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DYNAMICS OF WHEAT PRODUCTION IN EARLY REPUBLICAN TÜRKİYE (1925–1960)

ERKEN CUMHURİYET TÜRKİYE'SİNDE BUĞDAY ÜRETİMİNİN DİNAMİKLERİ (1925-1960)

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ABSTRACT

This study aims to analyze the socioeconomic and energy-based factors determining wheat production in Türkiye between 1925 and 1960 using econometric methodology. In the early Republican period, the agricultural sector was structured as one of the main axes of economic development, and wheat, as a strategic crop, was at the center of both production policies and support mechanisms. In this study, wheat production is explained by variables such as per capita income level, number of students enrolled in primary school, electricity production and crude oil price, and the ARDL bounds test approach is used in the model established with annual data. The findings reveal that electricity generation and economic growth support production in the long run, whereas the education indicator has a limiting effect on production. The lagged effects of oil prices, on the other hand, indicate that cost pressures have negative effects on production over time. Short-run analyses reveal that the effects of variables vary over time and that production decisions are affected not only by technical but also by structural transformation processes. The study provides a historical data-based contribution to explain the multidimensional structure of agricultural production in the first 35 years of the Republic.

Keywords: Wheat Production, Agricultural Production, Early Republican Period, Agricultural Transformation, ARDL Bounds Test

ÖZ

Bu çalışma, 1925–1960 yılları arasında Türkiye'de buğday üretimini belirleyen sosyoekonomik ve enerji temelli faktörleri ekonometrik yöntemle analiz etmeyi amaçlamaktadır. Cumhuriyetin erken döneminde tarım sektörü, iktisadi kalkınmanın temel eksenlerinden biri olarak yapılandırılmış; buğday ise stratejik bir ürün olarak hem üretim politikalarının hem de destekleme mekanizmalarının merkezinde yer almıştır. Çalışmada buğday üretimi, kişi başına düşen gelir düzeyi, ilkokula kayıtlı öğrenci sayısı, elektrik üretimi ve ham petrol fiyatı gibi değişkenlerle açıklanmış; yıllık verilerle kurulan modelde ARDL sınır testi yaklaşımı kullanılmıştır. Elde edilen bulgular, uzun dönemde elektrik üretiminin ve ekonomik büyümenin üretimi desteklediğini; buna karşın eğitim göstergesinin üretim üzerinde sınırlayıcı bir etkisi olduğunu ortaya koymuştur. Petrol fiyatlarının gecikmeli etkileri ise maliyet yönlü baskıların zaman içinde üretim üzerinde olumsuz etkiler yarattığını göstermektedir. Kısa dönem analizleri, değişkenlerin etkilerinin zamana bağlı olarak farklılaştığını ve üretim kararlarının sadece teknik değil, aynı zamanda yapısal dönüşüm süreçlerinden etkilendiğini ortaya koymaktadır. Çalışma, Cumhuriyet'in ilk 35 yılında tarımsal üretimin çok boyutlu yapısını açıklamaya yönelik tarihsel veri temelli bir katkı sunmaktadır.

Anahtar Kelimeler: Buğday Üretimi, Tarımsal Üretim, Erken Cumhuriyet Dönemi, Tarımsal Dönüşüm, ARDL Sınır Testi

1. INTRODUCTION

Since the establishment of the Republic of Türkiye, the economic development process has largely been shaped around the agricultural sector. The period between the foundation of the Republic of Türkiye and 1960 was a dynamic phase in which the country both built its institutional infrastructure and took the first steps towards opening up to the outside world through inward-oriented industrialization policies. In this process, agriculture came to the fore as both the main source of employment and the driving force of economic growth (Tezel, 2000). In particular, staple food products such as wheat played an important role not only in terms of domestic consumption but also in terms of foreign trade balance and strategic food security.

Infrastructure investments in Turkish agriculture gained momentum in the 1940s, with the aim of delivering services such as roads, irrigation and electricity to rural areas (Tezel, 2000). Following this preparatory period, an important transformation in agricultural policies took place in the 1950s with the Democratic Party government. Especially with rural electrification projects, the process of mechanization in agriculture accelerated and the use of machines such as tractors, harvesters and irrigation engines became widespread. These developments not only increased labor productivity but also brought about a transition from the traditional production structure to a more market-oriented, commercial agricultural model (Boratav, 1988). This structural transformation in agriculture also affected the rural class structure and triggered social restructuring (Keyder, 1981).

