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The empirical analysis of cereal production under the climate exchange and examining the effects of banks' domestic credit on cereal production: Evidence from Türkiye

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ABSTRACT

This study, it aims to examine the linkage among climate change, banks' domestic credit, and cereal production such as Turkey's CO2 emissions, average rainfall, and average temperature in the period 1980-2019. In the study, firstly, the stationarity properties of the variables are examined by KPSS, ADF and Ng-Perron tests, and the presence of cointegration between the variables is investigated through the ARDL boundary test. Then, the long-run elasticities of the independent series are estimated by applying the ARDL model, and the causality linkage among the series is detected through the VECM method. Empirical findings show that there is cointegration among the variables and that in Turkey, banks' domestic credit, CO2 emissions, average rainfall, and increase in cereal production area increase cereal production, while average temperature increase reduces cereal production. At the same time, it is determined that there is a bidirectional causality between banks' domestic credit, CO2 emissions, average rainfall, and average temperature and grain production, while there exists a uni-directional causality extending from the grain production area to the grain production. Finally, as a result of the examinations, it is detected that there exists a mutual linkage between the financial sector and cereal production.

I. Introduction

The concept of climate change is defined as significant changes in the average state of climatic conditions (precipitation, temperature) over many years (Türkeş, 2008). There is a serious increase in emissions of greenhouse gases in the atmosphere that trigger climate change. In addition, human activities that interfere with nature such as fossil fuel use, deforestation, and agricultural activities cause and continue to cause the deterioration of the natural greenhouse effect and the warming of the atmosphere (Keskin & Kanat, 2018). Therefore, with the United Nations Framework Convention on Climate Change-UNFCCC, measures against climate change have been initiated. Then, it takes its final form with the expansion of the Kyoto Protocol and the Paris Climate Agreement made today (Kaya, 2020). The Paris Agreement, which was adopted by 195 countries including Turkey in 2016, is becoming a turning point in the fight against climate change on a global scale (Köse, 2018).

Events that occur as a result of climate change affect the agricultural sector, which depends on natural conditions, and especially the countries that are dependent on the agricultural sector. The impact of climate change on productivity in agricultural production is seen as a threat to the economic and financial sectors (Acharya & Bhatta, 2013). With the fluctuations that climate change may create in agricultural production, it is thought that there may be a loss of yield and quality in products. While climate-related changes directly affect the agricultural economy, it is foreseen that they may also indirectly lead to negativities such as food inflation, land price increases, farmers' distancing from the sector, and a decrease in agriculture-based exports (TAGEM, 2001; Ozcatalbas, 2014; Koç et al., 2016). Many studies conducted globally and regionally also indicate that the adverse effects of climate change will increase in the future, especially on water, soil, and agricultural products (Calzadilla et al., 2013; Chandio et al., 2020, Kumar et al., 2021).

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At the same time, it is seen that the financial sector development element evaluated in this study is necessary for the sustainability of agricultural production. Thus, the agricultural sector is developing a comprehensive agricultural policy that meets financial needs and attracts investment. Financial institutions also utilize carbon finance as a key instrument to interfere in the stock market to raise funds for the implementation of cleaner generation policies, the development of agriculture, and the use of best practices in sustainable production (Chandio et al., 2021). On the other hand, the main role of the financial sector in the agricultural sector is due to the provision of agricultural credit and financing. The financial sector enables farmers to invest in innovative agricultural development technologies and helps poor farmers to receive the latest agricultural inputs such as seeds, chemicals, and fertilizers of a quality that can increase their agricultural productivity. For this reason, it seems that affordable financial services are necessary to increase productivity in agriculture (Chandio et al., 2022).

Beause the climatic conditions in Turkey are suitable for cereal production, cereal products have the largest share in the agricultural sector (Koday, 2000). While the amount of cereal production in Turkey was 31.869.886 tons in 2021, it is determined that it is 38.671.839 tons by increasing by 21.3% in 2022 (TÜİK, 2022). However, it is foreseen that Turkey will be among the countries that will be most affected by climate change, as well as countries such as Albania and Russia (Talu, 2015; Çaltı & Somuncu, 2019; Irdem, 2022). Therefore, Turkey is accepted as a sample in this study to determine whether climate change affects cereal production. In this direction, the study aims to investigate the impact of climate change on cereal production, which are series (e.g. CO2 emissions, rainfall amount and temperature) in Turkey's 1980-2019 period, and also to investigate the impact of the banks' domestic credit on this cereal production.

While creating the study model, Chandio et al. (2020) for Turkey, Kumar et al. (2021) for low-middle-income countries, Chandio et al. (2021) for Pakistan, Chandio et al. (2022) for Agrarian economy and Asfew and Bedemo (2022) for Ethiopia are taken into consideration and the regression model of this study is created and analyzed with the time series approach. First, the stationarity of series are examined by KPSS, ADF and Ng-Perron tests. In the second stage, banks' domestic credit, CO2 emissions, rainfall, temperature and the cointegration relationship between cereal production land and cereal production are examined by applying the ARDL boundary test. In the next stage, forecasters are used to determine the long-term coefficients of the series. In the final stage, the VECM approach is performed to state the causality linkage among the series. The study provides important advices to the literature. The first of these is that it is determined that climate change in Turkey in the period 1980-2019 has affected cereal production. Secondly, it provides an opportunity to evaluate that one of the most important factors for the continuity and increase of production in agriculture in Turkey and other countries is the financial sector/markets.

The rest of the work is designed as follows. In the second part, the studies on the subject of study in the literature are evaluated by opening. In the third part, the model and data created in line with the purpose of the study are explained. In the fourth section, the study methodology is mentioned. In the fifth section, the findings of the study subject analyzed by the time series method are evaluated by explaining and comparing them with first studies. In the last section, the result of the study is described.

2. Literature Review

Today, the focus of economists, agronomists, and policymakers is to study the impact of climate change and domestic credit as financial sector development on the agricultural sector and cereal production. Many studies on this subject focus on different countries and use different methods, and some of these studies are mentioned in this section. In the literature, when we examine the studies using time series analysis; for example, Loum and Fogarassy (2015) examined the effects of rainfall and temperature on cereal crops by examining Gambia's data from 1960-2013 in their study. According to the findings of the regression analysis, it is determined that the increases and decreases in rainfall and temperature adversely affect cereal production, but CO2 emission has a positive effect on cereals. Bayraç and Doğan (2016) investigate the factors affecting the agricultural sector by using data from 1980-2013 in Turkey. Their findings show that climate change harms the agricultural sector. Chandio et al. (2020) examines the relationship between climate change factors such as CO2 emissions, temperature, precipitation and cereal yield in Turkey between 1968-2014. As a result of the analysis carried out using the ARDL model, it is concluded that there is a long-term relationship between climate change factors and cereal yield. It is also found that there is a positive effect between the average amount of precipitation and the yield of cereal in both the long and short term. In their study, Ali et al. (2021) examine the effects of climate change in Pakistan on agriculture and crop production in particular. Using regression analysis, the study suggests that between 2006 and 2016, climate change was a threat not only to Pakistan, but to the entire world's agriculture.

