{+}_{t-i} + \lambda_{11} (CO_2)^{-}_{t-i} + \lambda_{12} (GLOB)_t + \square_t \quad (8)$$

Model 2

$$AGPR_t = \eta_0 + \sum_{i=1}^{q}\eta_1 (AGPR)_{t-1} + \sum_{i=1}^{q}\eta_2 (REER)_{t-i} + \sum_{i=1}^{q}\eta_3 (EMP)_{t-i} + \sum_{i=1}^{q}\eta_4 (POPG)_{t-i} + \sum_{i=1}^{q}\eta_5 (FTIM)_{t-i} + \sum_{i=1}^{q}\eta_6 (CMR)_{t-i} + \sum_{i=1}^{q}\eta_7 (MEANT)^{+}_{t-i} + \sum_{i=1}^{q}\eta_8 (MEANT)^{-}_{t-i} + \sum_{i=1}^{q}\eta_9 (PRE)_{t-i} + \sum_{i=1}^{q}\eta_{10} (CO_2)^{+}_{t-i} + \sum_{i=1}^{q}\eta_{11} (CO_2)^{-}_{t-i} + \sum_{i=1}^{q}\eta_{13} (EGLOB)_{t-i} + \lambda_1 (AGPR)_{t-1} + \lambda_2 (REER)_t + \lambda_3 (EMP)_t + \lambda_4 (POPG)_t + \lambda_5 (FTIM)_t + \lambda_6 (CMR)_t + \lambda_7 (MEANT)^{+}_{t-i} + \lambda_8 (MEANT)^{-}_t + \lambda_9 (PRE)_t + \lambda_{10} (CO_2)^{+}_t + \lambda_{11} (CO_2)^{-}_t + \lambda_{13} (EGLOB)_t + \square_t \quad (9)$$

Table 1: Description of variables and data sources

S. No.	Variables	Sources	Comments
Dependent variable			
1	Agricultural Production (APRO)	Economic Survey	Agri. Production at Current US Dollar
Independent Variables			
2	Temperature (MEANT)	CCP	Mean temperature (Celsius)
3	Carbon emission (Co2)	WDI	Carbon emission per kiloton (kt)
4	Precipitation (PER)	CCP	Precipitation (mm)
5	Inflation (CMR)	SBP	Call money rate
6	Employment (EMP)	SBP	% of total employment
7	Population growth rate (POPG)	SBP	annual %
8	Real effective exchange rate (REER)	SBP	REER
9	Fertilizer Import (FTIM)	Economic Survey	Import of Fertilizers (000N/Hectare
10	Globalization (GLOB)	Kof Globalization Index	Globalization index
11	Economic Globalization (EGLOB)	Kof Globalization Index	Economic globalization index
12	Trade Globalization (TGLOB)	Kof Globalization Index	Trade Globalization Index

Table 2: Correlation matrix

Variables	AGRI	CMR	CO_2	EMP	FTIM	GLOB	MEANT	PER	POPG	REER
AGRI	1									
CMR	0.0561	1								
CO_2	−0.2216	0.1487	1							
EMP	0.0778	−0.0749	−0.852	1						
FTIM	−0.2141	0.1359	0.723	−0.6113	1					
GLOB	−0.1957	0.2085	0.890	−0.8089	0.7187	1				
MEANT	−0.1304	−0.1333	0.560	−0.5640	0.3855	0.6590	1			
PER	−0.1209	0.2453	0.038	0.1742	0.0528	−0.0635	−0.5011	1		
POPG	0.1498	−0.1241	−0.899	0.8761	−0.7108	−0.7882	−0.6938	0.1184	1	
REER	0.0961	−0.1034	−0.764	0.8761	−0.6313	−0.7896	−0.4854	0.0972	0.7127	1

Model 3

$$AGPR_t = \eta_0 + \sum_{i=1}^{q} \eta_1 (AGPR)_{t-1} + \sum_{i=1}^{q} \eta_2 (REER)_{t-i}$$
$$+ \sum_{i=1}^{q} \eta_3 (\ddot{u}\ddot{u}\ddot{u}\quad)_{t-i} + \sum_{i=1}^{q} \eta_4 (\qquad)_{t-i} +$$
$$\sum_{i=1}^{q} \eta_5 (\ddot{u}\ddot{u}\ddot{u}\quad)_{t-i} + \sum_{i=1}^{q} \eta_6 (\qquad)_{t-i} +$$
$$\sum_{i=1}^{q} \eta_7 (MEANT)^{+}_{t-i} + \sum_{i=1}^{q} \eta_8 (MEANT)^{-}_{t-i}$$
$$+ \sum_{i=1}^{q} \eta_9 (PRE)_{t-i} + \sum_{i=1}^{q} \eta_{10} (CO_2)^{+}_{t-i} +$$
$$\sum_{i=1}^{q} \eta_{11} (CO_2)^{-}_{t-i} + \sum_{i=1}^{q} \eta_{14} (TGLOB)_{t-i}$$
$$+ \lambda_1 (AGPR)_{t-1} + \lambda_2 (REER)_t + \lambda_3 (EMP)_{t-i} +$$
$$\lambda_4 (POPG)_t + \lambda_5 (FTIM)_t + \lambda_6 (CMR)_t +$$
$$\lambda_7 (MEANT)^{+}_t + \lambda_8 (MEANT)^{-}_t + \lambda_9 (PRE)_t +$$
$$\lambda_{10} (CO_2)^{+}_t + \lambda_{11} (CO_2)^{-}_t + \lambda_{14} (TGLOB)_t + \mu_t \quad (10)$$

4. RESULTS AND DISCUSSIONS

4.1. Correlation Matric

Table 2 shows the correlation analysis. Results showed that CMR, EMP, POPG and REER positively associated with AGRI. On the other hand, CO_2 emissions, FTIM, GLOB, MEANT and PER have negative impact on agricultural production.

