

# Migration, land use, and trade in agricultural employment evidence from Türkiye's economic transformation

## Göç, arazi kullanımı ve tarımsal istihdam ticareti Türkiye'nin ekonomik dönüşümünden kanıtlar

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### ABSTRACT

This study examines the structural determinants of agricultural employment in Türkiye between 1988 and 2022, with a particular focus on the interactions among migration, agricultural land use, foreign trade, and minimum wage dynamics. The analysis aims to uncover the mechanisms underlying the long-term decline in agricultural labor and to assess the role of socioeconomic and policy-related factors in this transformation. Johansen cointegration and Granger causality methods are employed to identify both long-run equilibrium relationships and short-run dynamics affecting agricultural employment. The results show that rising minimum wages and the contraction of agricultural land have a negative impact on agricultural employment, while agricultural foreign trade and migration inflows contribute positively. A 1% increase in agricultural land corresponds to a 0.9% decrease in agricultural employment (AgrEmp), and a 1% increase in minimum wages leads to a 9.7% reduction in AgrEmp. Conversely, a 1% increase in agricultural foreign trade is associated with an approximately 0.7% rise in AgrEmp, indicating that trade expansion supports labor integration. Short-run VECM results indicate that agricultural foreign trade and international migration actively contribute to restoring short-term equilibrium. Causality analysis reveals the presence of both unidirectional and bidirectional relationships, suggesting that migration and trade expansion act as key drivers of agricultural employment, whereas land shrinkage and wage increases accelerate the reallocation of rural labor toward non-agricultural sectors. The findings indicate that agricultural employment in Türkiye is shaped by structural economic forces and policy interventions that influence labor mobility across sectors. The study highlights the importance of integrating land-use management, trade incentives, and wage regulation within a coherent rural development framework to mitigate employment losses, enhance labor productivity, and strengthen the resilience of the agricultural sector.

**Key Words:** *Agricultural employment, migration, minimum wage, Cointegration analysis, Granger causality.*

### ÖZ

Bu çalışma, 1988–2022 dönemi boyunca Türkiye'deki tarımsal istihdamın yapısal belirleyicilerini, göç, tarım arazisi kullanımı, ticaret ve asgari ücret dinamikleri arasındaki karmaşık etkileşim çerçevesinde incelemektedir. Araştırmanın amacı, tarımsal işgücündeki uzun vadeli azalışın ardındaki mekanizmaları belirlemek ve sosyoekonomik ile politika temelli faktörlerin bu dönüşüme nasıl katkı sağladığını değerlendirmektir. Johansen eşbütünlük ve Granger nedensellik analizleri kullanılarak, tarımsal istihdamı etkileyen değişkenler arasındaki kısa ve uzun dönem ilişkiler incelenmiş; bu ilişkilerin yönü ve gücü ortaya konulmuştur. Bulgular, artan asgari ücretler ile tarımsal alanlardaki daralmanın tarımsal istihdam üzerinde olumsuz etkisi olduğunu; buna karşılık tarımsal dış ticaret ve göç girişlerinin istihdama olumlu katkı sağladığını göstermektedir. Tarımsal arazideki %1'lik bir artış, tarımsal istihdamda

(AgrEmp) yaklaşık %0,9'luk bir azalışa; asgari ücrete yönelik %1'lik bir artış ise istihdamda yaklaşık %9,7'lik bir düşüşe karşılık gelmektedir. Buna karşın tarımsal dış ticaretteki %1'lik bir artış, tarımsal istihdamı yaklaşık %0,7 oranında artırmakta ve dış ticaret genişlemesinin işgücü entegrasyonunu desteklediğini göstermektedir. Kısa dönem VECM sonuçlarına göre tarımsal dış ticaret ve dış göç kısa vadede dengeyi yeniden sağlamada aktif rol oynamaktadır. Nedensellik sonuçları, tek yönlü ve çift yönlü ilişkilerin bulunduğunu göstermekte; göç akışlarının ve tarımsal ticaretin genişlemesinin tarımsal istihdamı artırdığını, buna karşın arazi daralması ve artan ücretlerin kırsal işgücünü tarım dışı sektörler'e yönlendirdiğini ortaya koymaktadır. Çalışma, Türkiye'de tarımsal istihdamın, sektörler arası işgücü hareketliliğini etkileyen yapısal ekonomik güçler ve politika müdahaleleri tarafından şekillendiğini ortaya koymaktadır. Arazi kullanımı yönetimi, ticaret teşvikleri ve ücret düzenlemelerinin bütüncül kırsal kalkınma stratejileri içinde birleştirilmesinin gerekliliğini vurgulamaktadır. Politika önerileri arasında, tarım işverenleri için hedefli ücret destek mekanizmalarının uygulanması ve göçmen işgücünün tarımsal işgücüne entegre edilmesine yönelik programların oluşturulması yer almaktadır. Bu önlemler, istihdam kayıplarını azaltabilir, işgücü verimliliğini artırabilir ve tarım sektörünün direncini güçlendirebilir.

**Anahtar Kelimeler:** *Tarımsal istihdam, göç, asgari ücret, eşbütünleşme analizi, Granger nedenselliği.*

## Introduction

The fact that unemployment has a significant effect on a country's economy and development statistics has been used in many studies. Some recent studies seem to focus on nonagricultural unemployment. The most important evidence to support this is that rural unemployment is ignored. As the rural population is ignored, the areas in the producing sector are decreasing daily. While this decrease limits job opportunities in rural areas, it is also insufficient to meet the needs of the increasing population. Malthus emphasized the delay in the increase in the production of material goods caused by population growth as the primary source of unemployment (Babushkin et al., 2021). Structural change in the agricultural sector is added to this country's basic unemployment problem. The most important reasons for this structural change are migration from the agricultural sector to nonagricultural sectors, population growth, migration and urbanization (Akin, 2018).