When we examine the studies that perform panel data analysis on the agricultural sector and cereal production; Lee et al. (2012), for example, address the negative effects of climate change on the agricultural sector in 13 Asian countries between 1998 and 2007. Using regression analysis, the study found that higher temperatures and more rainfall in the summer months increased agricultural production, while high-temperature autumn temperatures were found to be harmful in South and Southeast Asia. Hayaloğlu (2018) examines the impact of climate change on the agricultural sector and economic growth in the 1990-2016 periods for the 10 countries most affected by climate change. As a result of the panel data analysis, it is determined that climate change negatively affects economic growth and the agricultural sector. In their research, Kumar et al. (2021) address the effect of climate change on grain production between 1971 and 2016. According to the findings obtained by applying DOLS, FGLS and FMOLS tests, the existence of co-integration between grain production and climate change is determined. Another finding is that an increase in temperature decreases grain production, but precipitation and CO2 emissions have a favorable impact it.

In addition to this effect, when we evaluate many studies to evaluate the effect of financial sector on cereal production; Shahbaz et al. (2013) address the relationship between Pakistan's financial development and agricultural growth during the period 1971-2011. Using the ARDL and VECM methods, the research determines that financial development has a positive impact on agricultural growth and that there exists a bidirectional causal linkage between agricultural growth and development of financial sector. Yalçınkaya (2018) states that there is a causality extending from agricultural production to agricultural credits, that is, the amount of credit will increase as agricultural production increases for

Turkiye. Yalçınkaya (2018) states that there is a causality extending from agricultural production to agricultural credits, that is, the amount of credit will increase as agricultural production increases for Türkiye. Raifu and Aminu (2019) conduct a study for Nigeria. In this study, which deals with the period of 1981-2016, the ARDL model is used. According to the findings, financial development is found to have a favorable effect on agricultural performance in Nigeria. Zakaria et al. (2019) examines the effects of financial development on agricultural productivity in South Asia between 1973 and 2015.

According to the findings of this study, FMOLS method is preferred; It is concluded that financial development has an inverse U-shaped effect on agricultural productivity. Chandio et al. (2020) examine the impact of financial development on agricultural production for China between 1989 and 2016. As a result of the study using FMOLS and ARDL models, it was determined that there was a long-term relationship between the variables.

Similarly, as mentioned in the study of Tiryaki and Göker (2021), one of the most important factors for the continuity and increase of production in agriculture is the provision of the source of financing. Financing can be obtained from a variety of sources, and these are organized or unorganized markets. Therefore, ensuring the continuity of production in agriculture with the loans received shows the success of this financial management, financial market and financial sector. This, in turn, contributes to the development of financial markets and the sector. Similarly, Chandio et al. (2021), which examines whether Pakistan's financial sector development affected cereal production during the period 1977-2014, obtains that CO2 emissions have a negative impact on cereal production in the short and long term with the ARDL model. It is established that the increase in climate change will reduce cereal production, and financial development also is a stimulative for grain production.

In addition, researchers state that the credit of agricultural sector play an important role in enhancing farmers in Pakistan. In the agricultural sector, credit helps to adopt the efficient apply of resources and modern technologies and promotes the development of the agricultural sector through institutional support such as subsidies, taxes, and crop insurance. Chandio et al. (2022) also examine whether climate change and financial development are affecting agricultural production for ASEAN-4 countries. Researchers analyzed data from 1990-2016 using the CS-ARDL model. According to their findings; It is determined that climate change adversely affects agricultural production and that there is a U-shaped relationship between financial development and agricultural production. Furthermore, Grivins et al. (2023) find that banks play an important role in facilitating the transition to more sustainable models of agriculture in Latvia, Denmark, and the UK. In this context, it is foreseen that the financial sector in Türkiye and other countries is developing the financial sector in the agricultural sector where the agricultural sector is developing. Thus, information and communication technologies develop financial institutions and banks (Shahbaz et al., 2023), and these institutions develop the grain sector.

Thus, as a result of the disclosure of previous studies in the literature, it is seen that climate change has a significant impact on the agricultural production of many countries. At the same time, according to another conclusion, it is found that the development of the financial sector in countries such as Pakistan, Nigeria, South Asia, and China has significantly affected agricultural production in both the long and short term. These results from the studies in the literature motivate us to investigate whether climate change in Türkiye will affect grain production and to investigate the impact of banks' credit on cereal production.

3. Model and Data

This study aims to examine the effect of climate change on grain production and the effects of the economic and banks' domestic credit on this cereal production. Here, series like CO2 emissions, rainfall, and temperature are added to the study model as indicators of climate change, banks' domestic credit, and the cereal production area variable as the other explanatory variable. While creating the study model, the studies by Chandio et al. (2020) for Türkiye, Kumar et al. (2021) for low-middle-income countries, Chandio et al. (2021) for Pakistan, Chandio et al. (2022) for Agrarian economy and Asfew and Bedemo (2022) for Ethiopia are taken as a basis and the following model is created to examine the linkage between series for Türkiye.

$$lnCP_t = \delta_0 + \delta_1 lnCO2_t + \delta_2 lnRF_t + \delta_3 lnTP_t + \delta_4 lnLCP_t + \delta_4 lnDC_t + \mu_t \quad (1)$$

In the model, CP shows cereal production (Metrics tons) (Pickson et al., 2020; Rehman et al., 2021; Chandio et al., 2023); CO2 refers to per capita CO2 emissions (metric tons) as an indicator of climate change (Adzawla et al., 2019; Adam & Drakos, 2022); The RF specifies the average annual rainfall (mm) as an indicator of climate change (Alagidede et al., 2016; Castro et al., 2020); TP shows the annual average temperature (Celsius) as an indicator of climate change (Jatuporn & Takeuchi, 2023); LCP refers to the cereal production area (Pickson et al., 2020; Chandio et al., 2023); DC is domestic credit to private sector by banks (% of GDP) as banks' domestic credit (Chandio et al., 2022).

t shows the period 1980-2019; μ shows the residual value, the constant coefficient δ_0, and the long-term coefficients of CO2 emissions, precipitation, temperature, and cereal production area per person δ_1,δ_2,δ_3, and δ_4 respectively.

The study uses time series from 1980 to 2019 and the reason the series started from 1980 is because there are gaps in the data of the CO2 emission variable from previous years. Cereal production, per capita CO2 emissions, domestic credit to the private sector by banks (% of GDP), and cereal production area series are obtained by the World Bank-World Development Indicators (2023), and rainfall and temperature series are collected from the Climate Change Knowledge Portal of World Bank (2023) database. Table 1 shows the symbols, units of measurement and sources of the variables. Table 2 shows the summary statistical values of the variables, while Table 3 indicates the correlation matrix of the series.

Fig.1 shows the trend of variables over the period 1980-2019.

Table 1. Descriptions of variables.

