Mustafa Kemal Üniversitesi Tarım Bilimleri Dergisi, 29 (1), 158-167
Mustafa Kemal University Journal of Agricultural Sciences, 29 (1), 158-167
https://dergipark.org.tr/tr/pub/mkutbd
e-ISSN: 2667-7733

ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Analysis of the impact of agricultural credits on agricultural mechanization in Türkiye

Türkiye'deki tarımsal kredilerin tarımsal mekanizasyona etkisinin analizi

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ARTICLE INFO

Article history:
Recieved / Geliş: 04.11.2023
Accepted / Kabul: 13.12.2023

Keywords:
Agricultural loans
Agricultural mechanization
Time series analysis
ARDL bounds testing

Anahtar Kelimeler:
Tarımsal krediler
Tarımsal mekanizasyon
Zaman serisi analizi
ARDL sınır testi

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ABSTRACT

Agricultural mechanization is one of the high-cost important inputs used in agricultural production. Thanks to agricultural mechanization, time and manpower are saved greatly in the agricultural production process. Agricultural loans, one of the most important agricultural financing instruments, are considered necessary for agricultural enterprises to invest in agricultural mechanization. This study, which adopts a quantitative research method approach, aimed to analyze the impact of agricultural loans on agricultural mechanization in Türkiye using time series analysis. Within the scope of the purpose, annual data covering the period 1981-2022 were gathered from data sources related to loans and agricultural mechanization. A log-log model was constructed with loans as the independent variable and agricultural mechanization as the dependent variable, and ARDL bounds testing method was applied in the estimation of the model. According to the findings obtained from the estimation of the model, there was a long-term, positive, and statistically significant co-integration relationship between loans and agricultural mechanization variables. A 1% increase in the loan balance was found to increase agricultural mechanization by approximately 0.035%. On the other hand, the short-term relationship between the variables was found to be negative and statistically significant. Short-term deviations from the long-term equilibrium caused by shocks were shown to vanish by approximately 86% after 1 period. In this context, it is clear that the adaptation process between the variables is very rapid.

ÖZET

Tarımsal mekanizasyon, tarımsal üretimde kullanılan yüksek maliyetli önemli üretim girdilerinden biridir. Tarımsal mekanizasyon sayesinde tarımsal üretim sürecinde zamandan ve insan gücünden büyük ölçüde tasarruf edilmektedir. En önemli tarımsal finansman araçlarından biri olan tarımsal krediler, tarım işletmelerinin tarımsal mekanizasyona yatırım yapabilmeleri için gerekli görülmektedir. Nicel araştırma yöntemi yaklaşımını benimseyen bu çalışmada Türkiye'deki tarımsal kredilerin tarımsal mekanizasyona etkisini zaman serisi analiziyle analiz etmek amaçlanmıştır. Amaç doğrultusunda krediler ve tarımsal mekanizasyon ile ilgili veri kaynaklarından 1981-2022 dönemini kapsayan yıllık veriler toplanmıştır. Analiz için kredilerin bağımsız, tarımsal mekanizasyonun ise bağımlı değişken olarak yer aldığı tam logaritmik bir model kurulup bu modelin tahmininde ARDL sınır testi yöntemi uygulanmıştır. Model tahmininden elde edilen bulgulara göre; krediler değişkeniyle tarımsal mekanizasyon değişkeni arasında uzun dönemli, pozitif ve istatistiksel olarak anlamlı bir eşbütünleşme ilişkisi vardır. Kredilerin bakiyesindeki %1'lik artış, tarımsal mekanizasyonu yaklaşık %0.035 artırmaktadır. Diğer taraftan değişkenler arasındaki kısa dönemli ilişki ise negatif olup istatistiksel olarak anlamlıdır. Kısa dönemde yaşanan şoklardan sonra değişkenler arasında oluşan uzun dönem dengesinden sapma(lar) 1 dönem sonra yaklaşık %86 oranında ortadan kalkmaktadır. Bu bağlamda, değişkenler arasındaki uyarlanma sürecinin çok hızlı olduğu açıktır.