4.2. Unit Root Test

The indicators that have been selected to conduct this specific study have been tested through different models that portray different scenarios. It indicates the nature of the selected variables and their respective relationships with each other. The movement and fluctuations in agriculture productivity and environmental factors are the core components of the Sunspots theory of the business cycle. Through the unit root test, which was presented in Table 3, we can observe that all the variables are stationary enough to be run in the NARDL model. All these variables can be calculated by the NARDL model.

Table 3: Unit Root Test Results

Variables	At level	At first difference	Integrations
APRO	0.9983	0.5347**	1 (1)
CMR	0.0644*	0.0000***	1 (0)
CO2	0.3005	0.0827*	1 (1)
EGLOB	0.5623	0.0000***	1 (1)
EMP	0.2716	0.0000***	1 (1)
FTIM	0.0026***	0.0001***	1 (0)
GLOB	0.7090	0.0012***	1 (1)
MEANT	0.0381**	0.0000***	1 (0)
PER	0.0000***	0.0000***	1 (0)
REER	0.2444	0.0000***	1 (1)
POPG	0.9133	0.0567*	1 (1)
TGLOB	0.5347	0.0000***	1 (1)

(*) Indicates that the variables are stationary at 10%, (**) indicates that the variables are stationary enough at 5%, and (***) shows that the variables are stationary at 1%.

4.3. Bound Tests

Table 4 presents the F-bound test results for all the 3 models. The bound tests also show the upper and lower significance level. It proves that the long-run relationship between all the variables is greater than the limit.

4.4 Long-run Results for NARDL

NARDL's long-run results were presented in Table 5. We have estimated 3 models by keeping in view the different globalization scenarios. Model 1 shows the NARDL bound test for the following model in which it is shown that agriculture production is impacted by all the environmental factors such as precipitation, CO_2 emissions, and population growth. In this model, only globalization is considered due to which the impacts on agriculture production can be investigated further. Globalization usually includes mobility of finance, inputs, production techniques, and research over large geographical regions. Generally, globalization results in an increase in net income in money countries, poverty reduction and also increasing food security. However, the implication of frictionless travel and perfect information understates the conditions for reaping the benefits of globalization. These tendencies have existed throughout history. Because of globalization, the real costs of information transfer and commodities transportation have rapidly decreased, while perishability and bulk have decreased dramatically. Concurrently, increases in per capita income and market size have enabled scale economies for a bunch of new products, the majority of which involve value-added processes that necessitate investment and improved technology. Because of these rapid developments, agriculture has become much more specialized, resulting in cheaper costs and faster trade growth. In developing countries, globalization caused high agricultural production as compared to domestic consumption. This high growth of agricultural production proved as a development engine in low-income nations. High growth in agricultural production increases food security by expanding multipliers to the enormous, employment-intensive, non-tradable rural non-farm sector. With such potential benefits, it is still crucial to understand whether globalization lifts the poor out of poverty and hunger. Current research tries to capture the effect of globalization in Pakistan.

Table 4: Bound test results

Bound test			
Value	Sig.	I (0)	I (1)
24.27	10%	1.76	2.77
27.55	5%	1.98	3.04
23.65	2.50%	2.18	3.28
	1%	2.41	3.61

Table 5: Long-run results

Variables	Model 1	Model 2	Model 3
CO_2_POS (−1)	4.215	3.451	3.496
	(0.000)	(0.005)	(0.000)
CO_2_NEG (-1)	−3.163	−4.876	−4.213
	(0.167)	(0.204)	(0.007)
EMP	0.074	−0.027	−0.057
	(0.000)	(0.004)	(0.135)
FTIM	0.002	0.001	0.001
	(0.000)	(0.000)	(0.018)
CMR	−0.014	−0.022	−0.039
	(0.205)	(0.000)	(0.082)
MEANT_POS	−0.080	0.091	0.144
	(0.505)	(0.003)	(0.180)
MEANT_NEG	−0.287	1.390	−0.171
	(0.026)	(0.345)	(0.055)
LRER	−0.083	0.967	0.637
	(0.797)	(0.345)	(0.079)
POPG	0.136	0.967	1.466
	(0.687)	(0.000)	(0.046)
GLOB	0.002	-	-
	(0.273)	-	-
EGLOB	-	0.069	-
	-	(0.000)	-
TGLOB	-	-	0.055
	-	-	(0.009)

Results of Model 1 show that in presence of globalization, Climatic variables like CO_2_Neg and PER negatively affect agricultural production while CO_2_POS, MEANT_POS, and MEANT_NEG positively affect agricultural production. Our findings related to CO_2 emissions are supported by literature where it was found that due to globalization, industries will grow faster and population growth. As a result, agricultural productivity must expand to maintain food security and a steady supply of raw materials to the industrial sector (Schneider and Smith, 2009). Hence, increased agricultural production increases carbon dioxide emissions as well (Celikkol Erbas and Guven Solakoglu, 2017). Indeed, wrongful agricultural practices such as agricultural production in unsuitable areas to increase production, pesticides and chemical fertilizers, irrigation, soil processing, mistakes in plant hormone use, stubble burning, and dumping of unsuitable animal waste into soil increase CO_2 emissions due to crop production (Waheed et al., 2018). Literature shows that an increase in CO_2 emission increases the temperature that's why MEANT shows a positive relation with agricultural production. Our results show that magnitude of the positive effect of MEANT on agricultural production is low as compared to the negative effect. Further results confirmed that variables like employment, fertilizer import, population growth, and globalization positively affect agricultural production. On the other hand, MEANT, CMR, and RER hurt agricultural production. The findings indicated that the negative consequences of globalization outnumber the favorable aspects.

