

# The Long-Run Impact of Financial Development on Agricultural Productivity: The case of Türkiye

Serkan VARSAK\*   
Cüneyt KOYUNCU\*\*   
Halit YALÇIN\*\*\* 

## ABSTRACT

The objective of this study is to figure out how financial development and agricultural productivity interacts in the long-run in Türkiye by using two distinct measures of agricultural productivity. Well-established and developed financial market enables farmers to reach funds at lower funding costs and in turn enhance agricultural productivity. The analyses are based on annual time series data of Türkiye for the years between 1980 and 2021. Firstly we checked the stationarity status of each variable by using Kwiatkowski-Phillips-Schmidt-Shin stationarity test. Secondly we conducted co-integration analysis by employing ARDL bounds test to see if our variables move together in the long-run. Lastly we estimated short-run and long-run coefficients by utilizing ARDL estimation technique. Positive statistically significant long-run coefficient estimation was obtained for financial development variable. According to the estimation results, if financial development index goes up by 1% then agricultural productivity per worker increases by 1.75% and agricultural productivity per capita augments by 0.87%. We also obtained positive statistically significant long-run coefficient estimations for control variables of fertilizer consumption and number registered tractors. The finding of positive association between financial development and agricultural productivity reveals the importance of developed financial market for enhancement of agricultural productivity in an economy. Therefore policy makers aiming to improve agricultural productivity should prioritize policies supporting the development of financial markets besides the other policies.

**Keywords:** Agricultural Productivity, Financial Development, Fintech, ARDL, Co-integration

**JEL Classifications:** G10,O16,Q10

## Finansal Gelişimin Tarımsal Verimlilik Üzerindeki Uzun Vadeli Etkisi: Türkiye Örneği

### ÖZ

Bu çalışmanın amacı, Türkiye’de finansal gelişme ile tarımsal verimlilik arasındaki uzun dönemli etkileşimi, tarımsal verimliliğin iki farklı ölçütünü kullanarak incelemektir. İyi işleyen ve gelişmiş bir finansal piyasa, çiftçilerin fonlara daha düşük maliyetlerle erişimini mümkün kılar ve bu da tarımsal verimliliği artırır. Bu kapsamda çalışmada ilgili değişkenlere ilişkin yapılan analizler, 1980-2021 yılları arasındaki Türkiye’ye ait yıllık zaman serisi verilerine dayanmaktadır. İlk olarak, her bir değişkenin durağanlık durumu Kwiatkowski-Phillips-Schmidt-Shin (KPSS) testi kullanılarak kontrol edilmiştir. İkinci olarak, değişkenlerin uzun dönemde birlikte hareket edip etmediğini görmek amacıyla ARDL sınır testi ile eşbütünlük analizi yapılmıştır. Son olarak, kısa dönem ve uzun dönem katsayıları ARDL tahmin tekniğiyle hesaplanmıştır. Finansal gelişme değişkeni için pozitif ve istatistiksel olarak anlamlı uzun dönem katsayısı elde edilmiştir. Tahmin sonuçlarına göre, finansal gelişme endeksi %1 arttığında, işçi başına tarımsal verimlilik %1,75, kişi başına tarımsal verimlilik ise %0,87 artmaktadır. Ayrıca, kontrol değişkenleri olan gübre tüketimi ve kayıtlı traktör sayısı için de pozitif ve istatistiksel olarak anlamlı uzun dönem katsayıları bulunmuştur. Finansal gelişme ile tarımsal verimlilik arasındaki pozitif ilişkinin tespit edilmesi, bir ekonomide tarımsal verimliliğin artırılması için gelişmiş bir finansal piyasanın önemini ortaya koymaktadır. Dolayısıyla, tarımsal verimliliği artırmayı hedefleyen politika yapıcılar, diğer politikaların yanı sıra finansal piyasaların gelişimini destekleyen politikalara da öncelik vermelidir.

**Anahtar Kelimeler:** Tarımsal Verimlilik, Finansal Kalkınma, Fintek, ARDL, Co-integration.

**JEL Sınıflandırması:** G10,O16,Q10

\* **Corresponding Author/Sorumlu Yazar,** Asst. Prof., Bilecik Şeyh Edebâli University, Bilecik, Türkiye, serkan.varsak@bilecik.edu.tr

\*\* Prof. Dr., Bilecik Şeyh Edebâli University, Bilecik, Türkiye, cuneyt.koyuncu@bilecik.edu.tr

\*\*\* Asst. Prof., Bilecik Şeyh Edebâli University, Bilecik, Türkiye, halit.yalcin@bilecik.edu.tr

Makale Gönderim ve Kabul Tarihleri/Article Submission and Acceptance Dates: 06.09.2025-01.12.2025

**Citation/Atf:** Varsak, S., Koyuncu, C., & Yalçın, H. (2025). The long-run impact of financial development on agricultural productivity: the case of Türkiye. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 58, 295-308. <https://doi.org/10.52642/susbed.1779239>

This work is licensed under Creative Commons Attribution-NonCommercial 4.0 International License



## 1. Introduction

In recent years, measures have been developed to enhance the safety and reliability of food in response to various issues such as rapidly increasing population, fast-paced urbanization, industrialization, climate change, wars, and pandemics in the global economy. Climate change, in particular, has been observed to reduce agricultural productivity and disrupt supply chains due to significant natural phenomena such as temperature changes and variations in rainfall intensity, which are critical for agricultural production (Manogna & Kulkarni, 2024, p.280). In this context, the safety of food, the enhancement of its reliability, and the need for sustainable agricultural production have directed national and international institutions and organizations toward new pursuits. Recently, global financial developments and the increasing number of financial instruments have played a decisive role in financing agricultural production and productivity to mitigate the socio-economic impacts of food-related issues at both national and global levels. In this scope, the transformations in developing financial markets serve as a source for financing food production and sustainable agriculture.

The increase in the number of financial instruments available to economic actors within the global financial system is defined as an increase in financial depth. On the other hand, with growing financial diversity, the reach of financial services to a greater number of economic actors in both national and international markets, along with the volumetric growth of financial services, is defined as financial development. Recently, the increasing levels of financial depth and financial development in the global economy have been observed to cause structural transformations in the agricultural production and consumption patterns of national economies. It can be noted, in particular, that the developing financial sector and the growing variety of financial instruments provide certain advantages and disadvantages to economic actors in national and international markets. In this context, financial development and financial depth serve as significant drivers of economic growth (King & Levine, 1993, p.717). From this perspective, the agricultural sector, which serves as the driving force behind industrialization and economic growth, holds great significance in terms of its impacts on agricultural production and productivity. However, researchers in the economics literature argue that financial development and financial deepening may have both positive and negative effects on the agricultural sector and, consequently, on agricultural productivity. While financial development may positively influence agricultural productivity and production, it can also have adverse effects, such as increasing the volatility of agricultural product prices and undermining the sustainability of agricultural productivity and production. Studies show that these impacts can vary from country to country depending on the level of development and may even change over time within the same country. Therefore, there is no clear consensus on this matter in the economics literature.