Cite/Atıf Keskin, Ö. (2024). Analysis of the impact of agricultural credits on agricultural mechanization in Türkiye. *Mustafa Kemal Üniversitesi Tarım Bilimleri Dergisi, 29* (1), 158-167. https://doi.org/10.37908/mkutbd.1386236

INTRODUCTION

Agricultural mechanization as a production technology is an important factor that includes the design, development, production, marketing, providing usage training and use of all kinds of energy sources and mechanical tools and equipment to perform all operations related to agricultural production (Zeren et al., 1995). Thanks to agricultural mechanization, faster and larger capacity agricultural production is possible in the agricultural sector compared to labor-intensive processes. In addition to directly increasing productivity, the use of machinery and equipment in the agricultural sector brings about the implementation of new production methods instead of the usual production methods in rural areas. Thus, it ensures more accurate and efficient use of basic production inputs such as seeds, fertilizers and pesticides, reduces costs and thus increases profitability (Saral et al., 2000).

In addition to accelerating positive developments in the agricultural sector, agricultural mechanization has also created some problems. Namely, with the widespread use of machinery and equipment in agricultural production, an excess of labor force has started to occur in crowded families living in rural areas. This surplus has triggered migration towards cities where job opportunities are diverse. On the other hand, the need for labor in enterprises producing machinery and equipment, shops selling spare parts, maintenance and repair shops and petrol stations has gradually increased. As a result, the relationship between rural and urban areas has become tighter (Doğan, 2005).

The fact that agricultural enterprises in Türkiye are generally small and fragmented makes it difficult for them to follow technological developments and make investments, in other words, to purchase new machinery and equipment (Özgüven et al., 2010). This is because agricultural enterprises are generally insufficient in terms of the equity capital required to make such a high-cost investment. In addition, lending to agricultural enterprises is considered high-risk by commercial banks due to the unstable cash flows and the unique nature of the agricultural sector. Due to the risk element, commercial banks' loans are subject to high interest repayment, various collateral requirements, and lengthy formalities. Although the balance of commercial bank loans has been increasing over the years (see Table 1), it is not easy enough for agricultural enterprises to use loans to purchase machinery and equipment (Kredi Kayıt Bürosu, 2022).

Table 1. Agricultural loans extended by commercial banks in Türkiye by years

Çizelge 1. Türkiye'de ticari bankalar tarafından kullandırılan tarımsal kredilerin yıllara göre bakiyesi

Years	Balance (Turkish Lira (TL))-Thousand
2002	2.439.787
2006	5.978.681
2010	17.726.816
2014	34.367.368
2018	77.824.499
2022	255.951.679

Source: The Banks of Association Türkiye (BAT) (2023) Specialized Loans-Agriculture

The fact that use of machinery and equipment suitable for the structure of agricultural enterprises has not been developed sufficiently, the use of common machinery and equipment among small agricultural enterprises is not common, and the increase in the number of outdated machinery and equipment hurts the development of the level of agricultural mechanization in Türkiye. The varying hilly structure of agricultural lands in terms of geographical regions is also effective in this. Nevertheless, Türkiye, which has a history of more than half a century in agricultural mechanization, has made significant gains in both the availability of machinery and equipment and their use (Ünsal, 2020). Thus, according to the Turkish Statistical Institute (TURKSTAT), the total number of machinery and equipment increased from 8,637,750 in 2003 to 12,192,179 in 2022 (see Table 2) (TURKSTAT, 2023).

