Forward and Backward GVC Participation in Agriculture and Food Manufacturing: Comparative Developments in the EU and RCEP

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Abstract: In recent decades, global value chains (GVCs) have reshaped international trade, cross-border production, and specialization. Despite the growing body of research on GVCs, comparative regional analyses of agriculture and food manufacturing remain scarce. This paper examines how countries in the European Union (EU) and the Regional Comprehensive Economic Partnership (RCEP) participate in GVCs in these sectors. Distinguishing between forward and backward participation, it identifies structural and institutional factors associated with different integration modes. Using inter-country input-output data for 2001–2022 and sector-level decomposition, participation rates are calculated for 42 countries. The results reveal clear sectoral asymmetries: backward participation is much higher in food manufacturing, especially in the EU, whereas forward participation is stronger in agriculture and driven by raw material exports. Regression results show backward participation is mainly associated with income levels, with tariffs mattering only in agriculture. Forward participation is more complex, with significant effects from development-status shifts only in agriculture, not in food manufacturing.

Keywords: global value chains, forward linkages, backward linkages, agri-food sector, regional trade blocs

JEL: F14; O24; Q17

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1. Introduction

Approximately 70% of global trade flows–including raw materials, components, industrial products, and services–can be classified as part of global value chains (GVCs), indicating the growing fragmentation of production across various stages of the manufacturing process (World Bank, 2019). The agri-food sector is also increasingly structured around GVCs, where the various stages of transforming raw materials into consumer-ready products are distributed across multiple countries (Lim, 2021; Scoppola, 2022). Such a fragmentation of processes has been facilitated by reduced trade and investment barriers, along with advances in contracting, marketing, and logistics (OECD, 2020).

Studying GVCs in the agri-food sector is crucial for designing effective trade and development policies (Raimondi *et al.*, 2023). Agri-food constitutes one of the most sensitive sectors of the economy, closely linked to food security and social stability (Bonanno, 2017). Understanding the structure and dynamics of GVCs in this area enables the identification of stages at which value is created and an assessment of countries' and regions' positions within global agri-food production networks. GVC analysis allows for a more precise definition of the roles that individual countries play in global food trade (Balié et al., 2019; Greenville and Kawasaki, 2018). This is particularly important when designing policies to enhance national competitiveness or foster interregional cooperation. Moreover, the development of GVCs in the agri-food sector is associated with an increasing need for standardization and certification, which necessitates intergovernmental cooperation and regulatory harmonization (Blind *et al.*, 2018; Marette, 2016).

The European Union (EU) and the Regional Comprehensive Economic Partnership (RCEP) are among the leading players in the global agri-food trade. In 2024, the EU's share in global agri-food exports and imports in value terms was approximately 40%, while the RCEP's share was 20% (WITS, 2025). In both the EU and RCEP, the agri-food sector is perceived as a key component of food security, the protection of local producers, and tariff and non-tariff policies. The EU places particular emphasis on protecting small farms and compliance with environmental and sanitary standards in trade (Hart *et al.*, 2012; Kareem, 2016). RCEP countries show more diversity, but strategic markets, such as meat and rice, are also strongly protected, while more competitive areas are liberalized (Elms, 2021). In recent years, the EU and RCEP have intensified trade cooperation in the agri-food sector. In 2024, EU agri-food exports to RCEP countries reached USD 44 billion, while imports from RCEP countries amounted to USD 43 billion (WITS, 2025). Additionally, both trade blocs are deepening cooperation by signing free trade agreements (FTAs). The EU has concluded FTAs with Japan, South Korea, Singapore, and New Zealand, among others. Further agreements with RCEP members, such as the Philippines, Malaysia, and Indonesia, are currently under negotiation, with the agri-food sector regularly identified as a priority area (European Commission, 2025).

The study will incorporate two key perspectives: forward participation, which refers to a country's contribution to value added that is further exported by other countries, and backward participation, which involves the use of imported intermediate goods in domestic export production (Tian *et al.*, 2022). The study aims to identify patterns of forward and backward participation in the GVCs of the agriculture and food manufacturing sectors in the EU and RCEP, and to examine factors associated with GVC participation by participation type.

This study offers a novel contribution to the literature on GVCs by introducing a sector-specific and comparative approach that remains underexplored in existing research. While much of the GVC literature tends to focus either on the manufacturing sector or country-level participation patterns, this paper isolates two strategic and policy-sensitive sectors: agriculture and food manufacturing. By analyzing both forward and backward participation in GVCs–rather than relying solely on aggregate GVC shares–this study offers a more nuanced view of how countries and regions are embedded in global agri-food production networks.