The ongoing developments in the global financial system and increasing financial depth not only facilitate mechanization in agriculture and access to financial resources but also inevitably lead to increased agricultural production due to agricultural mechanization and technological advancements. As agricultural production rises, the supply of agricultural raw materials needed for industrial production is also expected to increase. Therefore, it can be stated that agricultural mechanization is an element that transforms societies not only economically but also socially. Consequently, while the policies implemented by countries to preserve existing resources and ensure food supply are significant, organizations with various objectives, such as reducing hunger, increasing food production, and ensuring food security play a crucial role in addressing food crises (Aydınbaş, 2023, p.63; Dağ & Akbay, 2022, p.101). Financial development and financial deepening positively impact the global economic system by intermediating the mobilization of small-scale savings into the economy, improving resource allocation, addressing income distribution inequalities, and thereby reducing poverty (Beck, 2002, p.107-131; Bruhn & Love, 2014, p.1347-1376).

In recent times, the development of financial technologies in global financial markets has significantly increased financial services and financial instruments (Allen, Qian, & Gu, 2017, p.191-231). The development of the global financial system in the world economy has facilitated economic actors' access to financial resources in financial markets. While this has provided resources for mechanization and technological advancement, it has also contributed to increased production (Shahzad, Kumar, Zakaria, & Hurr, 2017, p.185-192).

It can also be stated that in the agricultural sector, the sustainability of agricultural subsidies and the increase in production and productivity in agriculture are significant outcomes of financial development. Therefore, financial development enhances productivity in agricultural production and promotes agricultural development (Fan, Jiang, Sun, & Zhang, 2023, p.199-211). Moreover, financial development plays a crucial role in encouraging rural economies and, consequently, agricultural production, as well as in increasing rural output, combating poverty, and ensuring economic stability (Bernanke & Gertler, 1990, p.87-114; Burgess & Pande, 2005, p.780-795; Clarke, Zou, & Xu, 2003, p.2). Additionally, advancing financial technologies meet the financial needs that enable the deepening of agricultural capital, allowing for increased agricultural production and building a more robust foundation for the agricultural system ( Gao, Sun, & Chen., 2024, p.7).

With financial development, increasing financial inclusion, and the new generation technologies produced in this context (such as Mobile Payments, Mobile Credit Allocation, etc.), the traditional structure of the financial sector is changing, overcoming temporal and spatial constraints, and providing more financial services, thereby offering inclusive opportunities to agricultural producers (Zhu & Guo, 2024, p.2). At the same time, the increasing variety of inclusive financial products can not only meet the financing needs for the supply of advanced agricultural machinery used in agricultural production, but also lead the improvement of agricultural production methods ( Mei, Khan, Khan, Ali, & Luo, 2022, p.16). Furthermore, financial inclusion provides agricultural producers with financial tools that help protect them from price volatility and natural disasters, offering financial compensation rights and agricultural product insurance, thus ensuring the sustainability of agricultural production ( Chi, Guo, Mi, Wang, & Song, 2022, p.722; Y. Liu, Liu, & Zhou, 2021, 475-494).

A factor that further enhances the positive effects of financial development on agricultural productivity is the presence of Big Tech companies. It is argued that Big Tech elements will play a key role in reducing the negative impacts of natural disasters and other external shocks on agricultural enterprises and, consequently, agricultural productivity, as well as in compensating for the related damages during financial crises. Moreover, the intermediary services provided by Big Tech companies in accessing agricultural financial services and thus increasing agricultural productivity are of great importance for global sustainable agriculture (Björkegren & Grissen, 2018, p.70; Farrin & Miranda, 2015, p.199-211; Gambacorta, Huang, Qiu, & Wang, 2024, p.1).

The strengthening structure of big tech companies over time, the rapid progress in financial technologies, the increasing number of financial instruments, the rapidly developing digital finance, and even the financialization of certain strategic agricultural products are contributing to the development of agricultural production and the increase in agricultural productivity, and they are key determinants in the structural transformation of agricultural production. In addition to all this, the increasing accessibility of diversified financial instruments, especially digital finance, in rural areas is crucial for deepening agricultural capital (Cai, Ma, Wang, & Cai, 2024, p.1538). While developing financial technologies reduce the barriers to accessing new production technologies and capital in agricultural production, they also increase agricultural production and help to prevent volatility in agricultural product prices (Hu et al., 2024, p.766; Wang, 2023, p.1).

The development of the financial system also increases the opportunities for agricultural production companies to benefit from various financial support provided by both national and global financial systems. New-generation financial supports (such as R&D Funds, Technology Development Funds, etc.) provided to agricultural export companies will lead to a reduction in financing costs, the adoption of advanced technologies, an increase in competitiveness, and, consequently, an increase in agricultural production and productivity (Dowling & Lucey, 2023, p.5; Z. Liu, Zhang, Li, & Zhao, 2023, p.330; Wen, Cao, Liu, & Wang, 2021, p.6).

A rapidly developing element of the global financial system in recent times is the financialization of agricultural products, which is a result of financial development and the search for new investment instruments. The financialization of agricultural products under commodity index funds and exchange-traded funds (ETFs) provides investors with periodic opportunities, but it also brings certain risks. In particular, the fact that investors in ETFs act without considering physical delivery leads to price

speculation, which can also result in the risk of losses for investors. Financialized agricultural commodities are bought and sold through futures contracts (Manogna & Kulkarni, 2024, p. 280-291).

While financial development is expected to lead to an increase in agricultural production efficiency, it can also expose financialized agricultural commodities to price speculation, increase volatility in the market prices of agricultural products, contribute to food insecurity, promote monoculture farming, and cause disruptions in the supply chain (Clapp & Helleiner, 2012, p.181-207; Headey, 2011, p. 136-146; Mamabolo, Sebola, & Tsheola, 2021, p. 81-97; Tang & Xiong, 2012, p.54-74). Therefore, these negative outcomes can be considered as the adverse effects of financial development on agricultural productivity.

