Tarım Ekonomisi Dergisi
Turkish Journal of Agricultural Economics
ISSN 1303-0183
e-ISSN 3023-5596

The effect of global value chains on the agriculture sector: An evaluation for Türkiye

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Makale Künyesi

Araştırma Makalesi / Research Article

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Geliş Tarihi / Received: 12.06.2025

Kabul Tarihi / Accepted: 03.11.2025

Tarım Ekonomisi Dergisi
Cilt: 31 Sayı: 2 Sayfa: 433-448

Turkish Journal of Agricultural Economics
Volume: 31 Issue: 2 Page: 433-448

DOI
10.24181/tarekoder.1718304

JEL Classification: F02, F10, F14, F15

Abstract

Purpose: The main purpose of this paper is to scrutinize the integration of Türkiye's agriculture sector into global value chains (GVCs).

Design/Methodology/Approach: Drawing on data from the OECD-TiVA (2023) and WB-WDI (2025) databases, the paper employs input–output models and econometric techniques. Firstly, the paper calculated the GVC participation index, the GVC position index, net value-added gains, and import dependency. Then, using ARDL, Fourier-ARDL, and FMOLS estimators, the effects of GVCs integration on agricultural production were estimated.

Findings: According to the analysis results, the GVC participation index in the agricultural sector rose between 1995 and 2020, indicating that the sector has become integrated with global production networks and markets. However, over the 1995–2020 period, the GVCs position index for the agricultural sector remained negative and continued to decline steadily. This suggests that the sector has integrated into global value chains primarily through backward linkages. Between 1995 and 2020, the net value-added gain in the agricultural sector remained below 1. Similarly, this indicates that backward linkages in the sector were stronger than forward linkages. The findings derived from the input–output tables also confirm this situation, as they indicate that import dependency on intermediate inputs in the agricultural sector steadily increased between 1995 and 2020. Finally, according to the results obtained from the ARDL, FMOLS, and Fourier-ARDL estimators, during the 1995–2020 period, domestic value added in exports positively contributed to agricultural production, while foreign value added in exports hurt it.

Originality/Value: In today's modern global economy, production has become increasingly internationalized, and sectoral production has been progressively integrated into global production networks. However, a review of the literature reveals that studies focusing specifically on the agricultural sector remain limited. Therefore, this paper is expected to contribute to the literature by addressing the case of Türkiye's agricultural sector.

Keywords: Agriculture sector, ARDL, Global Value Chains (GVCs).

Küresel değer zincirlerinin tarım sektörüne etkisi: Türkiye üzerine bir değerlendirme

Özet

Amaç: Çalışmanın temel amacı Türkiye'de tarım sektörünün küresel değer zincirlerine (KDZ'lere) entegrasyonunun tarım üretimi nasıl etkilediğini analiz etmektir.

Tasarım/Metodoloji/Yaklaşım: Çalışmanın temel amacı kapsamında OECD-TiVA (2023) ve WD-WDI (2025) veri tabanlarından yararlanılarak, girdi-çıktı modelleri ve ekonometrik yöntemler kullanılmıştır. Çalışmada öncellikle, KDZ katılım endeksi, KDZ konum endeksi, Net Katma Değer Kazancı ve İthalat Ara Girdi Bağımlılığı hesaplanmıştır. Don sonra ARDL, F-ARDL ve FMOLS tahmincileri yarımıyla KDZ'lerin tarımsal üretim üzerindeki etkileri tahmin edilmiştir.

Bulgular: Analiz sonuçlarından elde edilen bulgulara göre, 1995-2020 döneminde tarım sektöründe KDZ katılım endeksi artış göstermiştir. Bu da tarım sektörünün küresel üretim ve piyasalar ile entegre olduğunu göstermektedir. Ancak 1995-2020 döneminde tarım sektöründe KDZ konum endeksi ise negatif ve sürekli küçülmüştür. Bu da tarım sektörünün daha çok geri bağlantılar yoluyla KDZ'lere entegre olduğunu göstermektedir. 1995-2020 döneminde tarım sektöründe net katma değer kazancı 1'den küçüktür. Aynı şekilde bu da tarım sektöründe geri bağıntıların ileri bağlantılardan daha yüksek olduğunu göstermektedir. Girdi-çıktı tablolardan elde dilen bulgular da bu durumu doğrulamaktadır. Çünkü bulgular, 1995-2020 döneminde tarım sektöründe ithal ara girdi bağımlılığının sürekli artığını göstermektedir. Son olarak, ARDL, FMOLS ve Fourier-ARDL tahmincilerinden elde edilen bulgulara göre, 1995-2020 döneminde ihracatın yurtiçi katma değeri tarımsal üretimi artırırken, ihracatın yabancı katma değeri ise tarımsal üretimi olumsuz etkilemektedir.

Özgünlük/Değer: Günümüz modern dünya ekonomisinde, üretim küresel bir hal almış ve sektörel üretim küresel üretim ağlarına gittikçe entegre olmuştur. Ancak literatür değerlendirildiğinde, özellikle tarım sektörü için çalışmaların sınırlı olduğu görülmüştür. Bu nedenle, Türkiye tarım sektörü için yapılmış olana bu çalışmanın literatüre katkı sağlayacağı düşünülmektedir.

Anahtar kelimeler: Tarım sektörü, ARDL, Küresel Değer Zincirleri (KDZ'ler).

INTRODUCTION

In the modern global economy, one of the most significant structural transformations is the international fragmentation of production, which has given rise to global value chains (GVCs) (Balie et al., 2019; Bialowas & Budzynska, 2022). One of the main drivers behind this structural transformation worldwide is the trend of globalization. With globalization, a new era of international competition has emerged, reshaping global production and trade dynamics. In fact, since the 1960s, multinational corporations began to fragment their supply chains in search of low-cost and foreign suppliers. By the 1980s, developed countries—particularly the United States of America (USA)—started to pursue overseas supply chains. As a result, the production process shifted from “producer-driven” commodity chains to “buyer-driven” supply chains. During the 1990s and 2000s, the scope and activities of this process expanded exponentially (Gereffi, 2014). Moreover, factors such as advances in information and communication technologies (ICT), declining transportation costs, and increased capital mobility have significantly contributed to the rapid expansion of GVCs (Jangam & Rath, 2021; Montalbano & Nenci, 2022; Olasehinde-Williams & Oshodi, 2024; Nana & Tabe-Ojong, 2025). Consequently, the international fragmentation of production, which began notably in the 1980s, accelerated in the 2000s, and GVCs have since played a defining role in the global economy (Ouedraogo & Takpara, 2025). GVCs refer to a production process in which a final good is produced by crossing multiple borders before reaching the end consumer (Kim & Biyik, 2025) [*In the literature, various terms are used to describe global value chains (GVCs), including vertical specialization, international fragmentation of production, global production networks, and trade in intermediate goods (Jangam & Rath, 2021)]*. In essence, GVCs represent the fragmentation of production across various countries, where each stage of producing a good or service takes place in a different location, and value is added at every stage of the process (Kim et al., 2024; Han & Lee, 2025). In this process, instead of producing a final good or service, a country specializes in a specific stage of the production process and focuses on particular activities (Olasehinde-Williams & Oshodi, 2024). Countries participate in GVCs in two main ways: through forward linkages and backward linkages. Forward linkages involve supplying intermediate inputs to other countries for their export-oriented production. Backward linkages, on the other hand, refer to using imported intermediate inputs in a country’s export-oriented production (Lebdioui, 2022; Kim & Biyik, 2025).