Variables	Symbol	Measure	Source
Cereal production	CP	Metric tons	WDI
CO2 emissions	CO2	CO2 emissions (Metric tons per capita)	WDI
Rainfall	RF	Millimeter	CCKP
Temperature	TP	Celsius	CCKP
Land under cereal production	LCP	Hectares	WDI
Banks' domestic credit	DC	Domestic credit to private sector by banks (% of GDP)	WDI

Table 2. Summary statistics.

	CP	CO2	RF	TP	LCP	DC
Mean	30911272	217633.7	706.593	11.382	12947137	28.833
Median	30810625	195815.0	712.185	11.350	13530117	19.070
Std. dev.	3748087	99332.68	70.423	0.862	1076055.	17.620
Min.	38632438	415900.0	848.240	13.350	14066559	65.937
Max.	23498600	75763.89	541.620	9.290	10746739	13.588
Skewness	-0.019	0.434549	-0.094	0.188	-0.796	1.140
Kurtosis	2.320	2.093	2.692	3.132	1.991	2.683
Obs.	40	40	40	40	40	40

Source: Authors' findings.

Table 3. Correlation matrix.

	CP	CO2	RF	TP	LCP	DC
CP	1.000					
CO2	0.798	1.000				
RF	0.060	-0.023	1.000			
TP	0.471	0.713	0.090	1.000		
LCP	-0.540	-0.861	0.012	-0.606	1.000	
BC	0.676	0.881	0.088	0.594	-0.911	1.000

Source: Authors' findings.

4. Methodology

In this study, it was aimed to investigate the effects of banks' domestic credit climate change on the production of cereal products in Turkey. The methodology used to test the model for the purpose of the study consists of four basic stages.

First of all, Kwiatkowski, Phillips, Schmidt, and Shin-KPSS, Augmented Dickey–Fuller-ADF, and Ng-Perron tests analyzes whether the variables contain unit roots and their stationary properties. The KPSS unit root test proposed by Kwiatkowski et al. (1992) is calculated by the LM statistic that the random gait has zero variance around a deterministic trend of the series (Kwiatkowski et al., 1992). The ADF unit root test was developed by Dickey-Fuller (1981) and is estimated to be fixed and fixed-trend (Dickey & Fuller, 1981). Ng-Perron test is being developed against the low power problem of ADF, Philips Perron (PP), and KPSS unit root tests (Ertuğrul & Soytaş, 2013). The Ng-Perron unit root test ADF, developed by Ng and Perron (2001), is applied to eliminate PP constraints and proposes four statistics for stability analysis: MZa, MZt, MSB, and MPT (Ng & Perron, 2001).

Since the variables in the model include unit roots at the difference level, the second stage of the methodology applies the ARDL boundary method to test the existence of a cointegration relationship between banks' domestic credit, CO2 emissions, rainfall, temperature, and cereal-producing land and cereal production. The ARDL boundary test developed by Pesaran et al. (2001) has several advantages. The first of these is utilized in the form of variables I(0) or I(1) or a mixture of the two. Second, cointegration between variables is investigated by taking into account the level values of the variables. The dynamic unrestricted error correction model is developed with the ARDL to examine short-run and long-run (Pesaran et al., 2001).

It is as follows:

$$InCP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\, \Delta InCP_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\, \Delta lnCO2_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\, \Delta lnRF_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, \Delta lnTP_{t-i} + \sum_{i=0}^{q} \alpha_{5i}\, \Delta lnLCP_{t-i} + \sum_{i=0}^{q} \alpha_{5i}\, \Delta lnDC_{t-i} + \beta_1 InCP_{t-1} + \beta_2 lnCO2_{t-1} + \beta_3 lnRF_{t-1} + \beta_4 lnTP_{t-1} + \beta_5 lnLCP_{t-1} + \beta_5 lnLCP_{t-1} + \beta_5 lnDC_{t-1} + u_t \quad (2)$$

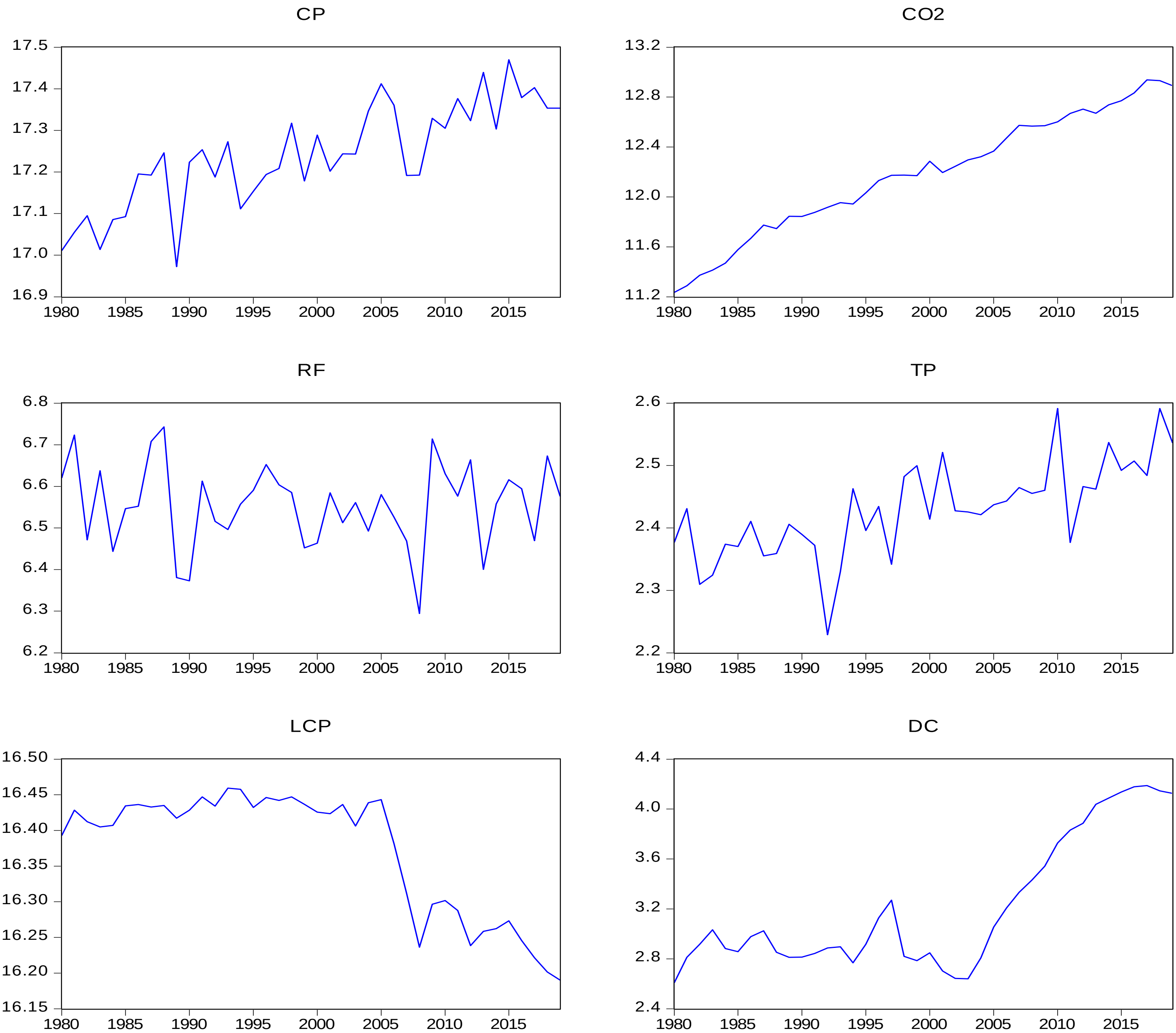

Fig. 1. The trend of variables (1980-2019)

