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Original Article

The Asymmetric Effects of Agricultural Policy Support on Agricultural Employment in Türkiye: A NARDL Approach

Zekiye Şengül Abedı [1]

[1]Department of Agricultural Economics, Faculty of Agriculture, Siirt University, Siirt, Türkiye

[1]https://orcid.org/0000-0002-2496-2867

zekiye.sengul@siirt.edu.tr

ABSTRACT

The agricultural sector is recognized as one of the primary economic pillars of Türkiye, contributing significantly to employment, GDP, and export revenues. However, the proportion of the workforce employed in agriculture has been diminishing in conjunction with the growth of the industrial and service sectors. Despite this long-term decline, annual fluctuations in the absolute value of agricultural employment suggest that the sector functions as a stabilizing factor, mitigating the impact of general labor market fluctuations and exhibiting high sensitivity to short-term changes in profitability and support policies. To support this sector, the government implements various policy instruments, including direct payments, input subsidies, and investment incentives. The extant literature suggests that the effects of these subsidies on employment exhibit a complex and paradoxical pattern. The promotion of capital-intensive technologies, the absence of direct employment effects associated with decoupled payments, and the consolidation of large-scale farms are the main mechanisms through which these interactions occur. It has been emphasized that reducing support could lead to more abrupt and disproportionate declines in employment, particularly by driving less efficient farms out of the sector. This reflects a downward asymmetry. In this context, the study analyzed the short- and long-term asymmetric effects of agricultural policy support, as measured by the OECD Producer Support Estimate (PSE) index, on agricultural employment levels in Türkiye. The dataset used for this study consists of annual time series data on agricultural employment, PSE, agricultural credit volume, agricultural product exports and imports, and the share of agriculture in gross domestic product (GDP) from 1986 to 2023. This data was obtained from the TurkStat, SBB, TBB, and OECD databases. The asymmetric relationships are tested using the NARDL cointegration methodology, which is a non-linear lag distributed autoregressive approach. According to the findings, positive shocks in PSE and agricultural credits significantly and positively affect employment in the long run, while positive shocks in agricultural exports negatively affect employment. Conversely, negative shocks to the share of agriculture in GDP increase employment, confirming the sector's "employment buffer" function. Long-run asymmetry is found in PSE and agricultural credits. In the short run, negative shocks to agricultural exports negatively impact employment, while positive shocks to agricultural credit have a negative lagged effect on employment. However, positive shocks to the share of agriculture in GDP increase employment in the short run. Short run asymmetry is observed for export and GDP share variables, but no significant asymmetry is found for PSE. Accordingly, the study suggests that policymakers adopt a multidimensional approach to agricultural subsidies that considers not only the amount, but also the design, orientation, and implementation context. The development of mechanisms that safeguard rural employment and promote alternative employment opportunities is of critical importance. It is recommended that flexible support and credit instruments be designed to target vulnerable groups in the face of short-term negative shocks, with priority given to labor-intensive subsectors and rural diversification initiatives. Moreover, policies aimed at facilitating transitions to non-agricultural employment—such as vocational training programs and support for local entrepreneurship—should be strengthened.

Key words: Producer support estimate (PSE), asymmetric effects, NARDL, cointegration

Türkiye'de Tarım Politikası Desteklerinin Tarımsal İstihdam Üzerindeki Asimetrik Etkilerinin Analizi: NARDL Yaklaşımı

ÖZ

Tarım sektörü, Türkiye ekonomisinin temel unsurlarından biri olarak, istihdam, GSYH katkısı ve ihracat gelirleri açısından kritik bir rol oynamaktadır. Ancak, sanayileşme ve hizmet sektörlerinin genişlemesiyle birlikte tarımın toplam istihdam içindeki payı düşüş eğilimi göstermektedir. Bu uzun vadeli düşüşe rağmen, tarımsal istihdamın mutlak değerlerinde gözlenen yıllık dalgalanmalar, sektörün genel işgücü piyasası şoklarını hafifletici bir tampon işlevi gördüğünü ve kısa vadeli karlılık değişimleri ile destek politikalarına karşı oldukça duyarlı olduğunu göstermektedir. Bu sektörü desteklemek amacıyla, devlet tarafında doğrudan ödemeler, girdi sübvansiyonları ve yatırım teşvikleri gibi çeşitli politika araçları uygulamaktadır. Literatürde, bu desteklerin istihdam üzerindeki etkilerinin karmaşık ve paradoksal bir örüntü sergilediği belirtilmektedir. Özellikle sermaye-yoğun teknolojilerin teşviki, ayrıştırılmış ödemelerin doğrudan istihdama etkisi olmaması ve büyük ölçekli çiftliklerin konsolidasyonu, bu etkileşimlerin temel mekanizmalarını oluşturmaktadır. Desteklerin azaltılmasının ise, özellikle verimsiz işletmelerin faaliyet dışına itilmesiyle istihdamda daha ani ve orantısız düşüşlere neden olabileceği, aşağı yönlü bir asimetri gözlendiği vurgulanmaktadır. Bu bağlamda çalışma Türkiye'de OECD Üretici Destek Tahmini (PSE) endeksiyle ölçümlenen tarımsal politika desteklerinin, tarımsal istihdam seviyesi üzerindeki kısa ve uzun dönemli asimetrik etkileri analiz etmek amacıyla yapılmıştır. Çalışmada kullanılan veri seti 1986-2023 dönemine ilişkin tarımsal istihdam, PSE, tarımsal kredi hacmi, tarımsal ürün ihracatı, tarımsal ürün ithalatı ve tarım sektörünün gayri safi yurt içi hasıla (GSYH) içindeki payına ait yıllık zaman serileri oluşturmakta olup, TÜİK, SBB, TBB ve OECD veri tabanlarında elde edilmiştir. Çalışmada asimetrik ilişkilerin ampirik olarak test edilmesinde Doğrusal Olmayan Gecikmesi Dağıtılmış Otoregresif (NARDL) eşbütünleşme metodolojisi kullanılmıştır. Bulgulara göre uzun dönemde, PSE ve tarımsal kredilerdeki pozitif şoklar istihdamı anlamlı ve pozitif yönde etkilerken, tarımsal ihracattaki pozitif şoklar istihdamı azaltmaktadır. Tarımın GSYH içindeki payındaki negatif şoklar ise istihdamı artırarak sektörün "istihdam tamponu" işlevini teyit etmektedir. PSE ve tarımsal kredilerde uzun dönemli asimetri olduğu tespit edilmiştir. Kısa dönemde, tarımsal ihracattaki negatif şoklar istihdam üzerinde negatif etki yaratırken, tarımsal kredilerdeki pozitif şokların gecikmeli etkisi istihdamı azaltmaktadır. Tarımın GSYH içindeki payındaki pozitif şoklar ise kısa dönemde istihdamı artırıcı bir rol oynamaktadır. İhracat ve GSYH payı değişkenlerinde kısa dönemli asimetri gözlenirken, PSE için kısa dönemde anlamlı bir asimetri bulunmamıştır. Bu doğrultuda çalışma, politika yapıcılara, tarımsal desteklerin sadece miktarını değil, aynı zamanda tasarımını, yönelimini ve uygulama bağlamını da dikkate alan çok boyutlu bir yaklaşım benimsemeleri önerilmektedir. Özellikle, kırsal bölgelerde istihdamı koruyucu ve alternatif istihdam olanaklarını destekleyici mekanizmaların geliştirilmesi büyük önem taşımaktadır. Esnek destek ve kredi araçlarının, kısa vadeli negatif şoklara karşı kırılgan grupları hedef alacak şekilde tasarlanması; emek-yoğun alt sektörlere ve kırsal çeşitlendirme faaliyetlerine öncelik verilmesi; tarım dışı istihdam geçişlerini kolaylaştıracak mesleki eğitim ve yerel girişimcilik desteklerinin artırılması önerilmektedir.

Anahtar kelimeler: Üretici destek tahmini (PSE), asimetrik etkiler, NARDL, eşbütünleşme.

INTRODUCTION

The agricultural sector is a key pillar of the Turkish economy. It has historically played a critical role in the country's employment structure and made significant contributions to the gross domestic product (GDP). Additionally, it has provided substantial support for rural development through export revenues (FAO, 2025). The sector's strategic importance stems from ensuring national food security, protecting food sovereignty, supplying the industrial sector with raw materials, and providing livelihoods for a significant portion of the rural population (Bayramoğlu & Gündoğmuş, 2008; Terİn et al., 2013; Yavuz, 2024). As of 2023, the agricultural sector employed about 14.84% of the total workforce and accounted for 6.62% of the GDP (TurkStat, 2025). Furthermore, Türkiye is among the leading countries in global agricultural product production, including hazelnuts, apricots, figs, and cherries. This endows the country with a substantial competitive advantage in international markets (FAO, 2025).

In addition to the economic size of the agricultural sector and its competitive position in the global market, the historical development of employment in the sector and its position within the changing economic structure are also important. The structural transformations undergone by the Turkish economy have had a significant impact on the sector's employment capacity, and the share of agriculture in total employment has undergone a transformation over time, particularly with the expansion of the industrialization and services sectors.

During the mid-20th century, the agricultural sector, which constituted approximately three-quarters of the total workforce, underwent a decline in its share of total employment as part of a broader economic transformation (Erhalim, 2011). For instance, in 2022, 15.8% of the employed population was employed in the agricultural sector, amounting to 4,866,000 individuals. This figure represents a decline of 82,000 compared to the previous year. However, data from 2024 indicates that despite the decline in the agricultural sector's share of total employment to 14.8%, there was an increase of 132,000 in the absolute number of employed individuals compared to the previous year (TurkStat, 2025). This persistent downward trend is attributed to a number of factors, including mechanization, industrialization, urbanization, and the fragmentation of agricultural land through inheritance (Görmüş, 2019). The annual fluctuations in the absolute values of agricultural employment (e.g., the decline in 2022 and the increase in 2024) reveal that, despite the long-term downward trend in the sector's share of total employment, it functions as a shock absorber (buffer) for the overall labor market (Olhan, 2011). This phenomenon underscores the sensitivity of agricultural employment decisions to short-term fluctuations in profitability and changes in support policies. This sensitivity may potentially exhibit an asymmetric structure, as evidenced by the ability to expeditiously attract labor during periods of contraction in other sectors. However, the capacity to generate new permanent employment opportunities or release existing labor in response to increased support may be comparatively diminished. Furthermore, structural issues, such as high levels of informality and underreported unemployment in the sector, suggest that the employment response to policy support may not be linear (Us & Akbıyık, 2023).