Developments in foreign policy also affected this process. In particular, the agricultural machinery and technical support provided by the United States under the Marshall Plan can be considered as one of the first examples of Türkiye's openness to externalization in agricultural policies (Boratav, 1988). While these supports contributed to the spread of mechanization, they also led to a certain level of improvement in the living conditions of farmers. Although the scope of rural electrification remained limited, the productivity growth during this period marks a remarkable phase of transformation in the history of Turkish agriculture.

Wheat production and productivity are shaped not only by physical production inputs, but also by human capital, infrastructure and economic prosperity. Education reforms initiated in the early Republican period aimed to increase literacy and improve the quality of production, especially in rural areas. In this context, the Village Institutes established in the 1940s not only created an educated peasant population but also contributed to the spread of agricultural techniques. Girgin (2011) finds that the increase in the number of Village Institute graduate teachers has significant and positive effects on both wheat yields and literacy rates. Reimers and Klasen (2013) also support these findings, showing that individuals with higher levels of education adopt agricultural innovations faster and increase productivity.

Similarly, the spread of rural electrification has paved the way for mechanization in agriculture, increasing labor productivity in the production process. The wider use of tractors and irrigation engines has increased both production capacity and farmer control over time and labor (Brigatte, 2010). In addition, the rise in per capita income also expanded farmers' capacity to invest in modern agricultural inputs, thus indirectly supporting agricultural productivity (Öz & Daş, 2019).

During this period, global economic developments also directly affected Türkiye's agricultural production. In particular, cost increases in strategic import items such as energy have disrupted Türkiye's foreign trade balance from time to time and played a decisive role in the current account deficit. In this period when industrialization and agricultural machinery became widespread, oil prices directly affected energy costs and shaped both production costs and the foreign trade balance. As shown in the model of Bruno and Sachs (1982), an increase in oil prices in countries with an import-based energy structure puts pressure on growth and production through the current account deficit. Türkiye's rapidly increasing energy demand after 1950 has been shaped in direct relation to these global dynamics.

Socioeconomic factors affecting agricultural productivity (income level, education, energy costs, infrastructure) have repercussions on the economy that are not limited to rural development. The link between food production and prices shows that these relationships can have important macro-level outcomes (İnal et al., 2023). The period between 1925 and 1960 in Türkiye was a period in which economic development efforts were mainly shaped around the agricultural sector. In this period, basic agricultural products such as wheat played a strategic role in terms of both domestic consumption and economic stability. Agricultural productivity depends not only on natural conditions but also on social and economic factors such as education, infrastructure and income level.

In this study, the number of students enrolled in primary school, electricity generation, per capita income and oil prices are considered as the main factors that may affect wheat production in Türkiye. In this context, the impact of education level on human capital, how infrastructure investments shape productivity, the relationship between economic prosperity and access to agricultural technologies, and the indirect effects of global energy costs on production are evaluated together. This approach distinguishes this study from similar studies. While the existing literature usually focuses on a single variable, this study proposes a multidimensional model. Thus, a more holistic view of Türkiye's early development process is offered by considering both micro-level (education, infrastructure) and macro-level (energy costs) factors together.

There is a special reason for choosing 1925-1960 as the time period of the study. This was a period in which the Republic's institutionalization efforts and agriculture-based development strategies were at the forefront. 1960, on the other hand, was a critical turning point when economic and political policies changed direction with the May 27 military coup. Therefore, the analysis is limited to 1960 in order to ensure both political continuity and economic integrity.

2. Literature Review

Agricultural productivity is shaped not only by natural conditions such as climate, soil structure and water resources, but also by socioeconomic factors such as education, infrastructure, income levels and energy costs. Accordingly, a large number of studies have appeared in the literature to explain the transformation of the agricultural sector, especially in the early stages of the development process. These studies examine the human and physical capital factors that directly and indirectly affect productivity growth in agriculture.

