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ESTIMATE OF STRUCTURAL FRACTURES IN WHEAT CULTURE AND PRODUCTION IN TÜRKİYE BY ECONOMETRIC ANALYSIS

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Abstract: This study, it was aimed to determine the amount of wheat fields planted in Türkiye and the structural breaks in wheat yield in the specified years. The data set obtained for this purpose was obtained from the wheat production and wheat cultivation area in the statistical tables between 1995 and 2020 published by the Turkish Grain Board (TMO). According to the estimation results; the data set obtained from the wheat planting area in the statistical tables between 1995 and 2020 was stabilized by taking the first differences and the red lines in the given table were left from the second half of 2005 to the beginning of 2014, there was a structural break between these years. It was determined by the analysis that there was a structural break between these years, since the data set was stabilized by taking the first differences and the red lines in the given chart were exceeded from the second half of 2005 to the beginning of 2015.

Keywords: Wheat, Wheat yield, Cultivation area, Years, Econometric program

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1. Introduction

Wheat has been among the most basic food sources since the existence of human life. The history of collecting itself and accompanying grains from nature dates to approximately 17,000 BC (Tanno and Willcox, 2006). It is also known that the first domestic use of wheat was in the southeast of Türkiye (Diamond, 2006). Although it is possible to come across various types of wheat in our age, three main groups are that are most commonly used. These are defined as bread wheat, biscuit and wheat (Kurt, 2012).

Production amounts of countries or regions vary due to changes in climatic conditions. The fact that some countries need more than they can produce affects the wheat trade. Wheat is produced in almost every part of the world and Türkiye; it is a very important grain product because it both affects the large producer mass and is a basic food source. In terms of production, it affects almost 4 million businesses, that is, about 15 million people, and the entire population of Türkiye in terms of consumption (TMO, 2021). For these reasons, developments in wheat production technology in the world are followed closely and tried to be applied in Türkiye. However, despite the high diversity in Türkiye, the appropriate variety was standard in wheat, yield and quality problems were not exactly a suitable solution. The fact that the production is spread over a very wide area, production even in dry conditions reduces the amount of production obtained in general.

Grain is cultivated in an area of 11.13 million hectares in Türkiye. Wheat comes first with 62% of the grain cultivation area (TMO, 2021).

In wheat production in Türkiye, the yield is low since mostly dry cultivation areas are used. In addition to wheat cultivation in some regions, there is almost no other crop cultivation (Anonymous, 2001).

This study, it was aimed to determine the amount of wheat fields planted in Türkiye and the structural breaks in wheat yield in the specified years.

2. Materials and Methods

The data set in this study was obtained from the wheat production and wheat cultivation area in the statistical tables between 1995 and 2020 published by the Turkish Grain Board (TMO, 2021). In Table 1. Wheat cultivation area and wheat yield are given by years.

In this research, unit root tests were used to make the time series stationary in the given data set. If there is a unit root, the time series is not stationary. Dickey-Fuller (DF) and Argumented Dickey-Fuller (ADF) tests, which are used to detect the presence of a unit root, are the most well-known methods (Dickey and Fuller, 1979; 1981).

The relationship of the variable γ_t with its value one period ago is formulated as given in Equation 1.

Table 1. Wheat cultivation area and wheat yield by years

Years	Wheat Plantation Area (HA)	Wheat Yield (Tons)	Years	Wheat Plantation Area (HA)	Wheat Yield (Tons)
1995	9.400.000	18.000.000	2008	8.090.000	17.782.000
1996	9.350.000	18.500.000	2009	8.100.000	20.600.000
1997	9.340.000	18.650.000	2010	8.103.400	19.674.000
1998	9.400.000	21.000.000	2011	8.096.000	21.800.000
1999	9.380.000	18.000.000	2012	7.529.639	20.100.000
2000	9.400.000	21.000.000	2013	7.772.600	22.050.000
2001	9.350.000	19.000.000	2014	7.919.208	19.000.000
2002	9.300.000	19.500.000	2015	7.866.887	22.600.000
2003	9.100.000	19.000.000	2016	7.671.945	20.600.000
2004	9.300.000	21.000.000	2017	7.668.879	21.500.000
2005	9.250.000	21.500.000	2018	7.299.270	20.000.000
2006	8.490.000	20.010.000	2019	6.846.327	19.000.000
2007	8.100.000	17.234.000	2020	6.922.236	20.500.000

$$\gamma_t = \beta\gamma_{t-1} + u_t \quad (1)$$

The hypotheses are based on the model;

$H_0 = \beta = 1$ (the series contains a unit root, the series is not stationary).