Türkiye has a long history of active government policies targeting the agricultural sector. These policies utilize a wide range of tools to achieve various objectives, including increasing production, raising self-sufficiency levels in food, supporting farmers' incomes, and promoting rural development (Baysuğ, 2017; Çelik, 2022; Demirdöğen et al., 2016; Konyali & Oraman, 2019). The strategic plans formulated by the Ministry of Agriculture and Forestry prioritize enhancing the competitiveness of the agricultural sector, optimizing production efficiency, and ensuring environmental sustainability as paramount policy objectives (T.R. Ministry of Agriculture and Forestry, 2025). Despite the evolution of agricultural support policies from direct price supports and input subsidies to decoupled and direct income support schemes, production-based supports remain a significant component of these policies (Kizilaslan et al., 2007; Tan et al., 2016).

The employment effects of agricultural policy supports frequently exhibit a complex and occasionally paradoxical pattern, contrary to the anticipated positive correlation (Table 1). While policy expectations suggest that increases in subsidies will protect agricultural employment by increasing farmer incomes and sectoral attractiveness, empirical findings indicate that this relationship is neither linear nor unidirectional (Demirdogen et al., 2022).

Table 1. Potential asymmetric channels of agricultural support shocks on employment decisions

Impact Channel	Expected Impact of Positive Support Shock	Expected Impact of a Negative Support Shock	Potential Source of Asymmetry
Production Level	Increase in labor demand with increased production	Decline in labor demand due to reduced production	Asymmetry of production responses
Income vs. Substitution Effects (On-farm, Off-farm labor)	Income effect: reduction in labor supply; Substitution effect (Coupled support): increase in on-farm labor	Income effect: increase in labor supply (compensating for loss of income); Substitution effect (Coupled support): decrease in on-farm labor	Relative magnitude of impacts, off-farm market conditions
Hiring/Firing Costs & Labor Market Rigidities	Slow recruitment (if there is uncertainty)	Rapid layoffs	Asymmetry of adjustment costs
Mechanization	Increased investment in labor-saving technology (may reduce employment in the long run)	Slowdown in mechanization investments	The irreversibility of technological change
Coupled vs. Decoupled Support Distinction	Coupled support: Increase in on-farm labor; Decoupled support: Increase in the probability of off-farm labor/on-farm uncertainty	Coupled support: Reduction in on-farm labor; Decoupled support: Potential increase in labor supply due to wealth reduction	Different behavioral effects of the type of support

Source: Ahearn et al., 2006; Ding et al., 2024; Garrone et al., 2019; Peng et al., 2022; Ray et al., 2025

Although positive shocks to agricultural support, such as increases in subsidies, have the potential to increase production and employment, the impact of these increases may fall short of expectations due to structural constraints (Bayramoğlu et al., 2021). The mechanisms underlying these interactions are particularly evident in the following phenomena: the reduction in net labor demand due to support measures promoting capital-intensive technologies; the absence of direct impact on employment of decoupled payments not linked to production and employment conditions; and the acceleration of consolidation of large-scale farms, resulting in a shift away from labor-intensive production patterns. (Berlinschi et al., 2012; Caunedo & Kala, 2021; Garrone et al., 2019; Rizov et al., 2013). Conversely, the reduction of subsidies in a sector with a high degree of reliance on such support could result in more abrupt and disproportionate employment declines, particularly as unproductive farms are compelled to cease operations. This downward asymmetry is further exacerbated by constraints on labor mobility, limited alternative employment opportunities in rural areas, and high sectoral exit costs. This process necessitates an evaluation of the impact on employment, encompassing not only the quantity of support but also the design, orientation, and implementation context of that support.

In order to comprehensively evaluate the policy ramifications of such structural asymmetries, it is imperative to depend not solely on theoretical assumptions but also on empirical evidence from diverse countries and regions. In this regard, studies conducted at the national and international levels have demonstrated that the effects of agricultural support on employment can vary significantly depending on the type of support, the context of implementation, market structure, and technology level. Dall'erba and van Leeuwen (2006), conducted a study encompassing 109 EU regions and found that support for animal production had no significant impact on employment. However, they determined that structural funds could support the regional employment share of the agricultural sector. A growing body of research is beginning to elucidate the more pronounced effects of mechanization policies on employment. As Nagarjuna et al. (2024) emphasize, the advent of mechanization in agriculture has the potential to effect profound changes not only in the physical production sphere but also in the labor market. The extant research indicates that, while contemporary agricultural technologies reduce the demand for labor, they concomitantly engender new employment opportunities in domains such as maintenance, data analysis, and the administration of digital agricultural systems. However, the realization of these prospects necessitates a workforce that is proficient in technical skills. Moreover, the digital divide can impede the capacity of small farmers to reap the benefits of mechanization, consequently influencing the regional and social distribution of employment opportunities. In Türkiye, studies have underscored the historical significance of agriculture in employment and the ramifications of policy shifts on small farms and rural poverty (Gülçubuk & Aluftekin, 2006). A number of studies have examined the effects of agricultural support on agricultural output (Akça & Altuntaş, 2022). A similar study by Guvenerek et al. (2022) examined the effect of price difference payment support, one of the agricultural support tools, on the production of selected product groups.

To accurately assess the impact of agricultural support programs on employment, comparative and structurally disaggregated analyses are needed at both the national and international levels. The Organization for Economic Co-operation and Development (OECD) has developed a set of four key indices to measure the effects of agricultural policies on producers, consumers, and public finances. These indices employ a standardized and comparable methodology (OECD, 2024). These indices systematically reveal the level, composition, transfer mechanisms, and policy orientation of agricultural support. Within the analytical framework established by the OECD, the Producer Support Estimate (PSE), which measures direct and indirect gross monetary transfers to producers, plays a central role. The PSE is defined as the total value of monetary transfers to producers through consumers and taxpayers (Karapici et al., 2024)**.** It is particularly well-suited for examining the effects of policies on producer income and employment. This because it includes both indirect interventions, such as market price support (e.g., intervention purchases and import protection), and direct budget transfers (e.g., area-based, product-based, input-based, and income support payments). This aspect renders it particularly well-suited for the examination of the effects on producer incomes and employment. Furthermore, the Consumer Support Estimate (CSE) analyzes the financial burden on consumers or the potential benefits of implemented policies, while the General Services Support Estimate (GSSE) covers expenditures on general public services such as R&D, infrastructure, and oversight directed toward the sector. Conversely, the Total Support Estimate (TSE) is a comprehensive metric that reflects the total financial support provided by a country to its agricultural sector, thereby offering a more holistic assessment of the economic and budgetary outcomes of agricultural policies.

A thorough examination of Türkiye's PSE value reveals that gross farm income stood at approximately 11% during the 2021–2023 period. This figure signifies a substantial decline when compared to the 40% level recorded during the 2000–2002 period. The observed trend points to a convergence of Türkiye's economic performance towards the OECD average, as depicted in Figure 1. Approximately 68% of the total support provided during this period consisted of market price support (MPS) implemented through tariffs, accompanied by the reduction of export debts and capital transfers to public enterprises. Direct budget transfers to producers are allocated in the form of product-based premium payments, area-based support, and input subsidies (e.g., diesel fuel, fertilizers, and agricultural insurance). GSSE accounts for 21% of agricultural support, which exceeds the OECD average of 14%. This category includes rural infrastructure investments, primarily irrigation systems, and marketing activities. The aggregate level of support furnished to the agricultural sector (TSE) persists at 1% of GDP, which exceeds the OECD average (0.6%). However, this ratio has diminished considerably compared to the 5.4% recorded at the onset of the 2000s, due to the general economic growth outpacing the growth rate of the agricultural sector (OECD, 2024).

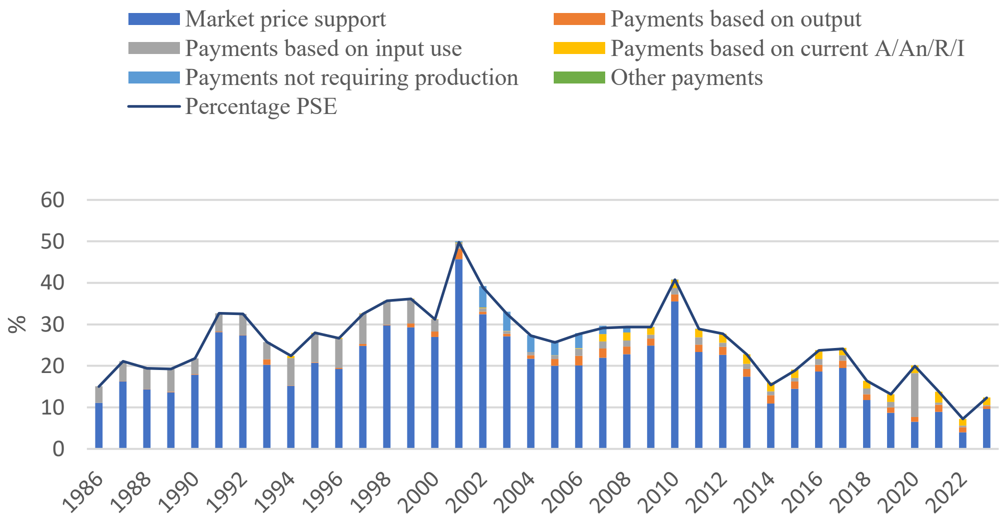

Figure 1. Trends in Türkiye's PSE composition relative to gross farm receipts, 1986–2023 (OECD, 2024)

Among the indicators developed by the OECD, PSE is particularly noteworthy, as it not only captures the magnitude of policy interventions but also reflects the structural characteristics of support measures and the overall orientation of agricultural policies. In the literature, the PSE indicator has been employed to evaluate the impact of agricultural support on the gap between domestic and world prices (Mullen et al., 2004), to analyze the trade-distorting effects of different forms of support (Blandford et al., 2007), to examine the relationship between levels of development, fiscal indicators, and PSE (Siudek & Zawojska, 2011), to compare the effects of PSE on productivity differences between exporting and importing countries (Eslami & Sherafatmand, 2013), to investigate the impact of PSE and the Nominal Rate of Assistance (NRA) on agricultural exports (Yanıkkaya & Koral, 2013), to assess its effects on farm incomes and to enhance policy transparency (Boháčková, 2015), to compare Türkiye's PSE levels with those of OECD countries (Semercİ, 2019), to analyze the effects of exchange rate fluctuations on PSE (Demirdöğen, 2020), and to examine the impact of agricultural support on agricultural productivity (Karakaya, 2023). While academic studies recognize the PSE as an indispensable tool for comparative policy analysis, they also highlight its limitations as a standalone measure. In this context, several critiques regarding the PSE index have been raised in the literature. Research indicates that the PSE does not adequately capture qualitative changes in agricultural policy frameworks (Tangermann, 2005). For instance, when a country transitions from price interventions to decoupled direct payments, the overall agricultural policy may become less market-distorting. However, as long as the total level of transfers remains constant, the PSE value will not be altered. As Oskam and Meester (2006) have noted, an exclusive focus on the total PSE figure may result in the oversight of crucial policy reforms. Consequently, the extant literature suggests that PSE data be disaggregated into its component parts for the purpose of analysis. Indeed, OECD reports also present countries' PSE components (e.g., the distinction between policies' disruptive effects on production and trade), enabling the tracking of transformations in the support structure (Tangermann, 2005). The second salient issue that merits deliberation is the impact of global market conditions on the PSE. In the market price support, which constitutes the primary component of the PSE, domestic prices are juxtaposed with international prices (border prices). Consequently, when a country's domestic currency devalues or appreciates in relation to international currencies, support indicators are influenced by this change. As a result of this effect, support may decrease while support indicators increase, or support may increase while support indicators decrease (Demirdöğen, 2020). A third point of criticism is that the PSE measures gross transfers rather than economic welfare effects. Therefore, even in the presence of a high PSE, it remains unclear how this is fully reflected in agricultural productivity or farmer welfare. Furthermore, given the indirect nature of the PSE's impact on employment, a cautious interpretation of this relationship is imperative. In this study, taking into account the aforementioned limitations, the effects of the PSE on agricultural employment were modeled within an asymmetric dynamic structure, together with complementary variables, and the results were interpreted in this context. The Nonlinear Distributed Lag Autoregressive (NARDL) model provides an appropriate framework for empirically testing these asymmetric relationships.