A country’s participation in GVCs can promote economic growth and development. For developing countries, engaging in GVCs offers the opportunity to benefit from comparative advantages and to leverage sectoral and production-stage efficiencies from other countries. Moreover, GVCs can also catalyze technological progress (Kim, 2024; Nana & Tabe-Ojong, 2025). Another important advantage of participating in GVCs is the ability to easily access intermediate inputs that are not available domestically, through backward linkages. This, in turn, enhances productivity and improves export performance in developing countries. Forward linkages in GVCs bring intermediate input producers in developing economies closer to final goods producers in more advanced economies. This allows developing countries to integrate into existing supply chains rather than having to build their own from scratch (Tinta et al., 2018; Pahl & Timmer, 2020; Jangam & Rath, 2021; Olasehinde-Williams & Oshodi, 2024; Ouedraogo & Takpara, 2025). Alongside their advantages, GVCs may also present certain drawbacks. For developing countries in particular, heavy dependence on primary products can create challenges in the process of GVC integration. As a result, these countries may face limitations in their ability to move into higher value-added stages of production (Kim & Biyik, 2025). Consequently, this situation can negatively affect both export performance and employment in developing countries (Pahl & Timmer, 2020). Moreover, factors such as economic crises and natural disasters can disrupt GVCs, creating disadvantages especially for developing countries (Han & Lee, 2025). In this regard, Gereffi (2014) emphasizes that participation in GVCs does not always guarantee advantages, either for developing or developed countries. Despite their advantages and disadvantages, the rise of GVCs has radically transformed the global economy. Kordalska and Olczyk (2023) and Tabe-Ojong et al. (2024) argue that nearly two-thirds of global trade today takes place through GVCs. In this context, GVCs have not only reshaped the industrial and service sectors but have also significantly transformed the agricultural sector in the modern global economy (Greenville et al., 2017; Awokuse et al., 2024). Bialowas and Budzynska (2022) and Beck et al. (2024) highlight that since the 1994 Uruguay Round, GVCs in the agri-food sector have expanded significantly. The participation of the agricultural sector in GVCs has made the production and consumption of agricultural and food products more accessible to many people (Tabe-Ojong et al., 2024). Kim et al. (2024) point out that, unlike the industrial and services sectors, the agricultural sector tends to participate in GVCs primarily through backward linkages. According to Pahl and Timmer (2020), participating in GVCs through backward linkages tends to generate low value added. Consequently, this makes the agricultural sector more vulnerable. The COVID-19 pandemic exposed this fragility, as disruptions in supply chains during the pandemic limited access to essential goods (Awokuse et al., 2024).

In this sense, this paper examines the impact of integrating the agricultural sector into global value chains (GVCs) on agricultural production in Türkiye, employing both input–output tables and econometric methods. When the studies on GVCs are evaluated, it is observed that the relationship between GVCs and various variables has been empirically analyzed, including economic growth (Nana & Tabe-Ojong, 2025; Musthaq & Afzal, 2024; Osabohien et al., 2024; Jingham & Rath, 2022; Taguchi & Nibayashi, 2021; Taguchi, 2024; Giuliani et al., 2005), exports (Quedraogo & Takpara, 2025; Olasehinde-Williams & Oshodi, 2023; Pahl & Timmer, 2020; Hiroyuki & Pham, 2019; Ahmad et al., 2017), competitiveness (Kordolska & Olczyk, 2023), agricultural production (Tabo-Ojango et al., 2024; Zhang & Sun, 2023; Mantalbano & Nenci, 2022; Bialowas & Budzynska, 2022; Mantalbano & Nenci, 2020; Balie et al., 2019), the environment (Han & Lee, 2025; Jithin & Ashraf, 2023), customs tariffs (Kim, 2024), and productivity (Wicaksano et al., 2023). While some studies on the agricultural sector exist in the literature, research on the process of Türkiye's agricultural sector's participation in GVCs and its impact on agricultural production is particularly limited. Therefore, this paper is expected to contribute to the existing literature. The main motivation of this research is to empirically examine the impact of Türkiye's integration into GVCs on agricultural production. For this purpose, data from the OECD-TiVA (2023) and WB-WDI (2025) databases were utilized to analyze the agricultural sector's GVC participation and its effects on production. The study focuses on the period from 1995 to 2020, as this is the most recent period for which GVC-related data are available in the OECD-TiVA (2023) database. The study is structured into five main sections. The introduction discusses the development and significance of GVCs. The second section presents agricultural growth and value-added trends in Türkiye. The third section presents a literature review related to the study. The fourth section outlines the methodology employed. The fifth section presents the findings and their discussion. Finally, the sixth section provides the conclusions of the study.

VALUE-ADDED TRENDS AND AGRICULTURE GROWTH IN TÜRKİYE

In Türkiye's economy, structural transformations have significantly affected the agricultural sector. After implementing the import substitution industrialization policies, the share of the industry and services sector in the economy increased, while the share of the agricultural sector declined. In the 1960-1970 period, the agricultural sector constituted almost 50% of the total economy. However, by the 1980s, the share of the agricultural sector in the total economy had fallen below that of the industrial sector. Because, again, in the post-1980 period, the export-oriented industrialization policy prioritized industrial production, leading to a gradual decline in agricultural production. Consequently, there have been significant declines in agricultural product exports. During the 1960–1980 period, agricultural raw material exports accounted for nearly 25% of merchandise exports, but this share fell below 10% after the mid-1980s. The policy transformations led to a decline in Türkiye's agricultural production, which in turn caused a substantial increase in the sector's import dependency in the global production process.

Figure 1 illustrates the growth rates of Türkiye's agricultural sector during the 1995–2020 period. As shown in Figure 1, agricultural production has experienced continuous fluctuations over the years. While the sector's growth rate was 1.96% in 1995, it declined to 0.73% by 2020. The highest growth rate was recorded in 2015 at 9.26%, whereas the lowest was in 2001 at -8.89%. Notably, during periods of economic crisis—such as in 1997/98, 2001, and 2008—growth rates dropped significantly. This indicates that the agricultural sector is particularly vulnerable to economic shocks.

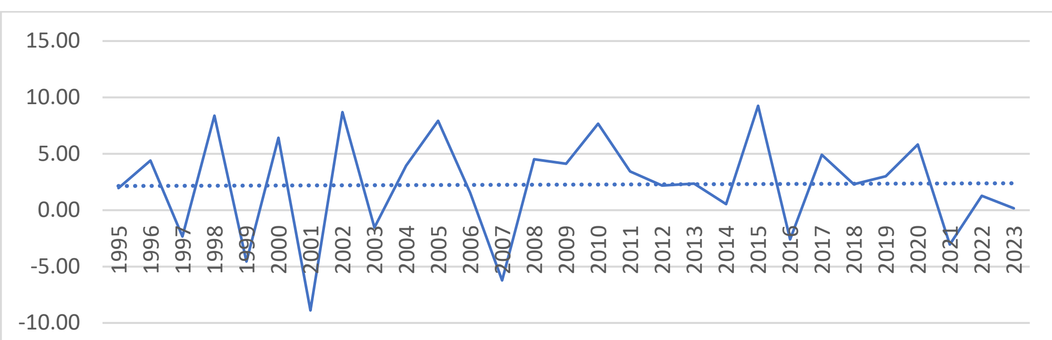

Figure 1. Growth rates in the agricultural sector, 1995-2023 (%)
Source: WB-WDI (2025).

Figure 2 presents the domestic value added (DVA) in agricultural exports for the period 1995–2020. Figure 2 compares Türkiye with OECD countries and non-OECD countries. Although Türkiye's DVA share in agricultural exports was higher than that of both OECD and non-OECD countries in 1995, the data show a downward trend over time. In 1995, the domestic value-added share in agricultural exports was 98.10% for Türkiye, 97.50% for OECD countries, and 94.70% for non-OECD countries. However, this share steadily declined in Türkiye, falling to 89% by 2020, dropping below the averages of both OECD and non-OECD countries. Starting from 2008, the DVA levels of OECD and non-OECD countries appear to converge.