Table 2. Change in the total number of agricultural machinery and equipment in Türkiye over the years
Çizelge 2. Türkiye'de toplam tarımsal makine ve alet sayısının yıllara göre değişimi

Years	Quantity
2003	8.637.750
2010	9.560.877
2016	10.570.235
2022	12.192.179

Source: TURKSTAT (2023) Agricultural Equipment and Machinery Statistics

If agricultural mechanization, which is a high-cost agricultural production input, is not selected and applied correctly, the profitability of production in agricultural enterprises may be negatively affected, the balance between agriculture and industry sectors may deteriorate against the agricultural sector and rural unemployment may increase. In this context, it is important to plan agricultural mechanization by considering the conditions of the rural areas where agricultural production will be carried out (Toğa, 2006). In addition, this planning is necessary to ensure that the loans obtained from commercial banks for the purchase of machinery and equipment can be used effectively for their intended purpose and thus create the desired added value in practice.

There are many studies in the literature on agricultural mechanization in Türkiye. Among these studies, for example;

-In the study conducted by Ertekin et al. (2021), the current situation of agricultural mechanization in Türkiye was evaluated and it was determined that there was a significant increase in fruit harvesting and cotton picking machines, motorized scythes and trailers from the past to the present, while there was a significant decrease in animal-drawn sowing machines, ploughs and black ploughs.

-In the study conducted by Ünsal (2021), the level of agricultural mechanization in Türkiye, problems and solution suggestions were tried to be revealed and it was determined that the regions showed significant differences in terms of level and half of the tractors in the tractor park have completed their economic life.

-In the study conducted by Altuntaş (2020), the projection of agricultural machinery utilization in Türkiye was estimated and it was determined that the use of technological harvesters and tractors will increase regularly until 2030.

-In the study conducted by Yücel and Çalışkan (2020), the effect of mechanization and production efficiency on agricultural employment in Türkiye's agricultural sector was investigated and it was found that there is a significant relationship between the level of mechanization and agricultural employment in the long run, while there is no such relationship between production efficiency and agricultural employment.

-In the study conducted by Oğuz et al. (2017), investigated the use of agricultural mechanization in 3 districts of Konya and it was determined that the level of agricultural mechanization use in agricultural enterprises in the areas examined was above the average of Türkiye.

-In the study conducted by Altuntaş (2016), it was tried to determine the level of agricultural mechanization in Türkiye in terms of regions and it was determined that the highest level was in the Aegean region and the lowest level was in Southeastern Anatolia.

-In the study conducted by Gökdoğan (2012), the indicators of mechanization level in Türkiye and European Union (EU) agriculture were compared and it was determined that the level indicator values of Türkiye were lower than the averages in the EU.

-In the study conducted by Gökdoğan and Bayhan (2011), it was aimed to create a database by determining the mechanization level of agricultural enterprises in Eğirdir district of Isparta and it was determined that the number of tractors per enterprise was 0.79, the number of machines was 4.70 and the number of machines per tractor was 5.17.

The literature summary clarified above shows that there is no similar study in the literature on "the effect of agricultural banking loans on agricultural mechanization" which is the subject of this study. Therefore, it can be said

that this study is important as it will contribute to filling the existing gap in the literature by analyzing the effect of agricultural loans on agricultural mechanization in Türkiye with time series analysis using quantitative raw data.
The scope of this study, which aims to determine the effect of agricultural banking loans on agricultural mechanization in Türkiye during the period 1981-2022 (annual data set with 42 observations) by conducting time series analysis, firstly, information about the material and methodology is given, and then the findings obtained from the analysis are presented and evaluated.

MATERIALS and METHODS

In this section of the study, explanations about the data collection tool and sampling, variables, model and method are given.

Data collection tool and sample

For the purpose of the study, data on loans and agricultural mechanization within the scope of agricultural banking were collected. Data on loans are compiled from the Our Banks books and data system published by the BAT and represent specialized loans (TL) extended to the agricultural sector. Data on agricultural mechanization are compiled from the Agricultural Machinery and Equipment Statistics on TURKSTAT's website and the Agricultural Statistics reports in its online library and represent the total number of agricultural machinery and equipment in use (units)[1].
Both datasets cover the period 1981-2022 (42 observations) and are annual in nature.