In recent years, Türkiye has emerged as a country that hosts significant migration movements. In particular, the Arab Spring, which began in 2010, has led to forced migrations in the Middle East, contributing to a notable increase in the number of migrants in Türkiye. This trend has had a significant impact on Türkiye's demographic structure, with the population reaching 85.3 million in 2022, a 33% increase from 2000, when it was 64.1 million. This increase in population has also led to notable changes in the labor market.

This increase in population has also led to notable changes in the labor market. Recent research has also demonstrated that international migration significantly influences the composition of agricultural employment and household labor distribution in Türkiye, confirming that migration dynamics reshape the rural labor market (Sarioğlu and Şengül, 2024). In 2000, 21 million people were employed, whereas in 2022, approximately 30 million people were employed. When considering the distribution of employment by sector, in 2000, 36% of the workforce was engaged in agriculture, 24% in industry, and 40% in the service sector. However, in 2022, 15.8% of the workforce was employed in agriculture, 27.7% in industry, and 56.5% in the service sector (TSI, 2023). Accordingly, the number of workers employed in agriculture has decreased by approximately 60% over the past 22 years, shifting labor from agriculture to the service sector. This situation can also be seen as evidence of both rural–urban migration and the shift of labor from agriculture to nonagricultural sectors. Unemployment rates have risen concurrently with this change, increasing from 6.5% in 2000 to 10.4% in 2022 (TSI, 2023a).

A significant part of international migration within the country is related to the refugee crisis resulting from conflicts in Syria. These data reveal that by 2022, there are 17 million immigrants, accounting for exactly 20% of Türkiye's overall population (PMM, 2023), indicating that Türkiye's actual population is 102 million people.

Migration between different countries arises for a variety of complex reasons. The main

reasons for this migration include the search for better employment opportunities (poverty), environmental changes (Black et al., 2011), improvements in living standards, economic crises, rural development and a decrease in economic opportunities. urbanization of rural areas (Wang, 2017; Lyu et al., 2019). Urbanization generally occurs with industrialization. The most serious problem in developing and underdeveloped countries is that urbanization and industrialization cannot grow at the same time. This situation is also valid for Türkiye, which experienced urbanization before industrialization. With the start of internal migration in Türkiye in the 1950s, unskilled agricultural workers left rural areas and settled in urban areas with minimum wage income. Limited land availability for urban expansion leads to alternative use of arable land, restricting production areas. The decrease in the agricultural labor force and production areas in the agricultural sector has caused a decrease in per capita income and living standards in the sector, causing workers to look for jobs in other sectors (Işın et al., 2010).

These agricultural unemployment and labour migration trends in Türkiye are closely in line with two significant theoretical models: Lewis's dual-sector model and the Push–Pull Migration Theory. As per Lewis (1954), labour shifts out of the agricultural sector, which is characterised by surplus labour and low productivity into the modern industrial sector that provides higher wages and better working environment. It is a painful process: as rural workers are absorbed into urban, frequently low-skilled industrial or service-sector jobs agricultural employment falls.

At the same time, the Push–Pull Migration Theory (Lee, 1966) gives a micro-level explanation to complement this macro perspective. The model suggests migration decisions are a function of the interaction of “push” factors in the source region — e.g., land fragmentation, low wages, absence of job opportunities — and “pull” factors in the destination region — e.g., higher wages, urban amenities, reliable jobs. Lee stresses that migration is down to rational economic decision

of the individual, taking into account expected benefits and information available from the home and host regions. As Wadood et al. (2021) describe, “push factors occur in the economically backward regions or countries of the world (low demand for employment opportunities and meager payment, compelling people to look for other places where their skills can be better utilized), whereas pull factors operate in the economically advanced regions or countries of the world (abundant employment opportunities and lucrative payment, motivating people to move in and reside there).” (Diago, 2024). In the case of Türkiye, contraction of rural land, stagnation of agricultural wage growth, and increase in employment opportunities in urban areas seem to reflect this two-sided dynamic and provide strong framework for understanding recent changes in agricultural labor.

In the literature, studies have separately examined the correlations between agricultural employment and agricultural areas, international migration, the minimum wage and agricultural foreign trade. A study in the USA concluded that a 10% increase in immigrants as a share of the population reduced local workers' wages by 1% (Göğebakan, 2018), that migrants caused a temporary and limited increase in unemployment (Jean and Jimenez, 2011), and that this increased unemployment rates (Aydemir and Kırdar, 2013; Ceritoğlu et al., 2015). Sarioğlu and Şengül (2024) found that rising migration levels have a negative impact on agricultural employment. Lu & Wu (2022) find that different types of migration and migration durations affect rural households' decisions to abandon, farm, or transfer farmland in China, highlighting how labor mobility interacts with agricultural land utilization. This finding showed that increased migration had only a minor effect on the Polish labor market, with no significant change in unemployment or wage growth (Barslund et al. (2014) and Kaczmarczyk et al. (2010)). Kaczmarczyk (2012) concluded that migration in Poland had no substantial influence on employment, unemployment, or salaries in the short or medium term. Baas et al. (2010)

examined the impact of migration on labor markets in the EU15 and EU8. After capital stocks in the labor market are accounted for, the effects of immigration on wages and unemployment are neutral.

The minimum wage is an important factor affecting wages in the agricultural sector, and one study showed that a 10% increase in the minimum wage would cause a 4% reduction in agricultural employment 10--20 years later. This means that the minimum wage has no effect on the expenditures of agricultural employers when they take on workers and that the total cost of workers' wages will remain the same with respect to higher minimum wages (Kandilov and Kandilov, 2020). Meer and West (2016) reported that the effect of the minimum wage on agricultural employment was not statistically significant. Dustmann et al. (2015) studied the influence of migration on the Polish labor market during the EU accession from 1998-2007. They found that earnings in unskilled labor decreased somewhat throughout this time period.