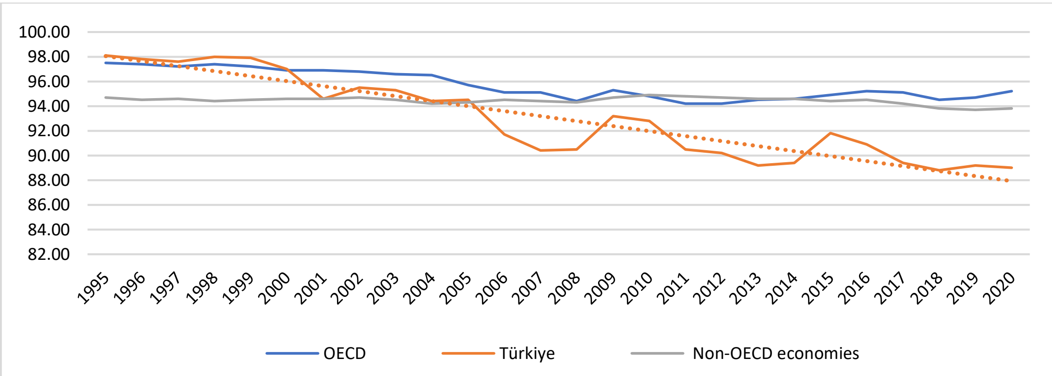

Figure 2. Domestic value-added agricultural sector's gross exports, 1995-2020 (%)
Source: OECD-TiVA (2023).

Figure 3 displays the share of foreign value added (FVA) in exports for Türkiye, OECD countries, and non-OECD countries in the agricultural sector during the 1995–2020 period. The share of FVA also reflects the extent of backward linkages. As seen in Figure 3, the FVA share in Türkiye's agricultural exports shows a steady upward trend throughout the period. In 1995, the FVA share was 1.9% for Türkiye, 2.5% for OECD countries, and 5.3% for non-OECD countries. This indicates that at the beginning of the period, Türkiye's backward linkages in agriculture were below the average of both OECD and non-OECD countries. However, over time, Türkiye's FVA share rose, surpassing both groups' averages. By 2020, the FVA share in Türkiye's agricultural exports had reached 11%, reflecting a growing dependency on imported intermediate inputs in the agricultural sector. Another notable observation in Figure 3 is that during periods of economic crisis, the share of FVA tends to decline. In the same period, as shown in Figure 2, the domestic value added in exports increases. This suggests that during crises, backward linkages are significantly affected, leading to disruptions in intermediate input imports and, consequently, a shift toward the use of domestic inputs in production.

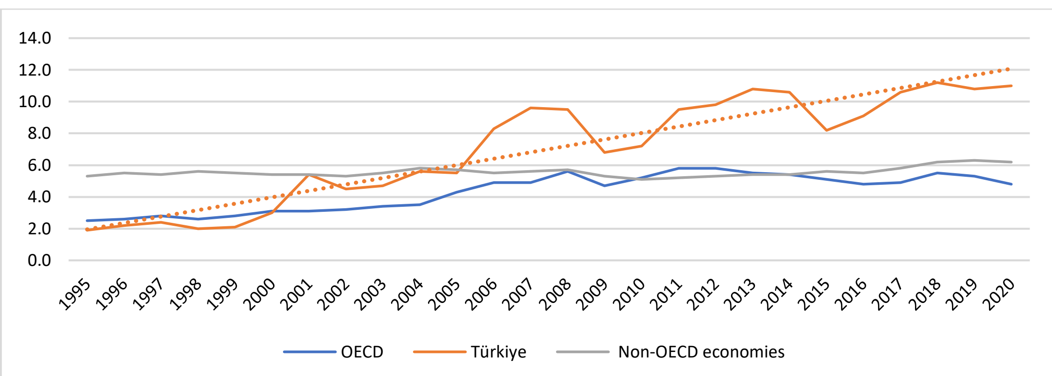

Figure 2. Foreign Value-Added Agricultural Sector's Gross Exports, 1995-2020 (%)
Source: OECD-TiVA (2023).

A BRIEF REVIEW OF LITERATURE

In today's modern global economy, where the dominance of global value chains (GVCs) continues to grow, the production of final goods has increasingly become shaped by patterns of exports and imports (Gereffi, 2014). As a result, rather than producing a final good or service, economies have increasingly adopted a strategy of specializing in specific stages of the production process. For a GVCs to emerge, a given good or service must pass through production stages in at least three different countries before reaching its final form, with value added at each stage

(Jangam & Rath, 2021; Kordalska & Olczyk, 2023; Kim & Biyik, 2025). Economies participate in GVCs in two main ways. The first is through forward linkages, which refer to the extent to which a country supplies intermediate inputs to the export-oriented production of other countries. The second is through backward linkages, which indicate the extent to which a country uses imported intermediate inputs in its export-oriented production (Pahl & Timmer, 2020; Kim et al., 2024). This also reflects the stage of the production network in which a country has specialized. If a country participates through forward linkages, it indicates upstream specialization, typically associated with higher value-added activities. Conversely, participation through backward linkages implies downstream specialization, often linked to lower value-added outcomes (Pahl & Timmer, 2020; Olasehinde-Williams & Oshodi, 2024; Han & Lee, 2025). In this context, it can be stated that a substantial body of literature has emerged analyzing the effects of GVCs. Within this framework, Ouedraogo and Takpara (2025), in their study on African countries, find that forward linkages, backward linkages, and GVCs contributed to industrialization during the 1995–2020 period. The study also notes that African countries have primarily integrated into GVCs through backward linkages. Similarly, Nana and Tabe-Ojong (2025), in their study on African countries covering the 1990–2022 period, report that GVCs have contributed to economic growth. Moreover, the study highlights that participation in GVCs, particularly through labor-intensive goods and knowledge-intensive services, is a key driver of growth. However, in contrast, Ouedraogo and Takpara (2025) argue that African countries primarily participate in GVCs through forward linkages. Kim and Biyik (2025), in their study analyzing 145 countries over the 1990–2018 period, argue that both forward and backward linkages generally enhance export performance. Han and Lee (2025), in a different approach, examined how natural disasters affect GVCs across 62 countries. The authors argue that prolonged and severe natural disasters weaken GVC linkages.

Kim (2024) emphasizes that additional burdens imposed on exporters—such as tariffs and quotas—hinder participation in GVCs through both forward and backward linkages. Tabe-Ojong et al. (2024) investigated the global position of the agro-food sector within GVCs. According to the study's findings, participation in GVCs by the agro-food sector increased significantly during the 1990–2020 period, with a particularly strong rise in developing countries. The study also notes that while the agricultural sector tends to participate in GVCs through backward linkages, the food processing sector is more integrated through forward linkages. Mushtaq and Afzal (2024) analyzed the importance of GVCs for economic growth in South Asian Association for Regional Cooperation (SAARC) countries. The authors found that, during the 1990–2022 period, both forward and backward linkages contributed positively to promoting growth. Similarly, Osabohien et al. (2024) report that participation in GVCs promoted economic development in ASEAN countries during the 2014–2022 period. Kordalska and Olczyk (2023), in their study on Central and Eastern European (CEE) countries, emphasize that during the 2000–2014 period, backward linkages significantly enhanced competitiveness. Zhang and Sun (2023) investigated the participation of the agricultural sector in GVCs across 58 countries during the 2000–2018 period. The findings of their study reveal a U-shaped relationship between agricultural GVC participation and agricultural total factor productivity (TFP). Moreover, while agricultural GVCs enhance TFP in high-income and upper-middle-income countries, such improvements are not observed in lower-middle-income countries. Jithin and Ashraf (2023) examined the environmental impact of GVCs participation across 61 countries. According to their findings, during the 2000–2018 period, GVC participation led to an increase in CO_2 emissions. Meanwhile, Wicaksono et al. (2023), in their analysis of Indonesia's automobile sector for the 1995–2014 period, reported a rising trend in the sector's GVC participation. The authors also noted that improvements in labor productivity within the sector contributed to an increase in domestic value added, thereby enhancing participation in GVCs.