Variables and model

For the purpose of the study, loans were determined as the independent variable and agricultural mechanization as the dependent variable. The log-log model[2] constructed by including the variables is as follows;

$$logmachinery_t = \alpha + \beta\ logcredit_t + \varepsilon_t$$

Model maker;
-*logmachinery* for number of machine and equipment,
-*t* for time,
-α for constant term,
-β for coefficient,
-*logcredit* for loans and
-ε for error term.

Method

Autoregressive Distributed Lag (ARDL) bounds testing is applied as a method in time series analysis conducted in the study.
Different co-integration tests (tests developed by Engle and Granger, Johansen and Pesaran, Shin and Smith) can be preferred in time series analysis. The term co-integration means that more than one variable integrates and moves together (this movement is defined as a long run). Among the tests, the ARDL test developed by Pesaran et

[1] A total of 82 different machines and equipment listed in 2023 data by TURKSTAT (excluding threshing sled, wooden plow and animal drawn plough)

[2] In the study, logarithms (log) of the series were taken to ensure that the series were linear, that their coefficients were interpreted as flexibility, that their were independent from measurement units, and that the problem of heteroscedasticity did not arise as a result of the analysis. Therefore, the real relationship between the variables will be interpreted as the % change in the independent variable versus the % change in the dependent variable.

al. can be used even if some of the variables are stationary at the I (0)-level and the other part is stationary at the I (1)-level. Using the first two tests requires that the stationarity levels of the variables are the same.
The ARDL test cannot be used if the variables are I (2). Therefore, it is necessary to confirm that the variables are not I (2).

RESULTS

The data values of the variables used in the analysis followed the course shown in Figure 1 for the 1981-2022 period.

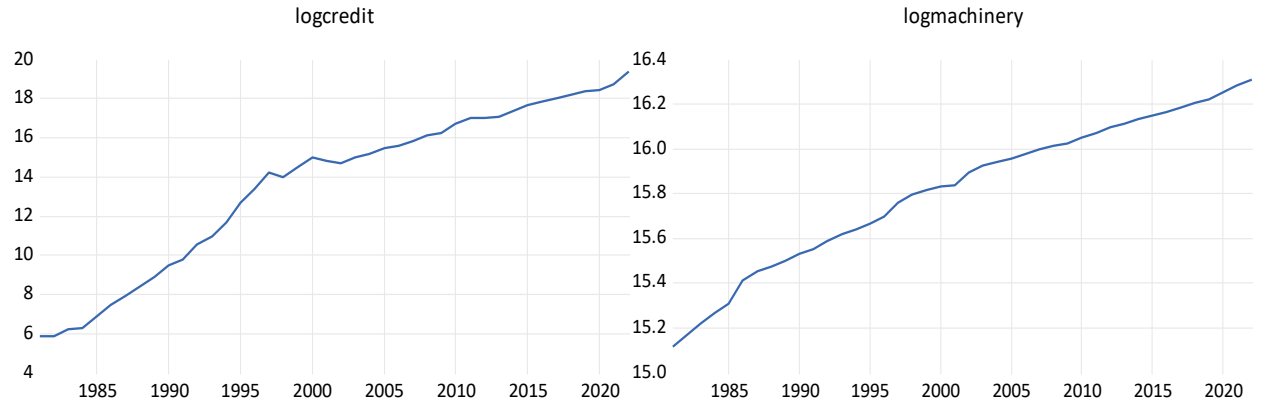

Figure 1. Course of variables
Şekil 1. Değişkenlerin izlediği seyir

Since the use of the ARDL test requires confirmation that the variables are not I (2), the Augmented Dickey Fuller (ADF) unit root test, which is a test without structural breaks, was performed (see Table 3)[3].