More recent studies emphasize the spatial dimension of agricultural labor migration. Du et al. (2023), focusing on Liaoning Province in China, show that agricultural labor out-migration contributes to structural changes in rural employment and affects land-labor allocation within the urban-rural dual economic system. Their findings suggest that labor mobility not only reduces agricultural employment but also indirectly influences land use efficiency and regional economic structures. Concern is growing about the food supply in the future because of the large number of workers leaving rural areas and the transfer of unworked fields (Xu et al., 2019). Studies conducted in China have reported that the movement to nonagricultural employment reflects the use of agricultural land negatively as a loss of workforce and positively in terms of income (Freng et al., 2010). A negative effect of workforce loss is expressed as nonagricultural employment reducing the workforce supply for agricultural production (Zhao et al., 2021). Taylor et al. (2003) reported

that when agricultural capital and technology were at a low level and lost labor was not replaced, this had negative effects on household labor transfer and agricultural land production. In studies that have been conducted, the relationship between agricultural employment and agricultural areas has not been addressed specifically.

Recent studies provide evidence to support the general opinion that trade has specific impacts on unemployment. However, the evidence has varied, with studies indicating that trade may influence unemployment in a variety of ways, and in certain circumstances, some academics have even claimed that trade has no effect on unemployment. Onifade et al. (2020) reported that trade has a negative effect on employment levels. Studies have shown that unemployment decreases when international trade increases; Gözgör and Pişkin (2011) and Hasan et al. (2011). Excessive imports may increase unemployment problems. This is partly because imports have become more affordable and domestic products are exposed to more competition. When such competition becomes unfavorable, some local producers leave business, and more people suffer from unemployment. Although studies have been conducted on the relationship between foreign trade and employment, this relationship has not been examined specifically in the agricultural sector.

The focus of our research is the causes and consequences of changes in agricultural employment. In particular, the effects of migration on agricultural employment, the shrinkage of agricultural land and the effects of increasing imports on farmers moving away from production were examined. It also aimed to test the hypothesis that increases in the minimum wage may lead agricultural workers to seek employment in different sectors. This study was undertaken to understand the complex interplay of factors shaping agricultural unemployment and its broader impacts on Türkiye's economy and development. These findings may help us understand the socioeconomic consequences of

changes in the agricultural sector and their impact on Türkiye's economic development.

## Materials and Methods

### *Data and descriptive analysis*

This study investigates the factors influencing

agricultural employment in Türkiye via time series data spanning from 1988--2022. This study aims to provide a holistic understanding of the multifaceted dynamics affecting agricultural employment by considering net migration, land use, trade and the minimum wage together. The names and sources of the variables used in the study and analysis are presented in Table 1.

**Table 1.** Information on Variables

Abbreviation of variable	Name of Variable	Source
AgrEmp	Agricultural Employment (1000 people)	TSI, 2023a
Wage	Minimum wage (\$)	MLSS, 2024
NetMig	Net migration (1000 people)	Altunç and Uçan. 2017, PMM 2024
AgrArea	Agricultural areas (1000 ha)	TSI,2023b.
AgrTrade	Agricultural net trade (million \$)	SBM, 2024

Data sources include official institutions such as the Turkish Statistics Institute (TSI), the Turkish Republic's Ministry of Labor and Social Security (MLSS), the Ministry of Strategy and Budget of the Republic of Türkiye (SBM) and the Presidency of Migration Management (PMM) variables used in the study;

**Net migration (NetMig):** Net migration reflects the difference between total inflows and outflows of migrants, including international protection holders, irregular migrants, and individuals under temporary protection status. This variable is largely driven by forced migration from Syria after 2011, which has significantly shaped labor market dynamics, particularly in low-wage and labor-intensive sectors such as agriculture.

**Agricultural areas (Agrarea):** This variable reflects the total extent of agricultural land in Türkiye. Changes in agricultural areas can directly affect employment in the agricultural sector, making it a key factor to consider when studying agricultural employment dynamics.

**Agricultural Employment (AgrEmp):** This is the dependent variable representing total employment in the agricultural sector. Understanding the factors influencing agricultural employment is crucial for policymakers and researchers to address issues related to rural

economies and labor markets.

**Agricultural net trade (Agrtrade):** This variable explains the trade balance in the agricultural sector. It can impact employment by influencing demand for agricultural products in domestic or international markets. This situation may lead to a surplus of imported agricultural products domestically, resulting in the abandonment of production, whereas a surplus of exported products can increase production, thus affecting employment. On the basis of this explanation, we can conclude that understanding how this variable affects the trade balance in the agricultural sector, and consequently employment, is important. Therefore, examining this variable can be a significant tool for analyzing the development of trade and employment in the agricultural sector.

**Minimum Wage (MinWage):** The minimum wage is a crucial economic indicator affecting various sectors, including agriculture. Changes in the minimum wage can influence labor supply and demand, affecting employment levels in both the agricultural and nonagricultural sectors.

**Exchange Rate Adjustment:** The minimum wage variable was converted into USD using the mid-year (June 15) exchange rate for each period. The same reference date was systematically applied across all years to maintain internal

comparability, reduce short-term volatility distortions, and prevent exchange rate fluctuations from dominating the wage–employment relationship. This approach ensures that the effect measured in the model reflects the economic impact of minimum wage dynamics rather than currency shocks.