A review of the literature on NARDL and other nonlinear models reveals a wide range of applications in the field of agricultural economics for analyzing various relationships. These models have been employed to investigate the asymmetric effects of input prices (such as diesel and fertilizers) on farm-gate prices (e.g., wheat) (Uzel et al., 2025), the asymmetric causality between agricultural support payments and agricultural production (Sağdıç & Çakmak, 2021), the asymmetric impacts of agricultural support and credits on agricultural output (Gezer & Gezer, 2022), the relationship between unemployment and output in the context of Okun's Law (Akkoyunlu, 2024), and the effects of positive and negative shocks in agricultural product prices on agricultural growth (Kashif et al., 2023).

The extant literature has largely addressed asymmetric effects within the framework of production volume or price dynamics. The NARDL approach has been applied in the Turkish agricultural sector primarily for macroeconomic indicators such as prices, foreign trade conditions, or credit supply. However, to date, the extant literature lacks a comprehensive and systematic empirical study that employs the same methodological framework to test the short- and long-term asymmetric elasticities of positive and negative shocks observed in the OECD PSE index on agricultural employment in Türkiye. This lacuna in the extant literature results in an absence of evidence-based policy outcomes, which are imperative for the effective design of agricultural support policies that increase employment. The present study endeavors to address a substantial methodological and empirical lacuna in the Turkish agricultural economy literature. The findings offer valuable insights to policymakers on formulating more effective agricultural support policies for achieving employment targets, particularly in the context of ongoing structural transformations in the agricultural sector and at the macroeconomic level. The study also provides significant insights for international discussions and comparative analyses of agricultural support policies by focusing on the PSE indicator.

In consideration of the aforementioned information, the main objective of this study is to empirically examine the potential short- and long-term asymmetric effects of agricultural policy support measured by the OECD PSE index on agricultural employment levels in Türkiye, using the NARDL cointegration methodology. Cointegration refers to a statistical relationship in which two or more variables exhibit a common long-term trajectory, indicating that they move together over time despite short-term deviations.

The fundamental research hypotheses are delineated below as H1, H2, and H3. These hypotheses form the primary focus of the study. However, the asymmetric effects of other variables included in the model, such as agricultural credit and agricultural imports, on agricultural employment have also been analyzed within the framework of the NARDL model estimation results.

H1: There is a statistically significant long-term (symmetric or asymmetric) cointegration relationship between the OECD PSE index and agricultural employment in Türkiye.

H2: The long-term effect of positive changes in the OECD PSE index on agricultural employment is significantly different from the long-term effect of negative changes in the OECD PSE index.

H3: The short-term dynamic effects of positive changes in the OECD PSE index on agricultural employment are significantly different from the short-term dynamic effects of negative changes in the OECD PSE index.

MATERIALS AND METHODS

Materials

The primary data set for this study consists of annual time series for agricultural employment, producer support estimate, agricultural credit volume, agricultural product exports, agricultural product imports, and the share of the agricultural sector in GDP for the period 1986–2023 (Table 2). The data were obtained from the databases of the Turkish Statistical Institute (TurkStat), the Presidency of the Strategic and Budgetary Office of the Republic of Türkiye (SBB), the Turkish Banking Association (TBB), and the OECD. To convert monetary values to real values, the GDP deflator was utilized, setting 2009 as the base year at 100.

Table 2. Definitions and data sources of the variables used in the study

Variable name	Description	Unit	Data Source
TIST	Agricultural Employment	Thousand Persons	(TurkStat, 2025)
RPSE	Real Producer Support Estimate	Million TL	(OECD, 2025)
RTK	Real Agricultural Credit	Million TL	(TBB, 2025)
RIHR_TAR	Real Agricultural Product Exports	Million TL	(TurkStat, 2025)
RITH_TAR	Real Agricultural Product Imports	Million TL	(TurkStat, 2025)
TGSYHP	Share of Agriculture in GDP	%	(SBB, 2025; TurkStat, 2025)

Methods

In this study, the asymmetric effects of PSE and other complementary economic variables on agricultural employment in Türkiye were analyzed using the NARDL model. EViews software was used in the analysis process.

The methodological process is presented in the following step-by-step manner:

Preparation of the data set

To facilitate the interpretation of regression coefficients in terms of elasticity and to mitigate the impact of heteroscedasticity (Gujarati, 2003), natural logarithm transformations were implemented on the variables of agricultural employment, real PSE, real agricultural credit, real agricultural product exports, and real agricultural product imports. Conversely, the share of agriculture in GDP was not subjected to logarithmic transformation due to its status as a ratio variable.

Stationarity tests

The degree of integration of time series is a critical factor in cointegration analyses and ARDL/NARDL modeling processes, as evidenced by research conducted by Pesaran et al. (2001) and Shin et al. (2014). Therefore, before advancing to the modeling stage, the stationarity levels of the variables were assessed using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The ADF test (Dickey & Fuller, 1979; Said & Dickey, 1984) is a parametric method that tests the presence of a unit root by estimating a regression model that accounts for the lagged values of the series, while the PP test (Phillips & Perron, 1988) primarily estimates a Dickey-Fuller type regression equation. However, after this estimation, the standard errors are revised through the implementation of non-parametric adjustments. These adjustments are employed to address potential issues of autocorrelation and heteroskedasticity present within the error terms of the series. In this study, critical values at the 1%, 5%, and 10% significance levels were employed for both tests, and the series were analyzed at both the level and first difference levels. The findings of the study indicate that none of the series are integrated at the I(2) level, thereby satisfying the suitability condition for ARDL/NARDL modeling (Göksü & Balkı, 2023). An I(2) process refers to a time series that achieves stationarity after being differenced two times.

Determination of the lag structure

In this study, the maximum lag length was set to 2, a choice that was made for the purposes of minimizing data loss and preventing over-parameterization of the model due to the annual frequency of the series. The Akaike Information Criterion (AIC) was employed to select the lag structure.

The basic structure of the NARDL model

In this study, the logarithm of agricultural employment (LN_TIST) was used as the dependent variable. The independent variables were, in order, the logarithm of producer support estimate (LN_RPSE), the logarithm of agricultural exports (LN_RIHR_TAR), the logarithm of agricultural imports (LN_RITH_TAR), the logarithm of agricultural credit volume (LN_RTK), and the share of agriculture in GDP (TGSYHP).

The independent variables have been separated into positive and negative components and incorporated into the model to accommodate potential asymmetric effects. To illustrate, the decomposition for the LN_RPSE variable is defined as follows (Eq.1):

$$LN\_RPSE_t^{+} = \sum_{j=1}^{t} \max\left(\Delta LN\_RPSE_j, 0\right), LN\_RPSE_t^{-} = \sum_{j=1}^{t} \min\left(\Delta LN\_RPSE_j, 0\right) \quad \text{(Eq.1)}$$

Similar separations have been performed for the LN_RIHR_TAR, LN_RITH_TAR, LN_RTK, and TGSYHP variables.

The short-run dynamics and error correction representation of the NARDL model used in this study is expressed as follows (Eq.2)(Pesaran et al., 2001; Shin et al., 2014).

$$\Delta LN\_TIST_t = \alpha_0 + \alpha_1 LN\_TIST_{t-1} + \alpha_2 LN\_RPSE_{t-1}^{+} + \alpha_3 LN\_RPSE_{t-1}^{-} + \alpha_4 LN\_\mathrm{RIHR\_TAR}_{t-1}^{+} + \alpha_5 LN\_\mathrm{RIHR\_TAR}_{t-1}^{-} + \alpha_6 LN\_\mathrm{RITH\_TAR}_{t-1}^{+} + \alpha_7 LN\_\mathrm{RITH\_TAR}_{t-1}^{-} + \alpha_8 LN\_\mathrm{RTK}_{t-1}^{+} + \alpha_9 LN\_\mathrm{RTK}_{t-1}^{-} + \alpha_{10}\mathrm{TGSYHP}_{t-1}^{+} + \alpha_{11}\mathrm{TGSYHP}_{t-1}^{-} + \sum_{i=1}^{p} \beta_i \Delta LN\_TIST_{t-i} + \sum_{i=0}^{q1}(\delta_i^{+}\Delta LN\_RPSE_{t-i}^{+} + \delta_i^{-}\Delta LN\_RPSE_{t-i}^{-}) + \sum_{i=0}^{q2}(\gamma_i^{+}\Delta LN\_\mathrm{RIHR\_TAR}_{t-i}^{+} + \gamma_i^{-}\Delta LN\_\mathrm{RIHR\_TAR}_{t-i}^{-}) + \sum_{i=0}^{q3}(\tau_i^{+}\Delta LN\_\mathrm{RITH\_TAR}_{t-i}^{+} +$$

$\tau_i^- \Delta LN\_\mathrm{RITH\_TAR}_{t-i}^-) + \sum_{i=0}^{q4}(\emptyset_i^+ \Delta LN\_\mathrm{RTK}_{t-i}^+ + \emptyset_i^- \Delta LN\_\mathrm{RTK}_{t-i}^-) + \sum_{i=0}^{q5}(\varphi_i^+ \Delta \mathrm{TGSYHP}_{t-i}^+ + \varphi_i^- \Delta \mathrm{TGSYHP}_{t-i}^-) + \varepsilon_t$ (Eq.2)

In the equation, the α_1 represents the speed of the model's return to long-run equilibrium, $\alpha_2 - \alpha_{11}$ represents the long-run effects of the positive and negative components of the independent variables, β_i represents the short-run effects of the lagged differences of the dependent variable, and $\delta_i^+, \delta_i^-, \gamma_i^+, \gamma_i^-, \tau_i^+, \tau_i^-, \emptyset_i^+, \emptyset_i^-, \varphi_i^+, \varphi_i^-$ represents the short-run effects of the positive and negative components of the independent variables.