$H_1 = \beta < 1$ (there is no unit root in the series, the series is stationary).

Here, u_t has independent identically distributed (iid) constant variance and zero means.

The error term with these properties is called white noise and the equation is shown as given in Equation 2.

$$u_t \approx \text{iid}(0, \sigma^2) \quad (2)$$

If $\beta = 1$, the series is under the influence of its value one period ago and random shocks.

It can be said that the series contains a unit root. If $\beta < 1$, the effect of γ_{t-1} on γ_t will gradually decrease depending on the value of β.

Here, the 'τ' (tau) statistic, which emerged in Dickey-Fuller's Monte Carlo application, is used. If the absolute value of the τ statistic exceeds the absolute value of the Dickey-Fuller critical value, the hypothesis that the time series is stationary is accepted and the Dickey-Fuller test is generally applied to the following regression patterns:

1) Dickey-Fuller equation with no constant term and no trend (Equation 3):

$$\Delta\gamma_t = \delta\gamma_{t-1} + u_t \quad (3)$$

2) Dickey-Fuller equation with constant term and no trend (Equation 4):

$$\Delta\gamma_t = \beta_0 + \delta\gamma_{t-1} + u_t \quad (4)$$

3) Dickey-Fuller equation with constant term and trend (Equation 5):

$$\Delta\gamma_t = \beta_0 + \beta_1 t + \delta\gamma_{t-1} + u_t \quad (5)$$

As a result of the Dickey-Fuller test, if the stationarity of the series is not mentioned, it is retested by taking the difference of the dependent variable. If the series becomes stationary as a result of the first difference operation, the first difference is said to be stationary. If the series does not become stationary as a result of the first difference, the second difference of the series is tested and continued. The series that becomes stationary at this stage is called second-order difference stationary. It is continued in this way for further difference taking operations. However, since the interpretation of the coefficients will be difficult and the degree of freedom will decrease, in practice, the difference is usually stopped after the second difference (Dickey and Fuller, 1979; Dickey and Fuller, 1981). In case of autocorrelation in the estimated regressions, the DF test results are invalid. An extended DF test is applied to fix this problem. Simply put, the lagged values of the dependent variable are to the right of the equation. The equations to be estimated in the ADF test are as follows.

$\Delta\gamma_t = \delta Y_{t-1} + \sum_{j=1}^{k} \alpha\Delta Y_{t-j} + u_t$ (without a fixed term)

$\Delta\gamma_t = \beta_0 + \delta Y_{t-1} + \sum_{j=1}^{k} \alpha\Delta Y_{t-j} + u_t$ (constant term)

$\Delta\gamma_t = \beta_0 + \delta Y_{t-1} + \sum_{j=1}^{k} \alpha\Delta Y_{t-j}\ \alpha_t + u_t$ (constant term and trend variable added)

$H_0 = \delta = 0$ If there is a unit root in the series, the series is not stationary.

$H_1 = \delta < 0$ on the other hand, there is no unit root in the series and the series is stationary (Dickey and Fuller, 1981).