By considering net migration, land use, trade, and wage policies together, this study aims to offer a holistic understanding of the multifaceted dynamics affecting agricultural employment. This study aims to provide a holistic understanding of the multifaceted dynamics affecting agricultural employment by considering net migration, land use, trade, and wage policies together. For this reason, each selected variable is considered a factor affecting agricultural employment, and a comprehensive view of these factors is presented. It covers various aspects of employment, migration, land use, trade dynamics and economic policies and is therefore highly relevant to policy, as it encompasses these variables and the internal and external factors that can shape agricultural employment trends. All statistical analyses and econometric tests, including the unit root, cointegration, VECM, and Granger causality tests, were conducted using EViews1 software. The time series analyses in this study were meticulously crafted to elucidate the intricate relationships among the dependent variable, agricultural employment, and various contributing factors. Emphasis was placed on delineating both short- and long-term relationships, providing valuable insights into the directionality of these relationships. To ensure the robustness of the findings, the stability of the variables was rigorously examined through the augmented Dickey Fuller (ADF) unit root test. The investigation of long-term relationships was conducted via the Johansen cointegration method. Finally, the Granger causality test was applied to discern the direction of the relationships between the variables. This comprehensive analytical approach not only contributes to a nuanced understanding of the factors influencing agricultural employment but

also enhances the credibility of the study's findings.

The stability of time series data is inherently challenging because of their tendency to exhibit an increasing trend over time. Consequently, unit root tests play a crucial role in assessing the stability of series, as highlighted by Sevüktekin and Çınar (2017). The hypotheses for unit root tests are formulated as follows:

$H_0: \rho \geq 1$  or  $H_0: \delta \geq 0$  (the series is not stable)  $H_1: \rho < 1$  or  $H_1: \delta < 0$  (the series is stable) In the Dickey–Fuller (DF) approach, the null hypothesis ( $H_0$ ) posits the existence of a unit root (indicating instability), whereas the alternative hypothesis ( $H_1$ ) suggests the absence of a unit root (indicating stability). If the DF tests reveal the presence of a unit root and differencing resolves this issue, it is considered appropriate. The DF test involves three distinct regression equations (1, 2, 3):

$$\Delta Y_t = \beta Y_{t-1} + \varepsilon_t \text{ No constant term or trend} \quad (1)$$

$$\Delta Y_t = a + \beta Y_{t-1} + \varepsilon_t \text{ Constant term but no trend} \quad (2)$$

$$\Delta Y_t = a + bt + \beta Y_{t-1} + \varepsilon_t \text{ Both constant term and trend} \quad (3)$$

Here,  $Y_t$  represents the time series,  $a$  is the constant term,  $bt$  is the trend,  $\varepsilon_t$  is the error term, and  $\beta$  is the coefficient of  $Y_{t-1}$ . The  $t$  value of this coefficient is compared with the tau statistics table, which is the critical value table of the DF test. If the value is below the critical threshold, the null hypothesis is rejected, indicating stability (Brooks, 2008; Khusayan, 2019). Throughout the DF test stages, it is assumed that there is no correlation between the error terms. To address the autocorrelation problem, the ADF test, an extension of the DF test, incorporates lag length into the model (Torun, 2015). In this study, the ADF test was employed to assess the stability of the time series data.

The descriptive statistics for the variables used in the study are presented in Table 2. According to the Jarque–Bera values, Netmig deviates from a normal distribution but to an acceptable extent. Agriemp, Agrarea, and Netmig exhibit right skewness, while Agrtrade displays left skewness, and Wage demonstrates a normal distribution.

**Table 2.** Descriptive Statistics

	AgriEmp	AgrArea	AgrTrade	Netmig	Wage
Std. Dev.	1673.307	1287.516	2169.958	1524989	174.9611
Skewness	0.244260	0.570273	-0.756150	1.062661	-0.011297
Kurtosis	1.350967	2.259308	2.911143	2.442753	1.373701
Jarque-Bera	4.313694	2.697139	3.346801	7.040130	3.857814
Probability	4.313694	2.697139	3.346801	7.040130	3.857814

This study uses time series analysis to illuminate the complex relationships between agricultural employment and other factors. The relationships between the variables were examined in the short and long term, and information on the direction of these relationships was presented. While cointegration suggests a causal relationship between variables, it does not reveal the direction of causality. Consequently, Granger causality analysis is adopted to discern the direction of influence. This dual-method approach facilitates a more comprehensive understanding of the intricate relationships within the dataset. This comprehensive analytical approach not only contributes to a detailed understanding of the factors affecting agricultural employment but also increases the reliability of the study's findings.

Johansen cointegration analysis is particularly valuable for its ability to identify both short- and long-term relationships between variables. In this process, the VAR model is used to uncover short-term dynamics, providing a comprehensive understanding of the interdependencies within the system. The choice of the Johansen method therefore allows for a robust investigation of dynamic relationships over time, adapting to the characteristics of the variables in the model and their shared lag lengths.

### Analyzes

**Johansen Cointegration Test:** Cointegration tests provide an average to determine whether a series of endogenous variables share a long-term stochastic trend. In the Johansen multiple cointegration model (1 and 2), the vector autoregressive model (VAR) is first considered, as shown below.

$$X_t = \pi_1 X_{t-1} + \pi_2 X_{t-2} + \dots + \pi_k X_{t-k} + \mu + \varepsilon_t \quad [1]$$

Taking the first differences of the nonstable X variable,

$$X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_{k-1} \Delta X_{t-k-1} + \dots + \pi_k X_{t-k} + \mu + \varepsilon_t \quad [2]$$

In the model,  $X_t$ : the dimensional vector (px1) of variables integrated in I(1),  $\varepsilon_t$ : the error term,  $\Gamma_1$  (pxp) dimensional parameters matrix,  $\pi$ : provides information on the long-term relationships of observations, and the rank of matrix  $\Gamma$ : the number of combinations of linear and stationary linear variables. If the rank is 0,  $X_t$  becomes a vector autoregressive (VAR) model in the form of first differences. If its rank is 1 or more than 1, there will be 1 or more cointegrating vectors, which will indicate a long-term relationship. The Johansen procedure starts with the VAR(k) model into a Vector Error Correction Model (VECM) and this analysis is used to estimate the short-term relationship.