Here, the constant term α_0 at time t is the first difference of Δ series, and u_t is the stochastic run and series. The lag length is detected via the Schwarz Information Criteria. The zero hypothesis of cointegration is $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ and the alternative hypothesis against $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$. By applying the F-test proposed by Pesaran et al. (2001) to check for the existence of a long-term relationship between the variables in the model, the calculated F-statistic is contrasted through the upper and lower boundary values. If the F-statistical value exceeds the upper value, the null hypothesis is rejected and the variables are cointegrated. However, if the F-statistical value falls below the lower value, the null hypothesis of cointegration is not rejected, indicating that there is no cointegration among the series. If the F-statistic is between these two limit values, the decision is inconclusive (Pesaran et al., 2001). In addition, to demonstrate the robustness of the ARDL boundary test approach to cointegration, autocorrelation, varying variance, normality of the error term, and model stability were used to perform graph drawing tests. A number of diagnostic tests are performed (CUSUM and CUSUMS) (Salahuddin et al., 2018).

In the third part, Canonical Cointegrating Regression (CCR), Fully Modified Least Square (FMOLS), and Dynamic Ordinary Least Square (DOLS) methods are used together with the Autoregressive Distributed Lag (ARDL) model to predict the direction or sign of the series used in the study and the long-term elasticities of series are estimated. The variables in the ARDL model become $I(0)$ and $I(1)$, while the CCR developed by Park (1992), FMOLS introduced by Stock and Watson (1993), and DOLS put forward by Philips and Hansen (1990) state that the variables should be $I(1)$ (Chandio et al., 2020; Raihan & Tuspekova, 2022).

After determining the long-term coefficients, finally, the causality linkage among the variables used in the study is examined utilizing the VECM Granger method. The ECT_{t-1} which is an error correction term is added to the classical Granger test by Engle and Granger (1987).

5. Findings and Discussion

Preliminary tests are carried out to confirm the results of the study. The first analysis is the unit root. Therefore, unit root tests are performed to determine the stationarity of variables before any operation. There are three tests to state whether the variables are stationary or not, and both the Augmented Dickey-Fuller (ADF) test, the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test, and the Ng-Perron Modified test are used to perform the unit root test on the variables examined. Table 4 reports the empirical findings of ADF, KPSS, and Ng-Perron Modified tests. Empirical results state that each of the series includes a unit root at the level. However, with the unit root tests performed by taking the first differences of the variables, it is expressed that the variables become stationary and the integration levels are $I(1)$. These findings correspond to the results of the ADF test with the findings of the KPSS and Ng-Perron Modified tests. The results confirm that the integration levels of the series are $I(1)$.

Table 4. Unit root tests.

		ADF test	KPSS test	Ng-Perron Modified test			
	Variables	Constant	Constant	MZa	MZt	MSB	MPT
Level	lnCP	-2.045	1.002	0.360	0.345	0.958	56.363
	lnCO2	-1.752	1.090	0.246	0.145	0.589	24.998
	lnRF	-1.805	0.353*	-5.685	-1.685	0.296	4.310
	lnTP	-1.797	0.935	-1.068	-0.492	0.460	14.128
	lnLCP	-0.037	0.825	0.118	0.055	0.469	17.968
	lnDC	-0.194	0.798	0.841	0.526	0.625	30.470
First difference	lnCP	-5.987***	0.076***	-1143.45***	-23.910***	0.020***	0.021***
	lnCO2	-6.641***	0.291***	-19.637***	-3.022***	0.153***	1.634***
	lnRF	-3.055**	0.437**	-10.676**	-2.271**	0.212**	2.444**
	lnTP	-7.004***	0.068***	-792.269***	-19.897***	0.025***	0.034***
	lnLCP	-4.738***	0.410**	-17.065***	-2.902***	0.170***	1.505***
	lnDC	-4.844***	0.155***	-16.204***	-2.817***	0.173***	1.619***

Source: Authors' findings. Note: *** and ** demonstrate significance at %1, and %5.

In addition, delay length criteria based on the VAR model are used to detect the available lag length for long-run relationship analysis and to predict the ARDL model. Table 5 shows the findings of all criteria for selecting the available lag length. Using the Schwarz Bayesian Criterion (SC), and the Hannan–Quinn Information Criterion (HQC), a distinct and appropriate delay sequence exists as one (1). Furthermore, the ARDL model is designed for analysis to assist in the appropriate delay sequence (1, 0, 0, 0, 1) of the detailed regressors.

Table 5. Appropriate lag length

Lag Length	LR	FPE	AIC	SIC	HQ
1	237.376*	4.98e-15	-15.934	-14.105*	-15.289*
2	50.964	4.89e-15*	-16.111	-12.715	-14.914
3	41.676	5.36e-15	-16.481*	-11.517	-14.731

Source: Authors' findings.

After checking for the stationarity of the series, the ARDL boundary test with F statistic is carried out to test the cointegration relationship in the model using the optimal lag length determined according to the VAR model. The results are stated in Table 6 and demonstrate the existence of a long-term equilibrium cointegration link among the series under consideration. According to the results in Table 6, the calculated statistical value F is 6.035, which is superior to the upper limit value at the significance level of 1%. This also rejects the null hypothesis that there exists no cointegration among the variables, proving the presence of a long-term linkage among the series. In addition, the fact that the $ECT_{(t-1)}$ is adverse and significant at 1% indicates the presence of cointegration between the variables. Thus, the findings confirm that there is a cointegration between cereal production, and banks' domestic credit, CO2 emissions, average rainfall, average temperature, and cereal production area.

After confirming cointegration with the ARDL boundary test approach in the study, the long-run elasticity of the variables is estimated. First, the findings predicted by the ARDL model in Table 7 are summarized. Table 7 shows that the coefficient of CO2 emission is 0.251 and it is statistically significant at the level of 1%. This means that a 1% increase in CO2 emissions also increases cereal production by 0.251%. In other words, it is stated that there exists a favorable linkage between climate change and grain production in Turkey in the period 1980-2019, or that the level of CO2 emissions is a stimulative for the growth of cereal production. As Kumar et al. (2021) point out, the negative impacts of climate change may be beneficial for grain production in some cases, meaning that CO2 is expected to have a stimulative impact by reducing sweating

Table 6. Cointegration test results

Panel A: *F*-Test		
Estimated Equation	F(CP/CO2, RF, TP, LCP, DC)	
Optimal Lag Structure	[1, 0, 0, 0, 0, 0]	
F-Statistic	5.892***	
$ECT_{(t-1)}$	-1.131***	
	Critical Values	
Significance level	Lower Bounds, *I*(0)	Upper Bounds, *I*(1)
1%	2.82	4.21
5%	2.14	3.34
10%	1.81	2.93

Source: Authors' findings. Note: *** and ** indicate 1% and 5% significance level, respectively.

rates and enhancing growth rates. That's because crops with increased CO2 levels can increase cereal production by using water more efficiently and effectively. This finding is in line with the outcomes of other studies (Ahsan et al., 2020; Kumar et al., 2021; Asfew & Bedemo, 2022; Abdi et al., 2023). However, this finding does not coincide with the findings of Chandio et al. (2020), who found that CO2 emissions negatively affect cereal production in the sample of Turkey using annual data for the period 1968-2014.