Model 2 shows the Long-run results in the presence of economic globalization (EGLOB). EGLOB has both beneficial and harmful impacts on all sectors, including agriculture. EGLOB is a process through which governments rapidly liberalize international trade, investment, finance, and long-distance movements, as well as the information and attitudes that accompany market exchanges (Dreher, 2006). Nowadays, the effects of EG appear to have spread to many sectors in developing countries, including agriculture. EGLOG strengthens competition in the agricultural market to produce high-quality and value-added products (Johannessen and Wilhite, 2010). Agriculture is important for improving food availability, food and nutrition security, employment, foreign exchange earnings, GDP, capital accumulation, and secondary industries in the country (Pawlak and Koodziejczak, 2020). It is concluded that disruptions in the agricultural sector might jeopardize a country's condition. Agriculture disruption may lower rural employees' earnings and working hours, as well as increase social strife and other elements of life (Dube and Vargas, 2013). As a result, economic globalization (EGLOB) might be one of the elements generating agricultural disruption in emerging nations. Economic globalization in the form of FDI encourages agribusiness growth and increases farmers' access to capital resources. As per the model 2 results, the presence of economic globalization CO_2 _POS has a positive influence on Agri production while CO_2_NEG hurts Agri production (Dogan 2016). One might argue of these findings are that agricultural production output and crops required, more use of high energy demanding feedstuffs, enhanced use of mineral fertilizers, and overuse of pesticides which leads to higher levels of CO_2 (Doğan, 2018). This finding is supported by Haider et al. (2020) and Zhang et al., (2017), who explained that the adoption of modern agricultural techniques, seeding technologies, harvesting machines, and genetic innovations in agricultural production is harmful to the climate but on the other hand these new technologies has a significant positive effect on agriculture productivity. The other control variables employment (EMP) and interest rate (CMR) negatively affect agricultural production while fertilizer import (FTIM), Real effective exchange rate (LRER), and population growth (POPG) Positively affect agricultural production. However, it is also noticeable that the negative effect of mean temperature (MEANT_NEG) is more than the positive effect of MEANT_POS on agricultural production.

Model 3 shows that in the short run how variables impact agriculture production in the presence of trade globalization. On a national scale, trade globalization refers to the fraction of total output that crosses a country's borders, as well as the number of employments in that country that rely on external trade. On a global scale, it indicates the fraction of total global production used for inter-country imports and exports. Results of Model 3 showed that trade globalization (TGLOG) has a significant positive effect on agriculture production. Our findings are consistent with those of Volosin et al. (2011), who stated that trade globalization enhances agricultural income and employment, strengthens national skill sets and export diversification, accelerates agricultural development, expands agricultural markets and value chains, and increases awareness of the need to conserve agrobiodiversity in developing nations. In the presence of TGLOG CO2_POS positively affect agricultural production while CO2_NEG negatively affects agricultural production. Moreover, there is an adverse effect of MEANT (NEG) and MEANT_POS on agriculture production. This result was also reinforced by Mishra (2017) and Antle (2008) who argue that climate changes can have both beneficial and harmful effects on agriculture depending on the geographical location or the types of crops developed in that region. They also conclude that a rise in temperature in some seasons is beneficial for crops and a lower temperature in the harvesting season of some crops is harmful to agriculture productivity. On the other hand, EMP, and CMR hurt agricultural production. FTIM, MEANT_POS, LRER, POPG, and TGLOB have a positive effect on agricultural production.

4.5. NARDL Short-Run Results

Table 6 represents the short-run results for NARDL. Model 1 shows that in presence of Globalization, CO_2_POS, EMP, FTIM, and POPG have a positive effect on agricultural production while CO2_NEG, CMR, MEANT_POS, MEANT_NEG, and RER hurt agriculture. These results are in line with that of Shakoor et al. (2011); Zeb et al. (2013) and Sokil et al. (2018) that there is both a short-run and long-run association of CO_2 emissions and MEANT with agricultural production.

Table 6: Short-run results

Variables	Model 1	Model 2	Model 3
CO_2_POS (−1)	2.671	2.142	2.36
	(0.000)	(0.012)	(0.000)
CO_2_NEG (−1)	−2.004	−3.026	−2.844
	(0.217)	(0.177)	(0.015)
EMP	0.047	−0.017	−0.039
	(0.002)	(0.001)	(0.085)
FTIM	0.001	0.0007	0.0005
	(0.000)	(0.000)	(0.006)
CMR	−0.009	−0.014	−0.027
	(0.211)	(0.000)	(0.044)
MEANT_POS	−0.051	0.056	0.097
	(0.482)	(0.008)	(0.210)
MEANT_NEG	−0.182	−0.121	−0.115
	(0.024)	(0.025)	(0.071)
LRER	−0.053	0.863	0.430
	(0.801)	(0.385)	(0.065)
POPG	0.086	0.600	0.990
	(0.697)	(0.000)	(0.030)
GLOB	−0.002	-	-
	(0.279)	-	-
EGLOB	-	0.043	-
	-	(0.000)	-
TGLOB	-	-	(0.037)
	-	-	−0.001
CointEq(−1)*	−0.634	−0.621	−0.675
	(0.000)	(0.000)	(0.000)

Results of model 2 show that in presence of EGLOB, CO_2_POS, FTIM, MEANT_POS, RER, and POPG positively affect the agriculture sector while CO_2_NEG, EMP, CMR, MEANT_NEG have negatively affected agricultural production.