Comparative studies between the two analyzed blocs remain rare in GVC research, despite both playing increasingly central roles in global agri-food trade and intensifying trade cooperation. Thus, this research fills key gaps in the literature and provides a valuable evidence base for designing differentiated trade and agricultural policies within and across trade blocs.

2. Literature Review

2.1. General factors associated with GVC participation

A foundational body of work emphasizes the role of structural factors, such as factor endowments, market size, and geography, in shaping countries' participation in GVCs (World Bank, 2020). For instance, low-skilled labor and foreign capital are central to backward participation. In contrast, forward participation is more prevalent in resource-abundant countries or those with advanced technological capabilities. Additionally, foreign direct investment (FDI), whether efficiency- or resource-seeking, tends to reinforce GVC integration in both dimensions (Xu *et al.*, 2022).

Trade openness is critical enabler, especially in terms of tariffs (Yanikkaya *et al.*, 2024) and trade agreements (Cheng *et al.*, 2022). Evidence from the RCEP region suggests that greater trade openness is strongly associated with increased backward GVC participation, particularly in low- and middle-income economies (Rahman et al., 2024).

Outward FDI is another mechanism through which home countries can reposition themselves within GVCs. Several studies have demonstrated that outward investment, particularly in high-tech sectors, facilitates technology upgrading and enhances the GVC position of the investing country (Li *et al.*, 2021). However, the relationship is not unequivocally positive; the benefits of OFDI depend on the home country's absorptive capacity and institutional context (Herzer, 2012).

2.2. Forward and backward GVC participation

Although many determinants influence overall GVC participation, recent studies have emphasized the importance of distinguishing between forward and backward integration. Backward participation is particularly common among countries entering GVCs through labor-intensive assembly tasks (Taguchi and Thet, 2021; World Bank, 2020). Forward participation is typically associated with more advanced capabilities in R&D, product design, and upstream manufacturing. Stojčić & Matić (2024) provide empirical evidence that the relationship between backward and forward integration is neither linear nor automatic. While backward integration can serve as a stepping stone, its capacity to generate long-term upgrading is limited unless complemented by domestic innovation, diversified trade partnerships, and supportive institutional environments.

The transition from backward to forward GVC participation remains a central challenge for many economies in lower income groups . Evidence suggests that excessive reliance on imported inputs may lead to a "low-end lock-in," in which countries remain trapped in low-value-added segments of GVCs without the capacity to move upstream (Stojčić and Matić, 2024; Xu *et al.*, 2022).

2.3. Agri-food GVCs

Despite the rising importance of agri-food GVCs in international trade and production (Nenci *et al.*, 2022), empirical evidence on the determinants of participation in these chains remains sparse. Compared to the manufacturing sector, where a rich literature identifies economic, institutional, and policy-related drivers of GVC integration, studies focusing on agriculture and food products are limited in both number and scope.

One of the few early empirical contributions to this field by Balié et al. (2019) uses a trade-in-value-added framework to analyze GVC participation in Sub-Saharan African economies. Importantly, their results demonstrate that trade policy variables such as bilateral tariffs and regional trade agreements significantly affect both forward and backward GVC participation, indicating that even modest reductions in trade barriers can enhance countries' integration into agri-food chains.

Expanding on the role of institutional integration, Kim and Steinbach (2025) present robust empirical evidence that membership in multilateral institutions, such as the WTO, significantly boosts agri-food GVC participation. Using a dynamic structural gravity model, they find that WTO membership increases backward participation by 56.7% and forward participation by 43.9%. These effects are notably larger than those associated with regional trade agreements (RTAs), which yield more limited gains (7.9% and 4.1% respectively). Their findings suggest that multilateral rules-based frameworks provide more effective and reliable channels for integrating into agri-food GVCs, primarily by reducing uncertainty and harmonizing trade procedures.

Steinbach and Zurita (2025) offer a complementary angle by investigating the impact of the WTO Trade Facilitation Agreement (TFA) on agri-food GVC participation. Their analysis indicates that while the TFA has the potential to lower trade costs and streamline border procedures, its effects are uneven across countries and provisions. For example, measures such as expedited shipments and advance rulings have a positive impact on GVC flows, whereas others, such as customs cooperation, may yield neutral or even negative short-term effects, particularly in countries with limited administrative capacity.