In the long term, the effect of average rainfall on cereal production is favorable at the level of 1%. In this case, it is suggested that the 1% increase in the average rainfall in Turkey during the period 1980-2019 stimulated a 0.093% increase in cereal production. This result, as noted in the study by Attiaoui & Boufateh (2019), appears to be the strong dependence of cereal farming on rainfall, with the best harvests recorded in the wettest years. Therefore, it indicates that a decrease in rainfall in the long term will have more harmful repercussions on cereal production. This finding of the study is in line with the finding of Pickson et al. (2020), which proved that China's average rainfall positively affects cereal production. A finding of this study is that the long-term effect of average temperature is positive and statistically significant at the level of 1%. This means that a 1% enhancement in average temperature leads to a proportional reduction of cereal production by 0.163% over the long term. In other words, there is a negative correlation between the average temperature and cereal production in Turkey in the period 1980-2019. The negative impact of the average temperature on cereal production is similar to the study findings obtained by Attiaoui & Boufateh (2019) for Tunisia during 1975-2014 and Abdi et al. (2023) for East Africa during 1990-2018.

According to the long-run findings of the ARDL model estimator, the coefficient of cereal production area is positive and statistically significant at the level of 1%. This, in turn, shows that the increase in the area of cereal production increases cereal production. In other words, it is stated that when the cereal production area in Turkey increased by 1% in the 1980-2019 period, the cereal production increased by 0.830%. Our results for the cereal production area coincide with the outcomes of Ahsan et al. (2020), Chandio et al. (2021), and Xiang & Solaymani (2022), who found that the effect of cereal cultivation area on cereal production is positive.

The long-term findings show that the elasticity of banks' domestic credit is stimulative and statistically significant at the level of 1%. This, in turn, demonstrates that the enhancement in the banks' domestic credit increases cereal production. In other words, this means that when the banks' domestic credit in Turkey increased by 1% in the 1980-2019 period, the cereal produced increased by 0.110%. Our results are in line with the findings of Shahbaz et al. (2013) and Tiryaki and Göker (2021), who reveals that the effect of banks' domestic credit on cereal production is positive. Table 7 also reports the results of diagnostic tests resulting from the ARDL estimator. The Breusch-Godfrey LM test confirms that there is no autocorrelation, while the ARCH LM test states that there is no problem of varying variance. In addition, the normality test results indicate that there is no normal distribution problem. Figure 2 shows the stability of the long-term forecasts confirmed by CUSUM and the CUSUM of Squares chart. In other words, it states that the estimated coefficients are between the upper and lower critical limits at the 5% significance level.

Table 7. ARDL Long-run results

Variables	Coefficient	*t*-statistics
lnCO2	0.251	36.126***
lnRF	0.093	3.978***
lnTP	-0.163	-6.146***
lnLCP	0.830	96.689***
lnDC	0.110	31.441***
Diagnostic Tests		
R^2	0.513	
Adj. R^2	0.439	
Breusch-Godfrey LM Test[a]	0.431 (0.653)	
Breusch-Pagan-Godfrey Test[b]	1.746 (0.142)	
Ramsey Reset	0.005(0.944)	
J-B Normality Test[c]	2.270 (0.321)	

Source: Authors' findings. [a], [b], [c] state autocorrelation, heteroscedasticity, and normality test. *** and ** show 1% and 5% significance level.

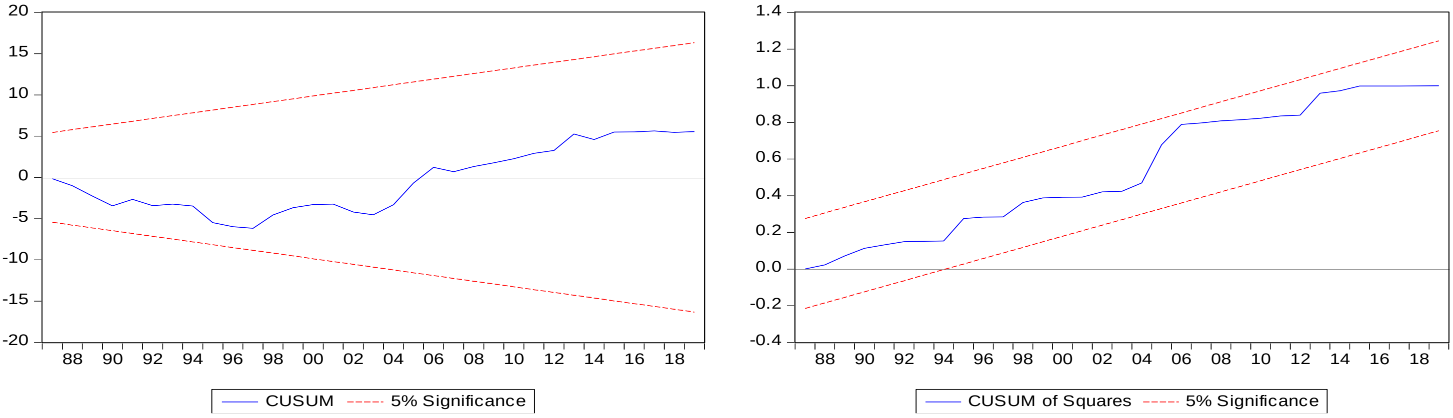

Fig.2. CUSUM and CUSUM²

In order to check the findings of long-run, CCR, FMOLS, and DOLS methods are performed in addition to the ARDL model. The findings of the FMOLS, CCR, and DOLS estimators are summarized in Table 8 and are similar to the long-run results of the ARDL approach to cereal production of each variable given in Table 7. This tells us that in the period 1980-2019, banks' domestic credit, CO2 emissions, rain amount, and cereal production area in Turkey have a positive relationship and temperature prevents cereal production.

Table 8. Robustness check

Methods	FMOLS		DOLS		CCR	
Variable	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics
C					0.174	0.080
lnCO2	0.246	14.719***	0.260	57.311***	0.249	15.649***
lnRF	0.111	2.566***	0.027	1.846***	0.104	1.920***
lnTP	-0.197	-2.634***	-0.233	-9.557***	-0.220	-2.321***
lnLCP	0.831	41.894***	0.859	129.329***	0.825	6.245***
lnDC	0.113	7.856***	0.122	32.835***	0.112	4.833***
Diagnostic Test Results						
R^2	0.740		0.784		0.741	
Adj. R^2	0.710		0.717		0.702	
SE of Regression	0.064		0.063		0.064	
SSR	0.139		0.115		0.138	

Source: Authors' findings. Note: *** state 1% significance level.