Cointegration Test

In order to examine whether the model exhibits a long-run relationship, the Bounds testing approach (Pesaran et al., 2001) was employed, utilizing both the F-Bounds and t-Bounds tests. Within this framework, the null hypothesis (H_0) of no cointegration and the alternative hypothesis (H_1) of the presence of cointegration were tested. The F-statistic and the t-statistic of the lagged level of the dependent variable (LN_TIST_{t-1}) were compared against the critical bounds values (I(0), I(1)) proposed by Pesaran et al. (2001) to determine whether a cointegrated long-run relationship exists within the model.

Asymmetric tests

To determine whether there is a significant difference (asymmetric effect) between positive and negative components within the model, the Wald test was employed for both the long-term and short-term contexts (Shin et al., 2014). In this context, the equality of positive and negative level coefficients in the long term and the equality of the total effects of positive and negative difference terms in the short term were evaluated using the Wald test.

Model diagnostic tests

A suite of diagnostic tests was employed to assess the validity of the model and its adherence to fundamental assumptions (Kocaman, 2024). The Jarque-Bera test was employed to assess the normality of error terms, the Breusch-Pagan-Godfrey and ARCH tests were utilized to ascertain the presence of heteroscedasticity (varying variance), the Breusch-Godfrey LM test was implemented to determine the presence of autocorrelation, and the Ramsey RESET test was used to test the accuracy of the model's functional form. Under the empirical evaluations conducted, it was determined that the model's fundamental assumptions are met at the 5% significance level, thereby affirming its reliability.

RESULTS AND DISCUSSION

The descriptive statistics of the analyzed variables reveal that the data sets mostly deviate from normal distribution (Table 3). The majority of the variables—particularly real agricultural exports, imports, and share of agriculture in GDP —demonstrate positive skewness (right-skewed distribution). This finding aligns with the observation that the means are elevated above the medians, suggesting that the sporadic high values recorded in the series are contributing to an upward shift in the mean. Notably, real agricultural product imports and real agricultural credits exhibit high standard deviations and coefficient of variation, with the coefficient of variation for real agricultural product imports approximating 0.813, suggesting substantial fluctuations in the series. Furthermore, real producer support estimate, real agricultural product imports, and exports manifest leptokurtic (peak-shaped and heavy-tailed) distributions, underscoring the impact of extreme values, while other variables exhibit a more platykurtic (flat-tailed) structure.

Table 3. Descriptive statistics of the variables analyzed in the study

	TIST	RPSE	RIHR_TAR	RITH_TAR	RTK	TGSYHP
Average	6786.6050	25892.8100	9189.7750	9872.7500	20558.4600	10.5837
Median	6120.0000	27375.5100	7869.4740	6984.1490	17388.6300	9.0661
Maximum	9259.0000	46966.9700	19850.1600	33687.8400	43031.5400	19.5126
Minimum	4695.0000	11987.5000	4536.5630	1506.9060	4969.9890	5.5338
Standard Deviation	1684.2640	6546.4760	3956.1510	8023.0430	11295.7000	4.3268
Skewness	0.1710	0.4596	1.3623	1.4006	0.4755	0.5950
kurtosis	1.3153	4.3940	4.0279	4.1356	1.9771	1.8494

The time series plots presented in Figure 2 reveals that the indicators under scrutiny exhibit substantial structural and cyclical dynamics over the 1986–2023 period. A decline in both agricultural employment and the share of agriculture in GDP was observed throughout the period under study. The decline in agricultural employment accelerated notably in the early 2000s, whereas the share of agriculture in GDP followed a more stable and gradual downward trajectory. Numerous studies on Türkiye have analyzed this pattern in the existing literature. For instance, in their study, Hatunoğlu and Eldeniz (2012) examined data from 1990 to 2011 and demonstrated that the decline in agricultural employment had accelerated and that the sector's share in GDP had fallen below 10%. A similar approach was taken in a study by Çiçen (2022), which analyzed structural transformations in Türkiye's labor market during the 2000s. The study indicated a decline in the proportion of the agricultural sector to the total workforce, reaching 36% in the year 2000. Furthermore, the study indicated that during periods of domestic economic crises in Türkiye, particularly in 1994 and during the 2000–2001 crise, there was a significant increase in labor mobility between the agricultural and services sectors.

In contrast, the indicators for real agricultural exports and imports have exhibited an accelerating upward trend, particularly in the post-2005 period. Since 2007, real agricultural exports have exhibited a steady increase, indicative of a heightened integration with international markets. Conversely, real agricultural imports have demonstrated a consistent upward trend, accompanied by notable volatility in recent years. In this context, the extant literature also highlights the influence of macroeconomic factors on Türkiye's agricultural trade dynamics. For instance, Karakaş and Erdal (2017) found that Türkiye's agricultural trade is directly affected by volatility in the real effective exchange rate. At times, these effects contribute to imbalances in agricultural import and export indicators.

Following a pronounced peak in 1997, accompanied by a subsequent decline, real agricultural credits embarked on a robust and protracted upward trajectory in the post-2005 era. Keskin and Çıkıryel's (2024) study similarly found that agricultural financing in Türkiye exhibited a positive growth trajectory during the period 2005Q1–2023Q4, with this trend exerting a significant and positive impact on agricultural GDP. In contrast, the real producer support estimate does not exhibit a clear long-term trend, though it displays notable peaks in certain years and reflects a high degree of volatility, capturing the composite effects of shifting policy components over time. Chalajour and Nashroodkoli (2022) reported that the level of producer support in Türkiye has fluctuated considerably over the years, particularly following the abolition of the direct payment system in 2009. This abolition led to a restructuring of policy components and resulted in periods of both increases and decreases in the PSE. This has contributed to an absence of a clear long-term trend and the emergence of a pronounced pattern of volatility driven by evolving policy dynamics.

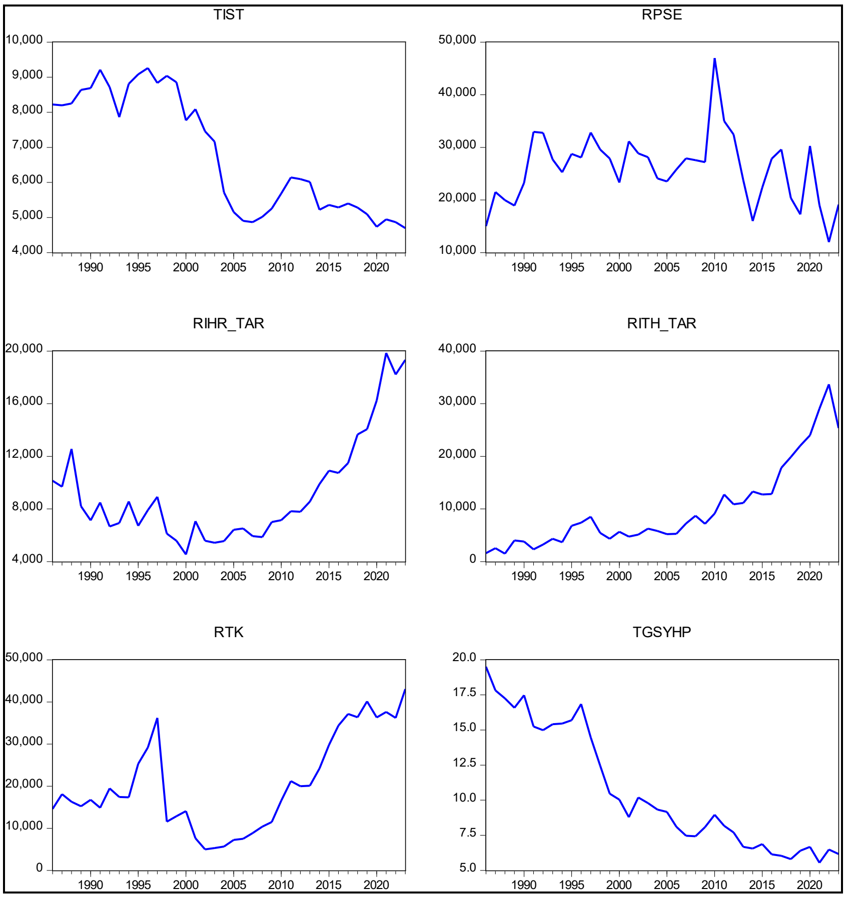

Figure 2. Time series graphs of variables (1986-2023)

In order to ascertain the stationarity properties of the variables—a fundamental prerequisite for NARDL analysis—this study implemented the ADF and PP unit root tests on all series (Table 4). The findings suggest that the variables LN_TIST, LN_RIHR_TAR, LN_RTK, and TGSYHP manifest unit roots at the level, yet become stationary at the first difference at the 1% significance level. Consequently, these variables are designated as I(1). The variable LN_RITH_TAR was found to be non-stationary at the level in the model with constant, but exhibited stationarity at the 5% level in the model with constant and trend, according to both the ADF test (p ≤0.05) and the PP test (p≤0.05). In contrast, the variable LN_RPSE was found to be stationary at a 1% significance level in both tests (p≤0.01). Accordingly, this variable is classified as I (0). The ADF and PP test results were generally consistent, and the fact that none of the variables were integrated of order two (I(2)) supports the appropriateness of employing the NARDL approach (Pesaran et al., 2001).

Table 4. Stationarity test of the variables included in the analysis

PP		**Level Value**					
		LN_TIST	LN_RPSE	LN_RIHR_TAR	LN_RITH_TAR	LN_RTK	TGSYHP
	Constant	-0.5086 (0.8606)	-3.7086 (0.0080) ***	-0.2789 (0.9186)	-1.3508 (0.5955)	-1.0793 (0.7137)	-2.2237 (0.2017)
	Constant and Trend	-2.1803 (0.4861)	-3.8252 (0.0262) **	-1.6593 (0.7490)	-3.9861 (0.0180) **	-1.3865 (0.8485)	-2.0370 (0.5625)
		1. Difference Value					
		d(LN_TIST)	d(LN_RPSE)	d(LN_RIHR_TAR)	d(LN_RITH_TAR)	d(LN_RTK)	d(TGSYHP)
	Constant	-4.9079 (0.0003) ***	-10.5770 (0.0000) ***	-8.0521 (0.0000) ***	-9.6715 (0.0000) ***	-5.7762 (0.000) ***	-5.9063 (0.0000) ***
	Constant and Trend	-4.8616 (0.002) ***	-16.9511 (0.0000) ***	-17.6514 (0.0000) ***	-9.5241 (0.0000) ***	-5.8492 (0.0001) ***	-6.3130 (0.0000) ***
ADF		**Level Value**					
	Constant	-0.4922 (0.8815)	-3.7732 (0.0068) ***	-0.6503 (0.8468)	1.4702 (0.9988)	-0.961 (0.7569)	-1.9935 (0.2883)
	Constant and Trend	-2.7384 (0.2284)	-3.9564 (0.0193) **	-1.6593 (0.7490)	-3.8731 (0.0235) **	-1.3602 (0.8561)	-1.9022 (0.6332)
		1. Difference Value					
	Constant	-4.9192 (0.0003) ***	-6.7638 (0.0000) ***	-7.8688 (0.0000) ***	-3.0855 (0.0393) **	-5.7785 (0.0000) ***	-5.9009 (0.0000) ***
	Constant and Trend	-4.8723 (0.002) ***	-7.0243 (0.0000)	-8.6572 (0.0000) ***	-3.5919 (0.0489) **	-5.8490 (0.0001) ***	-5.9855 (0.0001) ***

, **, * indicate 1%, 5% and 10% significance level respectively.*

In the cointegration analysis (Table 5), the calculated F-statistic (5.64) exceeds the upper bound critical value of I (1) at the 1% significance level (3.86). This finding provides strong evidence for the existence of a long-run cointegration relationship among the variables. Furthermore, the t-statistic (-4.96) associated with the lagged level of the dependent variable is more negative than the I (1) critical value at the 10% significance level (-4.69). This finding is consistent with the presence of a long-run cointegration relationship and indicates that the long-run structure of the model is statistically significant.

