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An Analysis of the Relationship between Interest-Free Financing of Agricultural Production and Agricultural Growth Using Contemporary Econometric Methods

Tarımsal Üretimin Faizsiz Finansmanı ve Tarımsal Büyüme Arasındaki İlişkinin Güncel Ekonometrik Yöntemlerle Analizi

Ömer KESKİN
Öğr. Gör. Dr., Van Yüzüncü Yıl Üniversitesi, Özalp Meslek Yüksekokulu, Dış Ticaret Bölümü
Lecturer Dr., Van Yuzuncu Yil University, Özalp Vocational School, Foreign Trade Department
Van /Türkiye
omerkeskin@yyu.edu.tr orcid.org/0000-0002-1939-2791

Burak ÇIKIRYEL
Dr. Öğr. Üyesi, Ankara Sosyal Bilimler Üniversitesi, İslami Araştırmalar Enstitüsü, İslam Ekonomisi ve Finansı Anabilim Dalı
Asst. Prof. Dr., Social Sciences University of Ankara, Institute for Islamic Studies, Department of Islamic Economics and Finance
Ankara/Türkiye
burak.cikiryel@asbu.edu.tr orcid.org/0000-0003-0009-6252

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An Analysis of the Relationship between Interest-Free Financing of Agricultural Production and Agricultural Growth Using Contemporary Econometric Methods

Abstract

Participation banks, operating on the principle of interest-free banking in the Turkish banking sector, have increasingly specialized in agricultural banking. Agricultural banking is a specialized sector of the banking industry that provides financial services to agricultural enterprises to help them manage their financial status, sustain their production activities, and further grow their businesses. Besides the financial gains accrued by banks, one of the primary objectives of providing financial services under agricultural banking is to enable agricultural enterprises to achieve high productivity per unit area, thereby contributing more significantly to growth in the agricultural sector. Hence, participation banks, similar to other banks, offer a diverse range of services to achieve this goal. Investigating the effects of participation banks' services is a noteworthy research topic. By employing time series analysis, this study examines the impact of participation banks' financing of the agricultural sector on agricultural gross domestic product (GDP) in Türkiye. The data sets used in the analysis include the agricultural financing supplied by participation banks and the agricultural GDP values. The period examined spans from 2005Q1 to 2023Q4. The methods applied in the analysis include the Fourier Augmented Dickey-Fuller (FADF) unit root test, the Fourier Autoregressive Distributive Lag (FADL) cointegration test, the Residual Augmented Least Squares-Fourier Autoregressive Distributive Lag (RALS-FADL) cointegration test, and the Fourier Toda-Yamamoto (FTY) causality test. According to the cointegration tests, a 1% increase in the agricultural financing provided by participation banks leads to a rise in agricultural GDP by 0.80% in the long-run and 0.15% in the short run. The results of the cointegration test are further supported by the findings of the causality test. Consequently, it is evident that the growth in funding allocated to the agricultural sector by participation banks in Türkiye triggers a surge in agricultural GDP. In this regard, it is recommended that all participation banks, particularly the publicly funded Ziraat Katılım Bankası A.Ş., which receives support from the Treasury, continue to increase their financial support to the agricultural sector annually to ensure its sustainable growth.

Keywords: Finance, Islamic Finance, Participation Banking, Agricultural Financing, Agricultural Growth.

Tarımsal Üretimin Faizsiz Finansmanı ve Tarımsal Büyüme Arasındaki İlişkinin Güncel Ekonometrik Yöntemlerle Analizi

Özet

Türk bankacılık sektöründe faizsiz bankacılık prensibiyle faaliyet gösteren katılım bankaları tarım bankacılığında giderek uzmanlaşmaktadırlar. Tarım bankacılığı, tarım işletmelerine mali durumlarını yönetmeleri, üretim faaliyetlerini sürdürmeleri ve işlerini daha da büyütmeleri konusunda yardımcı olmak için finansal hizmetler sağlayan bankacılık sektörünün uzmanlaşmış bir ihtisas alanıdır. Tarım bankacılığı kapsamında finansal hizmetlerin verilmesindeki temel amaçlardan biri, bankalardan elde edilen finansal kazanımların yanı sıra tarım işletmelerinin birim alandan yüksek verim elde etmelerini sağlayarak tarım sektörünün büyümesine daha önemli katkı sağlamaktır. Dolayısıyla katılım bankaları da diğer bankalar gibi bu amaca ulaşmak için çok çeşitli hizmetler sunmaktadırlar. Katılım bankalarının hizmetlerinin etkilerinin araştırılması, dikkate değer bir araştırma konusudur. Bu çalışma, Türkiye'deki katılım bankalarının tarım sektörüne sağladıkları finansmanın tarımsal gayrisafi yurt içi hasıla (GSYİH) üzerindeki etkisini zaman serisi analiziyle incelemektedir. Analizde kullanılan veri setleri, katılım bankalarının sağladıkları tarımsal finansman ve tarımsal GSYİH değerlerini içermektedir. İncelenen dönem, 2005Q1 ve 2023Q4 arasını kapsamaktadır. Analizde uygulanan yöntemler arasında Fourier Artırılmış Dickey-Fuller (FADF) birim kök testi, Fourier Otoregresif Gecikmesi Dağıtılmış (FADL) eşbütünleşme testi, Hata Terimleriyle Genişletilmiş En Küçük Kareler (RALS-FADL)