The Granger causality test is a test that is used to examine the direction and existence of causal relationships between time series. The Granger causality test supposes that only time series data can indicate the information needed for a relationship between variables. The Granger causality test relies on a standard F test, which is used to determine if any development in one variable causes development in another variable (Papas and Stoian, 2016). In these equations,  $\beta_{ij}$  and  $\alpha_{ij}$  are parameters. The hypotheses put forward by the first equations above are as follows:

$$H_0: \alpha_{11} = \alpha_{12} = \dots = 0 \text{ (not the cause)}$$

$$H_1: \alpha_{ij} \text{ (the cause)}$$

The hypotheses put forward by the second equations above are as follows:

$$H_0: \beta_{11} = \beta_{12} = \dots = 0 \text{ (not the cause)}$$

$$H_1: \beta_{ij} \text{ (the cause)}$$

The regression model used in the study is

shown below.

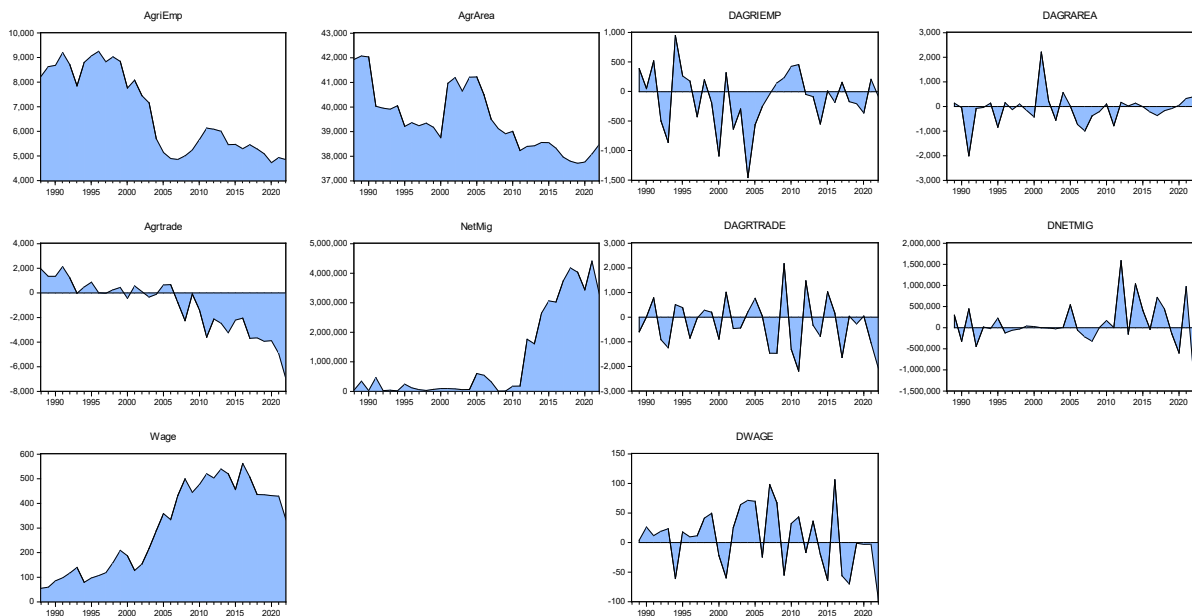
$$Emp = \beta_0 + \beta_1 NetMig + \beta_2 AgrArea + \beta_3 Agrtrade + \beta_4 MinWage + \epsilon_t$$

The study uses Johansen Cointegration analysis because all variables may be both dependent and independent; it permits the use of two or more variables, and it is a VAR-based cointegration technique employing the maximum likelihood method. Cointegration implies that there is causation between the two series, but it cannot reveal which way the causality is pointing. As a result, Granger causality analysis was used to assess the relationship's direction. To assess the applicability of the proposed model, a regression model was built. Thus, the independent factors explained 86.61% of the dependent variable, and

the corrected explanation rate was 84.82%. ( $R^2=0.866094$ , Adj.  $R^2= 0.848239$ ).

**Results and Discussion**

A time series spanning from 1988-2022 was constructed for Türkiye, and the stationarity of the variables was determined. Figure 1 presents graphical representations of the variables both at the level before conducting the unit root test and after becoming stationary. ADF unit root test was applied to ensure that the data were stationary. The hypotheses for testing the variables are as follows: H0: the variable is not stable. H1: The variable is stable.



**Figure 1:** Representation of the variables at different levels and 1st differences.

Table 3 presents the level and 1st difference values of the variables. The variables do not exhibit stability at the level, and the null hypothesis (H0) is accordingly accepted. Upon calculating the first difference I(1) of the variables, the null hypothesis (H0) is subsequently

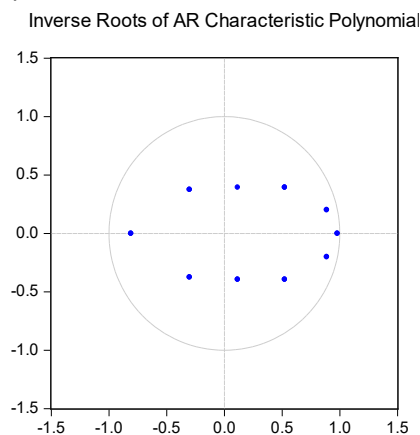
rejected, indicating stability in the series with a significance level of  $p < 0.05$ . Therefore, the stability of the first differences of the variables suggests integration at the first degree I(1), indicating suitability for cointegration testing.

**Table 3.** ADF test results of variables ( $P \leq 0.05$ )

Variables	Level		1st difference	
	t	Prob	t	Prob
AgrEmp	-1.331829	0.1658	-6.845518	0.0000
AgrArea	-1.007095	0.2756	-5.460959	0.0000
AgrTrade	2.453753	0.9955	-7.606902	0.0000
Wage	0.115411	0.7126	-5.302592	0.0000
NetMig	0.250868	0.7530	-6.736846	0.0000

Johansen Cointegration Test Results: Before performing the cointegration analysis, a VAR model was established with the lag length determined as (1 1). When the VAR model was used for the root test, the absolute values of the roots were less than 1.00 (Figure 2). The fact that

the inverse roots of the autoregressive characteristic polynomial do not exceed 1 shows that the VAR model has a stable structure; therefore, the application of the error correction model is appropriate.