Table 3. ADF test result
Çizelge 3. ADF testi sonucu

Variables	Constant	p	Constant, linear trend	p	None	p
logcredit	-2.152899 (0)	0.2260*	-0.742197 (0)	0.9628*	2.487491 (1)	0.9962*
logmachinery	-4.294494 (0)	0.0015*	-3.162714 (0)	0.1061*	10.40014 (0)	1.0000*

Values in parentheses are lag lengths calculated according to Akaike Info Criterion (AIC) maximum 9.
*indicates significance at 5% significance level. As can be seen, the logmachinery variable is stationary at level in the constant model. There is no autocorrelation problem in the model at lag length 0. In other words, the series is clean (LM test p=0.3186).

The ADF test is one of the unit root tests without structural breaks. If the series are non-stationary as a result of the unit root test without structural breaks, this may be due to structural break(s). Therefore, a unit root test with structural breaks is required. Otherwise, specification error may arise in the model. In such a case, the series, for example, would be non-stationary when they are normally stationary.
Since the above ADF test shows that the logcredit variable is not stationary at level, Perron 97 structural break unit root test, which takes into account the single break as endogenous, is performed (see Table 4).

[3] Under normal circumstances, seasonal effects may be encountered in the series. However, since the annual data set was used in the study, seasonal decomposition was not required.

Table 4. Perron 97 structural break unit root test result

Çizelge 4. Perron 97 yapısal kırılmalı birim kök testi sonucu

Variables	Trend model-t statistics	Breakout year	p
logcredit	-5.913806 (0)	1997	0.01*

Values in parentheses are lag lengths calculated according to AIC maximum 9.
*indicates significance at 5% significance level. As can be seen, the logcredit variable is stationary in the trend model. This means that the series is actually stationary but the reason for the non-stationarity in the ADF test is due to the structural break.

Tables 3 and 4 confirm that the variables used in the analysis are not I (2). In other words, the necessary condition for the use of the ARDL test is met. At this stage, the maximum lag length at which the AIC value is minimum and the autocorrelation problem does not occur in the ARDL test is determined as 9 as a result of testing the variables using different lag combinations. It is also concluded that the appropriate model is the (2, 9) model (see Table 5).

Table 5. ARDL test result

Çizelge 5. ARDL testi sonucu

k = 1	Equation to be estimated = log*machinery = f (*log*credit)*
F statistic value	8.065329
Model (unrestricted constant and restricted trend)	ARDL (2, 9)
p	**Critical values**
	I (1)
%1	8.213
%5	5.777
%10	4.867

Table 5 shows that the F statistic value (8.065) is larger than the critical value (5.777) at 5% significance level. This result indicates the existence of a long-run cointegration relationship between the loans variable and the agricultural mechanization variable.

Table 6. Results of estimation and diagnostic tests for the parameters of the ARDL (2, 9) model

Çizelge 6. ARDL (2, 9) modelinin parametrelerine ilişkin tahmin ve tanısal testlerine ilişkin sonuç

Variables	Coefficients	t statistical values	p
logmachinery(-1)	1.060842	6.563724	0.0000
logmachinery(-2)	-0.923269	-4.790491	0.0001
logcredit	0.011919	2.467824	0.0233
logcredit(-1)	-0.012167	-1.774022	0.0921
logcredit(-2)	0.013642	2.094398	0.0499
logcredit(-3)	0.005894	0.848154	0.4069
logcredit(-4)	-0.024230	-3.421015	0.0029
logcredit(-5)	0.039340	4.648010	0.0002
logcredit(-6)	-0.019558	-2.864415	0.0099
logcredit(-7)	0.022354	3.563206	0.0021
logcredit(-8)	-0.022425	-3.208966	0.0046
logcredit(-9)	0.015133	2.692851	0.0144
c	13.05049	4.680906	0.0002
@trend	0.010693	4.700947	0.0002
Diagnostic tests			
Breusch-Godfrey: 0.53 (p = 0.77)	White: 10.33 (p = 0.67)	Jarque-Bera: 1.26 (p = 0.53)	Ramsey Reset: 1.47 (p = 0.24)

The estimation output in Table 6 shows that the model parameters are generally significant, while the diagnostic tests show that there are no autocorrelation and variance problems in the model, the residuals are normally distributed and there are no errors in model fitting (p>0.05).