eşbütünleşme testi ve Fourier Toda-Yamamoto (FTY) nedensellik testi yer almaktadır. Eşbütünleşme testlerine göre katılım bankaları tarafından sağlanan tarımsal finansmandaki %1'lik yükseliş, tarımsal GSYİH'nin uzun vadede %0,80, kısa vadede ise %0,15 yükselmesine neden olmaktadır. Eşbütünleşme test sonuçları, nedensellik testinden elde edilen bulgularla da desteklenmektedir. Sonuç olarak, Türkiye'deki katılım bankalarının tarım sektörüne tahsis ettikleri fonlardaki artışın tarımsal GSYİH'deki artışı tetiklediği ortadadır. Bu bağlamda, tarım sektörünün sürdürülebilir bir şekilde büyüyebilmesi için başta Hazine desteğini alan kamusal sermayeli Ziraat Katılım Bankası A.Ş. olmak üzere diğer tüm katılım bankalarının tarım sektörüne yönelik verdikleri mali desteği her yıl artırarak sürdürmeleri önerilmektedir.
Anahtar Kelimeler: Finans, İslami Finans, Katılım Bankacılığı, Tarımsal Finansman, Tarımsal Büyüme.

Introduction

The term agriculture is used in a broad sense to encompass farming, forestry, fishing, soil and water, agro-industries, the environment, the production of agricultural inputs and machinery, and regional and rural development.[1] Traditionally, one of the primary functions of agriculture is to be an economic activity that provides people and animals with the necessary nutrients. Another significant function of agriculture is to supply production inputs, labor, and markets to all other sectors connected to it.[2] According to development economics, for an economy to reach the status of a developed country, there must be a healthy transition from the agricultural sector to the industrial sector and then to the service sector. Consequently, it is expected that the share of the agricultural sector in a nation's GDP will gradually decline as the economy develops.[3] Despite this transformation, the agricultural sector remains strategic, particularly in developing economies, due to its ability to grow even when other sectors contract. The growth of Türkiye's agricultural sector during the economic downturn caused by the COVID-19 pandemic is clear evidence of this.[4] Furthermore, the ongoing conflict between Ukraine and Russia, along with the rise in regional disputes, underscores the heightened importance of ensuring security within the food supply chain.

The increasing population, urbanization, climate change, epidemics, and wars are factors that hinder agricultural production. In this challenging environment, it is essential to produce agricultural products for human consumption and animal breeding in a sustainable and timely manner. With arable land becoming scarce, ensuring food supply and continuity depends on more efficient production. It is crucial to use inputs such as fertilizer, pesticides, seeds, mechanization, and labor consciously on the soil. Providing agricultural loans to agricultural enterprises interest-free will also be important for sustainable agricultural practices.

In Islam, the freedom to engage in financial activities is restricted by certain fundamental prohibitions to prevent unjust gains and unfair practices. For instance, charging interest on loans is prohibited in Islam.[5] The needs of those requiring capital can be met through interest-free financing methods such as qard, salam, and mudarabah. A large number of participation banks (Islamic banks, known as participation banks in Türkiye) have been established to operate within this interest-free financial system. In Türkiye, banks operating for this purpose were referred to as Special Finance Houses before 2005, after which they were renamed participation banks. As of May 2024, there are nine participation banks

1 Food and Agriculture Organization (FAO), "Glossary" (Access 11 May 2024).
2 Ali Rıza Karacan, *Tarım İşletmelerinin Finansmanı ve Tarımsal Kredi* (İzmir: Ege Üniversitesi Basımevi, 1991), 2-3.
3 Mislina Ersöz - Esra Bingöl, "İktisatın Unutulmuş Çocuğu: Tarım Sektörü ve Tarımın Orta Doğu'daki Geleceği", *Tarım Ekonomisi Dergisi* 28/1 (2022), 131.
4 Denizbank, *Faaliyet Raporu 2022* (Denizbank A.Ş., 2023), 68.
5 *Kur'an-ı Kerim ve Karşılıklı Muhtasar Meali*, trans. Hayrat Neşriyat Meal Heyeti (İstanbul: Hayrat Neşriyat, 2017), al-Baqara 2/275.

operating in Türkiye, including two digital banks.[6] Participation banks, whose market share in the banking sector is approaching 9%, have 1,469 branches, 20,806 employees, and 2,449 ATMs throughout Türkiye.[7]

One such specialized area that participation banks have focused on is agricultural banking. This area of the banking industry offers financial services to agricultural enterprises to help them manage their finances, support their production activities, and expand their operations. Among the services provided in this domain, the most crucial is financing, which constitutes an indispensable component of the economic activities of agricultural enterprises in Türkiye.[8] The rapid increase in the amount of agricultural loans, especially in the past few years of intensified inflation, is an indicator of this necessity.[9]

As of March 2023, the financing provided by participation banks to the agricultural sector in Türkiye has reached 15,137 billion TL. With this level of funding, participation banks contribute 2.5% to the total financing provided to the agricultural sector in Türkiye. It is followed by the development and investment banks with 5 billion 203 million TL financing, which represents a 0.9% share. The remaining 96.6% share is held by deposit banks.[10] The share of participation banks is quite low. Hence, an argument can be made that participation banks, operating under the principle of no interest, fail to fully exploit the existing customer potential in agricultural banking. This hinders their efforts to increase their market share in the Turkish banking sector.