Among these factors, education stands out as one of the most important sources of human capital that increases agricultural productivity. While Schultz (1964) argues that educated individuals can increase productivity by adapting to new technologies faster, Phillips (1994) states that there is a consensus in the literature that education has a generally positive effect on agricultural productivity. Examining the impact of education in the African context, Pinckney (1997), in his field research conducted in Kenya and Tanzania, found that farmers with literacy and basic math skills achieved higher levels of production. Studies conducted in Türkiye also support these findings. Girgin (2011) showed that both literacy rates and wheat productivity increased significantly in regions where Village Institute graduate teachers were employed. Similarly, Reimers and Klasen (2013), in their analysis covering developing countries, find that primary and higher levels of education have significant and positive effects on agricultural productivity. Similar findings on the education-productivity relationship are also found in studies conducted in rural Afghanistan. Haidary and Mahmoodi (2020) found that educated farmers earn higher incomes and adopt modern agricultural techniques faster.

Like education, infrastructure investments are one of the key factors affecting agricultural productivity. In particular, the development of electricity infrastructure enables the expansion of energy-dependent processes such as irrigation systems, storage facilities and mechanization. Bravo-Ortega and Lederman (2004) show that per capita electricity generation capacity has significant and positive effects on agricultural total factor productivity. A similar study on Brazil found that the development of electricity infrastructure in rural areas is directly related to productivity growth (Brigatte, 2010). Examining the historical impact of rural electrification in the US, Lewis and Severnini (2014) find that rural electrification between 1930 and 1960 increased agricultural productivity by 35% and significantly accelerated rural development. In regional comparative analyses on electricity access, Omoju et al. (2020) emphasized that electricity access increased agricultural productivity in Sub-Saharan African countries, but this effect was relatively limited in rural areas. One of the most recent studies by Manasseh et al. (2024) reveals that the impact of consumption and access levels on agricultural development is more pronounced than the direct impact of electricity generation.

Individual income levels and overall economic growth also have indirect but strong effects on the agricultural sector. Higher income supports agricultural productivity by increasing farmers' capacity to invest in modern inputs (e.g. tractors, fertilizers, quality seeds). Lusigi et al. (1998), covering 32 countries in Africa, show that there is conditional convergence between per capita income and agricultural total factor productivity. This finding suggests that low-productivity and low-income countries can achieve higher productivity levels over time. In their analysis of Africa, Asia and Latin America, Thirtle and Piesse (2007) find that increases in agricultural productivity contribute directly to per capita income levels, and that this effect is stronger in countries with higher governance quality. A similar trend is observed in studies conducted in the Turkish context. İmrohoroğlu et al. (2014)

attribute the slowdown in per capita income growth in Türkiye largely to low increases in agricultural productivity. In addition, Öz and Daş (2019) argue that the increase in per capita income positively affects agricultural productivity in the short run and that the increase in economic welfare facilitates the transition of producers to modern production methods.

Energy prices are one of the exogenous shocks affecting the agricultural sector. The rise in oil prices increases the cost of energy-based inputs (fuel, fertilizer, irrigation systems), thereby raising production costs and putting pressure on productivity. In their analysis of US agriculture, Sands et al. (2011) find that rising energy prices increase production costs, reduce product supply and put upward pressure on prices. However, it is also noted that this effect may vary regionally and is felt to a limited extent in some regions. A Nigerian study found that crude oil prices significantly affect the volume of agricultural production in the short run (Binuomote & Odeniyi, 2013). Similarly, David (2019) argues that rising oil prices make it difficult for small producers to access production resources, which negatively affects productivity. Hammayo (2020), on the other hand, found that oil price fluctuations have statistically significant effects on agricultural productivity in both the short and long run.

In general, multidimensional socioeconomic factors such as education, infrastructure, income levels and energy costs are among the main determinants of agricultural productivity, especially in the early stages of development. Considering these variables together contributes to a better understanding of rural transformation processes in developing countries.

3. Data

This study uses an annual data set covering the period 1925-1960 to analyze the long-run effects of key socioeconomic and energy variables affecting wheat production in Türkiye. This historical period provides a critical framework for understanding Türkiye's agricultural transformation process as it coincides with the first four decades of the Republic.

Wheat production, which is used as the dependent variable, refers to total annual production in tons and is obtained from the Turkish Statistical Institute (TurkStat). The number of students, one of the first variables considered as a determinant of wheat production, represents the total annual number of individuals enrolled in primary school. This variable is considered as an indirect indicator of the level of human capital in rural areas.