The long-term coefficient estimates presented in Table 6 for the NARDL model indicate that the level of agricultural employment in Türkiye exhibits asymmetric and flexible responses to various macroeconomic and sectoral determinants. When positive shocks are taken into account, an increase in producer support estimates (LN_RPSE_POS) is observed to have a statistically significant and positive effect on agricultural employment. A 1% increase in producer support estimates is estimated to increase agricultural employment by approximately 0.40% on average (coefficient = 0.3958; p≤0.05). A parallel increase in real agricultural credit volume (LN_RTK_POS) has been shown to result in an approximate 0.40% increase in employment (coefficient = 0.3967; p ≤0.05).

Table 5. Results of the cointegration (long run relationship) test

NARDL (1, 1, 2, 2, 2, 0, 0, 2, 0, 2, 1)								
k	**m**	**Test statistic**	**Test statistic**	**Test statistic**	**F- critical value**		**t- critical value**	
					I (0)	**I (1)**	**I (0)**	**I (1)**
10	2	F-statistic	5.636869	10%	1.83	2.94	-2.57	-4.69
				5%	2.06	3.24	-2.86	-5.03
		t-statistic	-4.959268	2.50%	2.28	3.50	-3.13	-5.34
				1%	2.54	3.86	-3.43	-5.68

k and m represent the number of independent variables and the maximum lag length, respectively.

A review of the extant literature reveals a paucity of consensus on the impact of agricultural support on agricultural employment. The findings do, however, vary according to the types of support and regional differences. Dall'erba and van Leeuwen's (2006) spatial econometric analysis, conducted as part of the European Union, the Common Agricultural Policy (CAP), and structural fund support, revealed the impact of these policies on changes in agricultural employment in European regions. The analysis demonstrated that this impact exhibited heterogeneous results depending on regional and neighborhood dynamics. In this context, the results of the current study are consistent with the extant literature, which points to the role of certain support mechanisms in increasing agricultural employment. However, it is imperative to acknowledge that the efficacy of support may be subject to variation depending on the implementation strategy and the regional structure. When examining the situation in terms of agricultural credit, the extant literature reports conflicting findings regarding the effects of agricultural credit on agricultural employment. Rios e Silva and Arruda's (2019) PVAR analysis, conducted at the state level in Brazil, revealed a positive relationship between increases in agricultural credit and agricultural employment in labor-intensive agricultural regions. Conversely, in capital-intensive and technology-driven regions, credit increases were found to have a negative effect on agricultural employment. This finding indicates that the impact of agricultural credit may be subject to variation depending on the regional production structure and labor intensity.

On the other hand, a 1% increase in agricultural exports (LN_RIHR_TAR_POS) was found to reduce employment by approximately 1% (coefficient = -1.0026; $p \leq 0.10$). The coefficients associated with both positive (LN_RITH_TAR_POS) and negative (LN_RITH_TAR_NEG) shocks in imports were found to be statistically insignificant ($p \geq 0.05$), thereby indicating that imports do not have a significant long-term effect on agricultural employment. A review of the extant literature reveals findings that are analogous to those of the present study. Remeikiene et al. (2018) found that increases in agricultural exports had negative effects on employment and labor force indicators in the agricultural sector in their study on the Baltic countries. However, He (2020) stated in his study on the US that increases in agricultural exports had positive and significant effects on farm employment, contradicting the research findings. The production structure, technology level, and export product pattern of countries are thought to be decisive factors in these different results. The shift toward a more capital-intensive production structure, changes in the input composition, and the substitution of labor-intensive domestic production for external demand are likely to contribute to this effect.

The positive and statistically significant coefficient of the TGSYHP_NEG variable at the 5% level of significance (coefficient =0.1056; $p \leq 0.05$) indicates that a one-percentage-point decrease in the share of agriculture in GDP leads to an approximate 11.14% ($100\times(e^{0.1056}-1)$) increase in agricultural employment in the long run. This finding suggests that during periods of structural transformation in the agricultural sector, agriculture functions as an "employment buffer," with a tendency for labor to shift back into the sector, particularly during times of heightened economic vulnerability. This outcome aligns with the extant literature that characterizes agriculture as a "sector of last resort" for low-skilled labor (Timmer, 1997). For instance, following the 2001 economic crisis, the Turkish economy exhibited an average annual growth rate of 7%, yet the slowdown in growth in 2008 and the contraction of 4.7% in 2009 coincided with a significant increase in agricultural employment. Specifically, the number of individuals employed in agriculture increased by approximately 8% in 2009 compared to 2007, reaching 5.254 million. This phenomenon suggests that the agricultural sector functions as a temporary refuge for employment during periods of economic downturn. In periods of economic downturn, when employment opportunities in other sectors become limited, a segment of the labor force tends to revert to agriculture. However, with the subsequent economic recovery, these individuals often transition back to non-agricultural sectors (Olhan, 2011).

The results of the Wald test applied to assess the symmetry of the long-term coefficients of the NARDL model indicate that some variables in the model have asymmetric long-term effects on agricultural employment (Table 6). Specifically, the null hypothesis that the long-term effects of positive and negative shocks in the real producer support estimate are equal has been rejected at the 5% significance level (Wald statistic = 7.1224, p≤0.05). This result indicates the presence of a significant long-term asymmetry for the LN_RPSE variable. In a similar vein, the Wald test applied to real agricultural credits rejected the hypothesis that the coefficients are symmetric at the 1% significance level (Wald statistic = 9.9570, p ≤0.01). This analysis demonstrated that the effects of LN_RTK on agricultural employment differ significantly depending on the direction of the effects. The Wald test for the share of agriculture in GDP revealed a significant difference between positive and negative changes (Wald statistic = 3.5831, p≤0.10), supporting a long-term asymmetry for TGSYHP. In contrast, no statistically significant difference was found between the long-term effects of positive and negative shocks for real agricultural product exports and real agricultural product imports.

Table 6. Long-run coefficient estimates in the NARDL model

Variable	Coefficient	Std. Error	t-statistic	Probability
Long Run Coefficients				
LN_RPSE_POS	0.3958**	0.1339	2.9551	0.0131
LN_RPSE_NEG	-0.0365	0.1804	-0.2025	0.8432
LN_RIHR_TAR_POS	-1.0026*	0.4952	-2.0245	0.0679
LN_RIHR_TAR_NEG	-0.6476	0.3631	-1.7835	0.1021
LN_RITH_TAR_POS	-0.0076	0.1541	-0.0490	0.9618
LN_RITH_TAR_NEG	-0.1656	0.1775	-0.9328	0.3709
LN_RTK_POS	0.3967**	0.1611	2.4621	0.0316
LN_RTK_NEG	-0.0039	0.1273	-0.0305	0.9762
TGSYHP_POS	-0.0386	0.0987	-0.3908	0.7034
TGSYHP_NEG	0.1056**	0.0368	2.8701	0.0152
Long Run Wald Test Results				
W_{LRLN_RPSE}: 7.1224 (0.0183) **		W_{LRLN_RTK}: 9.9570 (0.0070) ***		
$W_{LRLN\_RIHR\_TAR}$: 0.4185 (0.5281)		$W_{LRTGSYHP}$: 3.5831 (0.0792) *		
$W_{LRLN\_RITH\_TAR}$: 0.4635 (0.5071)				
Diagnostic Tests				
Jarque-Bera: 0.7352 (0.6924)		ARCH Heteroskedasticity: 0.1043 (0.7488)		
Breusch-Godfrey LM Autocorrelation: 0.8805 (0.4397)		Ramsey RESET: 1.1731 (0.2984)		
Breusch-Pagan-Godfrey Heteroskedasticity: 1.1869 (0.3777)				

, **, * indicate 1%, 5%, and 10% significance level respectively.*

The results of the diagnostic test, as presented in Table 6, indicate the continued validity of the estimated NARDL model with respect to its fundamental assumptions. Initially, the Jarque-Bera test was employed to evaluate the normality of the model residuals. This analysis yielded a result of JB = 0.7352 and p ≥0.05, suggesting that the null hypothesis cannot be rejected and that the residuals are normally distributed. The Breusch-Godfrey LM test results indicate the absence of autocorrelation (LM = 0.8805, p ≥0.05), suggesting that the model residuals are independent and do not exhibit autocorrelation. Furthermore, the Breusch-Pagan-Godfrey (F = 1.1869, p ≥0.05) and ARCH (F = 0.1043, p ≥0.05) tests substantiate the conclusion that the residuals possess constant variance, signifying the absence of heteroskedasticity in the model. The Ramsey RESET test (F = 1.1731, p ≥0.05) indicates that the functional form of the model is correctly specified and that no significant variables have been omitted from the model.

The results of the NARDL model's error correction mechanism and short-term dynamics reveal the speed at which agricultural employment converges to long-term equilibrium and its short-term responses to various shocks (Table 7). The error correction term (LN_TIST (-1)), a critical component of the model, was estimated at -0.8893 and was found to be statistically significant (p ≤0.01). The negative and significant nature of this coefficient confirms the existence of the long-term relationship previously identified through the cointegration test, while the magnitude of the coefficient indicates that approximately 88.9% of the deviations from the previous period are corrected in the current period, suggesting that employment is rapidly approaching its long-term equilibrium level.

At this stage, only three of the variables that constitute the long-term relationship were found to be statistically significant: the lagged value of positive shocks in real producer support estimate (p ≤0.05), the lagged value of positive shocks in real agricultural credit (p≤0.10), and the lagged value of negative shocks in share of agriculture in GDP (p ≤0.05). The directions and magnitudes of these variables have been thoroughly examined within the framework of previously normalized long-run elasticity estimates (Table 6).