Although the results of the diagnostic tests are evidence of a successful model estimation, it was also examined whether the estimation satisfies the stability condition (whether the model is stable) and concluded that it meets this condition at the 5% significance level (see Figure 2).

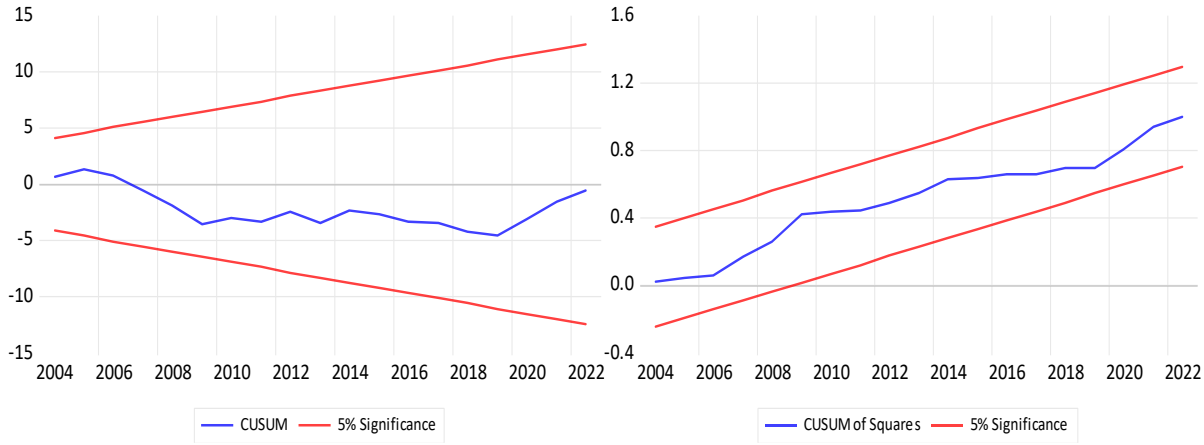

Figure 2. Results for Cusum and Cusum squared tests

Şekil 2. Cusum ve Cusum kare testlerine ilişkin sonuç

According to the estimation result of the long-run coefficients of the model, the coefficient of the logcredit variable with a positive sign is statistically significant (p<0.05). In other words, there is a positive relationship between the loans variable and the agricultural mechanization variable. A 1% increase in the balance of loans increases agricultural mechanization by approximately 0.035% (see Table 7).

Table 7. Estimation of the long-run coefficients of the ARDL (2, 9) model

Çizelge 7. ARDL (2, 9) modelinin uzun dönem katsayılarına ilişkin tahmin

Dependent variable: logmachinery			
Variables	**Coefficients**	**t statistic values**	**p**
@trend	0.012399	18.66451	0.0000
logcredit	0.034672	16.82691	0.0000

After the dynamics of the long-run cointegration relationship between the model variables have been revealed, it was proceeded to reveal the dynamics of the short-run relationship (see Table 8).

Table 8 shows that the error correction coefficient is negative and significant at 5% significance level (p<0.05). This result indicates that the deviations from the long-run equilibrium that occurred between the variables after the short-term shocks disappeared by approximately 86% after 1 period. In other words, the variables that moved away from each other due to the impact of short-term shocks are approximately 86% closer to each other again after 1 period.