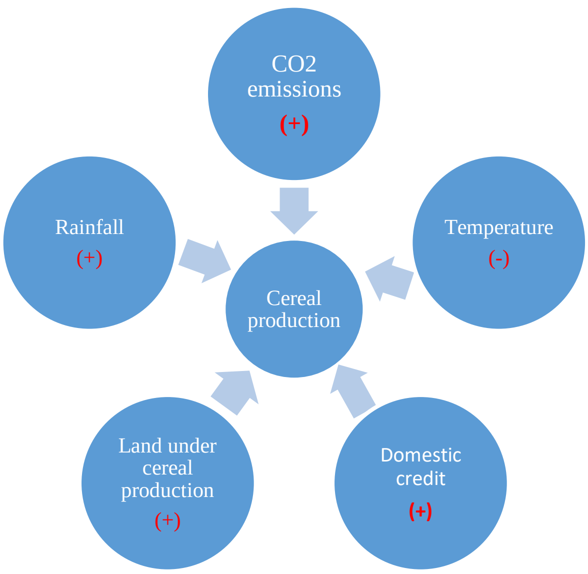

Fig. 3. The summary of long-run tests

The long-term relationship implies that there is at least one causality between the variables. In this study, the VECM Granger causality test is used to investigate the direction and validity of the causality relationship among independent variables and grain production. The findings of the test are summarized in Table 9. In this study, it is obtained that CO2 is the cause of grain production in the short run. At the same time, the findings indicate a bidirectional causality between CO2 emissions and cereal production in Turkey in the long term. This finding of the study is in line with the finding of Xiang and Solaymani (2022), who found that there is causality from Malaysia's CO2 emissions to grain production and from cereal production to CO2 emissions using the Toda Yamamoto test. The findings of Koondhar et al. (2021) and Chandio et al. (2022) also support the conclusion of the study. The causality findings reveal that both the average precipitation amount is the cause of the cereal production and the cereal production is the cause of the precipitation amount at the 1% significance level in the long run. However, Attiaoui and Boufateh (2019) prove that there exists unidirectional causality spanning from average precipitation to cereal production for Tunisia during the 1975-2014 period.

In addition, the findings indicate a bidirectional causality between CO2 emissions and cereal production in Turkey in the long term. This finding of the study is in line with the finding of Xiang and Solaymani (2022), who found that Malaysia casualized from CO2 emissions to cereal production and from cereal production to CO2 emissions using the Toda Yamamoto causality test. The findings of Koondhar et al. (2021) and Chandio et al. (2022) also support this conclusion of the study. At the same time, it is seen in Table 9 that there exists a long-term bidirectional causality at the significance level of 1% from the average temperature to cereal production and from cereal production to the average temperature in Turkey and that the average temperature is also the cause of cereal production in the short term. Similarly, Kumar et al. (2021) reveal a bidirectional causality between the average temperature of 11 low-middle-income countries and cereal production over the period 1971-2016. Thus, there appears to be a bidirectional causality between cereal production and climate change, which includes indicators of CO2 emissions, rainfall, and temperature. The causality findings demonstrate that there is a causality both from banks' domestic credit to cereal production, and cereal production to banks' domestic credit causality at the significance level of 1% in Turkey. But Chandio et al. (2021) reveal that banks' domestic credit as a financial sector development indicator is the cause of the cereal production in Pakistan. Finally, according to the VECM Granger causality finding in Table 9, it is obtained that there is a unidirectional causality spanning from cereal production land in Turkey to cereal production in the long term. Our finding is in line with the findings of Chandio et al. (2023) for four ASEAN countries over the period 1991-2018.

6. Conclusion

The purpose of the study is to search the relationship among climate change, banks' domestic credit, and cereal production in the period 1980-2019 in Turkey, including CO2 emissions, average precipitation, and average temperature variables. In the study, firstly, KPSS, ADF, and Ng-Perron tests are used to evaluate the variables. In the second stage, the cointegration among variables is examined by the ARDL boundary test. In the third stage, CCR, FMOLS, and DOLS methods are used in conjunction with the ARDL estimator to determine the long-term elasticity of the independent variables. In the final stage, the VECM approach is used to examine the causality between independent variables and cereal production.

Table 9. VECM Granger test

Dep. Variable	Independent Variables Short-run *F*-statistics(p-value)						LR t-statistics (p-value)
	ΔlnCP	ΔlnCO2	ΔlnRF	ΔlnTP	ΔlnLCP	ΔlnDC	ECT_{t-1}
ΔlnCP	-	-0.550	-0.577	0.410	0.618	1.146	-3.142***
		(0.586)	(0.567)	(0.684)	(0.540)	(0.260)	(0.003)
ΔlnCO2	-1.841*	-	-0.269	-0.748	1.131	1.090	-2.319**
	(0.075)		(0.789)	(0.460)	(0.266)	(0.284)	(0.027)
ΔlnRF	0.915	-0.203	-	-2.297**	-0.962	0.284	-5.564***
	(0.367)	(0.840)		(0.028)	(0.343)	(0.777)	(0.000)
ΔlnTP	2.170**	0.697	-1.252	-	0.617	-1.303	-4.622***
	(0.038)	(0.491)	(0.220)		(0.541)	(0.202)	(0.000)
ΔlnLCP	-0.033	-0.696	-0.850	0.162	-	-0.281	-1.125
	(0.973)	(0.491)	(0.401)	(0.872)		(0.780)	(0.269)
ΔlnDC	-0.209	0.813	-0.922	1.964*	0.857	-	-
	(0.835)	(0.422)	(0.363)	(0.058)	(0.398)		2.987***
							(0.005)

Source: Authors' findings. Note: ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

Empirical findings in the study determined that the variables are cointegrated at the *I*(1) level and that there is a long-term relationship between cereal production and banks' domestic credit, CO2, average precipitation, average temperature, and cereal production area. In addition it is concluded that banks' domestic credit, CO_2 emissions, average precipitation and increase in cereal production area also stimulate cereal production in Turkey and that the average temperature increase also reduces cereal production. According to the latest finding, CO_2 emissions, average precipitation, and average temperature are the cause of grain production, and grain production is the cause of climate change, which includes CO_2, average precipitation, and average temperature indicators. There is also a unidirectional causality that extends from grain production field to the grain production. In addition to these findings, as a result of the examinations, it is stated that there is a bidirectional relationship between the banks' domestic credit and grain production.

The findings from the study offer important advice for policymakers, agronomists, and economists alike. As Chandio et al. (2020) and Chandio et al. (2022) point out in their study, they should make long-term plans against temperature effects in the long term, primarily because temperature adversely affects cereal production in the long term. Therefore, planning the frequency of irrigation, the types of fertilizer to be used and the selection of the type of seed can be ensured to prevent the long-term negative effects of temperature. Secondly, new reforms should be made by the state to increase the production areas so that cereal production can be increased. Finally, according to the study of Grivins et al. (2023), reaching finance is important for farmers to improve competitiveness and farmers can access funds, which helps them stay profitable and integrate sustainable farming practices.