In the short run, negative changes in real agricultural product exports (D(LN_RIHR_TAR_NEG)) have had a statistically significant and negative impact of 5% on agricultural employment in the current period (Coefficient

= -0.7720, p≤0.05). In contrast, no significant effect of positive changes in exports (D(LN_RIHR_TAR_POS)) on agricultural employment was detected in the short term. A review of the extant literature reveals a variety of findings indicating that the relationship between agricultural exports and agricultural employment may be complex and asymmetric in terms of both direction and temporal effects. Khan et al. (2020) demonstrated in their study of the Pakistan agricultural sector that a two-way relationship exists between agricultural exports and agricultural employment in the short term. Furthermore, they showed that changes in exports may also affect employment. In a similar vein, Aytekin's (2024) analysis of Türkiye's economic landscape revealed that while employment growth in the agricultural sector initially led to an uptick in exports, this positive correlation eventually dissipated over time. These findings suggest that the relationship between employment and exports may be subject to variation depending on the time dimension and direction. Within this framework, the findings of the current study can be interpreted as consistent with the general trend in the literature, reflecting the short-term sensitivity of labor dynamics to trade shocks. This phenomenon suggests that export increases do not have a substantial impact on employment in the short term. This is likely that these increases are absorbed by existing capacity or their effect on employment manifests over time. Conversely, export declines have a more direct and rapid negative effect on employment.

Table 7. NARDL error correction model

Variable	Coefficient	Std. Error	t-statistic	Probability
C	7.7663	1.6119	4.8180	0.0005
Error Correction Term and Long Run Interactions				
LN_TIST (-1)	-0.8893***	0.1793	-4.9593	0.0004
LN_RPSE_POS (-1)	0.3520**	0.1369	2.5708	0.0260
LN_RPSE_NEG (-1)	-0.0325	0.1643	-0.1977	0.8469
LN_RIHR_TAR_POS (-1)	-0.8916	0.5575	-1.5992	0.1381
LN_RIHR_TAR_NEG (-1)	-0.5760	0.3823	-1.5067	0.1601
LN_RITH_TAR_POS	-0.0067	0.1370	-0.0491	0.9618
LN_RITH_TAR_NEG	-0.1472	0.1484	-0.9919	0.3426
LN_RTK_POS (-1)	0.3528*	0.1618	2.1808	0.0518
LN_RTK_NEG	-0.0035	0.1133	-0.0305	0.9762
TGSYHP_POS (-1)	-0.0343	0.0852	-0.4027	0.6949
TGSYHP_NEG (-1)	0.0939**	0.0388	2.4174	0.0342
Short Run Dynamics				
D(LN_RPSE_POS)	0.0440	0.1037	0.4244	0.6795
D(LN_RPSE_NEG)	0.0014	0.1209	0.0114	0.9911
D (LN_RPSE_NEG (-1))	-0.1777	0.1426	-1.2458	0.2387
D(LN_RIHR_TAR_POS)	-0.0615	0.2355	-0.2612	0.7988
D (LN_RIHR_TAR_POS (-1))	0.3925	0.2663	1.4739	0.1685
D(LN_RIHR_TAR_NEG)	-0.7720**	0.3447	-2.2395	0.0467
D (LN_RIHR_TAR_NEG (-1))	-0.2584	0.1730	-1.4941	0.1633
D(LN_RTK_POS)	0.0008	0.1412	0.0054	0.9958
D (LN_RTK_POS (-1))	-0.2844*	0.1333	-2.1331	0.0563
D(TGSYHP_POS)	0.0303	0.0510	0.5938	0.5646
D (TGSYHP_POS (-1))	0.0967**	0.0357	2.7084	0.0203
D(TGSYHP_NEG)	0.0088	0.0261	0.3361	0.7431
Short Run Wald Test Results				
W_{SRLN_RPSE}: 1.7318 (0.2093)			$W_{SRTGSYHP}$: 3.8211(0.0709) *	
$W_{SRLN\_RIHR\_TAR}$: 11.0019(0.0051) ***				

, **, * indicate 1%, 5% and 10% significance level respectively*

The lagged value of positive changes in real agricultural credit (D (LN_RTK_POS (-1))), when considered in the context of agricultural employment, exhibits a significant negative effect in the short term (Coefficient = -0.2844, p ≤0.10). This suggests that increases in credits, despite their long-term employment-enhancing effect, may potentially lead to a reduction in agricultural employment in the short term. The extant literature contains various findings indicating that the short- and long-term effects of agricultural credit may differ and, in particular, may produce unexpected results in the short term. Gezer and Gezer (2022), posit that increases in agricultural credit have the potential to stimulate production in the short term. However, they contend that the delayed effects of such measures can potentially have adverse consequences for production. In their analysis of the Nigerian agricultural sector, Saka et al. (2023) emphasized that short-term agricultural loans provided through banking institutions have significant and negative effects on agricultural development. In a similar vein, Gebeyehu and Bedemo's (2024) study revealed that agricultural loans exerted a deleterious effect on productivity in the short term in Ethiopia. The findings of these studies, which are oriented towards production and productivity, demonstrate that the adverse effects observed in agricultural production in the short term possess the capacity to diminish the demand for labor, which constitutes an input in the production process. Consequently, it is anticipated that the adverse repercussions of credit augmentation on production, which materialize with a temporal lag, will be manifest in agricultural employment in a congruent manner. This negative short-term effect can be explained by the fact that increased credit is primarily directed toward labor-saving technological investments or mechanization. While such investments may have a positive impact on employment in the long term through increases in production and productivity, they may initially reduce the existing labor demand. Moreover, the restructuring of farms that are financed by credit can result in short-term labor shortages. In this context, the current findings are consistent with trends documented in the extant literature and point to the dynamic and asymmetric nature of the agricultural finance-labor interaction.

The positive change in share of agriculture in GDP (D (TGSYHP_POS (-1))), has a significant and positive short-term effect on agricultural employment (Coefficient = 0.0967, $p \leq 0.05$). This finding indicates that an increase in the agricultural share in the previous period increases current-period employment by approximately 10.15% ($100x(e^{0.0967}-1)$). This short-term positive effect is consistent with established knowledge in the literature on agricultural economics and development. This short-term positive effect demonstrates that an increase in the contribution of the agricultural sector to the economy can create a temporary revival in agricultural activities and, consequently, in employment. This phenomenon can be partially attributed to the cyclical and seasonal nature of agricultural production. Favorable conditions or increased investments in one period can trigger higher labor demand for activities such as harvesting, processing, or marketing in the subsequent period (Kulikova et al., 2021; Olakojo & Sheet, 2016). Furthermore, particularly in developing economies, the agricultural sector can function as a "buffer" for employment during periods of economic downturns or structural transformation processes. In the event of a decline in employment opportunities in other sectors, individuals may opt to return to rural areas or engage in agricultural activities to sustain their livelihoods. An increase in the share of agricultural GDP can enhance the capacity to absorb this additional labor force (Timmer, 1997).

The results of the Wald test for the short-term symmetry analysis of the NARDL model reveal that certain variables exhibit asymmetric effects on agricultural employment in the short term (Table 7). A statistically significant difference was identified between the short-term cumulative effects of positive and negative shocks in real agricultural product exports (Wald statistic = 11.0019, $p \leq 0.01$). This finding suggests that fluctuations in exports, characterized by increases and decreases, exert asymmetric short-term effects on agricultural employment. The effects of positive and negative shocks on the share of agriculture in GDP are statistically significant and asymmetric (Wald = 3.8211, $p \leq 0.10$). This suggests that changes in the TGSYHP variable may lead to varied short-term responses in agricultural employment. However, the short-term Wald test for the real producer support estimate indicates that the effects of positive and negative shocks are symmetrical (Wald = 1.7318, $p \geq 0.05$). Consequently, no substantial directional discrepancy is evident in the short term for this variable.

The structural stability of the NARDL model was evaluated using the CUSUM and CUSUMSQ tests developed by Brown et al. (1975) (Figure 3). The purpose of these tests is to determine whether the model parameters remain constant over time during the estimation period. In the context of the CUSUM test, the stability of the model's coefficients over time is determined by the maintenance of the cumulative sum of the recursive residuals within the critical limits established at a 5% significance level. On the other hand, the CUSUMSQ test is designed to identify potential structural breaks in the variance of the residuals and imbalances in variability.

The CUSUM and CUSUMSQ graphs show that the test statistics remained within the limits at the 5% level. This finding suggests that the parameters of the estimated NARDL model remained structurally consistent throughout the period and that the model estimates are reliable.

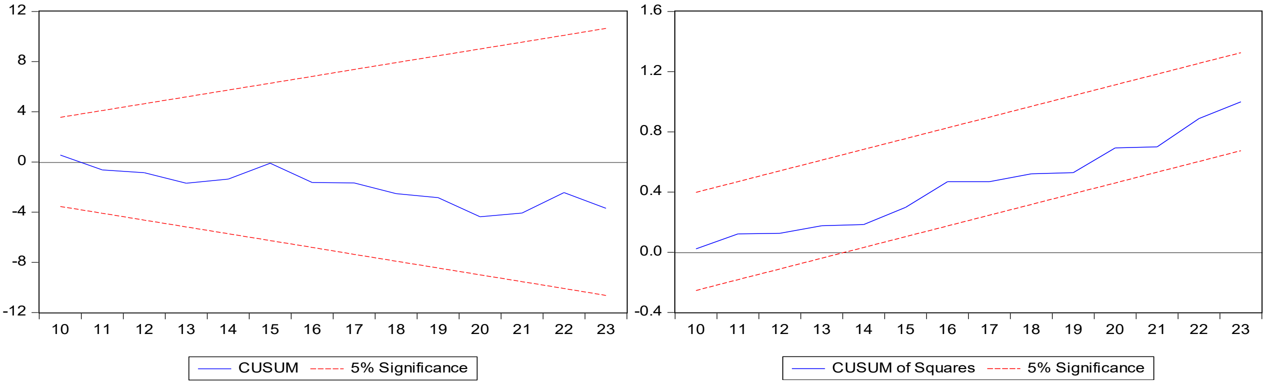

Figure 3. Evaluation of parameter stability with CUSUM and CUSUM-SQ tests

CONCLUSION

The present study examines the intricate nature of agricultural employment dynamics in Türkiye, with a particular focus on the asymmetric effects of macroeconomic and sectoral factors. The analysis utilizes the NARDL cointegration methodology to examine the impact of the OECD PSE index. The primary objective of this study is to reveal the short-term and long-term nonlinear effects of these critical variables on agricultural employment. The analyses underscore the limitations of conventional approaches predicated on the assumption of symmetric effects, illuminating the intricacies of responses to policy shocks and offering substantial methodological and empirical contributions to the extant literature.