In the context of global financial developments, our study will analyze the impact of increased financial development, the rising number of financial instruments, and consequently increased financial funding on agricultural productivity in Turkey, an important part of the global financial system, where financial depth has recently increased. It is expected that financial development in the Turkish economy will reduce the cost of financial funding in the agricultural sector, and the reduction in funding costs will lead to an increase in agricultural productivity. Our long-run coefficient estimations disclose that financial development possesses statistically significant positive impact on agricultural productivity. The remaining part of the study proceeds as follows: the next part explains data and methodology, the third part provides estimation results and discussion, and the last part concludes.

## 2. Data And Methodology

This study attempts to analyze long-run dynamic relationship between financial development and productivity of agricultural sector in Türkiye. We utilized an annual dataset for the period of 1980-2021 and ARDL estimation technique. The development of financial markets in an economy increases competitiveness in financial sector and this allows producers to access funding opportunities more easily and at lower cost. Low financing costs enable farmers to fund the purchases of additional agricultural machinery and equipment endowed with new technologies (e.g., tractor, cultivator, seed drills, plough, combine harvester, baler, forage harvester, plow, harrow, seeder etc.), agricultural inputs (e.g., seeds, phytosanitary products, fertilizers etc.), and farmland at lower financing rates. As a result of developed financial markets, farmers get chance to increase their production. Therefore the main hypothesis of this study claims that financial development in an economy augments agricultural productivity. Two distinct indicators of agricultural productivity are used to confirm the consistency of the findings of the study. These are agricultural productivity per worker (AGPRODPW) and agricultural productivity per capita (AGPRODPC). We also added two control variables to our model, namely number of registered tractors (TRACTOR) and fertilizer consumption (FERTILIZER). TRACTOR variable is the indicator of the level of agricultural technology and mechanization and FERTILIZER variable is the indicator of the agricultural essential input. Since both of them enhance agricultural production level, we expect to have positive coefficient estimation for them. (Table 1) below provides information on definitions and sources of dependent (i.e., AGPRODPW and AGPRODPC) and independent (i.e., FINDEV, TRACTOR, and FERTILIZER) variables. We used logarithmic forms of all variables in all analyses, and hence coefficients reflect elasticity of the relevant variable.

**Table 1.** Data Definitions and Sources

Variable	Definition	Source
<b>AGPRODPW</b>	Agriculture, forestry, and fishing, value added per worker (constant 2015 US\$)	WDI
<b>AGPRODPC</b>	Computed by dividing "Agriculture, forestry, and fishing, value added (current US\$)" with total population	WDI
<b>FINDEV</b>	Financial development index	IMF
<b>TRACTOR</b>	Number of registered tractors	Turkish Statistical Institute
<b>FERTILIZER</b>	Fertilizer consumption (% of fertilizer production)	WDI

We constructed and estimated the following two ARDL models for co-integration analysis via ARDL bounds test:

$$\Delta\text{AGPRODPW}_t = \alpha_0 + \sum_{i=1}^p \delta_i \Delta\text{AGPRODPW}_{t-i} + \sum_{i=0}^q \phi_i \Delta\text{FINDEV}_{t-i} + \sum_{i=0}^r \lambda_i \Delta\text{TRACTOR}_{t-i} + \sum_{i=0}^s \gamma_i \Delta\text{FERTILIZER}_{t-i} + \theta_0 \text{AGPRODPW}_{t-1} + \theta_1 \text{FINDEV}_{t-1} + \theta_2 \text{TRACTOR}_{t-1} + \theta_3 \text{FERTILIZER}_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta\text{AGPRODPC}_t = \alpha_0 + \sum_{i=1}^p \delta_i \Delta\text{AGPRODPC}_{t-i} + \sum_{i=0}^q \phi_i \Delta\text{FINDEV}_{t-i} + \sum_{i=0}^r \lambda_i \Delta\text{TRACTOR}_{t-i} + \sum_{i=0}^s \gamma_i \Delta\text{FERTILIZER}_{t-i} + \theta_0 \text{AGPRODPC}_{t-1} + \theta_1 \text{FINDEV}_{t-1} + \theta_2 \text{TRACTOR}_{t-1} + \theta_3 \text{FERTILIZER}_{t-1} + \varepsilon_t \quad (2)$$

In regard to Equation 1 and 2 above:  $\theta_0, \theta_1, \theta_2,$  and  $\theta_3$  symbols represent long run coefficients;  $\delta_i, \phi_i, \lambda_i,$  and  $\gamma_i$  symbols show short run coefficients;  $\Delta$  symbol stands for operator of first degree difference;  $\alpha_0$  is constant term, and  $\varepsilon_t$  symbol is white noise error.

In ARDL bounds test, the null hypothesis (i.e.,  $H_0: \theta_0 = \theta_1 = \theta_2 = \theta_3 = 0$ ) asserts the absence of co-integrating association among the variables of agricultural productivity, financial development, number of registered tractors, and consumption of fertilizers. On the other hand the alternative hypothesis (i.e.,  $H_1: \theta_0 \neq \theta_1 \neq \theta_2 \neq \theta_3 \neq 0$ ) claims the presence of co-integrating relationship among the variables of agricultural productivity, financial development, number of registered tractors, and consumption of fertilizers. F-statistic value of ARDL bounds test going beyond the critical value of upper limit at a given significance level points out the existence of co-integrating association among relevant variables, F-statistic value falls short of the critical value of lower limit at a given significance level indicates no co-integrating association among relevant variables, and finally F-statistic value falls between critical value of lower limit and critical value of upper limit implies indecisive zone.

We constructed and estimated the following two models in order to get short run and long run coefficient estimations:

$$\text{AGPRODPW}_t = \beta_0 + \sum_{i=1}^p \alpha_i \Delta\text{AGPRODPW}_{t-i} + \sum_{i=0}^q \mu_i \Delta\text{FINDEV}_{t-i} + \sum_{i=0}^r \theta_i \Delta\text{TRACTOR}_{t-i} + \sum_{i=0}^s \pi_i \Delta\text{FERTILIZER}_{t-i} + \gamma \text{ECM}_{t-1} + \varepsilon_t \quad (3)$$

$$\text{AGPRODPC}_t = \beta_0 + \sum_{i=1}^p \alpha_i \Delta\text{AGPRODPC}_{t-i} + \sum_{i=0}^q \mu_i \Delta\text{FINDEV}_{t-i} + \sum_{i=0}^r \theta_i \Delta\text{TRACTOR}_{t-i} + \sum_{i=0}^s \pi_i \Delta\text{FERTILIZER}_{t-i} + \gamma \text{ECM}_{t-1} + \varepsilon_t \quad (4)$$

The explanation of notations in Equation 3 and 4 as follows:  $\alpha_i, \mu_i, \theta_i,$  and  $\pi_i$  notations show dynamic coefficients; ECM term gives error correction term of the model;  $\gamma$  notation represents the speed of adjustment. The speed of adjustment coefficient must have a statistically significant negative sign.