Model 3 shows that in presence of TGLOB, CO_2_POS, FTIM, MEANT_POS, RER, and POPG have a positive effect the Agri production. On the other hand, CO_2_NEG, EMP, and MEANT_NEG, have negatively affected agricultural production.

The value of the coefficient of the error correction model is −0.634, −0.621, and −0.675 respectively in all models which shows the speed of adjustment towards the equilibrium value, and it is statistically significant at 1%. The value of ECM is based on the error correction coefficient in the ECM model, it can be stated that the system corrects its previous disequilibrium at a speed of approximately 63%, 62%, and 67% annually to reach the steady-state or long-run equilibrium implying that any shock in the explanatory variable will take almost 1 year to adjust.

4.6. Structural Stability Test

The graphs of CUSUMSQ and CUSUM are shown in Figures 4-6. We applied these tests in the manner of Brown et al. (1975), which indicates that the model does not depict any serial correlation, heteroscedasticity, or regularly distributed residuals. The findings reveal that nonlinear ARDL supports the model's stability. The blue line falls within a 5% level of significance, showing that the model is stable.

5. DISCUSSIONS

Business cycles are short-run fluctuations in aggregate economic activity around its long-run growth path. As the aggregate

Figure 4: CUSUM square for globalization

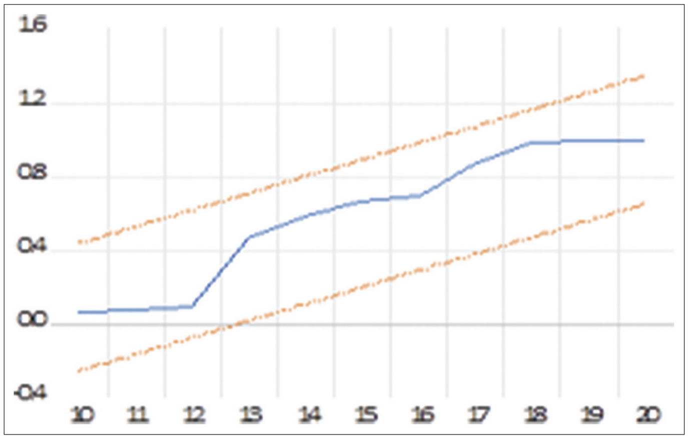


Figure 5: CUSUM square for trade globalization

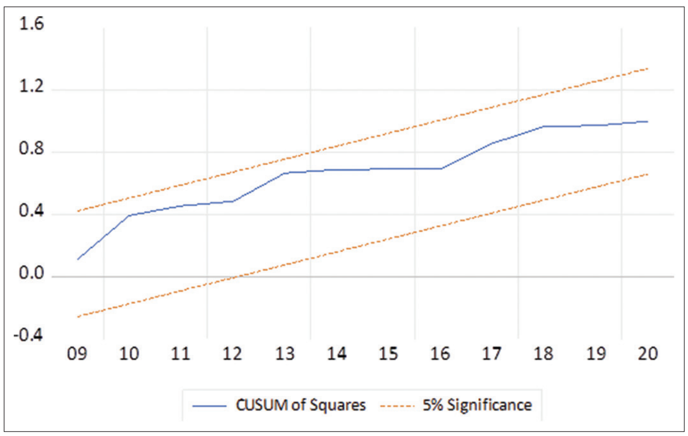
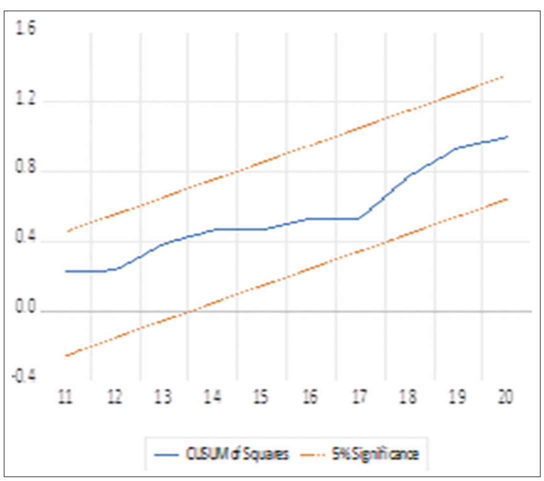


Figure 6: CUSUM square for economic globalization



activity fluctuates, the economies encounter a wide range of macroeconomic disequilibrium such as unemployment and inflation. Understanding the structure of business cycles is of great importance for emerging market economies. Business cycles are a series of fluctuations found in the aggregate economic activity of nations that organize their work mainly in business enterprises. A cycle consists of widespread expansions in numerous economic activities occurring at roughly the same time. The economic activities are usually followed by equally general recessions, contractions, and revivals that blend into the expansion period of the following cycle. The duration of the business cycle varies from 1 to 10 years (Burns and Mitchell, 1946). Many driving mechanisms of economic cycles have been studied continually, such as fiscal and monetary shocks, terms of trade shocks, oil price shocks, and total factor productivity shocks (González-Val and Marcén, 2017). Among the factors of business cycles across countries, the agriculture sector's share of the economy is a potential candidate (Oser, 1951).