**Figure 2:** Inverse roots of the AR characteristic polynomial

The Johansen cointegration test includes likelihood ratio tests, the trace test, and the maximum-eigenvalue test. The results of these tests are presented in Table 4. According to the findings presented in Table 4, both the trace statistic and the max-eigenstatistic exceed the critical values at the 5% significance level, leading to the rejection of the null hypothesis (H0). Consequently, the hypothesis suggesting no cointegration relationship is rejected, whereas

the alternative hypothesis, indicating the existence of at most one cointegration relationship, is accepted. Therefore, it can be inferred that the series move together in the long term. All series were found to be I(1), justifying the use of Johansen's procedure. The trace and maximum eigenvalue statistics confirmed the presence of at least one cointegrating vector.

**Table 4.** Results of the Johansen Cointegration test

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical val.	Prob.	Max-Eigen Statistic	0.05 Critical val.	Prob.
None*	82.27641	69.81889	0.0037	41.08715	33.87687	0.0058
At most 1	41.18926	47.85613	0.1827	17.80369	27.58434	0.5115
At most 2	23.38557	29.79707	0.2276	16.33686	21.13162	0.2058
At most 3	7.048710	15.49471	0.5720	6.907140	14.26460	0.5002
At most 4	0.141570	3.841466	0.7067	0.141570	3.841466	0.7067

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level. Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level \*denotes rejection of the hypothesis at the 0.05 level

Examining the results in Table 5, the impacts of agricultural area, agricultural foreign trade, net migration, and wages on agricultural employment were assessed using both the long-run equilibrium relationship and short-run dynamics within the VECM framework. The long-run results reveal the existence of a stable equilibrium relationship among the variables. Agricultural areas and wages exert a positive and statistically

significant effect on agricultural employment, indicating that expansion in cultivated land and higher wage levels support labor demand in the agricultural sector. In contrast, agricultural foreign trade and net migration have negative effects on agricultural employment in the long run, suggesting that increased trade exposure and labor mobility may reduce labor absorption in agriculture. In the short run, the variables

D(AgrTrade) ( $t = 3.48$ ) and D(NetMig) ( $t = 5.39$ ) are statistically significant at the 1% level, given that their absolute t-values exceed the critical value of 2.58. However, D(AgrEmp) remains statistically insignificant, as its t-statistic does not pass the conventional threshold. Accordingly, the short-run VECM estimates indicate that deviations from the long-run equilibrium are not primarily corrected through adjustments in agricultural employment itself. Instead, the error-

correction mechanism is mainly driven by changes in agricultural foreign trade and net migration, which respond more rapidly to short-term disequilibria. These results highlight that, while agricultural employment is shaped by land availability and wage dynamics in the long run, migration and trade play a more active role in restoring equilibrium in the short run.

**Table 5.** Long-term balance model and short-term estimate (VECM) results

Emp	AgrArea	AgrTrade	NetMig	Wage	
1.00000	0.976635	-0.739491	-0.000302	9.776330	
Standard Error	0.12527	0.15608	0.00011	0.90951	
T statistic	7.79612	-4.73805	-2.80984	10.7490	
VECM	D(AgrEmp)	D(Agrarea)	D(Agrtrade)	D(Netmig)	D(Wage)
CointEq1	-0.074939	-0.049781	0.874740	548.7843	0.003525
Standard Error	(0.14762)	(0.18087)	(0.25073)	(0.01396)	(0.01396)
T statistic	[-0.50764]	[-0.27523]	[3.48872]	[5.39269]	[0.25250]

After ensuring the existence of cointegration or a long-term equilibrium relationship between variables. The next step is to examine the vector error correction model (VECM). For the CointEq1 value (error correction coefficient) to be considered significant, it should fall between 0 and -1, and its calculated t value must be statistically significant with an absolute value exceeding. The short-run results indicate that D(AgrTrade) and D(NetMig) are statistically significant ( $t = 3.48$  and  $t = 5.39$ , respectively), confirming the presence of a short-run adjustment mechanism. However, D(AgrEmp) remains statistically insignificant. While the adjustment speed implies that deviations converge to long-run equilibrium in approximately 13.3 years ( $1/|-0.0749|$ ), the short-run dynamics demonstrate that trade and migration variables contribute significantly to this adjustment, whereas agricultural employment doesn't.

Following the Johansen cointegration study, this model was subjected to testing (autocorrelation LM test, normal distribution test, and changing variance test). The statistical probability values of these test results should be

$p > 0.05$ . The autocorrelation LM test findings show that there is no autocorrelation problem because the values are  $p > 0.05$  (LM-stat: 0.0705). The heteroskedasticity test results indicate that there is no heterogeneity concern since  $p = 0.3293$  ( $p > 0.05$ ). According to the normality test results, the series has a normal distribution because  $p = 0.5079$  ( $p > 0.05$ ). According to the results obtained, the model is suitable.

The presence of a relationship between two variables is not evidence of causality or direction of the relationship. Therefore, the causality of the relationship identified in the Johansen cointegration analysis is established via this test. Table 6 presents the hypotheses and test results of the Granger test.

The analysis results presented in Table 6 were tested for significance levels of 5% and 10%. According to these results, unidirectional causality exists between the variable "netmig" and other variables. This relationship suggests that changes in net migration significantly influence agricultural employment, agricultural areas, agricultural trade, and the minimum wage. Additionally, there is unidirectional causality between the variables "Agrarea", "Agrtrade" and "Agremp," which

specifically affect agricultural employment. Furthermore, a bidirectional causal relationship is

observed between the variables "Agrtrade" and "wage" (Figure 3).