In addition, the study has some limitations and these limitations present suggestions for further studies. First of all, in this study, the relationship between banks' domestic credit, climate change, and cereal production are tested. But future studies may also test the impact of the financial sector on cereal production for different countries. Secondly, in this study, while empirical analysis and evaluation of cereal production is made and evaluated only based on Turkey, this issue can be examined by considering the group of countries formed by more than one country (such as OECD countries, G7 countries, developing countries, developed countries group) in future studies. Third, variables such as CO_2 emissions, rainfall, and temperature are added to this study model as indicators of climate change, but future studies may examine the issue based on different climate change indicators. Finally, the ARDL model is utilized in this study. But the new methods such as the NARDL method can be applied in the future studies

Data availability: The datasets generated and analyzed during the current study are available in the World Bank Indicator, World Intellectual Property Organization repository.
Conflicts of Interest: The authors declare no conflict of interest.
Compliance with ethical standards
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References

Acharya, S.P., & Bhatta, G.R. (2013). Impact of Climate Change on Agricultural Growth in Nepal. NRB Economic Review, 25(2), 1-16.

Abdi, A. H., Warsame, A.A., & Sheik-Ali, I.A. (2023). Modelling the impacts of climate change on cereal crop production in East Africa: evidence from heterogeneous panel cointegration analysis. Environ Sci Pollut Res Int., 30(12), 35246-35257. doi: 10.1007/s11356-022-24773-0.

Adam, C., & Drakos, P. (2022). Climate change: north and south EU economies—an application of dynamic asymmetric panel data models. Environmental Science and Pollution Research, 29(46), 70573-70590.

Adzawla, W., Sawaneh, M., & Yusuf, A. M. (2019). Greenhouse gasses emission and economic growth nexus of sub-Saharan Africa. Scientific African, 3: e00065. https://doi.org/10.1016/j.sciaf.2019.e00065

Ahsan, F., Chandio, A. A., & Fang, W. (2020). Climate change impacts on cereal crops production in Pakistan: evidence from cointegration analysis. International Journal of Climate Change Strategies and Management, 12(2), 257-269.

Alagidede, P., Adu, G., & Frimpong, P. B. (2016). The effect of climate change on economic growth: evidence from Sub-Saharan Africa. Environmental Economics and Policy Studies, 18, 417-436.

Ali, U., Jing, W., Zhu, J., Omarkhanova, Z., Fahad, S., Nurgazina, Z., & Khan, Z. A. (2021). Climate change ımpacts on agriculture sector: A case study of Pakistan. Ciência Rural, 51.

Asfew, M., & Bedemo, A. (2022). Impact of Climate Change on Cereal Crops Production in Ethiopia. Hindawi Advances in Agriculture, 2208694, 1-8. https://doi.org/10.1155/2022/2208694

Attiaoui, I., & Boufateh, T. (2019). Impacts of climate change on cereal farming in Tunisia: a panel ARDL–PMG approach. Environmental Science and Pollution Research, 26, 13334-13345.

Bayraç H. N. & Doğan E. (2016). Türkiye'nin İklim Değişikliği: Tarım Sektörüne Etkileri. Eskişehir Osmangazi Üniversitesi İİBF Dergisi, 11(1), 23-48.

Calzadilla, A., Rehdanz, K., Betts, R., Falloon, P., Wiltshire, A., & Tol, R. S. (2013). Climate Change Impacts on Global Agriculture. Climatic change, 120, 357-374.

Chandio, A. A., Jiang, Y., Abbas, Q., Amin, A., & Mohsin, M. (2022). Does Financial Development Enhance Agricultural Production in the Long-Run? Evidence From China. Journal of Public Affairs, 22(2), e2342.

Castro, N. R., Spolador, H. F. S., & Marin, F. R. (2020). Assessing the economy–climate relationships for Brazilian agriculture. Empirical Economics, 59(3), 1161-1188.

Chandio, A. A., Gokmenoglu, K. K., Sethi, N., Ozdemir, D., & Jiang, Y. (2023). Examining the impacts of technological advancement on cereal production in ASEAN countries: Does information and communication technology matter?. European Journal of Agronomy, 144, 126747.

Chandio, A. A., Jiang, Y., Akram, W., Adeel, S., Irfan, M., & Jan, I. (2021). Addressing the effect of climate change in the framework of financial and technological development on cereal production in Pakistan. Journal of Cleaner Production, 288, 125637.

Chandio, A. A., Jiang, Y., Fatima, T., Ahmad, F., Ahmad, M., & Li, J. (2022). Assessing the impacts of climate change on cereal production in Bangladesh: evidence from ARDL modeling approach. International Journal of Climate Change Strategies and Management.

Chandio, A. A., Ozturk, I., Akram, W., Ahmad, F., & Mirani, A.A. (2020). Empirical analysis of climate change factors affecting cereal yield: evidence from Turkey. Environmental Science and Pollution Research, 27, 11944-11957. https://doi.org/10.1007/s11356-020-07739-y

Çaltı, N., & Somuncu, M. (2019). İklim Değişikliğinin Türkiye'de Tarım Üzerindeki Etkisi ve Çiftçilerin İklim Değişikliğine Yönelik Tutumları. 1. İstanbul Uluslararası Coğrafya Kongresi Bildiri Kitabı, 20-22 Haziran, İstanbul. http://dx.doi.org/10.26650/PB/PS12.2019.002.084

Dickey, D.A., & Fuller, W.A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica, 49(4), 1057-1072.

Engle, R.F., & Granger, C.W.J. (1987), Cointegration and error correction: representation, estimation, and testing. Econometrica, 55, 251-276.

Ertuğrul, H. M., & Soytaş, U. (2013). Sanayi Üretim Endeksinin Durağanlık Özellikleri. İktisat, İşletme ve Finans, 328(28), 51-66. http://dx.doi.org/10.3848/iif.2013.328.3751

Grivins, M., Thorsøe, M. H., & Maye, D. (2021). Financial subjectivities in the agricultural sector: A comparative analysis of relations between farmers and banks in Latvia, Denmark and the UK. Journal of Rural Studies, 86, 117-126.

Hayaloğlu, P. (2018). İklim Değişikliğinin Tarım Sektörü ve Ekonomik Büyüme Üzerindeki Etkileri. Gümüşhane Üni. S.B.D., 9(25), 51-62.

İrdem, C. (2022). Türkiye Buğday Verimindeki Değişimlerin Sıcaklık ve Yağış Koşulları ile İlişkileri. Turkish Studies - Social, 17(3), 377-392.

Jatuporn, C., & Takeuchi, K. (2023). Assessing the impact of climate change on the agricultural economy in Thailand: An empirical study using panel data analysis. Environmental Science and Pollution Research, 30(3), 8123-8132.

Kaya, H. E. (2020). Kyoto'dan Paris'e Küresel İklim Politikaları. Meriç Uluslararası Sosyal ve Stratejik Araştırmalar Dergisi, 4(10), 165-191.