Agriculture-intensive economies have significant aggregate output volatility and moderate employment volatility which in turn affects financial markets as well (Tabash et al., 2024). These economies usually have a low correlation between aggregate employment and production. Agricultural production and employment are also more variable and positively connected with output and employment in the rest of the economy (Da-Rocha and Restuccia, 2006). Agriculture is essential in business cycles because of these characteristics.

Pakistan has undergone significant structural changes since its independence. From being an agricultural-based economy in the 1960s, the economy has now shifted to the services sector, but the agriculture sector is still vital to the economy. Agriculture and industry have both played important roles in economic growth. The industrial (including manufacturing) and agricultural sectors accounted for 12.79 and 19.2% of total GDP, respectively, in 2021. However, whereas the industrial and manufacturing sectors accounted for 13.70% of total export values, agriculture only contributed 19.34%. In terms of employment, the industrial and manufacturing sectors employed 16.1percent of the total, while agriculture employed 42.3% (GoP, 2021).

The country's industrial sector has made great success, while the agricultural sector has not improved as much (Answer, et al. 2020). Agricultural development is dependent on industrial demand for agricultural commodities in industrialized nations where completed items are exported. The industry is represented as the next logical step to moving away from the traditionally agricultural-based economy (Henneberry et al., 2000). When this happens, a link is made between the newly developed agricultural region and the infant industrial sector. The agricultural sector affects the economy on two sides one is demand while the other is the supply side. Agriculture supports foodstuff, yarn, and raw stuff for industry, and profits in tum as industry benefits improve customary invention methods by offering dial-up connection of inputs, equipment, and enhanced managerial talents. The outcome is that mutually both divisions gain from each other, and the state advantages their development and expanded effectiveness. This connection among agricultural and industrial segments is of fantastic consequence to the financial system of Pakistan and other improving states and justifies near evaluation.

The agriculture sector is closely linked with other industries as it provides raw materials and resources to produce various manufactured products. Hence, if the agriculture sector of a country is impacted it will most likely also have a serious impact on the industrial sector as well. The agriculture sector provides food, fiber, and various other resources to the industrial sector and in return, the benefits from the progress of the industrial sector provide better machinery and technology for the agriculture sector. The result is that both sectors are dependent on each other for their growth. The government of Pakistan has failed to strike a balance between these two sectors, neglecting the link between agriculture and industry. All the industrial progress that has taken place in the country has been at the expense of the agriculture sector. Pakistan's leading industrial and exporting division is as well supported by agriculture for cotton, its primary raw substance. 75% of the transfers of the country are connected along with this segment. For maintaining its textile exports. Furthermore, both raw and processed cotton has contributed significantly to Pakistan's economic prosperity. Cotton is not only an important agricultural crop, but it is also important to Pakistan's industrial sector. Cotton cultivation occupied 14% of the arable land in 2021. Cotton export in 2021 is about the US $3.4 billion. The cotton textile sector accounts for 11% of GDP and 60% of export receipts and making Pakistan the 8th largest exporter of textile products in Asia. Despite the significance of agriculture, Pakistan has always followed a policy of industrial growth in its efforts to enhance per capita income. This discussion indicates that the agricultural sector is vital for industrial growth. So, for sustainable industrial sector growth, we should promote our agriculture sector.

Our research results showed that due to globalization effects, climatic variations also occurred in Pakistan. These climatic variations affect agricultural production which in return badly affects the industrial sector.

6. CONCLUSION AND POLICY IMPLICATIONS

Globalization is defined and discussed from several perspectives. Many people differ regarding the desirability of globalization, which implies trade openness and the integration of the home economy with other work to suit the needs of the global economy. The impacts of globalization vary between nations and regions due to differences in political, economic, and social circumstances. Globalization has also had an impact on the Pakistani economy. Empirical studies investigate the impact of globalization on Pakistan's industrial and service sectors. These studies neglect the impact of globalization on the agricultural sector which has already been affected by drastic climatic changes. Globalization has created a world in which finished products travel farther and more often around the world than ever before. Increased transport of goods can impact the environment in several ways, including increased emissions and invasive species. The farther a product travels, the more fuel is consumed, and a greater level of greenhouse gas emissions is produced. Overspecialization is an often-overlooked adverse consequence of globalization. Overspecialization can lead to serious environmental issues, often in the form of habitat loss, deforestation, or natural resource overuse. Globalization has allowed some nations to specialize in producing various energy commodities, such as oil, natural gas, and timber. Nations that depend on energy sales to fund a large portion of their national budgets are more likely to take intervening actions in the market. Further, Increased greenhouse gas emissions, ocean acidification, deforestation, climate change, and the introduction of invasive species all work to reduce biodiversity around the globe.