Olasehinde-Williams and Oshodi (2022) argue that both backward and forward linkages enhanced export performance in South Africa during the 1990–2018 period. Similarly, Montalbano and Nenci (2022), in their analysis of the agricultural sector across 189 countries, found that integration into GVCs increases value added per worker in agriculture. Another study focused on the agricultural sector was conducted by Bialowas and Budzynska (2022), who analyzed 28 developing countries over the 1995–2018 period. Their findings suggest that foreign value added in agricultural exports not only improves export performance but also provides comparative advantages for these countries. Xing et al. (2022) argue that China has continuously increased its use of foreign value added to meet final demand, highlighting that this strategy has positioned China as a major force in shaping the global economy. Similarly, Jangam and Rath (2021), in their study covering 58 countries during the 2005–2015 period, found that trade through GVCs significantly contributed to economic growth. Taguchi and Nibayashi (2021), in their study on East Asian countries, suggest a U-shaped relationship between the GVC position index and economic growth. Pahl and Timmer (2020), analyzing 59 countries over the 1970–2008 period, find that trade through GVCs enhances export efficiency. Likewise, Montalbano and Nenci (2020) emphasize that participation in GVCs increases value added per worker in the agricultural sector.

Balie et al. (2019) emphasize that participation of the agricultural sector in GVCs in Sub-Saharan African (SSA) countries leads to both positive and negative outcomes. Despite their relatively low share in global trade, the study highlights that SSA countries play an active role in GVC participation within the agricultural sector. Similarly, Hiroyuki and Pham (2019) find that GVC participation in Asian economies increases the domestic value added in exports and facilitates technology transfer. Tinta et al. (2018), in their study on ECOWAS countries, argue that backward linkages contribute to an increase in per capita energy supply. Ahmed et al. (2017), examining 46 countries over the 1996–2012 period, suggest that integration into GVCs reduces the real effective exchange rate elasticity of manufacturing exports. Ozer et al. (2016) emphasize that while Türkiye has integrated into GVCs, it has largely specialized in assembly operations and low value-added sectors. Jiand and Liu (2015) highlight that developing countries often serve as major suppliers, while developed countries remain the primary consumers and importers. Nevertheless, they emphasize that developing countries have significantly benefited from participating in global ICT production. Similarly, Taguchi (2014) notes that the participation of the manufacturing sector in GVCs has contributed to economic growth in Asian countries. In particular, the study underscores that integration into GVCs in high value-added sectors—such as machinery, electronics, and transportation equipment—serves as a key driver of growth. Giuliani et al. (2005) emphasize that the participation of Latin American countries in GVCs represents a significant dynamic for economic development. Similarly, Dolan and Tewari (2001) argue that integration into GVCs offers important opportunities for development in emerging economies. Based on the literature review, it can be concluded that there is a substantial body of both theoretical and empirical research on GVCs. These studies primarily examine the impact of GVCs on factors such as economic growth, exports, and the environment. However, research focusing specifically on how the agricultural sector is affected by integration into GVCs remains limited. Similarly, when the literature on Türkiye's economy is reviewed, it is observed that both theoretical and empirical studies examining how the agricultural sector's participation in GVCs affects agricultural production are limited. In this respect, it can be argued that there exists a significant gap in the literature regarding the relationship between GVC participation and agricultural production. Therefore, this study is expected to make a valuable contribution to the existing literature by addressing this gap.

METHODOLOGY

This paper aims to scrutinize how Türkiye's agricultural sector is integrated into GVCs and how the integration of the agricultural sector into GVCs affects agricultural production. For this purpose, two different methods were employed: firstly, input-output tables were utilized, and by applying traditional mathematical methods, the agricultural sector's GVCs participation, GVCs position, net value-added gains, and import dependency were calculated; secondly, econometric methods were employed to investigate how the domestic and foreign value-added of exports affects agricultural production. The OECD-TiVA (2023) and World Bank-WDI (2025) databases were used for the analysis. The OECD-TiVA (2023) database was used to calculate GVCs participation, GVCs position, and net value-added gains. The indicators in OECD-TiVA (2023) are based on the International Standard Industrial Classification Revision 4 (ISIC Rev. 4), comprising 45 sub-sectors and covering 76 countries. The most recent version of OECD-TiVA (2023) covers data for the period 1995–2020. For this reason, the fact that the empirical analyses cover the period 1995-2020 is attributable to the availability of GVCs data in the OECD-TiVA (2023) database, which begins in 1995 and ends in 2020. In the econometric analyses, the value-added data of the agricultural sector provided in the WB-WDI (2025) database were employed to represent agricultural production. The data used in the analyses are presented in Table 1.

Table 1: Data description and source

Variable	Description	Data Source
va	Agriculture value added	WB-WDI (2025)
exp	Gross exports	OECD-TiVA (2023)
dva	Domestic value added in gross exports	OECD-TiVA (2023)
fva	Foreign value added in gross exports	OECD-TiVA (2023)

Measuring indicators of GVCs

Based on the OECD-TiVA (2023) database, the methodologies proposed by Koopman et al. (2010) and Koopman et al. (2012) were followed to calculate the GVCs' participation, GVCs' position, and net value-added (NVA) gains indices for the agricultural sector. The participation, position, and NVA of sectors in GVCs are calculated as follows:

$$\text{GVCs participation} = dva/exp + fva/exp \quad (1)$$

GVCs position = log(1 + dva/exp) – log(1 + fva/exp) 2

NVA Gains = Forward Linkages (dva) / Backward Linkages (fva) 3

In the equations, *exp* indicates gross exports, *dva* indicates domestic value added in exports (forward linkages), and *fva* indicates foreign value added in exports (backward linkages). Equation (1) shows the GVCs participation index, which measures the extent to which a sector is involved in a vertically fragmented production process. A sector's or a country's participation in GVCs can occur through either forward linkages (intermediate goods exports) or backward linkages (intermediate goods imports) (Dağıstan, 2017; Wigley et al., 2018). Equation (2) shows the GVCs position index, which indicates whether a sector is specialized in the initial or final stages of production. The index increases when a sector's forward linkage effects are greater than its backward linkage effects. Therefore, if a sector operates at the early or upstream stages of production, its forward linkages are stronger. Conversely, if the sector's backward linkage effect is high, this implies specialization in the final stages of production and a high dependency on imported intermediate inputs (Kersan-Skabic, 2017; Dağıstan, 2017; Wigley et al., 2018). Equation (3) represents the net value-added gains, where net value-added is calculated as the ratio of forward linkages to backward linkages. If this ratio exceeds 1, it means that the country or sector has benefited in terms of net value added. Finally, using input–output tables, the import dependency on intermediate inputs for the agricultural sector was calculated (*import dependency on intermediate inputs is calculated using input–output tables with the following formula:* $R = A_m(I-A_d)^{-1}$. *For a detailed explanation, see: Aydoğuş (2015) and Miller and Blair (2009)*). The input–output tables available in the OECD database also cover the 1995–2020 period.

Econometric model

After calculating the agricultural sector's participation, position, and import dependency in GVCs using input–output models, the study proceeds to econometrically analyze how GVCs integration has affected agricultural production in Türkiye. For this purpose, the empirical analysis uses three key variables: agricultural value added (va), domestic value added in exports (dva), and foreign value added in exports (fva). These variables are presented in Table 1.

The empirical model that analyzes how GVCs affect agricultural production in Türkiye can be expressed as in Equation (4) (Ali et al., 2025; Chisanga, 2025):

$$lnva_t = \beta_0 + \beta_1 lndva_t + \beta_2 lnfva_t + \varepsilon_t \quad 4$$

In Equation (4), β_0 represents the coefficient of the constant term, β_1 and β_2 represent the coefficients of the parameters *lndva* and *lnfva* included in the model, and ε_t denotes the error term. The variables in Equation (4) are used in their natural logarithmic forms.