Considering participation banks' main goal of supporting the real sector, examining the impact of their financing on the agricultural sector indicators can be regarded as a noteworthy research topic, given agriculture's role as a primary sector. Thus, this study aims to analyze how this impact is manifested in agricultural growth indicators. Several scholarly inquiries have scrutinized the implications of participation banks' financing on the agricultural sector, reflecting the ongoing academic interest in this area. A summary of some researches is presented in Table 1 below.

Table 1. Summary of Literature

Sample	Topic	Methodology and Period	Findings
Pakistan	Exploring the Role of Islamic Banking in the Agricultural Sector of the Bahawalpur Region in Pakistan	Survey, 2011	Islamic banks do not provide financing for the establishment of irrigation systems in the agricultural sector, resulting in farmers not fully benefiting from financing opportunities.[11]
Malaysia	Analyzing the Impact of Islamic Banking on Sectoral Outputs in Malaysia	Autoregressive Distributed Lag (ARDL) and Error Correction Model, 1997Q1-2014Q4	Islamic agricultural finance exhibits no discernible impact on agricultural output.[12]
Iran	Investigating the Value-Added Impact of Islamic	ARDL, 1988-2014	The agricultural financing provided by Islamic banks exerts a

6 Banking Regulation and Supervision Agency (BRSA), "Banks" (Access 10 May 2024a).
7 Türkiye Katılım Bankaları Birliği (TKBB), "Banka ve Sektör Bilgileri" (Access 11 May 2024).
8 Kredi Kayıt Bürosu, *Türkiye Tarımsal Görünüm Saha Araştırması-2022* (Kredi Kayıt Bürosu, 2022), 37.
9 Türkiye Ziraat Odaları Birliği (TZOB), "2023 Yılı Değerlendirmesi ve 2024 Yılı Beklentileri Raporu" (Access 10 May 2024).
10 BRSA, "Sektörel Kredi Dağılımı-Katılım, Kalkınma ve Yatırım, Mevduat (Tarım, Avcılık, Ormancılık ve Balıkçılık)" (Access 11 May 2024b).
11 Muhammad Taimoor Hassan et al., "Role of Islamic Banking in Agriculture Development in Bahawalpur, Pakistan", *International Journal of Learning and Development* 2/3 (2012), 123-138.
12 Abdulsalam Abubakar - Salina Kassim, "Sectoral Impact of Bank Credit in Malaysia: ARDL Modelling Approach", *Pertanika J. Soc. Sci. & Hum* 24 (2016), 205-211.

Sample	Topic	Methodology and Period	Findings
	Banking on the Agricultural Sector in Iran		short-run adverse impact on agriculture, while yielding a positive effect in the long run.[13]
Türkiye	Studying the Relationship between Sectoral Credits and Economic Growth in Türkiye	Granger Causality, Toda-Yamamoto, 2007Q4-2015Q4	The financing of participation banks to the agriculture/fishery sector is the Granger cause for economic growth.[14]
Indonesia	Analyzing the Factors that Influence Agricultural Financing Service of Islamic Banks in Indonesia	Vector Error Correction Model (VECM), No Period	There is a one-way causal relationship between interest rates and Islamic banks' financing services in the agricultural sector.[15]
Indonesia	Examining the Role of Islamic Banks in the Development of the Indonesian Agriculture Sector	In-depth Interviews, 2019	The financing provided by Islamic banks to the agricultural sector remains highly inadequate due to perceived high risk and personnel shortages.[16]
Indonesia	Studying the Role of Islamic Banking on the Agricultural Sector in Indonesia	Ordinary Least Squares (OLS), 2014-2016	The incentives of Islamic Bank Indonesia Certificates, third-party funds, inflation, and non-performing financing significantly influence Islamic agricultural finance.[17]
Indonesia	Investigating the Role of Islamic Banks in the Development of Sectors in Indonesian Economy	Two Stage Least Square, 2005-2016	The agricultural financing provided by Islamic banks has a positive impact on sectoral GDP growth but adversely affects employment generation in the agricultural sector.[18]
Indonesia	Analyzing the Factors that Influence Islamic Agricultural Finance in Indonesia	VECM, January 2015-April 2019	The variables that significantly influence agricultural financing in the long-run are deposit funds, exchange rate, and Industrial Production Index.[19]
Indonesia	Determining the Macroeconomic Factors that Impact the Agricultural Financing Activities of Islamic Banks in Indonesia	VECM, June 2006-June 2020	Islamic banks' agricultural financing activities were influenced by interest rates and inflation in both the short and long

[13] Mohammad Abdi Seyyedkolaee - Fereshte Hoseinzadeh, "Investigating the Impact of Islamic Contracts Credits on the Value Added of Agricultural Sector in Iran", *The Second National Conference on Iran Economy*, (Mazandaran: University of Mazandaran, 2018), 1-16.