On the other hand, an enormous chunk of our population relies on the agriculture sector for their source of income. Changes in the seasons or changes in crucial factors like rainfall, wind, temperature, and humidity upsets the entire life cycle of the crops. This study has tried to highlight the damages and consequences of climate change and globalization on agricultural production. The variables selected for this study include precipitation, CO_2 emissions, globalization, economic globalization, trade globalization, fertilizer consumption, mean temperature, minimum temperature, and maximum temperature. All these variables are evaluated under the model NARDL, this model represents the long-term relationship of variables and tests whether the variables are asymmetric over time or not. Results confirmed that CO_2 emission, Variation in mean temperature, and inflation hurt agricultural production. Pakistan has witnessed a rise in temperature over the last few decades. Due to heat stress, there has been a decrease in the productivity of milk, meat, and other dairy products. The mortality rate of cattle and farm animals has increased as well. Climate change is a huge threat to the efficiency and sustainability of the livestock industry. There are direct consequences of climate change on the livestock industry such as a reduction in water availability and healthy feed. Climate change also impacts forage production as well as rangeland patterns. If climate change and global warming are not controlled, it is that in the future this phenomenon will cause even greater catastrophes. Further, Globalization, employment in the agricultural sector, and fertilizer imports have a positive effect on the agricultural sector. Economic literature further confirmed that the business cycle of an economy depends upon the availability of resources and production levels. If food crop production is reduced, it increases prices for basic commodities. Pakistan is already fighting the genuine issue of extreme poverty, hunger, and food security. The impact of global warming is, therefore, much more significant for the country. Our research concludes that the "sunspot theory" of the business cycle is validated in the current climatic scenario.

Climate change and global warming have become international problems, with governments and non-profit groups working around the clock to find a solution. Pakistan has already suffered significant losses because of this issue, and if appropriate steps are not implemented, the repercussions will only worsen. As literature shows that the agricultural sector is positively associated with the industrial sector, if we want to achieve the goal of sustainable development, we have to develop our agricultural sector. Some of the recommendations for Pakistan's government are as follows. The Pakistani government must expand tree planting projects and maintain greenery at all costs. The problem is expected to worsen as the temperature rises and the population grows. Agriculture producers must be taught new and sophisticated agricultural and cultivation practices. To address the issue of heavy rainfalls, the government of Pakistan must construct more dams and reservoirs to give farmers greater access to water.

Further, the problem of climate change and global warming will continue to cause damage unless it is dealt with by its root. The root cause of this problem is the increase in pollution resulting from various human activities. The burning of fossil fuels is one of the major reasons for pollution, the natural resources such as coal, gas and oil must be kept in the ground and instead the government should invest in research programs to find ways to produce renewable energy. There should be more educational programs for the farmers and livestock owners by the government of Pakistan at national and regional level. Unless and until the farmers are not made aware about the harmful impacts of global warming, they will not be able to adapt to the situation. New and modern techniques of farming and cultivation must be taught to the agriculture producers. Scope of current study can be enhanced further by empirically analyses the impact of agriculture production in industrial production.

REFERENCES

Abubakar, I.R., Dano, U.L. (2020), Sustainable urban planning strategies for mitigating climate change in Saudi Arabia. Environment, Development, and Sustainability, 22(6), 5129-5152.

Ahmad, J., Alam, D., Haseen, M.S. (2011), Impact of climate change on agriculture and food security in India. International Journal of Agriculture, Environment and Biotechnology, 4(2), 129-137.

Ahmed, I., Ahmad, B., Boote, K., Hoogenboom, G. (2020), Adaptation strategies for maize production under climate change for semi-arid environments. European Journal of Agronomy, 115, 126040.

Answer, M.K., Hina, T., Hameed, S., Nasir, M.H., Ahmad, I., Naseer, M.A. (2020), Modeling adaptation strategies against climate change impacts in integrated rice-wheat agricultural production system of Pakistan. International Journal of Environmental Research and Public Health, 17(7), 2522.

Antle, J.M. (2008), Climate change and agriculture: Economic impacts. Choices: The Magazine of Food, Farm, and Resource Issues, 23(1-3), 9-11.

Anwar, M.R., Wang, B., Li Liu, D., Waters, C. (2020), Late planting has great potential to mitigate the effects of future climate change on Australian rain-fed cotton. Science of the Total Environment, 714, 136806.

Arora, N.K. (2019), Impact of climate change on agriculture production and its sustainable solutions. Environmental Sustainability, 2(2), 95-96.

Aswani, S., Lemahieu, A., Sauer, W.H. (2018), Global trends of local ecological knowledge and future implications. PLoS One, 13(4), e0195440.

Awan, A.G., Yaseen, G. (2017), Global climate change and its impact on agriculture sector in Pakistan. American Journal of Trade and Policy, 4(3), 109-116.

Barnett, J., Evans, L.S., Gross, C., Kiem, A.S., Kingsford, R.T., Palutikof, J.P., Pickering, C.M., Smithers, S.G. (2015), From barriers to limits to climate change adaptation: Path dependency and the speed of change. Ecology and Society, 20(3), 1-11.

Bataka, H. (2021), Economic globalization and public debt in Sub-Saharan Africa. International Journal of Finance and Economics, 28, 1756-1771.

Boone, R.B., Conant, R.T., Sircely, J., Thornton, P.K., Herrero, M. (2018), Climate change impacts on selected global rangeland ecosystem services. Global Change Biology 24(3), 1382-1393.

Brown, R.L., Durbin, J., Evans, J.M. (1975), Techniques for testing the constancy of regression relationships over time. Journal of the Royal Statistical Society Series B: Statistical Methodology, 37(2), 149-163.

Burns, A.F., Mitchell, W.C. (1946), Measuring Business Cycles. New York: NBER.

Canter, D. (2017), Making space for climate change experiments. In: Social Science Perspectives on Climate Change. UK: Routledge. p109-112.