Electricity generation, which is used as an energy variable, represents gross electricity generation and is in units of 10^6 kilowatt-hours (kWh). The development of Türkiye's electricity infrastructure is considered as an important factor affecting productivity, especially through the expansion of agricultural irrigation and mechanized production.

Gross domestic product (GDP) per capita is used as the macroeconomic control variable. This variable refers to the level of real per capita income calculated at constant prices. Finally, the oil price variable, which is included in the model to represent the cost of fuel, an important input in the agricultural production process, shows the average international prices of crude oil and is taken from the BP Statistical Review of World Energy data, fixed in US dollars for 2023.

All variables used in the model are analyzed by transforming them into their natural logarithms. This transformation allows for the linearization of non-linear relationships between variables as well as the interpretation of the coefficients as percentage effects.

Table 1. Descriptive statistics

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Production	36	15.122	0.521	13.888	15.961
Student	36	13.791	0.584	12.916	14.868
Oil Price	36	3.076	0.157	2.565	3.477
Electricity	36	6.036	1.135	3.813	7.943
GDP	36	6.603	0.862	5.665	7.861

Descriptive statistics provide a general framework for the distribution and volatility of the variables in the model over the period. Although the wheat production variable follows a fluctuating course in the period in question, it reflects a generally stable production structure. The values for the number of students enrolled in primary school indicate an increasing trend in human capital and show that the rural education infrastructure has expanded over time. Electricity generation, on the other hand, exhibited a significant upward trend due to infrastructure investments and industrialization efforts in the early years of the Republic, which supported the expansion of mechanization and irrigation infrastructure, especially in agricultural production. The oil price variable shows relatively low volatility, implying that the pressure on production as an exogenous cost factor has remained stable. Observations on the per capita income level, on the other hand, suggest that economic growth has continued at a limited but steady pace and that a general welfare environment supportive of agricultural production has started to emerge. This overview reveals how the variables in the model are intertwined with Türkiye's development process and agricultural structural transformation.

4. Methodology

In this paper, the autoregressive distributed lag model (ARDL) developed by Pesaran, Shin and Smith (2001) is preferred. The reason for using this approach is that it allows working with series with different levels of stationarity (I(0) and I(1)). In addition, the ARDL model also provides long-run elasticities and short-run dynamics. Moreover, unlike univariate methods, it allows the estimation of multivariate models.

An ARDL(p_y, q_i) model with p_y as lagged explained variable and q_i as lagged explanatory variable and i=1,2,...,k can be written as follows:

$$y_t = \pi_0 + \sum_{j=1}^{p_y} \pi_j y_{t-j} + \sum_{i=1}^{k} \sum_{j=0}^{q_i} \alpha_{ij} x_{it-j} + \varepsilon_t \qquad (1)$$

$\{\varepsilon_t\} \sim (0, \sigma^2)$ is an error process with no serial correlation. The error correction mechanism of this model is,

$$\Delta y_t = c + \lambda y_{t-1} + \sum_{i=1}^{k} \rho_i x_{it-1} + \sum_{j=1}^{p_y-1} \gamma_j \Delta y_{t-j} + \sum_{i=1}^{k} \sum_{j=0}^{q_i-1} \zeta_{ij} \Delta x_{it-j} + \epsilon_t \qquad (2)$$

The parameter λ in equation (2) is known as the speed of adjustment parameter and y_{t-1} denotes the lagged values of deviations from the long-run equilibrium.

The autoregressive distributed lag model, ARDL (p, q), for the multivariate time series wheat production (Q), number of students (S), oil prices (P), per capita income (GDP) and electricity generation (E) can be written as follows (Pesaran et al., 2001):

$$Q = f(S, P, E, GDP) \qquad (3)$$

Equation 3 can be written as follows:

$$Q = \beta_0 + \beta_1 S + \beta_2 P + \beta_3 E + \beta_4 GDP + \varepsilon_t \qquad (4)$$