Further refining the discussion, Kim et al. (2024) examine the impact of deep trade agreements (DTAs)–those including provisions on investment, intellectual property rights, and regulatory harmonization–on GVC participation in the agri-food sector. Their results confirm that DTAs positively affect both forward and backward participation, with investment-related provisions showing the strongest association with value-added trade. However, the study also uncovers that specific clauses–especially those concerning geographical indications (GIs) and intellectual property rights (IPRs)–can have restrictive effects, particularly in lower-income economies that rely on flexible sourcing and less stringent standards. This duality suggests that the design and content of trade agreements matter as much as their existence in shaping agri-food GVC integration.

A recent sector-specific contribution by Török et al. (2025) adds further nuance to the determinants debate by explicitly estimating backward and forward agri-food GVC participation with panel data (54 countries, 2014–2023), using both OLS and country fixed effects and additionally splitting the sample into high-, average-, and low-performing groups. For backward participation, their fixed-effects results indicate a positive association with trade openness and market size, but a negative association with countries' income-group classification and FDI inflows. For forward participation, authors find that FDI inflows and income-group classification are positively associated with forward linkages, whereas trade openness is significantly negative. Importantly for synthesis, their estimates are mixed across specifications and sub-samples (e.g., sign changes between OLS and fixed effects for several covariates, and opposing FDI effects across performance groups), implying that agri-food GVC determinants are highly context-dependent and sensitive to identification strategy, so stylized conclusions should be drawn cautiously.

3. Materials and Methods

3.1 GVC participation rates

The data from multiregional input-output (MRIO) tables developed as part of the Organization for Economic Cooperation and Development (OECD) Trade in Value Added (TiVA) project (ICIOT) are used to calculate backward and forward GVC participation in EU and RCEP countries. The TiVA database is considered the most reliable government-based source of MRIO data (Aslam *et al.*, 2017). Alternatively, the EORA database is a frequently used data source (Lenzen *et al.*, 2013), mainly due to the representation of almost 190 countries in the model. However, all EU and RCEP countries are represented in TiVA ICIOT; therefore, it remains our choice as the most reliable data source.

The study covers the period 2001-2022, i.e., more than twenty years of dynamic international trade and regional trade agreements. The year 2001 was chosen as the initial period of analysis because of China's accession to the World Trade Organization (WTO) in that year, which influenced the dynamic development of international trade and enabled wider regional integration in Asia and the Pacific.

All calculations for GVC participation are based on a standard MRIO model with G countries and N sectors. To produce a unit of output of good i, a country consumes a quantity of intermediate good j produced domestically or imported from other countries. Thus, each unit of output can be consumed as a final good or used as an intermediate good at home or abroad:

$$X_s = \sum_{r}^{G} (A_{sr} X_r + Y_{sr}) \tag{1}$$

where: X is a $N\times 1$ vector of output; s represents the country of producer and r exporting country; A is a cost-structure matrix; Y is the final goods (final demand) vector.

Using a block matrix notation, the general equation of production and trade with G countries and N sectors (commodities) can be expressed as follows:

$$\underset{(NG\text{x}1)}{\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_G \end{bmatrix}} = \underset{(NG\text{x}NG)}{\begin{vmatrix} A_{11} & A_{12} & \dots & A_{1G} \\ A_{21} & A_{22} & \dots & A_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ A_{G1} & A_{G2} & \dots & A_{GG} \end{vmatrix}} \underset{(NG\text{x}1)}{\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_G \end{bmatrix}} + \underset{(NG\text{x}G)}{\begin{vmatrix} Y_{11} & Y_{12} & \dots & Y_{1G} \\ Y_{21} & Y_{22} & \dots & Y_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ Y_{G1} & Y_{G2} & \dots & Y_{GG} \end{vmatrix}} \underset{(G\text{x}1)}{\begin{bmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{bmatrix}} \tag{2}$$

The following relationship between output and final demand can be derived from the above equation:

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_G \end{bmatrix} = \begin{vmatrix} I - A_{11} & -A_{12} & \dots & -A_{1G} \\ -A_{21} & I - A_{22} & \dots & -A_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ -A_{G1} & A -_{G2} & \dots & I - A_{GG} \end{vmatrix}^{-1} \begin{bmatrix} \sum_{r}^{G} \mathrm{Y}_{1r} \\ \sum_{r}^{G} \mathrm{Y}_{2r} \\ \vdots \\ \sum_{r}^{G} \mathrm{Y}_{1G} \end{bmatrix} = \begin{vmatrix} B_{11} & B_{12} & \dots & B_{1N} \\ B_{21} & B_{22} & \dots & B_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ B_{G1} & B_{G2} & \dots & B_{GG} \end{vmatrix} \begin{bmatrix} \sum_{r}^{G} \mathrm{Y}_{1r} \\ \sum_{r}^{G} \mathrm{Y}_{2r} \\ \vdots \\ \sum_{r}^{G} \mathrm{Y}_{1G} \end{bmatrix} \tag{3}$$

where: B represents the global Leontief inverse matrix for the entire intercountry model.