Equation (4), which was established to analyze the impact of Türkiye's agricultural sector participation in GVCs on agricultural production, was estimated using the Autoregressive Distributed Lag (ARDL) model (*for robustness check of the ARDL results, the FMOLS and FARDL estimators were also applied*). The ARDL method was chosen because the study covers a 26-year period (1995–2020), and one of the main advantages of the ARDL approach is its applicability in small sample sizes (Pesaran et al., 2001). Moreover, the ARDL approach is known to produce robust results as it helps eliminate problems of endogeneity and serial correlation (Bertsatos et al., 2022; Liu et al., 2022; Sun et al., 2023). In this approach, first proposed by Pesaran et al. (2001), it is not necessary for the variables in the model to be integrated of the same order. That is, the independent variables can be stationary at level I(0), at first differences I(1), or a mixture of both. However, the dependent variable must be stationary at first differences I(1) (Ozgur et al., 2022; Uzar & Eyuboglu, 2025). Once the stationarity condition of the series is satisfied, the existence of a long-run relationship among the variables is tested using the ARDL bounds testing approach based on the F-statistic. Accordingly, the long-run cointegration relationship in the model is estimated using the following equation (Osman et al., 2025; Gharbi et al., 2025):

$$\Delta lnva_t = \beta_0 + \sum_{t=1}^{n} \beta_{1i} \Delta lnva_{t-i} + \sum_{t=0}^{n} \beta_{2i} \Delta lndva_{t-i} + \sum_{t=0}^{n} \beta_{3i} \Delta lnfva_{t-i} + \theta_1 lnva_{t-1} + \theta_2 lndva_{t-1} + \theta_3 lnfva_{t-1} + \varepsilon_t \quad 5$$

In Equation (5), Δ denotes the first differences of the series; n represents the lag lengths of the variables; and ε_t is the error term. The coefficients θ_1, θ_2, and θ_3 indicate the long-run cointegration relationship among the variables. Here, the null hypothesis ($H_0: \theta_1 = \theta_2 = \theta_3 = 0$) suggests that the variables are not cointegrated in the long run, while the alternative hypothesis ($H_1: \theta_1 \neq \theta_2 \neq \theta_3 \neq 0$) indicates that the variables are cointegrated in the long-run (Nor & Yusof, 2025; Hussein & Abdullahi, 2025). If the alternative hypothesis H_1 is accepted, the long-run and short-run coefficients of the model can be estimated as follows (Sun et al., 2023; Ali et al., 2025; Laghari et al., 2025):

$$lnva_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i} lnva_{t-i} + \sum_{t=0}^{\rho_2} \beta_{2i} lndva_{t-i} + \sum_{t=0}^{\rho_3} \beta_{3i} lnfva_{t-i} + +\varepsilon_t \quad 6$$

$$\Delta lnva_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i} \Delta lnva_{t-i} + \sum_{i=0}^{\rho_2} \beta_{2i} \Delta lndva_{t-i} + \sum_{i=0}^{\rho_3} \beta_{3i} \Delta lnfva_{t-i} + \delta ECM_{t-1} + \varepsilon_t \quad 7$$

Equation (6) presents the estimation of long-run coefficients in the ARDL ((ρ_1, ρ_2, ρ_3)) model. After estimating the long-run coefficients, the short-run coefficients are estimated using Equation (7). The term ECM_{t-1} represents the error correction term in the model. This coefficient is expected to be negative and statistically significant. If the coefficient meets these theoretical expectations, it indicates that short-run disequilibria in the model converge toward the long-run equilibrium (Bergougui, 2022; Laghari et al., 2025; Nor & Yusof, 2025).

EMPIRICAL FINDINGS AND DISCUSSION

Global value chains (GVCs)

The GVCs participation index calculated via Equation (1) is the sum of forward and backward linkages. Figure 4 shows the GVCs participation index of the agricultural sector in Türkiye. As seen in Figure 4, Türkiye's agricultural sector shows an upward trend in GVCs participation during the 1995–2020 period. In 1995, the GVCs' participation index in the agriculture sector (A) was 2.20%, rising to 11.30% in 2020. In the agriculture and forestry sub-sector (A01_02), the participation index was 2.10% in 1995 and increased to 11.50% by 2020. In the fishing and aquaculture sub-sector (A03), the index rose from 1.70% in 1995 to 8.20% in 2020. Therefore, the findings indicate that the agricultural sector's participation in GVCs steadily increased between 1995 and 2020, demonstrating a growing integration of the sector into global markets. The integration of the agricultural sector into the global production system is lower than other sectors. For example, in the manufacturing industry, the GVCs participation index was 19.30% in 1995, rising to 40.10% in 2020. In the services sector, the GVCs participation index was 10.40%, and increased to 16.30% in 2020. In the total economy, the GVCs participation index was 20.50%, and rose to 38.70% in 2020. The agricultural sector's integration into GVCs exhibits similarities to that of the services sector. By 2020, it can be argued that the participation indices for both sectors had converged. Nevertheless, the agricultural sector's integration into global markets is arguably higher than that of the services sector.

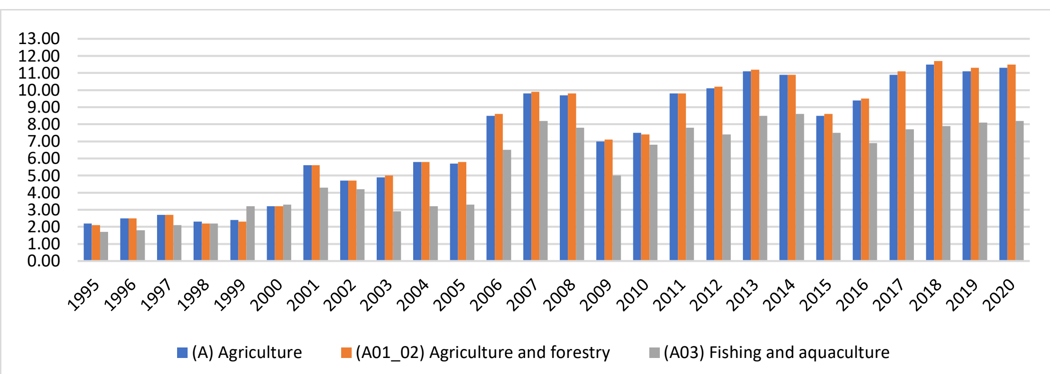

Figure 4: GVCs participation index in the agricultural sector, 1995-2020.
Source: Authors' Calculation based on OECD-TiVA (2023).

Figure 5 illustrates the agricultural sector's position within GVCs. The results show a consistent decline in the GVC position index of the agriculture sector (A). The index dropped from -0.016 in 1996 to -0.101 in 2020. A similar trend is observed in the sector's sub-categories: the position index for agriculture and forestry (A01_02) declined from -0.017 in 1995 to -0.103 in 2020, while the index for fishing and aquaculture (A03) decreased from -0.017 in 1995 to -0.079 in 2020. Thus, the position of the agricultural sector and its sub-sectors within GVCs weakened between 1995 and 2020. This indicates that the sector is increasingly integrated into GVCs through backward linkages. The GVCs position index of the agricultural sector exhibits a trend similar to that of the manufacturing and services sectors. The position index has decreased in all three sectors, which indicates that these sectors are specializing more in the final, downstream stages of production. In the overall economy, the GVCs position index was positive during the period 1995-2020, however, after 2000, it turned negative and continued to decline. In the manufacturing industry, the GVCs position index was -0.0158 in 1995, declining to -0.1014 by 2020. Similarly, in the services sector, the GVCs position index was -0.0266 in 1995, decreasing to -0.0712 in 2020. This finding suggests that, in both the aggregate economy and the major sectors, integration into GVCs has predominantly occurred through backward linkages.