[14] Tuğrul Kandemir et al., "Sektörel Krediler ve Ekonomik Büyüme Arasındaki Nedensellik İlişkisi: Türkiye Katılım Bankaları Örneği", *Aksaray Üniversitesi İktisadi ve İdari Bilimler Dergisi* 10/2 (2018), 19-30.

[15] Heri Sudarsono et al., "Analysis of Factors Affecting the Financing with Islamic Banks in Agriculture Sectors", *Asian Journal of Islamic Management* 1/2 (2019), 116-126.

[16] Satria Utama et al., "The Role of Islamic Banking in Agriculture Financing (Case Study of Indonesian Agriculture Sector)", *Humanities & Social Sciences Reviews* 7/2 (2019), 261-269.

[17] Tari Lestari, "Analysis of Islamic Bank Influence on Agricultural Financing Sector Period 2014-2016", *Journal of Islamic Economic Laws* 2/1 (2019), 88-119.

[18] Iwan Setiawan, "The Role of Islamic Banking in the Development of Economic Sectors in Indonesia", *International Journal of Applied Business Research* 1/2 (2019), 88-99.

[19] Satrio Arif Wicaksono - Yeny Fitriyani, "Analysis of Factor Affecting Islamic Commercial Bank Financing for the Agricultural Sector in Indonesia", *Asian Journal of Islamic Management* 2/2 (2020), 123-137.

Sample	Topic	Methodology and Period	Findings
			run.[20]
Türkiye	Examining the Effect of Banks' Credit Growth on Agricultural GDP in Türkiye	Engle-Granger Cointegration Test, 2009Q1-2019Q4	The escalation of funding from participation banks directed towards the agricultural sector does not yield a favorable contribution to the increase in agricultural GDP.[21]
Indonesia	Investigating the Determinants of Islamic Agricultural Finance (Shariah Banking) in Indonesian Agriculture Sector	OLS, 2014-2020	The variables of third-party funds and exchange rates significantly affected Islamic agricultural finance.[22]
Türkiye	Examining the Relationship between Agricultural Credits and Agricultural Growth in Türkiye	ARDL, 2005Q1-2021Q4	The expansion of agricultural financing facilitated by participation banks demonstrates a positive effect on agricultural GDP.[23]
Pakistan	Nexus between Islamic Bank Decomposed Financing and Agriculture Output Growth in Pakistan	ARDL, 2010Q1-2020Q4	The agricultural financing provided by Islamic banks positively influences agricultural growth up to a certain threshold, beyond which the effect reverses.[24]
Indonesia	Determining the Factors that Affect the Agricultural Financing Activities of Islamic Banks in Indonesia	ARDL, 2012Q1-2021Q4	Agricultural financing risk and economic growth have a positive effect, while inflation has a negative effect on the agricultural financing activities of Islamic banks.[25]

Among the studies in the literature on the subject, Çinko and Balcı[26] found that agricultural financing provided by participation banks did not have a positive impact on agricultural GDP, while Setiawan[27] and Uygur and Kaya[28] reached the opposite conclusion. Additionally, while Abubakar and Kassim[29] found no noticeable effect of interest-free agricultural financing on agricultural production, Yasmin and Ayaz[30] observed a significant effect at a certain level of financing. These studies reveal contradictory findings regarding the

20 Faizul Mubarok, "Acceleration of Islamic Bank Financing in Indonesian Agriculture Sector", *Shirkah: Journal of Economics and Business* 6/2 (2021), 185-204.

21 Levent Çinko - Ahmet Balcı, "Bankaların Kredi Büyümesinin GSYİH'ye Olan Etkisinin Sektör Bazlı İncelenmesi: Türkiye İçin Ekonometrik Bir Analiz", *Ekonomi İşletme ve Maliye Araştırmaları Dergisi* 4/1 (2022), 16-33.

22 Azhar Alam et al., "The Determinant of Shariah Financing in the Agricultural Sector: Evidence from Indonesia", *Journal of Asian Finance* 9/4 (2022), 287-298.

23 Esra Uygur - Emine Öner Kaya, "Tarım Kredileri ile Tarımsal Büyüme Arasındaki İlişkinin İncelenmesi: Türkiye Örneği", *3. Sektör Sosyal Ekonomi Dergisi* 57/3 (2022), 2004-2022.

24 Sadia Yasmin - Mohammad Ayaz, "Nexus between Islamic Bank Cecomposed Financing and Agriculture Output Growth in Pakistan", *Journal of Islamic Business and Management* 13/2 (2023), 211-232.

25 Muhammad Alan Nur et al., "Agricultural Financing Risk and Ib Agricultural Financing: A Long Relationship", *Journal of Islamic Finance and Accounting* 5/2 (2023), 75-88.

26 Çinko - Balcı, "Bankaların Kredi Büyümesinin GSYİH'ye Olan Etkisinin Sektör Bazlı İncelenmesi: Türkiye İçin Ekonometrik Bir Analiz", 16.