In order to obtain the long-run elasticities between variables, the basic ARDL model can be written as follows:

$$Q_t = \beta_0 + \Sigma\beta_1 S_{t-i} + \Sigma\beta_2 P_{t-i} + \Sigma\beta_3 E_{t-i} + \Sigma\beta_4 GDP_{t-i} + \varepsilon_{1t} \qquad (5)$$

$$Q_t = \gamma_0 + \Sigma\gamma_1 S_{t-i} + \Sigma\gamma_2 P_{t-i} + \Sigma\gamma_3 E_{t-i} + \Sigma\gamma_4 GDP_{t-i} + \varepsilon_{1t} \quad (6)$$

The error correction model to estimate the short-run dynamics between the variables in Equation 6 is given below:

$$\Delta Q_t = \delta_0 + \Sigma\delta_1 \Delta S_{t-i} + \Sigma\delta_2 \Delta P_{t-i} + +\Sigma\delta_3 \Delta E_{t-i} + \Sigma\delta_4 \Delta GDP_{t-i} + \tau ECM_{t-1} + \epsilon_{1t} \quad (7)$$

In Equation 7, Δ stands for difference models. δ_0 is the constant in the model and δ_i coefficients represent the parameter estimates. ECM is the error correction term. A bounds test was conducted to identify the possible long-run relationship between the variables. In addition, the alternative hypothesis was tested against the null hypothesis of no cointegration. The calculated F-statistic values are compared with the critical values suggested by Pesaran et al. When the F-statistic value exceeds the upper critical bound, the null hypothesis of no cointegration is rejected. When the F-statistic value is below the lower critical threshold, the null hypothesis of no cointegration cannot be rejected. This implies that there is no long-run relationship between the variables. Moreover, if the F-statistic remains between the lower and upper critical limits, the analysis is inconclusive.

5. Empirical Results

Determining the stationarity levels of the variables used in time series analyses is a critical step that directly affects both the model selection and the reliability of the estimation results. In this context, the Augmented Dickey-Fuller (ADF) test, one of the most widely used tests, helps to determine whether the series are stationary (I(0)) or non-stationary (I(1)) by analyzing whether the series contain unit roots (Dickey and Fuller, 1979). The ADF test is applied by adding lagged difference terms to the series to remove autocorrelation. The Phillips-Perron (PP) test similarly tests for the presence of a unit root, but controls for possible serial correlation and heteroskedasticity in the series through non-parametric corrections (Phillips and Perron, 1988). In both tests, if the test statistic is less than the critical value, the null hypothesis is rejected and the series is considered stationary. For non-stationary series, the test is repeated by taking the first difference and thus the degree of integration of the series is determined. These determinations play a fundamental role in deciding which econometric method to use in the following stages.

Table 2. Unit root tests

Variables	ADF		PP	
	I(0)	I(1)	I(0)	I(1)
Q	-0.928	-10.922***	-2.373	-28.489***
S	0.249	-4.282**	1.281	-4.658***
P	-4.109**	-8.529***	-4.045**	-8.702***
E	-2.165	-8.581***	-2.140**	-8.155***
GDP	-6.758***	-7.117***	-4.529***	-8.185***

Note: ***, ** and * denote 0.01, 0.05 and 0.1 significance levels, respectively.

The ADF and PP unit root test results presented in Table 2 were applied to determine the degree of integration of the variables used in the model. Accordingly, wheat production (Q), number of students (S) and electricity production (E) variables were not found to be statistically significant at the level in both ADF and PP tests; however, when first differences were taken, they became stationary at 1% significance level in both tests. This indicates that these three variables are I(1), i.e. integrated at first order. On the other hand, oil price (P) and GDP per capita variables were found to be significant at the level of significance in both tests and were therefore I(0), i.e. stationary at the level. In this structure with different degrees of integration, the fact that not all variables are I(2) and that there are variables at both I(0) and I(1) makes it methodologically appropriate to prefer the ARDL approach in time series analysis. This is because the ARDL model can produce valid results in structures with I(0) and I(1) integrated series and allows for the analysis of both short and long run relationships (Pesaran et al., 2001).