Table 8. Estimation of the error correction coefficient of the ARDL (2, 9) model
Çizelge 8. ARDL (2, 9) modelinin hata düzeltme katsayısına ilişkin tahmin

Variables	Coefficients	t statistical values	p
Error correction coefficient*	-0.862428	-5.171357	0.0000
d(logmachinery(-1))	0.923269	5.302052	0.0000
d(logcredit)	0.011919	2.945603	0.0077
d(logcredit(-1))	-0.030150	-4.157891	0.0004
d(logcredit(-2))	-0.016508	-2.414824	0.0249
d(logcredit(-3))	-0.010614	-1.664963	0.1108
d(logcredit(-4))	-0.034844	-6.848235	0.0000
d(logcredit(-5))	0.004496	0.967452	0.3443
d(logcredit(-6))	-0.015062	-3.529224	0.0020
d(logcredit(-7))	0.007292	1.587856	0.1273
d(logcredit(-8))	-0.015133	-3.251520	0.0038
c	13.05049	5.174686	0.0000

DISCUSSION

Differences in development between the geographical regions of Türkiye are also evident in terms of the agricultural mechanization characteristics of the regions. Although there has been a significant development in the number of machines and equipment used in agricultural operations and the level of knowledge on their use since the beginning of agricultural mechanization in Türkiye, it is not at the desired sufficiency and quality. The reasons for this situation can be attributed to the hilly terrain in Türkiye, which varies considerably in terms of geographical regions, and the generally small and fragmented structure of agricultural holdings. Therefore, for a balanced and adequate development of Türkiye's agricultural mechanization level, it is important to plan agricultural machinery and equipment by taking into account the production pattern in geographical regions, to organize training activities for the correct use of machinery and equipment by the Ministry of Agriculture and Forestry and cooperatives, and to diversify and develop credit resources and credit services provided by them (especially micro-credits).

In this study, the impact of agricultural loans on agricultural mechanization in Türkiye is analyzed by time series analysis. In order to keep the number of observations as high as possible in the analysis, data were collected from archival and up-to-date data sources. The data period was determined as 1981-2022 based on the data that could be collected. The time series analysis is conducted using the ARDL test method, which enables to reveal the dynamics of short and long term relationships between two or more variables.

According to the findings obtained from the estimation of the log-log model established in the study, there is a long-run, positive and statistically significant cointegration relationship between the loans variable and the agricultural mechanization variable. Namely, a 1% increase in the balance of loans increases agricultural mechanization by approximately 0.035%. Moreover, the short-run relationship between the two variables is also statistically significant and negative. That is to say, the deviation(s) from the long-run equilibrium between the variables due to the effect of short-term shocks disappear after 1 period by approximately 86%. In this context, it is clear that the adjustment process between the variables used in the study is very fast.

Based on this finding of the research, it can be clearly said that one of the dynamics of the increase in the level of agricultural mechanization in Türkiye is the provision of financial support to the agricultural sector within the scope of agricultural banking. However, since the cost of investing in agricultural mechanization is high, financial support for the sector should be provided long-term, adequately, and under reasonable conditions. In this connection, all other public and private commercial banks should try to play an active and sensitive role, just as Ziraat Bank and DenizBank are trying to do today. In this way, agricultural mechanization throughout the country will be able to continuously improve.

To facilitate access to agricultural mechanization loans in Türkiye and to use the existing mechanization resources more rationally and efficiently, it is thought that low-interest and/or interest-free loan support mechanisms should be implemented by commercial banks and the mechanization assets with completed service life should be valued at attractive amounts within the scope of scrap discount application.

Based on this study, another study can be conducted to examine the impact of government support payments to the agricultural sector on agricultural mechanization in Türkiye using time series analysis.

STATEMENT OF CONFLICT OF INTEREST

The author(s) declare no conflict of interest for this study.

AUTHOR'S CONTRIBUTIONS

All authors have contributed equally to the experiment.

STATEMENT OF ETHICS CONSENT

Ethical approval is not applicable, because this article does not contain any studies with human or animal subjects.

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