Celikkol Erbas, B., Guven Solakoglu, E. (2017), In the presence of climate change, the use of fertilizers and the effect of income on agricultural emissions. Sustainability, 9(11), 1989.

Charania, I., Li, X. (2020), Smart farming: Agriculture's shift from a labor intensive to technology native industry. Internet of Things, 9, 100142.

Chaudhry, Q.U.Z. (2017), Climate Change Profile of Pakistan. Philippines: Asian Development Bank.

Chen, C., Pinar, M., and Stengos, T. (2020), Renewable energy consumption and economic growth Nexus: Evidence from a threshold model. Energy Policy, 139, 111295.

Chen, C., Woods, M., Chen, J., Liu, Y., Gao, J. (2019), Globalization, state intervention, local action and rural locality reconstitution-a case study from rural China. Habitat International, 93, 102052.

Da-Rocha, J.M., Restuccia, D. (2006), The role of agriculture in aggregate business cycles. Review of Economic Dynamics, 9(3), 455-482.

Dogan, N. (2016), Agriculture and Environmental Kuznets Curves in the case of Turkey: evidence from the ARDL and bounds test. Agricultural Economics/Zemědělská Ekonomika, 62(12), 20-29.

Doğan, N. (2018), The impact of agriculture on CO_2 emissions in China. Panoeconomicus, 66(2), 257-271.

Dreher, A. (2006), Does globalization affect growth? Evidence from a new index of globalization. Applied Economics, 38(10), 1091-1110.

Duarte, R., Pinilla, V., Serrano, A. (2021), The globalization of Mediterranean agriculture: A long-term view of the impact on water consumption. Ecological Economics, 183, 106964.

Dube, O., Vargas, J.F. (2013), Commodity price shocks and civil conflict: Evidence from Colombia. The Review of Economic Studies, 80(4), 1384-1421.

Eggen, M., Ozdogan, M., Zaitchik, B.F., Ademe, D., Foltz, J., Simane, B. (2019), Vulnerability of sorghum production to extreme, sub-seasonal weather under climate change. Environmental Research Letters, 14, e045005.

Elias, E.H., Flynn, R., Idowu, O.J., Reyes, J., Sanogo, S., Schutte, B.J., Smith, R., Steele, C., Sutherland, C. (2019), Crop vulnerability to weather and climate risk: Analysis of interacting systems and adaptation efficacy for sustainable crop production. Sustainability, 11, 6619.

González-Val, R., Marcén, M. (2017), Divorce and the business cycle: A cross-country analysis. Review of Economics of the Household, 15(3), 879-904.

Government of Pakistan (GoP). (2021), Available from: https://www.pbs.gov.pk/sites/default/files/external_trade/annual_analytical_report_on_external_trade_statistics_of_pakistan_2020-21.pdf

Government of Pakistan (GoP). (2021), Economics Survey 2020-21. Available from: https://www.finance.gov.pk/survey/chapters_18/02-agriculture.pdf

Graue, E. (1930), The relationship of business activity to agriculture. Journal of Political Economy, 38(4), 472-478.

Guo, J., Zhou, Y., Ali, S., Shahzad, U., Cui, L. (2021), Exploring the role of green innovation and investment in energy for environmental quality: An empirical appraisal from provincial data of China. Journal of Environmental Management, 292, 112779.

Haider, H., Zaman, M., Liu, S., Saifullah, M., Usman, M., Chauhdary, J.N., Anjum, M.N., Waseem, M. (2020), Appraisal of climate change and its impact on water resources of Pakistan: A case study of Mangla watershed. Atmosphere, 11(10), 1071.

Henneberry, S.R., Khan, M.E., Piewthongngam, K. (2000), An analysis of industrial-agricultural interactions: A case study in Pakistan. Agricultural Economics, 22(1), 17-27.

Huong, N.T.L., Yao, S., Fahad, S. (2019), Assessing household livelihood vulnerability to climate change: The case of Northwest Vietnam.

Human and Ecological Risk Assessment: An International Journal, 25(5), 1157-1175.

Ivanic, M., Martin, W. (2018), Sectoral productivity growth and poverty reduction: National and global impacts. World Development, 109, 429-439.

Johannessen, S., Wilhite, H. (2010), Who really benefits from fairtrade? An analysis of value distribution in fairtrade coffee. Globalizations, 7(4), 525-544.

Khurshid, N., Ajab, S., Tabash, M.I., Barbulescu, M. (2023a), Asymmetries in climate change and livestock productivity: Non-linear evidence from autoregressive distribution lag mode. Frontiers in Sustainable Food Systems, 7, 1139631.

Khurshid, N., Emmanuel Egbe, C., Fiaz, A., Sheraz, A. (2023b), Globalization and economic stability: An insight from the rocket and feather hypothesis in Pakistan. Sustainability, 15(2), 1611.

Khurshid, N., Emmanuel Egbe, C., Fiaz, A., Sheraz, A. (2023c), Globalization and economic stability: An insight from the rocket and feather hypothesis in Pakistan. Sustainability, 15(2), 1611.

Khurshid, N., Fiaz, A., Ali, K., Khurshid, J. (2022), Climate change shocks and economic growth: A new insight from Non-linear analysis. Frontiers in Environmental Science, 2022, 1039128.