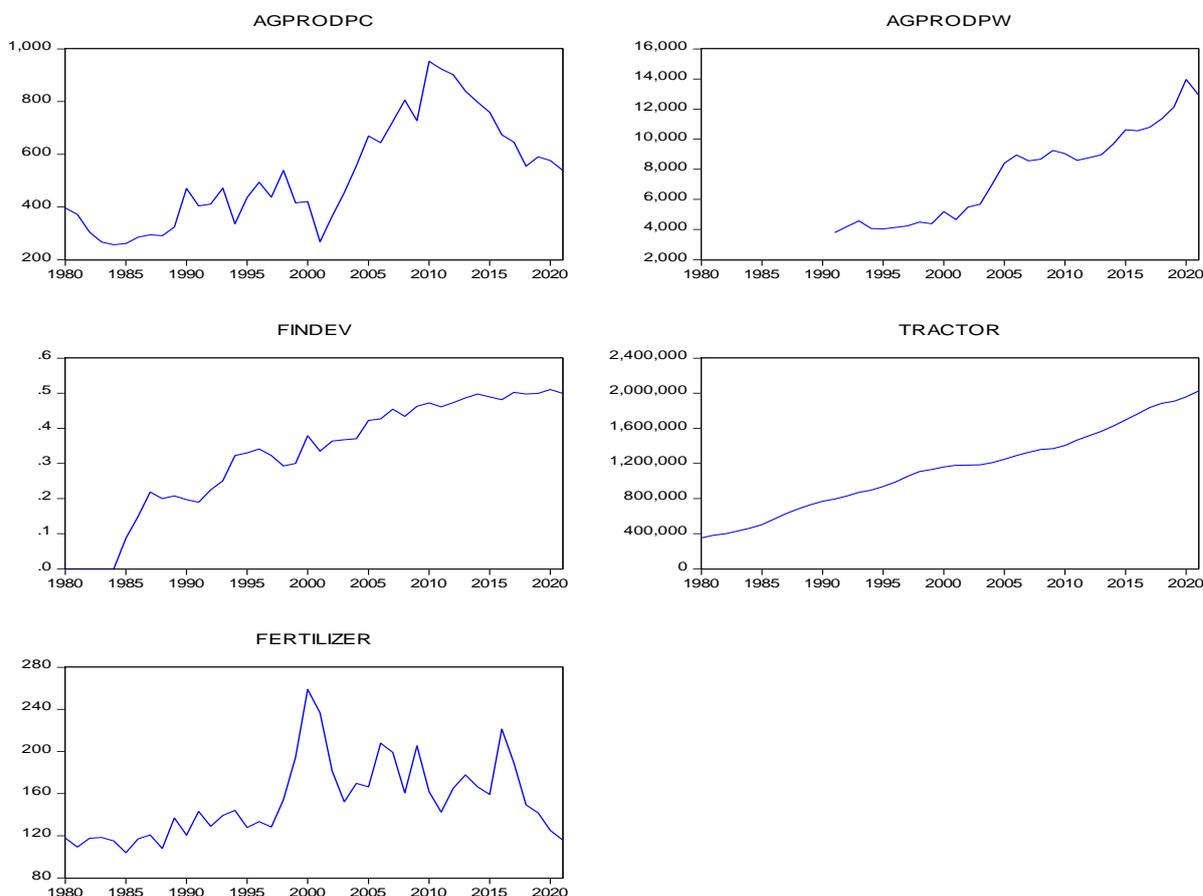
In (Table 2) below we displayed descriptive statistics for the variables of AGPRODPW, AGPRODPC, FINDEV, TRACTOR, and FERTILIZER.

**Table 2.** Descriptive Statistics

	AGPRODPC (1980-2021)	AGPRODPW (1991-2021)	FINDEV (1980-2021)	TRACTOR (1980-2021)	FERTILIZER (1980-2021)
<b>Mean</b>	530.6322	7809.9721	0.3220	1204639.6444	152.7213
<b>Median</b>	482.5540	8576.1243	0.3524	1180127	143.1329
<b>Maximum</b>	952.5301	13967.6264	0.5109	2252224	259.0505
<b>Minimum</b>	256.3362	3791.9499	0.0000	352427	103.8652
<b>Std. Dev.</b>	202.7017	3115.9384	0.1647	530763.5312	36.7394
<b>Skewness</b>	0.4248	0.2189	-0.7099	0.1940	0.9655
<b>Kurtosis</b>	2.0705	1.8265	2.3732	2.1101	3.4068
<b>Jarque-Bera</b>	2.9073	2.0917	4.2150	1.7672	6.9769
<b>Probability</b>	0.2337	0.3514	0.1215	0.4133	0.0305
<b>Sum</b>	23347.8159	249919.1083	13.5235	54208784	6567.0159
<b>Sum Sq.Dev.</b>	1766782.7135	300981236.9387	1.1115	12395236744154.3	56690.9889

In (Graph 1) we show how the variables of agricultural productivity, financial development, number of registered tractors, and consumption of fertilizer behave over time. While the AGPRODPC variable had a fluctuating horizontal pattern until 2000, it experienced a sharp rise between 2000 and 2010 and a sharp

drop after 2010. On the other hand the variables of AGPRODPW, FINDEV, and TRACTOR consistently increased over the estimation period. The FERTILIZER variable horizontally fluctuates with sharp fluctuations after 1995.