Table 3. ARDL Bound test

Dependent variable: lnQ					
F-stat	Df.	CV	Lower Limit	Upper Limit	Result
11.77	(4, 32)	%1	3.29	4.37	Cointegration
		%2,5	2.88	3.87	
		%5	2.56	3.49	
		%10	2.20	3.09	

The bounds test applied to test the potential of the ARDL model to establish a long-run relationship evaluates the existence of a cointegration relationship between the dependent variable wheat production (lnQ) and the independent variables. In this framework, the F-statistic value is 11.77, which is well above the upper bound critical values at all significance levels (1%, 2.5%, 5% and 10%). In particular, while the upper bound value is 4.37 at the 1% significance level, the fact that the test statistic exceeds this value almost three times indicates the existence of a strong and statistically significant long-run cointegration relationship among the variables included in the model. This result indicates that the system tends towards a common equilibrium in the long run, even though some variables in the model are at I(0) and some are at I(1) level. Therefore, the short-run and long-run coefficients obtained with the ARDL approach are economically interpretable and the reliability of the model is strengthened.

The estimation results of the long-run coefficients in Table + reveal the statistical and economic effects of the variables in the model on wheat production. Accordingly, the coefficient of the electricity generation variable is positive and quite large at the 1% significance level. This finding indicates that the increase in electricity supply significantly supports wheat production in the long run. The increase in electricity generation plays a productivity-enhancing role, especially in terms of irrigation systems, mechanized agriculture and the functionality of agricultural infrastructure.

Oil prices are also included in the model with a positive and significant coefficient at the 5% level, indicating a positive effect on production despite higher energy costs. This finding can be interpreted as oil prices had not yet reached the level of global shocks in the period in question, and therefore, instead of directly suppressing production, they may have triggered modernization in agriculture together with capital depth.

The number of primary school students has a negative coefficient in the model and is significant at the 1% level. This result suggests that the schooling of the rural youth population may have a contractionary effect on the volume of production in the short and medium term through effects such as a decrease in family labor contribution or a decrease in child labor. However, this finding should be carefully evaluated by considering the quality of education and long-term human capital effects.

The GDP per capita variable has a positive coefficient significantly at the 5% level. This indicates that general welfare increase plays a supportive role in production by facilitating the use of agricultural inputs. With economic growth, agricultural investments may increase, technological diffusion may accelerate, and production capacity may expand.

In general, the long-run estimation results reveal that factors such as infrastructure (electricity), macroeconomic welfare level (GDP) and energy costs have constructive effects on wheat production, whereas the education indicator, which represents the transformation process of the rural labor force, exhibits a negative relationship.

Table 4. ARDL (4, 2, 4, 4, 3)

Variables	Coefficient	Std. Error
Long-run		
lnE	0.982***	0.177
lnP	0.401**	0.179
lnS	-1.382***	0.262
lnGDP	0.171**	0.069
C	25.855***	3.213
Short-run		
D(lnQ(-1))	0.705***	0.142
D(lnQ(-2))	0.842***	0.134
D(lnQ(-3))	0.374***	0.076
D(lnE)	1.675***	0.303
D(lnE(-1))	-1.116***	0.346
D(lnP)	0.009	0.118
D(lnP(-1))	-0.824***	0.128
D(lnP(-2))	-0.583***	0.121
D(lnP(-3))	-0.310**	0.104
D(lnS)	-0.180	0.374
D(lnS(-1))	0.297	0.479
D(lnS(-2))	1.592***	0.422
D(lnS(-3))	2.184***	0.403
D(lnGDP)	0.301***	0.061
D(lnGDP(-1))	-0.387***	0.067
D(lnGDP(-2))	-0.258***	0.078
ECM(-1)	-2.171***	0.211
R^2	0.97	
Adj. R^2	0.94	
Durbin-Watson	2.29	
RESET	1.56	prob: 0.15
Serisel Correlation LM Test	1.85	prob: 0.39
Breusch Pagan Godfrey	18.01	prob: 0.65
Jarque-Bera	3.58	prob: 0.16

Note: The RESET test tests whether the functional form of the model is appropriate. The LM test for serial correlation is used to test whether the model is autocorrelated. Statistical significance levels: *** %1, ** %5, * %10.

Short-run estimation results reveal the transitory effects of the main variables affecting wheat production in Türkiye during the 1925-1960 period. The fact that the lagged differences of wheat production are significant and positive in the model indicates that the production process has significant continuity and that the increases in production remain permanent in the short run. This shows that the production structure of the period is largely stable and based on internal dynamics.