Afterward, Cusum of Squares test, which is an econometric program, was used to determine structural breaks. The Cusum of Squaraes test is a way of using squares of consecutive residuals (Equation 6).

$$S_t = \frac{\sum_{s=1}^{n} w_s^2}{\sum_{s=k+1}^{n} w_t^2} \qquad t=k+1, k+2, \dots, n \quad (6)$$

S_t graphed after its value is calculated. The expected value of this test (Equation 7),

$$E(S_t) \cong \frac{t-k}{n-k} \quad (7)$$

is calculated as. The expected value is 0 when t=k is present, and 1 when t=n is present. Confidence level limits are $E(S_t) \pm C_0'$. This value can be obtained with α margin of error, n number of observation values and k number of parameters. C_0 value is obtained with m and α values as well as the tables that can be created in case the analysis is double or unilateral. α for one-sided analysis; C_0 value is obtained by using α/2 for bilateral analysis. If the n-k value for analysis is an odd number (Equation 8),

$$m = \frac{1}{2}(n-k) - 1 \quad (8)$$

form is obtained. If n-k is an even number (Equation 9-10),

$$m = \frac{1}{2}(n-k) - \frac{3}{2} \quad (9)$$

$$m = \frac{1}{2}(n-k) - \frac{1}{2} \quad (10)$$

estimation must be made. Then, the Cusum of Squares graph is obtained by drawing the lower and upper limits with the values determined from the table. If the graph is outside the limits of the determined confidence level, it is decided that there is a structural break, and if it stays within the limits of the determined confidence level, there is no structural break (Brown et al., 1975).

3. Results

This study, it was aimed to determine the amount of wheat fields planted in Türkiye and the structural breaks in wheat yield in the specified years. For this purpose, data were obtained from the wheat production and wheat cultivation area in the statistical tables between 1995 and 2020 published by the Turkish Grain Board (TMO, 2021). In the research, the data set was stabilized using Argumented Dickey Fuller method and analysis was made with the help the Cusum of Squares method.

According to the results of the research, the series is stationary because the probability value of the wheat planted area is less than 0.05, and at the same time, the Argument Dickey-Fuller test statistic is 9.630941 in the absolute value, and the series is stationary when the absolute values of the crystal test values are greater than 9.389762. In addition, since the probability value of wheat yield is less than 0.05, the series is stationary, and at the same time, the Argument Dickey-Fuller test statistic 9.633309 value within the absolute value of the crystal test values is determined to be stationary when the sum of the absolute values of the crystal test values is 9.365273.

In the data set obtained by years from the wheat cultivation area in the statistical tables between 1995 and 2020, published by the Turkish Grain Board (TMO, 2021), it is seen that there is a structural break between these years, since the red lines in the given table are gone from the second half of 2005 to the beginning of 2014. In the data set obtained from the wheat yield and wheat yield by years, it was determined by the analysis that there was a structural break between these years, as the red lines in the given table were exceeded from the second half of 2005 to the beginning of 2015.

In order to obtain better results in the data set obtained from the wheat production and wheat cultivation area in the statistical tables between 1995 and 2020, published by the Turkish Grain Board (TMO, 2021), it is necessary to keep the number of observations in the data set wider, to determine the economic and climatic conditions in the selected years. It should be taken into account that changes should not be ignored and the decrease in efficiency due to natural events and global warming that has occurred in Türkiye in recent years. In order to avoid these and similar problems in future articles or thesis research, the deficiencies mentioned should not be ignored.

4. Discussion and Conclusion

The data set in this study was obtained from the wheat production and wheat cultivation area in the statistical tables between 1995 and 2020 published by the Turkish Grain Board (TMO, 2021). In the obtained data set, as a first step, the stationarity of the series was tested with the help of The Argumented Dickey Fuller (ADF) method.

In Table 2, the first differences were taken with the help of the unit root test and the data set of the cultivated area was made stationary.

In Table 3, the first differences were taken with the help of the unit root test and the data set of wheat yield was made stationary.

The years of structural breaks between the wheat field planted and the amount of production received according to the years were tested with the help of the econometric program Cusum Square.