**Graph 1.** Series of AGPRODPW, AGPRODPC, FINDEV, TRACTOR, and FERTILIZER

### 3. Estimation Results And Discussion

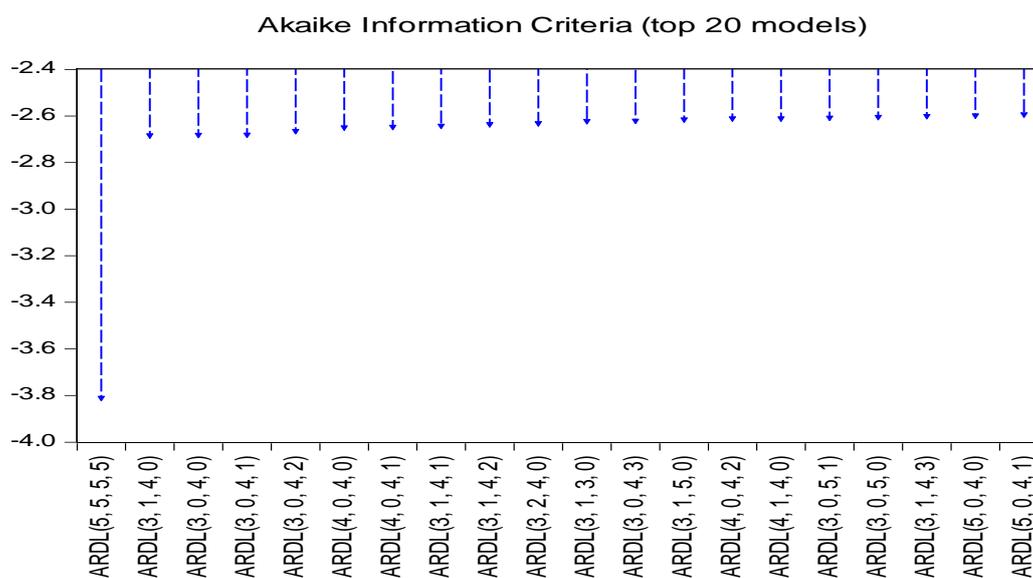
ARDL bounds test requires to have series integrated with order no more than one and thus we firstly checked the integration order of our variables by using Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationarity test. KPSS test results are displayed in (Table 3) below. As indicated by KPSS test findings, the variables of AGPRODPW, AGPRODPC, FINDEV, and FERTILIZER are integrated order zero and hence they are stationary at levels. TRACTOR variable is integrated order one and thus it is stationary at first differences. As a result, each one of our variables meets the requirement of ARDL bounds test and we are able to employ ARDL bounds test for co-integration analysis.

**Table 3.** KPSS Stationarity Test

Null Hypothesis: <b>AGPRODPW</b> is stationary		Integrated Order Zero/I(0)
Model: Constant		
Kwiatkowski-Phillips-Schmidt-Shin test statistic:	<b>0.716110</b>	
Asymptotic critical value at 1% level:		0.739000
Null Hypothesis: <b>AGPRODPC</b> is stationary		Integrated Order Zero/I(0)
Model: Constant		
Kwiatkowski-Phillips-Schmidt-Shin test statistic:	<b>0.653247</b>	
Asymptotic critical value at 1% level:		0.739000

Null Hypothesis: <b>FINDEV</b> is stationary Model: Constant Kwiatkowski-Phillips-Schmidt-Shin test statistic: <b>0.496143</b> Asymptotic critical value at 1% level: 0.739000	Integrated Order Zero/I(0)
Null Hypothesis: <b>TRACTOR</b> is stationary Model: Constant Kwiatkowski-Phillips-Schmidt-Shin test statistic: <b>0.833110</b> Asymptotic critical value at 1% level: 0.739000	Integrated Order One/I(1)
Null Hypothesis: <b>D(TRACTOR)</b> is stationary Model: Constant Kwiatkowski-Phillips-Schmidt-Shin test statistic: <b>0.491028</b> Asymptotic critical value at 1% level: 0.739000	
Null Hypothesis: <b>FERTILIZER</b> is stationary Model: Constant Kwiatkowski-Phillips-Schmidt-Shin test statistic: <b>0.425575</b> Asymptotic critical value at 1% level: 0.739000	Integrated Order Zero/I(0)

Another step in ARDL technique is to identify the best ARDL model in terms of optimal lag length. We used AIC criterion in order to find out the best ARDL model and selected top 20 ARDL models are exhibited in Figure 1 and 2. As seen from Figure 1 and 2, AIC criterion after evaluating 1080 unique ARDL models picked the ARDL(5,5,5,5) model for AGPRODPW model given in Equation 1 and the ARDL(5,5,5,4) model for AGPRODPC model given in Equation 2. Therefore we conducted our all analyses via ARDL(5,5,5,5) and ARDL(5,5,5,4) models.



**Figure 1.** Identifying Optimal Lag Length for AGPRODPW Model

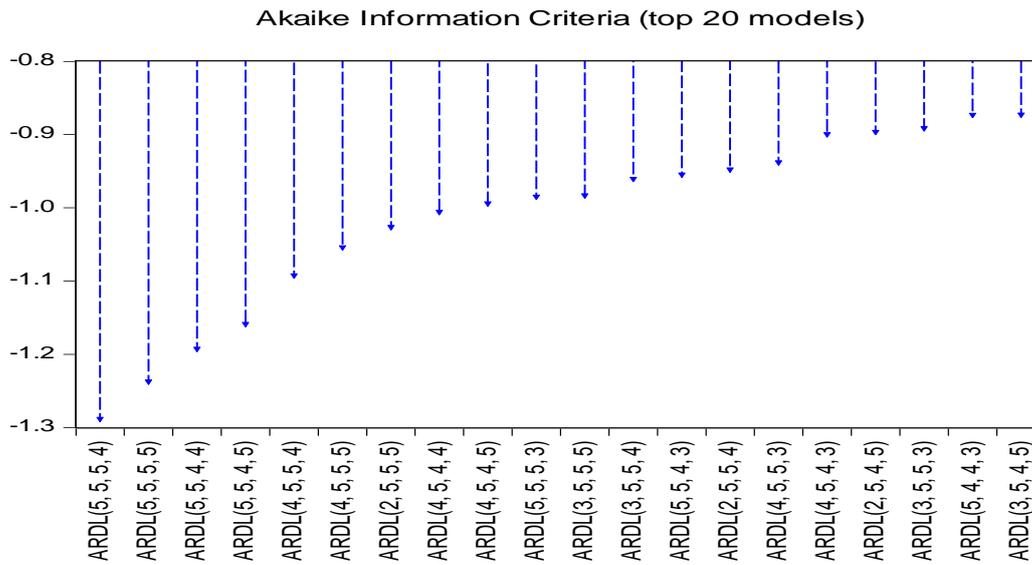


Figure 2. Identifying Optimal Lag Length for AGPRODPC Model

By utilizing ARDL(5,5,5,5) and ARDL(5,5,5,4) models for ARDL bounds test, we implemented co-integration analysis and test findings are given in (Table 4) and (Table 5). As can be deduced from the results given in (Table 4) and (Table 5), values of F-statistic obtained for AGPRODPW and AGPRODPC models are bigger than the upper critical values at all significance levels, thus we say that there is co-integrating relationship among the variables of agricultural productivity, financial development, number of registered tractors, and consumption of fertilizers. In other words the variables of agricultural productivity, financial development, number of registered tractors and consumption of fertilizers move together in the long run over the estimation period.