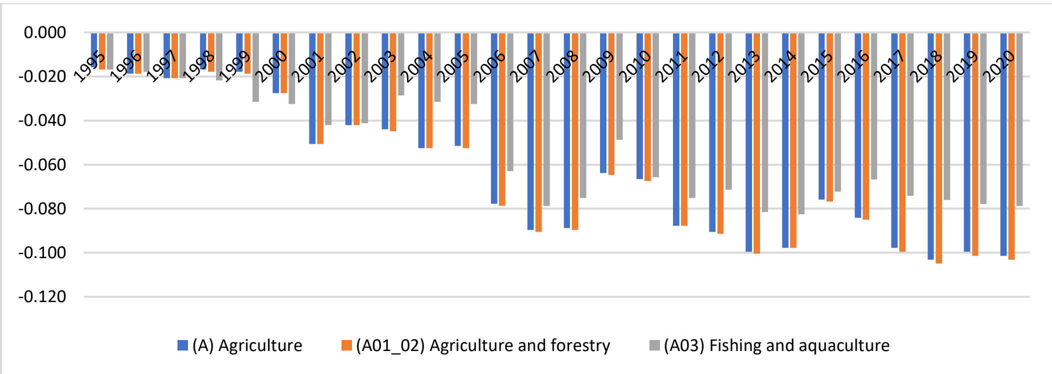

Figure 5: GVCs position index in the agricultural sector, 1995-2020.
Source: Authors' Calculation based on OECD-TiVA (2023).

An increase in a sector's participation in GVCs within an economy does not necessarily indicate that the sector or the economy has benefited. Whether GVCs' participation generates gains can be assessed through the calculation of net value added. Thus, after a country or sector becomes integrated into GVCs, the ratio of forward to backward linkages serves as an indicator of net gains in terms of value added. In this context, the net value-added gains calculated for the agricultural sector are shown in Figure 6. As observed in Figure 6, there is a declining trend in net value-added gains for the agricultural sector and its sub-sectors during the 1995–2020 period. Moreover, throughout the entire period, the net value-added ratio remained below 1. This indicates that the agricultural sector's participation in GVCs did not generate value-added gains for the sector. In the process of participation in global production, the net value-added gains of the agricultural sector is lower than other sectors. In the 1995-2000 period, the total economy's net value-added gains exceeded 1, indicating that the economy had integrated into global production through forward linkages. But after 2001, the value-added gains have consistently remained below 1. Accordingly, the net value-added gains of the overall economy was 1.33 in 1995, whereas it declined to 0.79 in 2020. For the manufacturing industry, net value-added gains was 0.61 in 1995, and it decreased to 0.41 in 2020. For the services sector, net value-added gains was 0.58 in 1995, and it decreased to 0.36 in 2020. Hence, at both the aggregate and sectoral levels, integration into global production has predominantly occurred through backward linkages, accompanied by a steady decrease in net value-added gains.

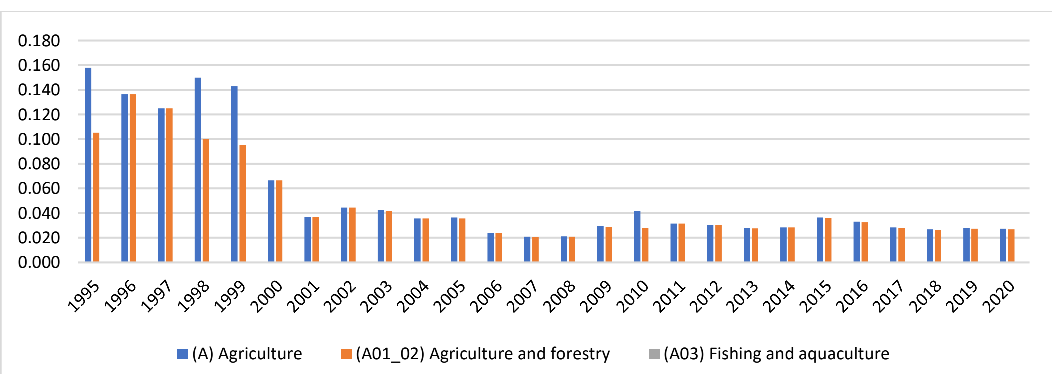

Figure 6: Net value-added gains in agricultural sector, 1995-2020.
Source: Authors' Calculation based on OECD-TiVA (2023).

In the context of GVCs, an assessment of Türkiye's agricultural sector reveals that its participation in GVCs is higher compared to both OECD and non-OECD countries. When compared with the European Union (EU), while participation was lower than the average of EU countries at the beginning of the period, it increased during the period and was almost the same as the EU at the end of the period. For that reason, it is evident that Türkiye's agricultural sector has integrated global production more rapidly than the agricultural sectors of the EU, OECD, and non-OECD countries. In evaluating the position index, Türkiye's agricultural sector was in a better position than the EU at the beginning of the period but had fallen behind by the end of the period. In a similar vein, the position index of the agricultural sector has exhibited a downward trend compared to that of OECD and non-OECD countries since the early 2000s. This implies that, while the agricultural sector has rapidly integrated into global markets, it has specialized in the final stages of the global production chain compared to the EU, OECD, and non-OECD countries. As a consequence of the decline in the position index, the net value-added gain of Turkey's agricultural sector has exhibited a downward trend relative to the EU, OECD, and non-OECD countries. Consequently, the net value-added gain of the agricultural sector, which was above the EU average at the beginning of the period, fell behind the EU, particularly after 2008–2009. Similarly, since the 2000s, it has also declined relative to both OECD and non-OECD countries.

Figure 7 presents the import requirement for intermediate goods in the agricultural sector, derived from these input-output tables. The calculated values have been indexed (1995 = 1). The findings in Figure 7 indicate how much import is required to produce one unit of output in the agricultural sector under equilibrium conditions. According to the results, the dependency on imported intermediate inputs in the agricultural sector showed a consistent increase over the 1995–2020 period. A similar upward trend is observed in both sub-sectors, as the import dependency index for intermediate inputs continues to rise.

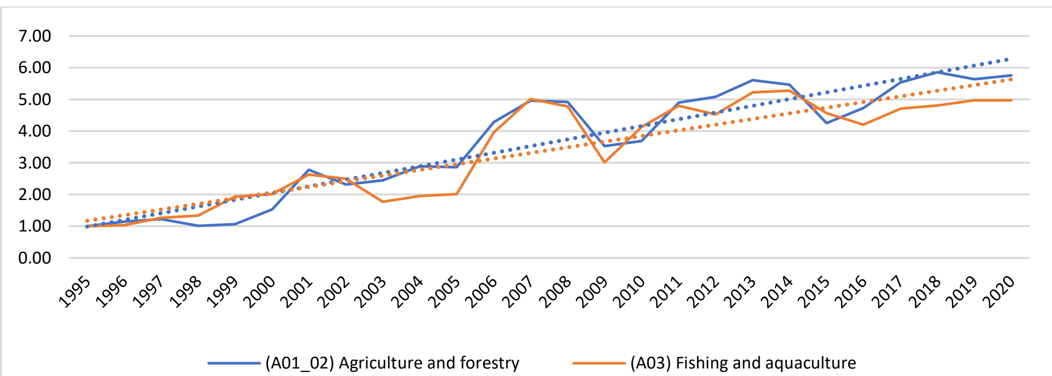

Figure 4: Import dependency in the agricultural sector, 1995-2020.
Source: Authors' Calculation based on Input-Output Tables.

ECONOMETRIC FINDINGS

Unit root tests and cointegration

One of the most important steps in time series analysis is testing whether the series contains unit roots. This is crucial because estimating models without first checking for stationarity may lead to biased or incorrect results. Therefore, unit root tests are among the preliminary procedures that must be performed in time series analyses (Laghari, 2025). Moreover, one of the key features of the ARDL approach applied in this study is that, provided the dependent variable is integrated of I(1), the independent variables may be integrated at different levels (I(0) or I(1))—but not I(2) (Pesaran et al., 2001; Ozgur et al., 2022; Manasseh et al., 2025). For this reason, before testing for cointegration, the stationarity properties of the variables were examined using the Augmented Dickey-Fuller (ADF), Kwiatkowski-Phillips-Schmidt-Shin (KPSS), Fourier ADF, and Fourier KPSS tests. The results of these unit root tests are presented in Table 2. According to the results in Table 2, the series included in the model are stationary at their first differences.