The findings indicate that agricultural employment exhibits asymmetric responses to each determinant over different time horizons. Positive shocks in producer support estimates have been shown to have a significant and encouraging effect on agricultural employment in the long term. Additionally, the absence of such support does not produce the same symmetric negative effect. Similarly, increases in agricultural credit have been shown to have a positive effect on employment over the long term. However, these increases may result in a temporary decline in employment in the short term through labor-saving investments. These asymmetric responses necessitate flexibility and foresight in the design of support and credit policies.

Foreign trade dynamics have complex effects on agricultural employment. While an increase in agricultural exports has been shown to result in a reduction in employment over time, this phenomenon can be attributed to the structural transformation and increased capital intensity within the sector. This signifies a shift towards production methods that utilize more machinery and technology relative to human labor, thereby decreasing the overall demand for agricultural workers. In the short term, sudden declines in exports have a direct and negative impact on employment, revealing the sector's vulnerability to external shocks. In contrast, the decline in the share of agriculture in GDP, particularly during periods of economic fragility, has demonstrated that the sector functions as a critical "employment buffer" by increasing agricultural employment in the long term. In the short term, increases in the agricultural share have been shown to have a positive effect on employment, thereby demonstrating the sector's capacity for recovery.

These analyses underscore the intricate equilibrium exhibited by the policies implemented in Türkiye's agricultural sector, which is contingent upon the direction, magnitude, and timing of their repercussions on labor dynamics. The model's robust error correction mechanism demonstrates that employment quickly converges toward its long-term equilibrium. However, asymmetric responses in the short term highlight the necessity of proactive and adaptive policy interventions in response to sudden shocks. In this context, the following strategic approaches can be considered:

- Development of Flexible Support and Credit Mechanisms: Policies designed to support and encourage employment in the agricultural sector can be developed with consideration for their potential asymmetric effects. To bolster the sector against adverse economic shocks, it is recommended that diversified and flexible credit and support packages be developed. In order to mitigate the short-term potential negative effects, it would be beneficial to direct credits toward labor-intensive sub-sectors and rural diversification projects (e.g., skill development programs, microfinance).
- Integration of Employment-Focused Trade Policies: It is imperative to align agricultural export strategies with employment targets. Incentives can be directed towards products and value chains that utilize a greater proportion of local inputs and are characterized by high labor intensity. In order to address the issue of potential labor displacement resulting from foreign trade, there is a need to implement policies

that focus on the creation of non-agricultural employment opportunities in rural areas and the facilitation of labor transitions. Examples of such policies include vocational training programs and initiatives to support local entrepreneurship. Furthermore, the enhancement of risk management instruments, such as market diversification and export insurance, has the potential to bolster the resilience of specific sectors against external shocks.

- Strategic Optimization of Agriculture's “Buffer” Role: The role of agriculture as an employment buffer during periods of economic fluctuation necessitates the formulation of policies aimed at enhancing the productivity and quality of the workforce in this sector. Investments in rural infrastructure, facilitating market access for small-scale farmers, and expanding social safety nets to include the agricultural sector can be supported. The ultimate objective may be for the agricultural sector to transition from a state of mere "reserve" to one that provides more stable and high-productivity employment opportunities for the overall economy in the long term.
- Frameworks for the Evaluation of Adaptive and Data-Driven Policy: In policy impact analyses and future projections, it is imperative to employ advanced econometric modeling techniques that internalize the asymmetric and dynamic relationships revealed in this study. This approach has the potential to maximize policy effectiveness and minimize possible undesirable outcomes.

Limitations: While this study provides significant findings on the asymmetric effects of agricultural policy support on employment, several methodological and data-related limitations must be acknowledged. Firstly, given that the analysis is predicated on annual time series data, short-term fluctuations and seasonal dynamics specific to the agricultural labor market may not be adequately captured by the model. Secondly, while the NARDL approach offers advantages in modeling nonlinear and asymmetric relationships, it is constrained by a fundamental limitation: it cannot accommodate variables that are integrated of order two (I(2)). Furthermore, the model demonstrates limited sensitivity to structural breaks and may not flexibly account for time-varying policy regimes or shifts driven by external shocks. The complexity of the model, particularly in cases involving multiple lags or explanatory variables, can result in interpretative challenges and necessitate caution when working with small sample sizes.

Thirdly, the PSE indicator employed in the analysis reflects solely the quantitative magnitude of support, disregarding qualitative aspects such as targeting efficiency, policy design, and the directional focus of interventions. Consequently, the explanatory power of the model may be limited in cases where structural changes in policy composition occur without a corresponding change in the overall PSE value. Additionally, the utilization of nationally aggregated data for both PSE and agricultural credit may obfuscate regional disparities and sector-specific effects.

In light of these limitations, future research could benefit from the incorporation of higher-frequency data (e.g., quarterly or monthly time series) to more effectively capture seasonal and short-run dynamics within the agricultural labor market. In addition, the integration of empirical findings with micro-level qualitative data, such as farm household surveys, has the potential to offer more profound insights into the behavioral impacts of policy support on employment decisions.

Declaration of interests

The Author declares that there is no conflict of interest

Author Contributions

Zekiye Şengül Abedı contributed to the study by conceptualizing the research, designing the methodology, conducting data collection and analysis, and preparing the manuscript.

ORCID

Zekiye Şengül ABEDI **https://orcid.org/0000-0002-2496-2867**

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REFERENCES

Ahearn, M. C., El-Osta, H., & Dewbre, J. (2006). The impact of coupled and decoupled government subsidies on Off-farm labor participation of U.S. farm operators. *American Journal of Agricultural Economics*, *88*(2), 393–408.

Akça, H., & Altuntaş, H. (2022). Tarımsal desteklerin tarımsal çıktı üzerine etkisi: Türkiye için amprik bir analiz. *Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *31*(2), 560–572. https://doi.org/10.35379/cusosbil.1125443

Akkoyunlu, Ş. (2024). Testing Okun's law for Turkey (1923-2019). *Studies in Economics and Econometrics*, *48*(2), 113–132. https://doi.org/10.1080/03796205.2024.2329876

Aytekin, İ. (2024). Türkiye'de sektörel istihdamın ihracat üzerindeki etkisi. *Uluslararası Yönetim Akademisi Dergisi*, *7*(3), 803–813. https://doi.org/10.33712/mana.1576966

Bayramoğlu, Z., Ağızan, K., & Ağızan, S. (2021). Kamu desteklerinin tarımsal ürün piyasalarına bozucu etkisi. *Journal of the Institute of Science and Technology*, *11*(4), 3184–3194. https://doi.org/10.21597/jist.942035

Bayramoğlu, Z., & Gündoğmuş, E. (2008). Türkiye ekonomisinde öne çıkan tarımsal ve tarıma dayalı sanayii alt sektörlerinin belirlenmesi. *Verimlilik Dergisi*, *2*, 143–155.

Baysuğ, İ. (2017). *2014-2020 dönemi katılım öncesi yardım aracı kırsal kalkınma bileşeni (IPARD II) ın Türk tarımı açısından değerlendirilmesi*. İCPESS.

Berlinschi, R., Swinnen, J. F. M., & Van Herck, K. (2012). Subsidies and agricultural employment: The education channel. *August 18-24, Foz Do Iguacu, Brazil*.

Blandford, D., Brunstad, R. J., Gaasland, I., & Vardal, E. (2007). Optimal agricultural policy and PSE measurement: an assessment and application to Norway. *NHH Dept. of Economics Discussion Paper.*, 1–19.

Boháčková, I. (2015). Several comments on creation and use of PSE indicator within measuring of financial transfers to agricultural producers. *Agris On-Line Papers in Economics and Informatics*, *7*(1), 21–31.

Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society. Series B (Methodological)*, *37*(2), 149–192.

Caunedo, J., & Kala, N. (2021). Mechanizing agriculture impacts on labor and productivity. *Dispersion in Financing Costs and Development.*, 1–59.

Çelik, A. D. (2022). Contributions of agricultural subsidies to increase producer income in cotton and milk productions: A case study of Hatay Province-Turkey. *The Philippine Agricultural Scientist*, *105*(1), 92–99.

Chalajour, M., & Nashroodkoli, P. S. (2022). A review and analysis of agricultural support policies in OECD countries (1995-2015). *International Journal of Health Sciences*, *6*(S1), 12685–12708. https://doi.org/10.53730/ijhs.v6nS1.8185

Çiçen, Y. B. (2022). 2000'li yıllarda Türkiye'de emek piyasasında gelişmeler: Karşılaştırmalı bir analiz. *The Journal of International Scientific Researches*, *7*(3), 260–281. https://doi.org/10.23834/isrjournal.1150218

Dall'erba, S., & van Leeuwen, E. (2006). *Does agricultural employment benefit from EU support?* 46th Congress of the European Regional Science Association (ERSA).

Demirdöğen, A. (2020). Döviz kurundaki değişimin OECD tarımsal destek göstergeleri ile ilişkisi: Türkiye örneği. *Tarım Ekonomisi Araştırmaları Dergisi*, *6*(2), 74–85.

Demirdöğen, A., Olhan, E., & Chavas, J.-P. (2016). Food vs. fiber: An analysis of agricultural support policy in Turkey. *Food Policy*, *61*, 1–8. https://doi.org/10.1016/j.foodpol.2015.12.013

Demirdogen, A., Olhan, E., & Hasdemir, M. (2022). Heterogeneous impact of agricultural support policies: Evidence from Turkey. *Environment, Development and Sustainability*, *24*(10), 12203–12225. https://doi.org/10.1007/s10668-021-01941-9

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, *74*(366), 427–431. https://doi.org/10.2307/2286348

Ding, G., Fan, H., Li, R., Wang, H., & Xi, X. (2024). *Agricultural imports, labor mobility and welfare* (SSRN Scholarly Paper 5041835). Social Science Research Network. https://doi.org/10.2139/ssrn.5041835

Erhalim, S. (2011). *Türkiye'de tarım sektöründe istihdamın azalması ve işgücü piyasasına etkisi* [Yüksek Lisans Tezi]. Dokuz Eylül Üniversitesi, Sosyal Bilimler Enstitüsü.

Eslami, M. R., & Sherafatmand, H. (2013). The impact of producer support estimate (PSE) on the productivity: Evidence from Maize production. *International Journal of Agronomy and Plant Production*, *4*(6), 1271–1280.

FAO. (2025). *Türkiye at a glance*. https://www.fao.org/turkiye/fao-in-turkiye/turkey-at-a-glance/en/ Accessed 17 May 2025

Garrone, M., Emmers, D., Olper, A., & Swinnen, J. (2019). Jobs and agricultural policy: Impact of the common agricultural policy on EU agricultural employment. *Food Policy*, *87*, 101744. https://doi.org/10.1016/j.foodpol.2019.101744

Gebeyehu, L., & and Bedemo, A. (2024). How agricultural credit and subsidies impact agricultural productivity in Ethiopia: Empirical evidence using ardl model. *Cogent Food & Agriculture*, *10*(1), 2329118. https://doi.org/10.1080/23311932.2024.2329118

Gezer, T., & Gezer, M. A. (2022). Tarımsal destek ve kredilerin tarımsal üretim üzerindeki etkinliği. *Türk Tarım ve Doğa Bilimleri Dergisi*, *9*(4), 1102–1113. https://doi.org/10.30910/turkjans.1151057

Göksü, S., & Balkı, A. (2023). *ARDL ve NARDL eşbütünleşme analizleri: Adım adım Eviews uygulaması*. Serüven Yayınevi.