Table 4. ARDL Bounds Test for ARDL(5,5,5,5) Model (AGPRODPW Model)

	Signif. Level	Lower Limit	Upper Limit
F-statistic: <b>5.894084</b>	10%	2.01	3.1
k: 3	5%	2.45	3.63
	2.5%	2.87	4.16
	1%	3.42	4.84

Table 5. ARDL Bounds Test for ARDL(5,5,5,4) Model (AGPRODPC Model)

	Signif. Level	Lower Limit	Upper Limit
F-statistic: <b>8.030558</b>	10%	2.01	3.1
k: 3	5%	2.45	3.63
	2.5%	2.87	4.16
	1%	3.42	4.84

(Table 6) and (Table 7), report the estimation results for long run coefficients. For the model given in Equation 1, we obtained positive statistically significant coefficient estimation for FINDEV variable. If financial development index increases by 1% then agricultural productivity per worker goes up by 1.75% in Türkiye over the estimation period. We also got positive statistically significant coefficient estimations for FERTILIZER and TRACTOR variables. One percent jumps in FERTILIZER and TRACTOR variables enhance agricultural productivity per worker by 1.22% and 0.27% respectively.

**Table 6.** Long-run Coefficient Estimations for ARDL(5,5,5,5) Model (AGPRODPW Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob
<b>FINDEV</b>	1.752549	0.11825	14.82068	0.0007
<b>FERTILIZER</b>	1.224441	0.239051	5.122081	0.0144
<b>TRACTOR</b>	0.266278	0.087171	3.054661	0.0552
EC = AGPRODPW - (1.7525*FINDEV + 1.2244*FERTILIZER + 0.2663*TRACTOR)				

Regarding to the model given in Equation 2, positive statistically significant coefficient estimation for FINDEV variable was computed. If financial development index goes up by 1% then agricultural productivity per capita expands by 0.87% in Türkiye during the estimation period. Positive statistically significant coefficient estimation for FERTILIZER variable was obtained but no statistically significant coefficient estimation for TRACTOR variable. One percent rise in FERTILIZER variable augments agricultural productivity per capita by 5.15%.

**Table 7.** Long-run Coefficient Estimations for ARDL(5,5,5,4) Model (AGPRODPC Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<b>FINDEV</b>	0.868034	0.341904	2.538826	0.0227
<b>FERTILIZER</b>	5.151044	2.311485	2.228457	0.0416
<b>TRACTOR</b>	-1.471408	0.87596	-1.679766	0.1137
EC = AGPRODPC - (0.8680*FINDEV + 5.1510*FERTILIZER -1.4714*TRACTOR)				

(Table 8) and (Table 9), below display short run coefficient estimation results for ARDL(5,5,5,5) and ARDL(5,5,5,4) models. As indicated by Table 8, second and third lags of AGPRODPW variable possess positive statistically significant short run coefficient estimations and fourth lag of AGPRODPW variable has negative statistically significant short run coefficient estimation. Second and fourth lags of FINDEV variable possess positive statistically significant short run coefficient estimations. Current period short run coefficient estimation of FERTILIZER variable is positive and statistically significant while the remaining short run coefficient estimation of FERTILIZER variable is negative and statistically significant. First and third lags of TRACTOR variable has negative statistically significant short run coefficient estimations whereas second and fourth lags of TRACTOR variable possess positive statistically significant short run coefficient estimations. As expected we got negative statistically significant coefficient estimation for ECM term.

**Table 8.** Short-run Coefficient Estimations for ARDL(5,5,5,5) Model (AGPRODPW Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGPRODPW(-1))	-0.3252	0.1829	-1.7778	0.1735
D(AGPRODPW(-2))	0.5971	0.1903	3.1380	0.0517
D(AGPRODPW(-3))	3.1141	0.6605	4.7152	0.0181
D(AGPRODPW(-4))	-1.4235	0.2495	-5.7057	0.0107
D(FINDEV)	-0.7570	0.4121	-1.8371	0.1635
D(FINDEV(-1))	0.3710	0.3028	1.2249	0.3080
D(FINDEV(-2))	2.6657	0.4705	5.6662	0.0109
D(FINDEV(-3))	0.4636	0.2227	2.0812	0.1288
D(FINDEV(-4))	1.8679	0.3561	5.2457	0.0135
D(FERTILIZER)	0.9319	0.1670	5.5815	0.0114
D(FERTILIZER(-1))	-2.1314	0.2810	-7.5842	0.0048
D(FERTILIZER(-2))	-2.1160	0.2968	-7.1284	0.0057
D(FERTILIZER(-3))	-2.5861	0.3872	-6.6793	0.0068
D(FERTILIZER(-4))	-1.6452	0.2968	-5.5424	0.0116
D(TRACTOR)	4.2799	2.7372	1.5636	0.2159
D(TRACTOR(-1))	-35.2495	8.4499	-4.1716	0.0251
D(TRACTOR(-2))	45.6840	9.0685	5.0377	0.0151
D(TRACTOR(-3))	-19.9168	4.9125	-4.0543	0.0270
D(TRACTOR(-4))	24.9455	4.4484	5.6078	0.0112
ECMt-1	-1.8612	0.2710	-6.8668	0.0063

As seen from the (Table 9), first lag of AGPRODPW variable possess negative statistically significant short run coefficient estimation whereas third and fourth lags of AGPRODPW variable have positive statistically significant short run coefficient estimations. Current period short run coefficient estimation of FINDEV variable has positive statistically significant short run coefficient estimation while the remaining lags of FINDEV variable get negative statistically significant coefficient estimations. Except statistically insignificant current period short run coefficient estimation, the remaining lags of FERTILIZER variable possess negative and statistically significant short run coefficient estimations. Short run coefficient estimations of current period and third lag of TRACTOR variable have positive statistically significant short run coefficient estimations. Negative statistically significant coefficient estimation for ECM term was obtained as required.