Table 2: Results of the unit root test

Variables	ADF		KPSS	
	c	c & t	c	c & t
lnva	1.118667 (0.9964)	-1.875932 (0.6354)	0.745367	0.257466
lndva	-1.646702 (0.4449)	-1.866690 (0.6414)	0.887794	0.260674
lnfva	-1.713514 (0.4126)	-1.706427 (0.7181)	0.897343	0.421492
Δlnva	-8.659227 (0.0000)	-9.056243 (0.0000)	0.190353***	0.046332***
Δlndva	-5.869277 (0.0001)	-5.602846 (0.0007)	0.147443***	0.064774***
Δlnfva	-4.660781 (0.0013)	-4.815061 (0.0043)	0.275198***	0.054103***
		Fourier ADF		**Fourier KPSS**
lnva	-0.047	-3.126	0.860	0.340
lndva	-0.454	-3.122	0.632	0.751
lnfva	-0.577	-3.854	0.811	0.062
Δlnva	-8.817***	-8.721***	0.021***	0.018***
Δlndva	-4.508***	-5.431***	0.068***	0.049***
Δlnfva	-5.543***	-5.645***	0.032***	0.029***

Note:
1. c; with constant, c & t; with constant & trend.
2. *, **, *** indicate that the variables are stationary at %10, %5 and %1 respectively.
3. For the ADF test, the lag length is determined by the Akaike Information Criterion (AIC), and the maximum lag is 1.
4. For the KPSS test, the spectral estimation method, Bartlett kernel, and Newey-West Bandwidth are chosen.
5. Critical Values for KPSS:

At constant, 0.739000, 0.463000, and 0.347000 with critical values for 1%, 5%, and 10%, respectively. At constant % trend, 0.216000, 0.146000, and 0.119000 with critical values for 1%, 5%, and 10%, respectively.

6. Critical Values for Fourier ADF:

At Constan (k=1), -4.420, -3.810, and -3.490 with critical values for 1%, 5%, and 10%, respectively. At constant & trend (k=1), -4.950, -4.350, and -4.050 with critical values for 1%, 5%, and 10%, respectively.

7. Critical Values for Fourier KPSS:

At Constan (k=1), 0.270, 0.172, and 0.132 with critical values for 1%, 5%, and 10%, respectively. At constant & trend (k=1), 0.072, 0.055, and 0.047 with critical values for 1%, 5%, and 10%, respectively.

Once the stationarity levels of the variables included in the model are determined, the existence of a long-run cointegration relationship can be tested. As shown in Table 2, the results of the unit root tests indicate that the variables are stationary at their first differences, satisfying the necessary precondition for applying the ARDL model. To determine the cointegration relationship, the F-statistic proposed by Pesaran et al. (2001) is used. The results of the ARDL bounds test for cointegration are presented in Table 3. When evaluating the results in Table 3, it is observed that the F-statistic value obtained for the ARDL model is higher than the upper critical bounds at the 1%, 5%, and 10% significance levels. This indicates that the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. Therefore, there exists a long-run cointegration relationship among the variables (Pesaran et al., 2001; Ali et al., 2025; Chisanga et al., 2025; Osman et al., 2025; Gharbi et al., 2025).

Table 3: ARDL bounds test (Co-integration)

F-statistic		10%		5%		1%	
	Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
6.343243	30	2.915	3.695	3.538	4.428	5.155	6.265
	Asymptotic	2.630	3.350	3.100	3.870	4.130	5.000

Long-run and short-run estimations

After confirming that the variables in the model move together in the long run (co-movement), the long-run and short-run coefficient estimates can be obtained. The ARDL model allows for the estimation of both long-run and short-run coefficients. These estimates are presented in Table 4. Based on the findings, it is observed that in the long run, domestic value added in agricultural exports has a positive effect on agricultural production. Specifically, a 1% increase in domestic value added in exports leads to an approximate 0.21% increase in agricultural production. A similar effect is observed in the short run as well. In the short run, a 1% increase in domestic value added in exports increases agricultural production by approximately 0.18%. Foreign value added in agricultural exports is found to harm agricultural production. In the long run, a 1% increase in foreign value added in exports reduces agricultural production by approximately 0.14%. A similar effect is observed in the short run as well. In the short term, a 1% increase in foreign value-added leads to a decrease in agricultural production by around 0.12%. To ensure the reliability of the results obtained from the ARDL model, robustness checks were conducted using the FMOLS and FARDL estimators. The findings from the FMOLS estimation also support the results of the ARDL model. Accordingly, in the long run, the domestic value added in exports increases agricultural production, while foreign value added in exports decreases it. Similarly, the FARDL findings also support the results obtained from the ARDL and FMOLS estimations (*before estimating the FARDL model, a cointegration test was conducted to examine whether the series move together in the long run. In the FARDL framework, the FA statistic is used to test for cointegration (Zhou et al., 2024; Sun et al., 2023; Liu et al., 2022). The FA statistic was found to be 9.07 with a p-value of 0.001, indicating that the result is statistically significant at the 1% level*). According to the FARDL results, a 1% increase in the domestic value added in agricultural exports increases agricultural production by approximately 0.44% in the long run and by around 0.30% in the short run. A 1% increase in the foreign value added in agricultural exports reduces agricultural production by approximately 27% in the long run and about 14% in the short run. To test whether the ARDL and FARDL models are functioning properly, an error correction model (ECM) was applied. The findings show that in both the ARDL and FARDL models, the error correction term meets theoretical expectations, being negative and statistically significant. This confirms that the error correction mechanism in both models is valid and functioning as expected.

Table 4: ARDL long-run and short-run estimated results

	LR Coefficient		SR Coefficient		
	lndva	**lnfva**	**lndva**	**lnfva**	**ecm**
ARDL	0.210487 (0.0029)	-0.139671 (0.0001)	0.184048 (0.0015)	-0.122127 (0.0000)	***-0.874392*** ***(0.0000)***
FMOLS	0.216068 (0.000)	-0.148435 (0.0000)			
Fourier ARDL	0.436165 (0.007)	-0.268424 (0.010)	0.3094854 (0.064)	-0.142786 (0.068)	***-0.757958*** ***(0.033)***

Stability test and diagnostic tests

After the model was estimated, diagnostic tests were applied to assess the validity of the results. The outcomes of these diagnostic tests are presented in Table 5. According to the results in Table 5, there are no diagnostic problems in the ARDL model. In addition, to test the stability of the model, CUSUM and CUSUMQ tests were conducted. The results of these tests are shown in Figure 8. Based on Figure 8, the model is stable, and there is no evidence of structural breaks.