Görmüş, A. (2019). Türkiye'de tarımsal istihdamın cinsiyete dayalı yapısı ve sosyal politika önerileri. *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi*, *14*(3), 563–578. https://doi.org/10.17153/oguiibf.451375

Gujarati, D. N. (2003). *Basic econometrics* (4. ed). McGraw Hill.

Gülçubuk, B., & Aluftekin, N. (2006). Impact of international agricultural policies on rural poverty in Turkey. *International Business & Economics Research Journal (IBER)*, *5*(1), 9–18. https://doi.org/10.19030/iber.v5i1.3444

Guvenek, B., Afsar, B., & Karacor, Z. (2022). The effect of agricultural support policies on economic development and growth. *Journal of Business Management and Economic Research*, *6*(6), 338–352. https://doi.org/10.29226/TR1001.2022.313

Hatunoğlu, E., & Eldeniz, F. (2012). 2000 yılı sonrası türk tarım sektöründe yapısal dönüşüm politikaları. *Sayıştay Dergisi*, *86*, 27–56.

He, X. (2020). US agricultural exports and labor market adjustments. *Agricultural Economics*, *51*(4), 609–621. https://doi.org/10.1111/agec.12575

Karakaş, G., & Erdal, G. (2017). Döviz kuru oynaklığının Türkiye'nin tarımsal dış ticaretine etkisi. *Turkish Journal of Agriculture - Food Science and Technology*, *5*(6), 668–675. https://doi.org/10.24925/turjaf.v5i6.668-675.1141

Karakaya, M. C. (2023). *OECD ülkelerinde tarımsal destekleme politikalarının tarımsal verimlilik üzerindeki etkisi* [Yüksek Lisans Tezi]. Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü.

Karapici, V., Gjipali, A., & Matraku (Dervishi), D. (2024). Producer support estimate effects in terms of commodity production – An empirical investigation. *WSEAS Transactions on Business and Economics*, *21*, 1325–1341. https://doi.org/10.37394/23207.2024.21.108

Kashif, U., Shi, J., Naseem, S., Ayaz, M., Butt, R. S., Khan, W. A., & Al-Faryan, M. A. S. (2023). Do agricultural commodity prices asymmetrically affect the performance of value-added agriculture? Evidence from Pakistan using a NARDL model. *Humanities and Social Sciences Communications*, *10*(1), 1–9. https://doi.org/10.1057/s41599-023-01888-4

Keskin, Ö., & Çıkıryel, B. (2024). An analysis of the relationship between interest-free financing of agricultural production and agricultural growth using contemporary econometric methods. *Kocatepe İslami İlimler Dergisi*, *7*(3), 72–86. https://doi.org/10.52637/kiid.1508721

Khan, Z. A., Koondhar, M. A., Aziz, N., Ali, U., & Tianjun, L. (2020). Revisiting the effects of relevant factors on Pakistan's agricultural products export. *Agricultural Economics (Zemědělská Ekonomika)*, *66*(12), 527–541. https://doi.org/10.17221/252/2020-AGRICECON

Kizilaslan, N., Cetin, İ., & Kizilaslan, H. (2007). Direct income subsidy practices in Turkey. *Australian Journal of Basic and Applied Sciences*, *1*(2), 115–125.

Kocaman, M. (2024). Kamu harcamalarının dışlama etkisinin nardl yöntemi ile sınanması: Türkiye örneği. *Sayıştay Dergisi*, *134*, 459–482. https://doi.org/10.52836/sayistay.1559190

Konyali, S., & Oraman, Y. (2019). *The role of agricultural supports in sustainable rural development: The case of Turkey*. Proceedings of the International scientific and practical conference, Bulgaria of regions.

Kulikova, A., Astashova, A., & Kvasha, A. (2021). Features of the legal regulation of seasonal workers employed in agriculture. *E3S Web of Conferences*, *273*, 08028. https://doi.org/10.1051/e3sconf/202127308028

Mullen, K., Sun, D., Orden, D., & Gulati, A. (2004). Producer support estimates (PSEs) for agriculture in developing countries: Measurement issues and illustrations from India and China. *Nternational Food Policy Research Institute*, *74*, 1–86.

Nagarjuna, D. P., Rao, D. P. M., Kiran, D. B. V. S., & Rajyalakshmi, D. B. (2024). Transforming farms role and impact of agricultural mechanization. *Transforming Farms Role and Impact of Agricultural Mechanization, Edition 1*, 1–263. https://doi.org/10.9734/bpi/mono/978-81-982889-9-8

OECD. (2024). *Agricultural policy monitoring and evaluation 2024* (p. 657). https://www.oecd.org/en/publications/agricultural-policy-monitoring-and-evaluation-2024_74da57ed-en.html

OECD. (2025). *Data Explorer*. https://data-explorer.oecd.org/ Accessed 01 May 2025

Olakojo, S. A., & Sheet, A.-F. (2016). Seasonal labour market rigidities: Impact on farm employment and wages in Nigeria. *Economics of Agriculture*, *63*(4), 1123–1140. https://doi.org/10.5937/ekoPolj1604123O

Olhan, E. (2011). *Türkiye'de kırsal istihdamın yapısı* (pp. 1–24). FAO.

Oskam, A. J., & Meester, G. (2006). How useful is the PSE in determining agricultural support? *Food Policy*, *31*(2), 123–141. https://doi.org/10.1016/j.foodpol.2005.10.004

Peng, J., Zhao, Z., & Liu, D. (2022). Impact of agricultural mechanization on agricultural production, income, and mechanism: Evidence from Hubei Province, China. *Frontiers in Environmental Science*, *10*. https://doi.org/10.3389/fenvs.2022.838686

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326.

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, *75*(2), 335–346. https://doi.org/10.2307/2336182

Ray, S., Haqiqi, I., Hill, A. E., Taylor, J. E., & Hertel, T. W. (2025). The role of labor markets in determining the efficacy and distributional impact of sustainability policies. In I. Haqiqi & T. W. Hertel (Eds.), *SIMPLE-G: A Gridded Economic Approach to Sustainability Analysis of the Earth's Land and Water Resources* (pp. 199–216). Springer Nature Switzerland.

Remeikiene, R., Gaspareniene, L., & Volkov, A. (2018). Evaluation of the influence of the export in agricultural products on the Baltic States economic growth. *Montenegrin Journal of Economics*, *14*(3), 83–94.

Rios e Silva, J. P., & Arruda, E. F. (2019). *Impactos do crédito rural no mercado de trabalho da agropecuária dos estados brasileiros*. *13*(3), 340–356.

Rizov, M., Pokrivcak, J., & Ciaian, P. (2013). CAP subsidies and productivity of the EU farms. *Journal of Agricultural Economics*, *64*(3), 537–557. https://doi.org/10.1111/1477-9552.12030

Sağdıç, E. N., & Çakmak, E. (2021). Tarımsal destek ödemeleri ile tarımsal üretim düzeyi arasındaki nedensellik ilişkisi: Türkiye örneği. *İnsan ve Toplum Bilimleri Araştırmaları Dergisi*, *10*(2), 1858–1880. https://doi.org/10.15869/itobiad.851919

Said, S. E., & Dickey, D. A. (1984). Testing for unit roots in autoregressive-moving average models of unknown order. *Biometrika*, *71*(3), 599–607. https://doi.org/10.2307/2336570

Saka, K. A., Akinde, M. A., & Afolabi, A. R. (2023). Credit financing and agricultural development in Nigeria. *Archives of Business Research*, *11*(10), 1–15. https://doi.org/10.14738/abr.1110.15172

SBB. (2025).T.C. Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı - SBB. https://www.sbb.gov.tr/ Accessed 01 May 2025

Semerci, A. (2019). Türkiye'de tarımsal destekleme uygulamaları. *ÇOMÜ Ziraat Fakültesi Dergisi*, *7*(1), 181–186. https://doi.org/10.33202/comuagri.418108

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In R. C. Sickles & W. C. Horrace (Eds.), *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications* (pp. 281–314). Springer.

Siudek, T., & Zawojska, A. (2011). Relationship of development and fiscal indicators with agricultural producer support in the OECD economies. *International Congress, August 30-September 2, Zurich, Switzerland*.

Tan, S., Tan, S. S., Everest, B., Hasdemir, M. (2016). Agricultural support policies and public budgeting in Turkey. *Management Studies*, *4*(6), 237–242.

Tangermann, S. (2005). *Is the concept of the producer support estimate in need of revision?* (OECD Food, Agriculture and Fisheries Papers 1; p. 22).

TBB. (2025). *Türkiye Bankalar Birliği veri sistemi*. https://verisistemi.tbb.org.tr/ Accessed 05 May 2025

Terin, M., Aksoy, A., & Güler, İ. O. (2013). Tarımsal büyümeye etki eden ekonomik faktörlerin belirlenmesi üzerine bir çalışma. *Iğdır Üni. Fen Bilimleri Enst. Der.*, *3*(3), 41–50.

Timmer, C. (1997). How well do the poor connect to the growth process? *CAER Discussion Paper No, Harvard Institute for International Development.*, *179*.

T.R. Ministry of Agriculture and Forestry. (2025). *2024-2028 Stratejik plan* (p. 94). https://www.tarimorman.gov.tr/SGB/Belgeler/stratejikplan.pdf

TurkStat. (2025). *Türkiye İstatistik Kurumu*. https://www.tuik.gov.tr/ Accessed 20 April 2025

Us, K., & Akbıyık, N. (2023). Tarım sektöründe istihdam ve çalışanların sosyal güvenliği. *Econharran*, *7*(12), 25–36.

Uzel, G., Kuzu, M., Güler, A., & Gürlük, S. (2025). Asymmetric effects of agricultural input prices on farmgate prices in Türkiye. *Agriculture*, *15*(6), 607. https://doi.org/10.3390/agriculture15060607

Yanıkkaya, H., & Koral, Z. (2013). Impacts of agricultural supports on exports of individual agricultural products in turkey. *International Review of Economics and Management*, *1*(1), 1–37. https://doi.org/10.18825/iremjournal.109057

Yavuz, F. (2024). Türkiye tarımı gıda arz güvenliğini sağlar mı? *Kriter Dergi*. https://kriterdergi.com/ekonomi/turkiye-tarimi-gida-arz-guvenligini-saglar-mi