**Table 9.** Short-run Coefficient Estimations for ARDL(5,5,5,4) Model (AGPRODPC Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGPRODPC(-1))	-0.4925	0.1368	-3.6007	0.0026
D(AGPRODPC(-2))	0.1333	0.1357	0.9825	0.3415
D(AGPRODPC(-3))	0.4952	0.1249	3.9637	0.0012
D(AGPRODPC(-4))	0.3054	0.1296	2.3556	0.0325
D(FINDEV)	0.3171	0.0522	6.0800	0.0000
D(FINDEV(-1))	-0.1291	0.0312	-4.1406	0.0009
D(FINDEV(-2))	-0.1207	0.0314	-3.8434	0.0016
D(FINDEV(-3))	-0.1163	0.0301	-3.8670	0.0015
D(FINDEV(-4))	-0.1059	0.0283	-3.7451	0.0020
D(FERTILIZER)	-0.1274	0.1339	-0.9517	0.3564
D(FERTILIZER(-1))	-2.5367	0.3701	-6.8541	0.0000
D(FERTILIZER(-2))	-1.9944	0.3250	-6.1366	0.0000
D(FERTILIZER(-3))	-1.1819	0.2456	-4.8122	0.0002
D(FERTILIZER(-4))	-0.3953	0.1935	-2.0431	0.0590
D(TRACTOR)	8.5011	2.3487	3.6195	0.0025
D(TRACTOR(-1))	1.5674	3.0469	0.5144	0.6145
D(TRACTOR(-2))	4.3439	2.9527	1.4712	0.1619
D(TRACTOR(-3))	6.4873	1.8976	3.4186	0.0038
ECMt-1	-0.4159	0.0670	-6.2086	0.0000

We conducted several diagnostic tests (i.e., tests for normality, autocorrelation, heteroscedasticity, and model specification) and test results are exhibited in Table 10 and 11. As indicated by the test results in (Table 10) and (Table11),, our estimated ARDL(5,5,5,5) and ARDL(5,5,5,4) models are not exposed to autocorrelation, heteroscedasticity, non-normality, and model misspecification problems.

**Table 10.** Diagnostic Test Results for ARDL(5,5,5,5) Model (AGPRODPW Model)

Tests	Test Value / (Prob.)
Jerque-Bera Normality Test	0.587232 (0.745563)
Breusch-Godfrey Serial Correlation LM Test	38.47823 (0.1133)
ARCH Heteroskedasticity Test	0.516828 (0.4794)
Ramsey RESET Test	6.299570 (0.1288)

**Table 11.** Diagnostic Test Results for ARDL(5,5,5,4) Model (AGPRODPC Model)

Tests	Test Value / (Prob.)
Jerque-Bera Normality Test	0.654375 (0.720948)
Breusch-Godfrey Serial Correlation LM Test	0.752778 (0.4905)
ARCH Heteroskedasticity Test	0.055339 (0.8154)
Ramsey RESET Test	0.289742 (0.5988)

Moreover we implemented parameter stability test by using CUSUM parameter stability test for ARDL(5,5,5,5) and ARDL(5,5,5,4) models but not reported results to save space. The findings of CUSUM parameter stability test pointed out that the parameters of ARDL(5,5,5,5) and ARDL(5,5,5,4) models are stable.

#### 4. Conclusion

This study investigates the long run influence of financial development on agricultural productivity for two different indicators of agricultural productivity by employing ARDL estimation method and a dataset covering the years between 1980 and 2021 for Türkiye. KPSS stationarity test results disclosed the stationarity of variables of agricultural productivity per worker, agricultural productivity per capita, financial development, and fertilizer consumption at levels (i.e.,  $I(0)$ ) and also stationarity of variable of number registered tractors at first differences (i.e.,  $I(1)$ ). Cointegration analysis performed by utilizing ARDL bounds test and the test findings show that there is co-integrating association among the variables of agricultural productivity, financial development, number of registered tractors, and consumption of fertilizers and thus they move together in the long run during the estimation period.

For the model where agricultural productivity per worker (i.e. AGPRODPW variable) is dependent variable, we got positive statistically significant coefficient estimation for financial development variable. If financial development index goes up by 1% then agricultural productivity per worker augments by 1.75%. Meanwhile we had positive statistically significant coefficient estimations for FERTILIZER and TRACTOR variables. One percent rises in FERTILIZER and TRACTOR variables increase agricultural productivity per worker by 1.22% and 0.27% respectively.

For the model where agricultural productivity per capita (i.e. AGPRODPC variable) is dependent variable, we obtained positive statistically significant coefficient estimation for financial development variable. If financial development index increases by 1% then agricultural productivity per capita augments by 0.87%. Positive statistically significant coefficient estimation for FERTILIZER variable was computed but statistically insignificant coefficient estimation for TRACTOR variable was obtained. One percent jump in FERTILIZER variable enhances agricultural productivity per capita by 5.15%. Meantime we implemented several diagnostic tests (i.e., tests for normality, autocorrelation, heteroscedasticity, model specification, and parameter stability) and test results revealed that our estimated ARDL(5,5,5,5) and ARDL(5,5,5,4) models are free from autocorrelation, heteroscedasticity, non-normality, model misspecification, and parameter instability problems.

In sum this study makes contribution to the literature as first study addressing to the long-run impact of financial development on agricultural productivity for the case of Türkiye. The findings of the study are in parallel to ones existing in the literature. The transition mechanism of the identified positive significant influence of financial development on agricultural productivity may be indirectly occurring. Firstly the development of financial market in a country enhances competitiveness in financial sector and thus farmers are able to access funding opportunities more easily and at lower cost. Secondly farmers funding their additional purchases (i.e., purchases of additional agricultural machinery and equipment endowed with new technologies, agricultural inputs, farmland etc.) at low financing costs gets chance to realize higher agricultural production. As in the literature, we obtained positive significant coefficients for the control variables fertilizer consumption and number registered tractors. Both control variables make positive contribution to agricultural productivity but the most contributing one is fertilizer consumption. One of the limitations of this study arises from the number included control variables. Since estimated two models (i.e., ARDL(5,5,5,5) and ARDL(5,5,5,4) models) are quite big models in terms of lag length we easily lose degrees of freedom and this make us unable to estimate parameters and hence unable to include more control variables. Another limitation of this study is restriction of the sample observations for just years between 1980 and 2021 due to unavailability of the data for the other years. Moreover the finding of significant positive association between financial development and agricultural productivity discloses the importance of developed financial market for enhancement of agricultural productivity in a country. Therefore policy makers targeting to enhance agricultural productivity and thus agricultural production should prioritize policies and incentives supporting the development of financial markets besides the other policies and precautions brought into action.

**Arařtırmacıların Katkı Oran Beyanı / Contribution of Authors**

Yazarların alıřmadaki katkı oranları Serkan VARSAK %34/ Cüneyt KOYUNCU %33/ Halit YALÇIN %33  
şeklindedir.