Khurshid, N., Sharif, H., Tabash, M.I., El Refae, G.A. (2024), An assessment of asymmetric impact of financial stability and agricultural subsidies on agricultural production in Pakistan. Journal of Agribusiness in Developing and Emerging Economies, https://doi.org/10.1108/JADEE-10-2023-0248

Markovic, M., Tadić, V., Josipovic, M., ZebeC, V., Filipović, L. (2015), Efficiency of maize irrigation scheduling in climate variability and extreme weather events in Eastern Croatia. Journal of Water and Climate Change, 6, 586-595.

Mishra, P.K. (2017), Socio-economic impacts of climate change in Odisha: Issues, challenges and policy options. Journal of Climate Change, 3(1), 93-107.

Mohamed, G., Chiad, F., Abdesslam, M., Omar, B., AL-Absy, M.S.M. (2024), Identifying determinants of food security using panel data analysis: Evidence from Maghreb countries. Economies, 12(4), 91.

Molefe, K., Meyer, N., De Jongh, J. (2018), A comparative analysis of the socio-economic challenges faced by SMMEs: The case of the Emfuleni and Midvaal local municipal areas. Journal of Economics and Behavioral Studies, 10(4), 7-21.

Nathaniel, S.P., Nwulu, N., Bekun, F. (2021), Natural resource, globalization, urbanization, human capital, and environmental degradation in Latin American and Caribbean countries. Environmental Science and Pollution Research, 28(5), 6207-6221.

Olen, B., Wu, J., Langpap, C. (2015), Irrigation decisions for major West coast crops: Water scarcity and climatic determinants. American Journal of Agricultural Economics, 98, 254-275.

Olesen, J.E., Bindi, M. (2002), Consequences of climate change for European agricultural productivity, land use and policy. The European Journal of Agronomy, 16, 239-262.

Oser, J (1951), Agricultural policy and the business cycle. Social Research, 18, 32-54.

Pawlak, K., Kołodziejczak, M. (2020), The role of agriculture in ensuring food security in developing countries: Considerations in the context of the problem of sustainable food production. Sustainability, 12(13), 5488.

Ramakgasha, M.J., Thaba, T.K., Rudzani, N. (2024), Agricultural production and agricultural employment rate in South Africa: Time series analysis approach. International Journal of Economics and Financial Issues, 14(4), 148-153.

Schneider, U.A., Smith, P. (2009), Energy intensities and greenhouse gas emission mitigation in global agriculture. Energy Efficiency, 2(2), 195-206.

Schwarz, J., Mathijs, E., Maertens, M. (2019), A dynamic view on agricultural trade patterns and virtual water flows in Peru. Science of the Total Environment, 683, 719-728.

Shahzad, U., Ferraz, D., Nguyen, N.H., Cui, L. (2022), Investigating the spill overs and connectedness between financial globalization, high-tech industries and environmental footprints: Fresh evidence in context of China. Technological Forecasting and Social Change, 174, 121205.

Shakoor, U., Saboor, A., Ali, I., Mohsin, A.Q. (2011), Impact of climate change on agriculture: Empirical evidence from arid region. Pakistan Journal of Agricultural Sciences, 48(4), 327-333.

Shangquan, G. (2000), Economic Globalization: Trends, Risks and Risk Prevention. CDP Backround Paper 1. New York: Economic and Social Affairs. p1-8.

Sharma, G.D., Tiwari, A.K., Erkut, B., Mundi, H.S. (2021), Exploring the Nexus between non-renewable and renewable energy consumptions and economic development: Evidence from panel estimations. Renewable and Sustainable Energy Reviews, 146, 111152.

Shin, Y., Yu, B., Greenwood-Nimmo, M. (2014), Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications, 2014, 281-314.

Sokil, O., Zhuk, Z., Vasa, L. (2018), Integral assessment of the sustainable development of agriculture in Ukraine. Economic Annals-XXI, 170, 15-21.

Song, M., Zhao, X., hang, Y. (2020), The impact of low-carbon city construction on ecological efficiency: Empirical evidence from quasi-natural experiments. Resources, Conservation and Recycling, 157, 104777.

Source: Worldometer. Available from: https://www.worldometers.info

Syam, M.A., Djaddang, S., Adam, A., Merawati, E.E., Roziq, M. (2024), Carbon accounting: Its implications on accounting practices and corporate sustainability reports. International Journal of Economics and Financial Issues, 14(4), 178-187.

Tabash, M.I., Chalissery, N., Nishad, T.M., Al-Absy, M.S.M. (2024), Market shocks and stock volatility: Evidence from emerging and developed markets. International Journal of Financial Studies, 12(1), 2.

Volosin, J., Smutka, L., Selby, R. (2011), Analysis of external and internal influences on CR agrarian foreign trade. Agricultural Economics, 57(9), 422-435.

Waheed, R., Chang, D., Sarwar, S., Chen, W. (2018), Forest, agriculture, renewable energy, and CO_2 emission. Journal of Cleaner Production, 172, 4231-428.

Xia, W., Apergis, N., Bashir, M.F., Ghosh, S., Doğan, B., Shahzad, U. (2022), Investigating the role of globalization, and energy consumption for environmental externalities: Empirical evidence from developed and developing economies. Renewable Energy, 183, 219-228.

Zeb, A., Khattak, I., Naveed, S., Farid, T. (2013), Analysis of climatic change and its negative impact on agriculture. Scholarly Journal of Agricultural Science, 3(6), 233-237.

Zhang, P., Zhang, J., Chen, M. (2017), Economic impacts of climate change on agriculture: The importance of additional climatic variables other than temperature and precipitation. Journal of Environmental Economics and Management, 83, 8-31.