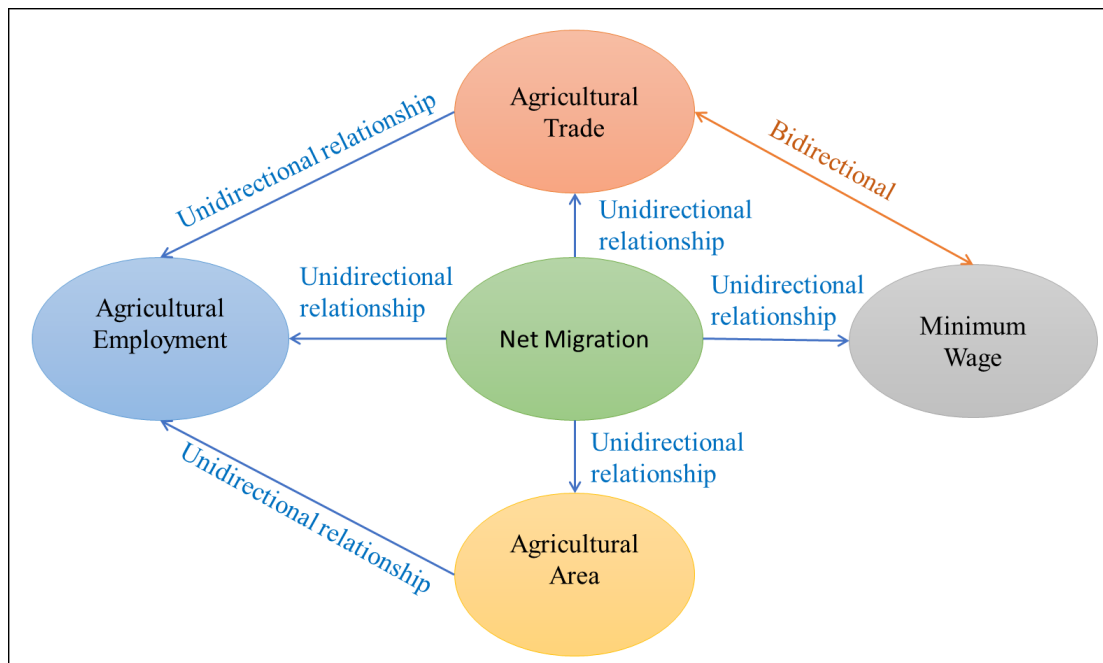
**Table 6.** Results of Granger causality tests

Null Hypothesis:	P-value	Decision	Causality
AgrEmp does not Granger Cause Agrarea	0.8785	Do not reject	Unidirectional
Agrarea does not Granger Cause AgrEmp	0.0676*	Reject	Agrarea → AgrEmp
AgrEmp does not Granger Cause AgrTrade	0.3775	Do not reject	Unidirectional
AgrTrade does not Granger Cause AgrEmp	0.0095**	Reject	Agrtrade → AgrEmp
AgrEmp does not Granger Cause Netmig	0.9852	Do not reject	Unidirectional
Netmig does not Granger Cause AgrEmp	0.0192**	Reject	Netmig → AgrEmp
AgrEmp does not Granger Cause Wage	0.5781	Do not reject	No causality
Wage does not Granger Cause AgrEmp	0.9968	Do not reject	No causality
Agrarea does not Granger Cause AgrTrade	0.3316	Do not reject	No causality
Agrtrade does not Granger Cause Agrarea	0.1082	Do not reject	No causality
Agrarea does not Granger Cause Netmig	0.6629	Do not reject	Unidirectional
Netmig does not Granger Cause Agrarea	0.0197**	Reject	Netmig → Agrarea
Agrarea does not Granger Cause Wage	0.2528	Do not reject	No causality
Wage does not Granger Cause Agrarea	0.6033	Do not reject	No causality
Agrtrade does not Granger Cause Netmig	0.1214	Do not reject	Unidirectional
Netmig does not Granger Cause Agrtrade	0.0376**	Reject	Netmig → Agrtrade
Agrtrade does not Granger Cause Wage	0.0186**	Reject	Bidirectional
Wage does not Granger Cause Agrtrade	0.0223**	Reject	Mig ↔ Trade
Netmig does not Granger Cause Wage	0.0270**	Reject	Unidirectional
Wage does not Granger Cause Netmig	0.1135	Do not reject	Netmig → MinWage

\*, \*\*at the 0.10 and 0.05 significance levels

Despite policies in Türkiye supporting agriculture, a reduction has been observed over many years in agricultural areas and the labor force. The reduction in agricultural employment may depend on many factors, but in this study, the effects of four variables (agricultural areas, agricultural foreign trade, international migration and the minimum wage) are emphasized. These variables were focused on because they affect agricultural growth and play a role in reducing the share of agriculture. According to the results of the analysis, in the long run, the minimum wage and agricultural land variables have a negative and statistically significant effect on agricultural employment, whereas the agricultural foreign trade and migration variables have a positive and significant effect. In the long-run cointegration equation, a 1% increase in agricultural land (AgrArea) is associated with a 0.97% decrease in

agricultural employment (AgrEmp), indicating that reductions in cultivated land correspond to lower labor integration in the agricultural sector. Similarly, a 1% increase in the minimum wage (Wage) results in a 9.77% reduction in AgrEmp, reflecting the sensitivity of agricultural labor demand to labor costs and the reallocation of workers toward non-agricultural sectors. These findings support the argument that land contraction and rising labor costs are key structural drivers behind the decline in agricultural employment in Türkiye. These findings suggest that changes in the minimum wage and agricultural land availability are associated with decreases in agricultural employment, whereas variations in agricultural foreign trade and migration contribute to long-term increases in agricultural employment.