The authors' contribution rates in the study are Serkan VARSAK %34/ Cüneyt KOYUNCU %33/ Halit YALÇIN %33  
form.

**ıkar atıřması Beyanı / Conflict of Interest**

alıřmada herhangi bir kurum veya kiři ile ıkar atıřması bulunmamaktadır.  
There is no conflict of interest with any institution or person in the study.

**İntihal Politikası Beyanı / Plagiarism Policy**

Bu makale İntihal programlarında taranmış ve İntihal tespit edilmemiřtir.  
This article was scanned in Plagiarism programs and Plagiarism was not detected.

**Bilimsel Arařtırma ve Yayın Etięi Beyanı / Scientific Research and Publication Ethics  
Statement**

Bu alıřmada Yükseköęretim Kurumları Bilimsel Arařtırma ve Yayın Etięi Yönergesi kapsamında belirtilen  
kurallara uyulmuřtur.  
In this study, the rules specified within the scope of the Higher Education Institutions Scientific Research and  
Publication Ethics Directive were followed.

## References

- Allen, F., Qian, J. Q., & Gu, X. (2017). An overview of China's financial system. *Annual Review of Financial Economics*, 9(1), 191-231.
- Aydınbaş, G. (2023). A study on smart agriculture (agriculture 4.0) from an economic perspective. *BİLTÜRK Ekonomi ve İlişkili Çalışmalar Dergisi*, 5(2), 63-86.
- Beck, T. (2002). Financial development and international trade: Is there a link? *Journal of International Economics*, 57(1), 107-131.
- Bernanke, B., & Gertler, M. (1990). Financial fragility and economic performance. *The Quarterly Journal of Economics*, 105(1), 87-114.
- Björkegren, D., & Grissen, D. (2018). *The potential of digital credit to bank the poor*. Paper presented at the AEA papers and proceedings, 108, 68-71.
- Bruhn, M., & Love, I. (2014). The real impact of improved access to finance: Evidence from Mexico. *The Journal of Finance*, 69(3), 1347-1376.
- Burgess, R., & Pande, R. (2005). Do rural banks matter? Evidence from the Indian social banking experiment. *American Economic Review*, 95(3), 780-795.
- Cai, R., Ma, J., Wang, S., & Cai, S. (2024). Access to credit and scale efficiency: Evidence from family farms in East China. *Economic Analysis and Policy*, 84, 1538-1551.
- Chi, M., Guo, Q., Mi, L., Wang, G., & Song, W. (2022). Spatial distribution of agricultural eco-efficiency and agriculture high-quality development in China. *Land*, 11(5), 722.
- Clapp, J., & Helleiner, E. (2012). Troubled futures? The global food crisis and the politics of agricultural derivatives regulation. *Review of International Political Economy*, 19(2), 181-207.
- Clarke, G. R., Zou, H.-f., & Xu, L. C. (2003). *Finance and income inequality: test of alternative theories* (Vol. 2984): World Bank Publications.
- Dağ, M. M., & Akbay, C. (2022). Sürdürülebilir tarımsal uygulamalar ile küresel gıda krizine karşı alternatif çözümler. *Tarım Ekonomisi Araştırmaları Dergisi*, 8(2), 101-113.
- Dowling, M., & Lucey, B. (2023). ChatGPT for (finance) research: The Bananarama conjecture. *Finance Research Letters*, 53, 103662.
- Fan, S., Jiang, M., Sun, D., & Zhang, S. (2023). Does financial development matter the accomplishment of rural revitalization? Evidence from China. *International Review of Economics & Finance*, 88, 620-633.
- Farrin, K., & Miranda, M. J. (2015). A heterogeneous agent model of credit-linked index insurance and farm technology adoption. *Journal of Development Economics*, 116, 199-211.
- Gambacorta, L., Huang, Y., Qiu, H., & Wang, J. (2024). How do machine learning and non-traditional data affect credit scoring? New evidence from a Chinese fintech firm. *Journal of Financial Stability*, 73, 101284.
- Gao, Q., Sun, M., & Chen, L. (2024). The impact of digital inclusive finance on agricultural economic resilience. *Finance Research Letters*, 66, 105679.
- Headey, D. (2011). Rethinking the global food crisis: The role of trade shocks. *Food Policy*, 36(2), 136-146.
- Hu, Y., Liu, J., Zhang, S., Liu, Y., Xu, H., & Liu, P. (2024). New mechanisms for increasing agricultural total factor productivity: Analysis of the regional effects of the digital economy. *Economic Analysis and Policy*, 83, 766-785.
- King, R. G., & Levine, R. (1993). Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics*, 108(3), 717-737.
- Liu, Y., Liu, C., & Zhou, M. (2021). Does digital inclusive finance promote agricultural production for rural households in China? Research based on the Chinese family database (CFD). *China Agricultural Economic Review*, 13(2), 475-494.
- Liu, Z., Zhang, M., Li, Q., & Zhao, X. (2023). The impact of green trade barriers on agricultural green total factor productivity: Evidence from China and OECD countries. *Economic Analysis and Policy*, 78, 319-331.

Mamabolo, M., Sebola, M., & Tsheola, J. (2021). The Economics Of Communal Smallholder Farming Within South Africa's Historical Agricultural Structure. *Journal of Global Business & Technology*, 17(2), 81-97.

Manogna, R., & Kulkarni, N. (2024). Does the financialization of agricultural commodities impact food security? An empirical investigation. *Borsa Istanbul Review*, 24(2), 280-291.

Mei, B., Khan, A. A., Khan, S. U., Ali, M. A. S., & Luo, J. (2022). Complementarity or substitution: a study of the impacts of internet finance and rural financial development on agricultural economic growth. *Agriculture*, 12(11), 1786.

Shahzad, S. J. H., Kumar, R. R., Zakaria, M., & Hurr, M. (2017). Carbon emission, energy consumption, trade openness and financial development in Pakistan: a revisit. *Renewable and Sustainable Energy Reviews*, 70, 185-192.

Tang, K., & Xiong, W. (2012). Index investment and the financialization of commodities. *Financial Analysts Journal*, 68(6), 54-74.

Wang, J. (2023). Digital inclusive finance and rural revitalization. *Finance Research Letters*, 57, 104157.

Wen, F., Cao, J., Liu, Z., & Wang, X. (2021). Dynamic volatility spillovers and investment strategies between the Chinese stock market and commodity markets. *International Review of Financial Analysis*, 76, 101772.

Zhu, K., & Guo, L. (2024). Financial technology, inclusive finance and bank performance. *Finance Research Letters*, 60, 104872.