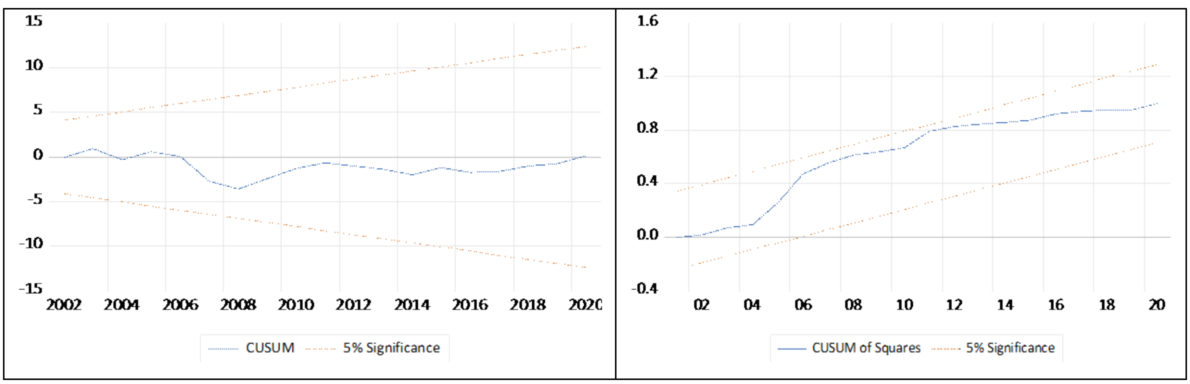

Figure 8: Cusum and Cusumq Tests

DISCUSSION

Since the 1980s, liberalization policies have played a significant role in shaping countries' integration into the global economy. In this process, countries have utilized various liberalization tools such as foreign trade, fragmented production, outsourcing, and GVCs. Among these tools, GVCs have emerged as one of the most important mechanisms of integration within the framework of liberalization policies. Technological, institutional, and political developments have accelerated the integration of the production process into global production (Antràs, 2020). In particular, thanks to advanced information and communication technologies, developing countries can carry out specific stages of the production process, thereby gaining access to global markets and benefiting from the comparative advantages of other countries (Antràs, 2022; Pahl & Timmer, 2020). In this context, the present study on Türkiye's agricultural sector finds that the integration of the agricultural sector into global production has increased significantly. This is because the agricultural sector's GVCs participation index has exhibited a continuous upward trend. However, the participation index has experienced a significant decline, particularly during periods of economic crisis. The reason for this is that, in times of crisis, firms tend to rely more on inventories rather than importing intermediate inputs due to demand uncertainty, and thus carry out production accordingly (Los et al., 2015; Gyasi et al., 2024). Within the framework of GVCs, total value added is composed of both forward and backward linkages. While forward linkages capture the domestic value-added content of exports, backward linkages reflect the foreign value-added component of exports (Erkök, 2020). High participation in GVCs does not always generate gains for sectors. In this regard, the GVC position index provides information on the extent to which a sector or country participates in the global production process. Based on the calculated GVCs position index, the agricultural sector's position index has shown a declining trend throughout the period. Such a decline suggests that the sector's integration into GVCs has primarily occurred via backward linkages. Thus, this finding suggests that the agricultural sector has neither secured a high share from GVCs nor achieved considerable value-added gains. The findings obtained for net value-added gains also support this situation, as the calculated net value-added gain is less than one. Therefore, the share of imported intermediate inputs in the agricultural sector increased during the period, a result that is further corroborated by the evidence derived from the input–output tables.

An assessment of the econometric findings indicates that forward linkages have a positive impact on agricultural production in both the short and long-run. The results are in line with the findings of Ouedraogo and Takpara (2025), Nana and Tabe-Ojong (2025), Kim and Biyik (2025), Tabe-Ojong (2025), Kordalska and Olczyk (2023), as well as Olasehinde-Williams and Oshodi (2023). Forward linkages represent the domestic value added of exports. In other words, they refer to the export of intermediate goods supplied by the sector for the production undertaken by other countries for export purposes. At the same time, they also increase the demand for sectoral production. In this way, such exports naturally enhance the production potential of the sector. As a result, as also noted by Gyasi et al. (2024), the sector tends to specialize in the earlier stages of production within GVCs, thereby generating higher value-added. The analyses reveal that backward linkages have a negative impact on agricultural production in both the short and long run. These findings are consistent with those reported by Bialowas and Budzynska (2022). Backward linkages indicate the reliance on imported intermediate inputs in export-oriented production, a component commonly defined as the foreign value-added content of exports. In this regard, the negative effect of backward linkages may be attributed to the high reliance on imported inputs (Han & Lee, 2025). Furthermore, the evidence derived from the position index corroborates this conclusion, demonstrating that the agricultural sector's position within GVCs has gradually deteriorated over the period. That is, foreign value added has persistently risen and eventually exceeded domestic value added. Belie et al. (2029) also demonstrate that integration into GVCs may have negative effects on agricultural production. Similarly, Ozer et al. (2016) argue that Türkiye's integration into GVCs has been concentrated primarily in low value-added sectors. The net value-added gain remained below one throughout the period, thereby confirming the robustness of this result. Moreover, instead of being used in the production process, the imported intermediate inputs may have been re-exported to third countries, which could in turn affect production (Los et al., 2025; Antràs, 2020).

CONCLUSION

In today's modern global economy, the production of goods and services has become increasingly internationalized. Global value chains (GVCs) have played a decisive role in the globalization of goods and services. GVCs encompass all activities involved in the process—from production and design to delivery to the final consumer. In other words, a product goes through multiple stages before reaching its final form. In this process, countries have adopted a strategy of specializing not in producing the final good, but in specific stages of its production. Moreover, virtually all sectors of the economy participate in GVCs and thus engage in global trade through these chains (Olasehinde-Williams & Oshodi, 2024; Ouedraogo & Takpara, 2025; Nana & Tabe-Ojong, 2025; Kim & Biyik, 2025; Han & Lee, 2025). In this context, the primary aim of this study is to analyze how the participation of Türkiye's agricultural sector in global value chains (GVCs) affects agricultural production. To achieve this, the study first calculates the GVC participation and position indices, as well as net value-added gains for the agricultural sector. Then, the importance of GVCs for agricultural production is estimated using econometric methods. According to the calculated GVC participation index, Türkiye's agriculture and its sub-sectors showed a continuous increase in participation in global value chains during the 1995–2020 period. This indicates that the agricultural sector has become increasingly integrated with global markets. When evaluating the GVC position index, it is observed that the index for agriculture and its sub-sectors is negative and has declined over time. A declining position index implies that the sector is participating in GVCs primarily through backward linkages. This finding is further supported by the net value-added gain, which is less than 1. A net value-added gain below 1 indicates that backward linkages outweigh forward linkages in the sector. In this context, the findings indicate that the agricultural sector is integrated into global value chains in a downstream manner, meaning it is specialized in the final stages of production. This also reflects an increasing dependency on imported intermediate inputs. The results are further confirmed by the import dependency index, calculated using input–output tables. The evidence shows that the agricultural sector's reliance on imported intermediate goods consistently increased during the 1995–2020 period. Additionally, an econometric model was applied to assess the effects of forward and backward linkages. For this purpose, ARDL, F-ARDL, and FMOLS estimators were used. The findings obtained from these estimators indicate that, in both the short run and the long run, forward linkages positively affect agricultural production, whereas backward linkages have a negative impact.

These results suggest that increased reliance on backward linkages and imported intermediate inputs negatively affects agricultural output. In this context, a high level of forward linkages indicates that the sector is engaged in upstream activities, meaning it specializes in the early stages of production—where value added tends to be higher (Olasehinde-Williams & Oshodi, 2024). Participation in global value chains (GVCs) through backward linkages can have negative implications for employment and productivity, particularly in developing countries (Pahl & Timmer, 2020; Awokuse et al., 2024). The empirical findings of this study support this argument, as the results indicate that backward linkages negatively affect agricultural production. Additionally, the GVC position index further confirms that the agricultural sector is integrated into the global production process mainly through backward linkages, highlighting the sector's specialization in downstream activities. In this context, Greenviller et al. (2017) and Kim et al. (2024) also argue that the agricultural sector is predominantly integrated into global value chains (GVCs) through backward linkages. Participation through forward linkages tends to increase capital value added, while backward linkages are associated with a decline in capital value added and productivity (Pahl & Timmer, 2020; Tabe-Ojong et al., 2024). Therefore, as countries and sectors integrate into global value chains (GVCs), they must carefully manage the integration process to benefit from international competition, acquire technological capabilities, and enhance productivity. In particular, to mitigate potential disruptions in the agricultural sector during times of crisis or natural disasters, it is crucial to strengthen forward linkages.

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