While the current period difference of the electricity generation variable is positive and significant, the one-period lagged difference is negative and significant. These findings indicate that electrification led to a rapid increase in production; however, this effect reversed after one period. This shows that the electricity infrastructure of the period initially provided support to agriculture, but in the following period, electricity use remained limited and the positive effect on production could not be sustained. This directional effect of electricity generation on agricultural production reveals that the electrification process failed to deepen in agriculture.

While the current period difference of oil prices is not statistically significant, the first, second and third lagged differences are negative and significant. These results suggest that past increases in oil prices have had negative effects on wheat production by increasing production costs over time. It is understood that with the spread of mechanization in agriculture in the 1950s, sensitivity to fuel and energy increased, which put pressure on production.

While the current period difference and one-period lagged difference of the education variable are not statistically significant, the second and third lagged differences are positive and significant. These results suggest that increasing schooling in rural areas does not have a direct effect on production in the short run; however, increasing access to education has a supportive effect on production over time. This finding suggests that the expansion of primary education has a lagged effect on agricultural productivity and organization rather than a direct increase in production.

For the per capita income variable, the current period difference is positive and significant, whereas the first and second lagged differences are negative and significant. This shows that economic growth supported the agricultural sector in the first phase; however, in the following periods, growth caused a shift of capital and labor from agriculture to other sectors. Considering the industrialization and urbanization trends that started in the 1950s, this structural transformation caused short-term production pressures in the agricultural sector.

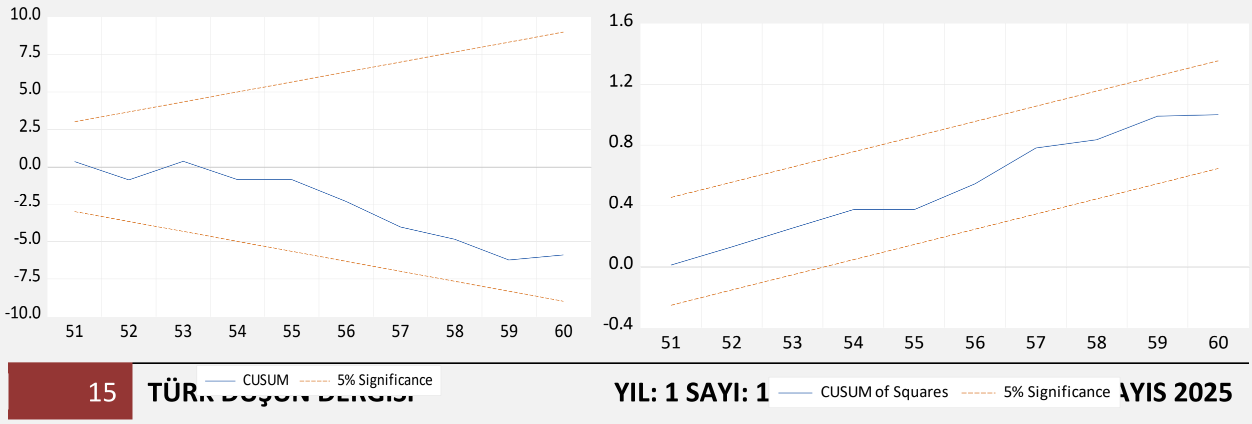
Finally, the error correction term (ECM(-1)) is found to be negative with a coefficient of -2.171 and significant at the 1% level. This finding suggests that the system is able to quickly return to long-run equilibrium by strongly eliminating short-run imbalances. The high absolute value of the error correction coefficient indicates that the production system has a strong rebalancing mechanism. This shows that the agricultural support and guidance policies implemented by Türkiye in this period were in a structure that would ensure production stability.

The diagnostic tests applied to assess the validity of the model show that the ARDL model largely satisfies the basic assumptions. The R^2 value indicating the explanatory power of the model is 97% and the adjusted R^2 is 94%, which indicates that wheat production, the dependent variable, is explained by the variables in the model at a very high rate. The Durbin-Watson statistic is 2.29, which indicates that there is no first order autocorrelation.

The p-value obtained as a result of the RESET test is 0.15 and the null hypothesis is not rejected at the 5% significance level, indicating that the functional form of the model is correctly established. The p-value obtained for the LM test for serial correlation is 0.39, confirming that there is no autocorrelation in the model. The Breusch-Pagan-Godfrey test for heteroskedasticity yielded a p-value of 0.65, indicating that the error terms have constant variance. The p-value of the Jarque-Bera normality test is 0.16, which indicates that the assumption that the error terms are normally distributed is not rejected.