Keskin, A., & Kanat, Z. (2018). Dünyada İklim Değişikliği Üzerine Yapılan Çalışmalar ve Türkiye'de Mevcut Durum. Atatürk Üniversitesi Ziraat Fakültesi Dergisi, 49(1), 67-77.

Koç, G., Uzmay, A., & Çukur, F., (2016). İklim Değişikliği ve Hayvancılık Sektörü İlişkisinin Dünya'da ve Türkiye'de Tarım Ekonomisi Açısından Değerlendirilmesi, XII. Tarım Ekonomisi Kongresi, 25-27 Mayıs 2016, Isparta.

Koday, Z. (2000). Türkiye'nin Tahıl Üretimi. Türk Coğrafya Dergisi, 35, 299-320.

Koondhar, M. A., Aziz, N., Tan, Z., Yang, S., Abbasi, K. R., & Kong, R. (2021). Green growth of cereal food production under the constraints of agricultural carbon emissions: A new insights from ARDL and VECM models. Sustainable Energy Technologies and Assessments, 47, 101452. https://doi.org/10.1016/j.seta.2021.101452

Köse, İ. (2018). İklim değişikliği müzakereleri: Türkiye'nin Paris Anlaşması'nı imza süreci. Ege Stratejik Araştırmalar Dergisi, 9(1), 55-81. http://dx.doi.org/10.18354/esam.329348

Kumar, P., Sahu, N. C., Kumar, S., & Ansari, M. A. (2021). Impact of climate change on cereal production: evidence from lower-middle-income countries. Environmental Science and Pollution Research, 28, 51597-51611. https://doi.org/10.1007/s11356-021-14373-9

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that the economic time series have a unit root?. Journal of Econometrics, 54(1992), 159-178. https://doi.org/10.1016/0304-4076(92)90104-Y

Lee, J., Nadolnyak, D. A., & Hartarska, V. M. (2012). Impact of Climate Change on Agricultural Production in Asian Countries: Evidence From Panel Study. Research in Agricultural & Applied Economics, (No. 1372-2016-109059). DOI: 10.22004/ag.econ.119808

Loum A., & Fogarassy C. (2015). The Effects of Climate Change on Cereals Yield of Production and Food Security in Gambia. Applied Studies in Agribusiness and Commerce, 9(4), 83-92.

Ng, S., & Perron, P. (2001). Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. Econometrica, 69, 1519-1554.

Özçatalbaş, O. (2014). Küresel İklim Değişikliğinin Tarım Yayımı ve Politikaları Üzerine Olası Etkileri, Ulusal Aile Çiftçiliği Sempozyumu, 30-31 Ekim 2014, Ankara.

Park, J.Y. (1992). Canonical cointegrating regressions. Econometrica, 60(1), 119-143.

Pesaran M.H., Shin, Y., & Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16, 289-326.

Phillips, P., & Hansen, B. (1990) Statistical Inference in Instrumental Variables Regression with I(1) Processes. Review of Economic Studies, 57, 99-125. http://dx.doi.org/10.2307/2297545

Pickson, R. B., He, G., Ntiamoah, E. B., & Li, C. (2020). Cereal production in the presence of climate change in China. Environmental science and pollution research, 27, 45802-45813.

Raifu, I.A., & Aminu, A. (2020). Financial Development and Agricultural Performance in Nigeria: What Role do Institutions Play?. Agricultural Finance Review, 80(2), 231-254. https://doi.org/10.1108/AFR-06-2018-0045.

Raihan, A., & Tuspekova, A. (2022). Nexus between economic growth, energy use, agricultural productivity, and carbon dioxide emissions: new evidence from Nepal. Energy Nexus, 7. https://doi.org/10.1016/j.nexus.2022.100113

Rehman, A., Ma, H., Ahmad, M., Ozturk, I., & Chishti, M. Z. (2021). How do climatic change, cereal crops and livestock production interact with carbon emissions? Updated evidence from China. Environmental Science and Pollution Research, 28, 30702-30713.

Salahuddin, M., Alam, K., Ozturk, I., & Sohag, K. (2018). The effects of electricity consumption, economic growth, financial development and foreign direct investment on CO2 emissions in Kuwait. Renewable and sustainable energy reviews, 81, 2002-2010. ttp://dx.doi.org/10.1016/j.rser.2017.06.009

Shahbaz, M., Shahbaz Shabbir, M., & Sabihuddin Butt, M. (2013). Effect of financial development on agricultural growth in Pakistan: New extensions from bounds test to level relationships and Granger causality tests. International Journal of Social Economics, 40(8), 707-728. https://doi.org/10.1108/IJSE-01-2012-0002

Shahbaz, M., Çetin, M., Avcı, P., Sarıgül, S. S., & Topcu, B. A. (2023). The Impact of ICT on Financial Sector Development Under Structural Break: An Empirical Analysis of the Turkish Economy. Global Business Review, 09721509221143632.

Stock, J.H., & Watson, M.W. (1993). A simple estimator for cointegrating vectors in higher order int. systems. Econometrica, 4, 783-820.

TAGEM (2000). İklim Değişikliklerinin Tarım Üzerindeki Etkileri. Tarım ve Köy İşleri Bakanlığı Koruma ve Kontrol Genel Müdürlüğü İklim Değişikliklerinin Tarım Üzerindeki Etkileri Paneli, Ankara.

Talu, N. (2015). Türkiye'de İklim Değişikliği Siyaseti. Phoenix Yayınevi.

Tiryaki, M., & Göker, İ. E. K. (2021). Türkiye'de tarım sektörünün finansal yapısı ve tarımın finansmanı üzerine bir çalışma: Alternatif bir finansman yöntemi olarak Selem sözleşmeleri. İktisadi İdari ve Siyasal Araştırmalar Dergisi, 6(14), 1-18.

TÜİK, (2022). Bitkisel Üretim İstatistikleri, 2022. https://data.tuik.gov.tr/Bulten/Index?p=Bitkisel-Uretim-Istatistikleri-2022-45504#:~:text=Tah%C4%B1l%20%C3%BCretimi%202022%20y%C4%B1l%C4%B1nda%20bir,7%20milyon%20ton%20olarak%20ger%C3%A7ekle%C5%9Fti.

Türkeş M., (2008). Küresel iklim değişikliği nedir? Temel kavramlar, Nedenleri, Gözlenen ve Öngörülen Değişiklikler, İklim Değişikliği ve Çevre, 1: 26-37.

Xiang, X., & Solaymani, S. (2022). Change in cereal production caused by climate change in Malaysia. Ecological Informatics, 70, 101741. https://doi.org/10.1016/j.ecoinf.2022.101741

Yalçınkaya, H. (2018). Tarım Kredilerinin Ekonomiye Olan Etkisinin Granger Nedensellik Analizi ile Tespiti. Bilgi Ekonomisi ve Yönetimi Dergisi, 13(1): 51-61.

Zakaria, M., Jun, W., & Khan, M. F. (2019). Impact of financial development on agricultural productivity in South Asia. Agricultural Economics, 65(5), 232-239.

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