27 Setiawan, "The Role of Islamic Banking in the Development of Economic Sectors in Indonesia", 88.

28 Uygur - Kaya, "Tarım Kredileri ile Tarımsal Büyüme Arasındaki İlişkinin İncelenmesi: Türkiye Örneği", 2004.

29 Abubakar - Kassim, "Sectoral Impact of Bank Credit in Malaysia: ARDL Modelling Approach", 205.

30 Yasmin - Ayaz, "Nexus between Islamic Bank Cecomposed Financing and Agriculture Output Growth in Pakistan", 211.

relationship between interest-free agricultural financing and agricultural growth in different countries. This situation may be due to differences in the underlying financial and economic dynamics of the countries, as well as differences in the methods and time periods examined in these studies.

A review of the existing literature reveals that studies considering Türkiye as a case study have typically employed econometric methods that do not account for structural breaks. Additionally, the periods examined are relatively short, resulting in an insufficient number of observations. Moreover, the methods employed in these studies have yielded conflicting results, and the number of studies is limited to only three. In this regard, the present study is significant because the literature lacks a sufficient number of studies with robust findings on this topic. This study applies contemporary analysis methods that account for structural breaks, which yield more robust findings than those that do not consider structural breaks. Specifically, it employs the FADF unit root test, the RALS-FADL and FADL cointegration tests, and the FTY causality test using datasets consisting of 76 observations for the period between 2005Q1 and 2023Q4. The period begins with the transition of Islamic banking institutions from being referred to as Special Finance Houses to being designated as participation banks.

The subsequent section of the study will provide detailed information on the data and methods used, followed by the findings. Finally, the study will conclude with a discussion of the conclusion and policy reccommendations.

1. Data and Methodology

1.1. Data

The datasets were collected from official data sources, which are depicted in Table 2 below.

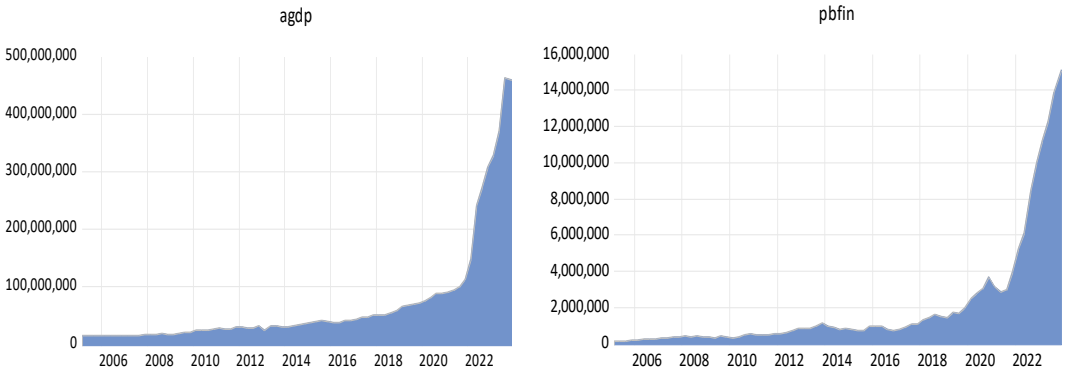
The data consist of financing provided by participation banks to the agricultural sector in Türkiye and the agricultural GDP.

Table 2. Data

Data	Source	Information About the Data
Financing provided by participation banks to the agriculture sector	BRSA	The data represents the amount of financing (in thousands of Turkish Liras) extended by participation banks, specifically within the agriculture, hunting, forestry, and fishing sectors.[31]
Agricultural GDP	TURKSTAT	The data represents seasonally adjusted agricultural GDP (in thousands of Turkish Liras).[32]

[31] BRSA, "Sektörel Kredi Dağılımı-Katılım, Kalkınma ve Yatırım, Mevduat (Tarım, Avcılık, Ormancılık ve Balıkçılık)".
[32] Turkish Statistical Institute (TURKSTAT), "Dönemsel Gayri Safi Yurt İçi Hasıla, IV. Çeyrek: Ekim-Aralık ve Yıllık, 2023" (Access 11 May 2024).

Figure 1: Course of the Series over the Years



The period under investigation, spanning from 2005Q1 to 2023Q4, indicates that this study utilizes a comprehensive range of data. This time period was selected because it marks a significant transition in the Islamic banking industry, with institutions shifting from being labeled as Special Finance Houses to being recognized as participation banks. The BRSA and TURKSTAT were chosen as data sources due to their status as primary providers of reliable data on the subject addressed in this study.

1.2. Methodology

As previously mentioned, the methods employed in this study include the FADF unit root test developed by Enders and Lee[33], the FADL cointegration test developed by Banerjee et al.[34], the RALS-FADL cointegration test developed by Yılancı et al.[35], and finally, the FTY causality test developed by Nazlıoğlu et al.[36].

Enders and Lee expanded the ADF unit root test with a Fourier function and introduced it to the literature.[37] For the application of the FADF unit root test, it is not necessary to know when (time), how many times (number of times), or in what form structural change occurred. What needs to be estimated is the appropriate frequency value of the Fourier function.

$$\Delta agdp_t = \rho agdp_{t-1} + \beta_0 + \beta_1 t + \beta_2 sin(\frac{2\pi kt}{T}) + \beta_2 cos(\frac{2\pi kt}{T}) + \varepsilon_t \quad (1)$$

$$\Delta pbfin_t = \rho pbfin_{t-1} + \chi_0 + \chi_1 t + \chi_2 sin(\frac{2\pi kt}{T}) + \chi_2 cos(\frac{2\pi kt}{T}) + \mu_t \quad (2)$$

The FADF unit root test involves estimating the models presented in Equations 1 and 2. The terms within parentheses represent the following:

- k: Frequency
- t: Trend coefficients
- T: Number of observations
- β_0 and χ_0: Constant terms
- β_1 and χ_1: Coefficients of trend
- β_2 and χ_2: Coefficients of trigonometric terms
- ε_t and μ_t: Error terms

33 Walter Enders - Junsoo Lee, "The Flexible Fourier Form and Dickey-Fuller Type Unit Root Tests", *Economics Letters* 117/1 (2012), 196-199.