When all these findings are evaluated together, it is concluded that the model is both technically valid and statistically reliable. The estimated ARDL model successfully explains the cyclical production dynamics with its structure that can reflect both short and long run relationships.

Figure 1: Cusum and Cusum of square



To test the structural stability of the model, CUSUM and CUSUM of Squares tests are used to assess whether the coefficients of the estimated ARDL model remain constant over time. The CUSUM test examines whether the model coefficients change in general, while the CUSUM of Squares test examines whether there are sudden jumps in variance or structural breaks.

As can be seen in Chart 1, both the CUSUM and CUSUM of Squares tests do not fall outside the 5% significance bands representing the statistical bounds. This result indicates that the effects of the independent variables used in the model on wheat production remained stable throughout the analysis period and the model coefficients did not undergo a significant structural change over time. Therefore, it is concluded that the model is structurally stable and the obtained forecasts are based on a reliable foundation.

6. Conclusion

This study aims to analyze the main socioeconomic and energy-based factors determining wheat production in Türkiye between 1925 and 1960. The first thirty-five years of the Republic was a period in which both institution building processes and agriculture-centered development strategies were at the forefront. In this context, especially wheat production has a special position in terms of its strategic importance, basic consumption and foreign trade balance.

The findings obtained with the ARDL model used in the study show that agricultural production is shaped not only by natural resources but also by human capital, energy infrastructure and general economic welfare. The long-run coefficients reveal that electricity generation has a strong and positive effect on wheat production. This finding implies that the rural electrification efforts that started in the 1940s and the mechanization process that accelerated from the 1950s onwards directly supported productivity. However, short-run analysis reveals that the effect of electricity generation fluctuates over time and energy use is not fully institutionalized.

In terms of oil prices, the findings show that while the current period effect is statistically insignificant, lagged effects are negative and significant. With the increase in mechanization in agriculture since the 1950s, fuel costs have become more significant and this has put pressure on production. This result supports the negative effects of energy-based external dependence on the production structure mentioned in the introduction of the study.

While the variable of the number of students enrolled in primary school affects wheat production negatively in the long run, it yielded positive and significant results in the short run, especially in the second and third lags. This shows that although the increase in the level of education has a limiting effect on production by reducing the supply of rural labor in the first stage, it contributes to productivity by increasing knowledge and agricultural organization capacity in the following years. This finding is in line with studies such as Girgin (2011) and Reimers and Klasen (2013), which emphasize the capacity of Village Institutes to create knowledge-based transformation in agriculture.

The per capita income variable, on the other hand, positively affected production in the long run, while in the short run, it had limiting effects on production in some periods. This dual structure points to a sectoral reallocation of resources and structural transformation as a result of the increased attractiveness of non-agricultural sectors with the industrialization process of the period. This finding is consistent with the assessments of Boratav (2005) and Keyder (1981), mentioned in the introduction of the study, on the class and sectoral transformations of the period.

In addition to these assessments, the role of subsidies provided to the agricultural sector on production is frequently emphasized in the literature. Studies on Türkiye reveal that these supports significantly increase crop production both in the short and long run. In his analysis for the period 1995-2018, Canbay (2021) shows that agricultural subsidies have created incentive effects on production, especially for staple crops such as wheat, and stabilized production growth. This finding is important in terms of making sense of the production stability observed in the 1925-1960 period and how the foundations of the production structure shaped by public interventionism were laid in the historical context.

The results obtained from the diagnostic tests of the model reveal that there are no violations of basic assumptions such as structural breaks or autocorrelation, while the CUSUM and CUSUM of Squares tests show that the coefficients are stable over time. These findings suggest that the results are not only statistically significant but also consistent within the historical context.

Overall, this study evaluated the agricultural structure of the early Republican period not only in terms of production quantities, but also in terms of the social and economic variables that determine it, with a holistic approach. Factors such as education, infrastructure and economic prosperity have been shown to have a decisive impact on production decisions and productivity levels in the agricultural sector. Thus, Türkiye's agricultural transformation process in the first half of the 20th century is explained with a multidimensional approach and concrete data.

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