Table 2. Unit root test result of wheat planted area

		Level		First Difference	
		t- statistics	Probability	t- statistics	Probability
ADF		-0.004695	0.9495	-9.630941	0.0026
	%1	-3.724070		-3.752946	
	%5	-2.986225		-2.998064	
	%10	-2.632604		-2.638752	

Table 3. Wheat yield unit root test result

		Level		First Difference	
		t- statistics	Probability	t- statistics	Probability
ADF		-4.790087	0.0620	-9.633309	0.0000
	%1	-3.724070		-3.737853	
	%5	-2.986225		-2.991878	
	%10	-2.632604		-2.635542	

In the data set obtained from the wheat cultivation area according to the years in the statistical tables between 1995 and 2020 published by the Turkish Grain Board (TMO, 2021) in Figure 1 and Figure 2. It was determined by the analysis that there was a structural break between them.

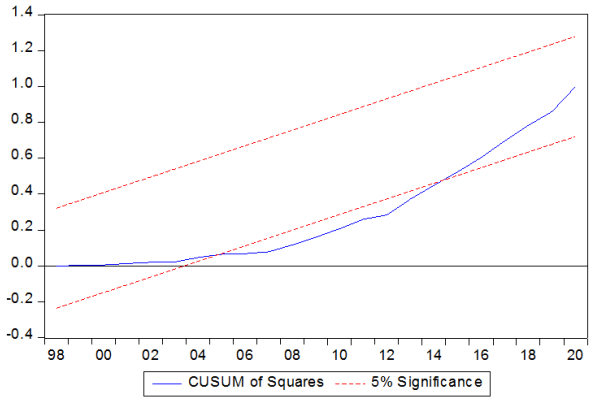

Figure 1. Test of wheat planted area of Cusum of Squares.

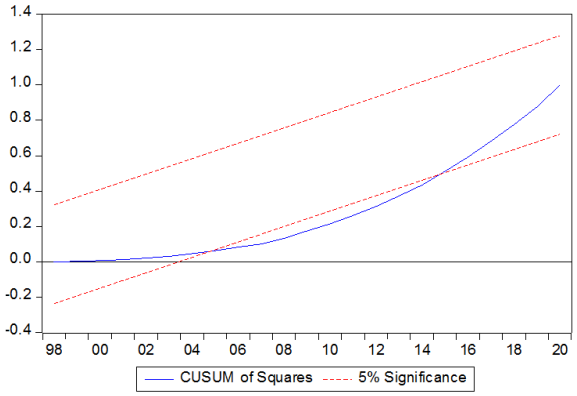

Figure 2. Wheat yield test of Cusum of Squares.

The data set obtained from the wheat yield in the statistical tables between 1995 and 2020 published by the Turkish Grain Board (TMO, 2021) in Table 3. It was determined by the analysis that there was a structural break.

In a study, the negative effects on the pasta industry were investigated. As a result of the research, it has been determined that solving the problems such as raw material problem in the sector, low consumption, marketing problems and insufficient support will increase the competitiveness of the sector and help its development (Turhan, 2008). In a study, it was concluded that there has not been a certain increase in wheat production in the last two decades in developed countries and that developing countries have to make up for this deficiency (Atar, 2017). In a study, it was concluded that irrigation and fertilizer amounts affect productivity in Hatay, and the age of the producer in Şanlıurfa in addition to Hatay province (Tiryakioğlu et al., 2017). In a study, it was concluded that the progress in wheat production in Türkiye lags behind the world average and population growth rate (Duru et al., 2019). In a study, it was concluded that when it comes to adequacy in agricultural production, it started to decrease as of 1990 and it started to become dependent on foreign sources in the 2000s (Çetin, 2020). In a study, it was concluded that there is a moderate relationship in the ARDL limit test applied to the effect of climate change on honey yield in Türkiye (Duru and Parlakay, 2021). In a study conducted to examine the relationship between onion production and its price in Türkiye, it was concluded that there is a long-term relationship between onion production and price (Gümüşsoy, 2021). The difference between this researches from the studies in the literature is the determination of the amount of wheat field planted by years and the structural breaks in wheat yield in Türkiye.

Author Contributions

The percentage of the author(s) contributions is present below. All authors reviewed and approved final version of the manuscript.

	İ.G.	M.Ş.
C	50	50
D	50	50
S	50	50
DCP	50	50
DAI	50	50
L	50	50
W	50	50
CR	50	50
SR	50	50
PM	50	50
FA	50	50

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

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