34 Piyali Banerjee et al., "Fourier ADL Cointegration Test to Approximate Smooth Breaks with New Evidence from Crude Oil Market", *Economic Modelling* 67 (2017), 114-124.

35 Veli Yılancı et al., "The Role of Affluence, Urbanization, and Human Capital for Sustainable Forest Management in China: Robust Findings from A New Method of Fourier Cointegration", *Sustainable Development* 31/2 (2023), 812-824.

36 Şaban Nazlıoğlu et al., "Oil Prices and Real Estate Investment Trusts (REITs): Gradual-Shift Causality and Volatility Transmission Analysis", *Energy Economics* 60 (2016), 168-175.

37 Enders - Lee, "The Flexible Fourier Form and Dickey-Fuller Type Unit Root Tests", 196.

- ρ: Lagged values of the coefficients

$$\Delta agdp_t = \alpha_0 + \delta_1 sin(\frac{2\pi kt}{T}) + \delta_1 cos(\frac{2\pi kt}{T}) + \phi_1 agdp_{t-1} + \varphi_1 pbfin_{t-1} + \gamma \Delta pbfin_t + \nu_t \quad (3)$$

The model is estimated in equation 3 of the FADL cointegration test. The equation's left-hand side shows the first difference of the dependent variable. The right-hand side includes trigonometric components, lagged values of both dependent and independent variables, the first difference of the independent variable and an error term.

The FADL cointegration test, similar to the FADF unit root test, first estimates the frequency value (k). Then, to correct for potential autocorrelation problems, lagged values of the differenced variables are added to the right side of the equation. The appropriate lag length is determined using any information criterion. In the final step, the significance of the lagged version of the dependent variable is tested to examine the basic hypothesis (H_0), which indicates no cointegration among the variables.

$$\Delta agdp_t = \alpha_0 + \delta_1 sin(\frac{2\pi kt}{T}) + \delta_1 cos(\frac{2\pi kt}{T}) + \phi_1 agdp_{t-1} + \varphi_1 pbfin_{t-1} + \gamma \Delta pbfin_t + \lambda \hat{w}_t + \zeta_t \quad (4)$$

The RALS-FADL cointegration test estimates the model in Equation 4. The term $\hat{w}$ represents the term containing information about the high moments of the residuals that are not normally distributed.

Both standard unit root and cointegration tests typically don't consider the normality of residuals. However, residuals also contain valuable information. By utilizing this information, more robust tests can be developed. Therefore, several RALS tests have been developed in the literature.

For instance, the standard FADL cointegration test does not utilize the information from the higher moments of non-normally distributed residuals. However, incorporating this information with the $\hat{w}$ terms into the FADL equation results in the RALS-FADL cointegration test, which offers a much stronger approach.[38]

Both FADL and RALS-FADL cointegration tests require the variables to be integrated at order one, denoted as I(1).

$$agdp_t = \alpha_0 + \beta_1 sin(\frac{2\pi kt}{T}) + \beta_1 cos(\frac{2\pi kt}{T}) + \chi_1 agdp_{t-1} + \ldots + \chi_{p+d} agdp_{t-(p+d)} + \psi_t \quad (5)$$

$$pbfin_t = \phi_0 + \varphi_1 sin(\frac{2\pi kt}{T}) + \varphi_1 cos(\frac{2\pi kt}{T}) + \gamma_1 pbfin_{t-1} + \ldots + \gamma_{p+d} pbfin_{t-(p+d)} + \xi_t \quad (6)$$

The FTY causality test involves estimating the models presented in Equations 5 and 6. The test is implemented by selecting the lag length and the value of k that minimize the minimum information criterion. Appropriate critical values for the test are obtained through Bootstrap simulations.[39]

The hypothesis to be tested in this study is that a positive and statistically significant cointegrating relationship exists between the financing provided by participation banks to the agricultural sector and agricultural GDP.

2. Findings

This section presents the findings of the tests applied using the EViews 13 and Gauss 24 software programs. The analysis was conducted with the natural logarithmic (*log*) transformations of the variables (*logagdp* and *logpbfin*). The full logarithmic-logarithmic (log-log) model aimed to be estimated in the study is as follows (Equation 7):

$$logagdp_t = \alpha + \beta logpbfin_t + \mu_t \quad (7)$$

[38] Yılancı et al., "The Role of Affluence, Urbanization, and Human Capital for Sustainable Forest Management in China: Robust Findings from A New Method of Fourier Cointegration", 816.

[39] Nazlıoğlu et al., "Oil Prices and Real Estate Investment Trusts (REITs): Gradual-Shift Causality and Volatility Transmission Analysis", 172.