**Figure 3:** Direction and structure of Granger causality relationships among agricultural employment, migration, land use, trade, and wages

The Johansen cointegration study shows that migration has no substantial influence on employment. Kaczmarczyk et al. (2010), Jean and Jimenez (2011), Baas et al. (2010), Kaczmarczyk (2012), and Barslund et al. (2014) reported that external migration has little to no influence on employment. Aydemir and Kirdar, 2017, and Ceritoğlu et al., 2015, differ from the hypothesis that migration increases unemployment rates. The effect of migration on agricultural employment can be explained by the concentration of migrant labor in labor-intensive and low-wage agricultural activities, particularly seasonal harvesting and informal employment. Migrant workers often substitute for local labor that has shifted toward non-agricultural sectors due to wage differentials and urban employment opportunities. This mechanism allows agricultural production to be sustained despite declining domestic labor supply. Consequently, Türkiye presents a unique situation due to the scale, speed, and sectoral concentration of migration flows. This, combined with a structurally fragile agricultural sector, leads to labor market outcomes that differ from those observed in many other host economies.

In terms of the relationship between the minimum wage and employment, Meer & West (2016) reported that a 10% increase in wages

increased unemployment by 0.7%, but the effect of the minimum wage on agricultural employment was statistically nonsignificant. Kandilov & Kandilov (2020) concluded that the minimum wage has a negative effect on agricultural employment. According to the findings of this study, a 1% increase in the minimum wage lowers the number of agricultural employees by 12.25%. In other words, it is believed that employees who leave agriculture are more inclined to work for minimum pay. This outcome is consistent with previous investigations.

Similar findings were reported in previous investigations (Freng et al., 2010 and Zhao et al., 2021). According to this analysis, losses in agricultural regions will result in 0.97% of people employed in agriculture becoming unemployed. In this scenario, the loss may be viewed as approximately ten people being laid off for one hectare of agricultural land.

Although research has been conducted on the relationship between international commerce and employment, it has not been extensively explored in the agricultural sector. In this study, the relationship between agricultural international commerce and employment was explored, and an increase in foreign trade resulted in a 0.7% increase in employment. In

other words, a 1% increase in agricultural foreign commerce means that one more person can work in agriculture.

In this study, according to the results of the causality analysis, certain causal relationships between variables were identified. The unidirectional causal relationship between agricultural foreign trade and agricultural employment is consistent with Gül and Kamacı (2012), whereas Khan et al. (2020) reported a difference with bidirectional causality. On the other hand, studies by Aslan and Altınöz (2010) and Boubtane et al. (2013) did not find a causal relationship between migration and unemployment; however, this study identified a unidirectional causal relationship from migration to employment, which differs from the literature. Studies supporting a unidirectional causal relationship from migration to unemployment include Espinosa and Diaz-Emparanza (2021). Additionally, this study revealed a unidirectional causal relationship between migration and agricultural foreign trade. This result differs from the study of Ghosh and Enami (2015).

## Conclusions

This study investigated the determinants of agricultural employment in Türkiye between 1988 and 2022, focusing on the roles of migration, agricultural land, trade, and minimum wage dynamics. The results demonstrate that land contraction and rising minimum wages significantly reduce agricultural employment, whereas migration inflows and agricultural trade positively support rural labor demand. Causality analysis further confirmed that migration and trade act as leading drivers of agricultural labor market dynamics.

The findings extend the existing literature in three ways. First, these studies differ from previous studies that analyzed demographic, economic, and policy factors separately by providing evidence of how these variables collectively shape agricultural employment. Second, they show that Türkiye represents a

unique case, as large-scale migration inflows have altered agricultural labor outcomes differently compared to many other migrant-receiving countries. Third, they contribute to policy debates on land use and wage regulation in emerging economies undergoing rapid structural transformation.

From a policy perspective, the results underscore the need for coordinated interventions that address land use, wage dynamics, and labor mobility simultaneously. From a comparative perspective, similar challenges have been addressed within the framework of the EU's Common Agricultural Policy (CAP), where wage support schemes, seasonal migrant labor regulations, and land preservation incentives are used to stabilize agricultural employment. Adapting such policy instruments to Türkiye's institutional context could enhance labor retention and sectoral resilience. In this regard, three policy priorities emerge.

-Protecting agricultural land by preventing excessive conversion to non-agricultural uses in order to sustain rural employment capacity.

-Designing targeted wage-support schemes, such as seasonal subsidies or conditional compensation, to mitigate the adverse employment effects of rising minimum wages.

-Integrating migrant labor through temporary work permits, skills training, and access to basic services, thereby stabilizing rural labor supply and strengthening sectoral resilience.

This study has certain limitations. First, non-agricultural employment variables were not explicitly included in the model, which may limit the interpretation of labor reallocation across sectors. Second, informal employment and undocumented migrant labor could not be directly measured due to data constraints. A further limitation concerns the exclusion of non-agricultural employment from the empirical model. This choice is deliberate, as the study aims to identify the direct determinants of agricultural employment. Since non-agricultural employment both influences and reacts to agricultural labor

dynamics, its inclusion could generate reverse causality and distort VECM estimates. The updated short-run results support this decision: the adjustment mechanism operates mainly through migration and agricultural trade, while agricultural employment itself does not respond significantly in the short term. Therefore, the model remains focused on how migration, land use, trade, and wage dynamics function within the agricultural labor market without interference from broader labor market feedback effects.

Future research could extend this analysis by incorporating regional-level data, sectoral distinctions within agriculture, and variables related to technological change and climate conditions. Comparative studies involving other developing or EU candidate countries may also provide further insights into the interaction between migration, trade, land use, and agricultural employment. Finally, the existing framework can be expanded by modeling agricultural and non-agricultural employment together using a multi-sectoral or panel-based approach.

## Declarations

## Conflicts of Interest

We declare that there is no conflict of interest between us as the article authors.

## Authorship Contribution Statement

All analyses and manuscript writing were performed by

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