In the model presented, logagdp represents the dependent variable, which is the "value of agricultural GDP.". On the other hand, logpbfin represents the independent variable, which is "the amount of financing provided by participation banks to the agricultural sector.". Below are the results of unit root, cointegration, and causality tests, respectively.

To interpret the results of the FADF unit root test, it is necessary to test the significance of the functions containing trigonometric terms in sine and cosine. If these functions are found to be significant, the results of the FADF unit root test can be interpreted. Otherwise, the results of the traditional ADF unit root test are reported (Table 3).[40]

Table 3. FADF and Traditional ADF Unit Root Test Results

Variable	FADF Unit Root Test		Traditional ADF Unit Root Tests	
	F Test Statistics	FADF Test Statistics	Test Statistics	P Value
logagdp	5.157703#	-1.896157	1.049579	0.9999
logpbfin	6.414133#	-2.903884	-0.115146	0.9937
logagdp(1)	-	-	-8.063850	0.0000*
logpbfin(1)	-	-	-7.356330	0.0000*

 # This signifies the acceptance of the null hypothesis that the trigonometric terms within the function are not significant at the 10% significance level.
Note: The critical value for the comparison at the 10% significance level is 7.78.
** It denotes the rejection of the null hypothesis of non-stationarity of the relevant variable at the 1% significance level.*

As seen in Table 3, the functions containing trigonometric terms were found to be insignificant for both variables. Therefore, the results of the traditional ADF unit root test were considered rather than the results of the FADF unit root test. According to the test results, the variables become stationary after taking their first differences. As previously mentioned, the application of FADL and RALS-FADL cointegration tests requires the variables to be integrated at order one I(1). Thus, this condition has thus been met (Table 4).

Table 4. FADL and RALS-FADL Cointegration Test Results

Dependent Variable	Frequency Value (k)	FADF Test Statistics	RALS-FADL Test Statistics	Rho
logagdp	4	-4.213008*	-10.278452**	0.256598

** It is significant at the 5% significance level.*
Note: The critical value for comparison is -3.96. The value of -4.21 is greater in absolute terms than -3.96.
*** It is significant at the 1% significance level.*
Note: The critical value for comparison is -3.64. The value of -10.27 is greater in absolute terms than -3.64.
Note: The Rho coefficient indicates the correlation between the residuals of the test statistics of the FADL and RALS-FADL cointegration tests. This coefficient is used when referring to the appropriate critical values in the table.

As seen in Table 4, the test statistics for both tests were calculated to be greater in absolute value than the critical values in the comparison table. This indicates evidence of cointegration between the variables according to both tests. After identification of the cointegration, the Fully Modified Ordinary Least Squares (FMOLS) estimator was employed and the long-run coefficient was estimated (Table 5).

[40] Yılancı et al., "The Role of Affluence, Urbanization, and Human Capital for Sustainable Forest Management in China: Robust Findings from A New Method of Fourier Cointegration", 817.

Table 5. FMOLS Long-Run Coefficient Estimation Result

Dependent Variable	Independent Variable	Coefficient	P Value
logagdp	logpbfin	0.804652	0.0000*
	c	6.477336	0.0000*
	sin	0.075694	0.0152**
	cos	0.055655	0.0632***

, ** and * indicate significance at the levels of 1%, 5%, and 10%, respectively.*

As observed in Table 5, there exists a long run, positive, and statistically significant relationship between the financing provided to the agricultural sector by participation banks and agricultural GDP. According to the results, a 1% increase in agricultural financing leads to a 0.80% increase in agricultural GDP. After the long-run coefficient was determined, the error correction mechanism (ecm) in the study was examined (see Table 6).

Table 6. Error Correction and Short-Run Coefficient Estimation Results

Variable	Coefficient	T-Statistic	P Value
ecm	-0.075626	-7.685523	0.0000*
d(logpbfin)	0.154049	2.572093	0.0122**
c	0.035675	6.923702	0.0000*

, ** and * indicate significance at the levels of 1%, 5%, and 10%, respectively.*

Table 6 demonstrates that the error correction coefficient is negative and statistically significant. Therefore, the ecm in the study is appropriate. According to the results, 0.075% of the deviations from the long-run equilibrium of the variables disappear after one period. In other words, the variables are again exhibiting a tendency to converge. Additionally, the short-run coefficient is also positive and statistically significant. A 1% increase in the agricultural financing provided by participation banks raises the agricultural GDP by approximately 0.15% in the short run. As a result, it is observed that the logpbfin variable positively affects the logagdp variable in both the short and long run. Finally, the FTY causality test was applied to test the existence of a causal relationship between the variables (Table 7).

Table 7. FTY Causality Test Results

Direction of the Relationship	T-Statistic	Frequency Value (k)	Bootstrap P Value
logagdp ↛ logpbfin	39.892995	1	0.1933
logpbfin → logagdp	53.325812	1	0.0967*

** It is significant at the 10% significance level.*
Note: 10,000 simulations were used when applying the test.

As seen in Table 7, a one-way causal relationship was identified from the amount of agricultural financing provided by participation banks to the value of agricultural GDP variable at the 10% significance level. The result of the causality test supports the findings of the cointegration tests above. The results of all the applied tests consistently support the study's initial hypothesis: a positive and statistically significant cointegration relationship exists between the amount of financing provided by participation banks to the agricultural sector and the value of agricultural GDP.

Conclusion and Policy Recommendations

This study investigates the relationship between the amount of financing provided by participation banks to the agricultural sector and agricultural GDP in Türkiye. The selection of the amount of agricultural financing given by participation banks as the independent variable in the analysis is due to the fact that the market share of these banks in the Turkish banking sector has nearly reached 10%, and their recognition among the public is steadily increasing. Another reason is that they constitute an important alternative institution for those in Türkiye who are sensitive to interest. In this way, they both ensure that idle funds are channeled into the real economy and that those who are reluctant to enter into a financial relationship with the banking system are connected to the system. The value of agricultural GDP was chosen as the dependent variable of the study due to the increasing efficiency in production despite the decrease in the number of agricultural enterprises and the significant reflection of this on agricultural growth. Indeed, one of the primary objectives of commercial banks in providing agricultural loans is to ensure that agricultural enterprises produce more efficiently.

Time series analysis was conducted using datasets spanning the period 2005Q1-2023Q4. The data were collected from the Banking Regulation and Supervision Agency and Turkish Statistical Institute data platforms, and contemporary methods such as the FADF unit root, FADL and RALS-FADL cointegration, and FTY causality tests were applied. The results of the cointegration tests indicated a positive and statistically significant relationship between the variables in both the long and short run. According to the findings, a 1% increase in the financing provided to the agricultural sector leads to a 0.80% increase in agricultural GDP in the long-run and a 0.15% increase in the short run. The findings support the notion that participation banks by prioritizing real sector financing, can directly address the needs of production units, thereby contributing to economic growth. This is also corroborated by the results of the causality test.

This study, conducted using a sample from Türkiye, it has been demonstrated that the agricultural financing provided by participation banks leads to an increase in agricultural GDP. Focusing on the Turkish context, this study demonstrates that participation bank financing to the agricultural sector contributes to agricultural GDP growth. The findings of this study support the results of the study by Uygur and Kaya[41], but contradict the results of the study by Çinko and Balcı[42]. Possible reasons for the contradictory results may be that the cointegration test used in the study by Çinko and Balcı does not account for structural changes, and the dataset used for the test has a small number of observations.

Based on our findings, these policy recommendations are proposed to support participation banks' financing in agriculture:

- The decision regarding the provision of Treasury Profit Share Supported Investment and Business Financing for Agricultural Production by Ziraat Katılım Bankası A.Ş. took effect in December 2023. In this context, the publicly funded participation bank, Ziraat Katılım Bankası A.Ş., has been given a significant opportunity to become one of the leading banks in agricultural banking, thereby increasing the market share of participation banks in the sector. Besides ensuring that the support provided by the Treasury is substantial, it is crucial to raise awareness about this support among agricultural enterprises. In this vein, Ziraat Katılım Bankası A.Ş. should develop informative outreach initiatives and targeted advertising campaigns. These efforts should emphasize the unique features of their Treasury-supported program, clearly differentiating it from the existing Treasury-backed agricultural interest-based loan program.

41 Uygur - Kaya, "Tarım Kredileri ile Tarımsal Büyüme Arasındaki İlişkinin İncelenmesi: Türkiye Örneği", 2012.
42 Çinko - Balcı, "Bankaların Kredi Büyümesinin GSYİH'ye Olan Etkisinin Sektör Bazlı İncelenmesi: Türkiye İçin Ekonometrik Bir Analiz", 16.

- The legal framework for the salam contract, which is currently applied on a small scale in countries such as Sudan, Pakistan, Bangladesh, and Malaysia, should be established and implemented in Türkiye as well. In fact, the provisions of the sales contract in one of the section of the Turkish Code of Obligations can serve as a legal basis for the practical use of the salam contract. However, establishing a specific legal regulation regarding the salam contract could clarify the legal nature of the method and increase its widespread use in practice. In this regard, coordination and close cooperation between Agricultural Credit Cooperatives and participation banks should be established, and meetings and field experiments should be organized, considering the opinions of all stakeholders in the agricultural sector regarding how the method can be implemented based on regions and key strategic agricultural products.

- In Türkiye, public and private commercial banks provide various agricultural banking services. Among these banks, the ones with the highest assets are T.C. Ziraat Bankası A.Ş. and Denizbank A.Ş.. These banks have advanced mobile applications for the agricultural sector and credit cards that allow agricultural enterprises to receive agricultural input from thousands of member businesses. Therefore, participation banks should diversify their services in agricultural banking. For example, in line with the digitalization strategy, mobile applications should be developed that provide quick information and technical support on various agricultural topics (such as the status of agricultural weather and markets). Additionally, branch expansion should be prioritized in regions with intensive agricultural production. Agricultural engineers should be employed as customer representatives in these new branches, and efforts should be made to provide employment opportunities for the children of farmers who own agricultural businesses in the region. Moreover, participation banks should carry out agricultural consultancy activities for a reasonable fee to increase efficiency in agricultural production.

To gain a deeper understanding of the drivers of profitability in the participation banking sector, future research could examine the impact of participation banks' digitalization indicators on their overall profitability using contemporary econometric methods.

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