We calculate GVC participation rates for the agriculture and food sectors in each analyzed country. Agriculture is equated with sector A01, according to the International Standard Industrial Classification of All Economic Activities (ISIC Rev. 4). Based on the same classification, the food sector accounts for the manufacture of food products, beverages, and tobacco products (from now on referred to as the food sector). Borin and Mancini (2019) point out that the most widely used export decomposition method in the literature (Koopman et al., 2014) is applicable only to aggregate exports (without sectoral breakdown). Moreover, as the authors prove, some elements of the decomposition of Koopman et al. (2014) are imprecisely defined; hence, we use the method of Borin and Mancini (Borin and Mancini, 2019), which represents the first successful attempt at value-added exports decomposition at the bilateral and sectoral levels, allowing proper estimation of backward and forward GVC participation on the sectoral level.

The method used calculates trade value added from a source-based perspective. In this approach, value added is attributed to a trade stream when the component (commodity) first crosses the border. A full description of the method and proofs can be found in Borin and Mancini (2019). Here, we provide only a final source-based decomposition of GVC trade into forward and backward participation indicators:

$$GVCbackward_{sr} = \frac{V_s(I - A_{ss})^{-1} \sum_{j \neq s}^{G} A_{sj} B_{js} E_{sr} + \sum_{t \neq s}^{G} V_t B_{ts} E_{sr}}{u_N E_{sr}} \quad (4)$$

$$GVCforward_{sr} = \frac{V_s(I - A_{ss})^{-1} A_{sr} (I - A_{rr})^{-1} (\sum_{j \neq r}^{G} Y_{rj} + \sum_{j \neq r}^{G} A_{rj} \sum_{k}^{G} \sum_{l \neq s}^{G} B_{jk} Y_{kl}}{u_N E_{sr}} \quad (5)$$

where: V_s is a $1 \times N$ vector that contains the shares of value added per unit of output produced in country s; E_{sr} is a vector of exports (E) of country s to country r; u_N is the $1 \times N$ unit row vector; k is the country (market) of manufacture of the product; l is the country (market) of final absorption of the product.

3.2 Regression models

3.2.1 Data

This study uses a balanced panel dataset comprising 42 countries (27 EU and 15 RCEP countries) over the period 2001–2022. All variables are annual, and the final dataset has no missing values. The explanatory variables include economic indicators (e.g., GDP per capita and development status based on income classification), investment (FDI outflows), and trade policy (tariffs and DTAs). The selection of variables is grounded in the empirical and theoretical literature on GVC participation (see the Literature Review Section). These variables are intended to capture broad structural, investment-related and trade-policy conditions at the country-sector level. The initial model specification also included the FDI inflow variable. However, it was found to be statistically insignificant in all cases. Consequently, it was excluded from the final specification. See supplementary files (Tables S1 and S2) for the overview and descriptive statistics of variables used.

3.2.2 Baseline Model Specification

Given the panel structure and the expectation of time-invariant unobserved heterogeneity across countries, the fixed-effects (within) estimator is applied. This approach removes all time-invariant omitted variables that could bias results, aligning with standard panel modeling guidance (Baltagi, 2021; Wooldridge, 2010). It is particularly appropriate when country-specific characteristics may be correlated with included regressors, and when N > T, as in this study. To ensure statistical reliability, the model also accounts for cross-sectional dependence, heteroskedasticity, and serial autocorrelation, which are common in macro-panel settings. Diagnostic testing (reported in the Robustness Checks section) confirms the presence of cross-sectional dependence, groupwise heteroskedasticity, and first-order autocorrelation. Accordingly, we implement the Driscoll-Kraay (DK) standard error correction (Driscoll and Kraay, 1998), which produces standard errors robust to all three issues. Each model includes country fixed effects and year dummies, controlling for time-varying global shocks and country-invariant factors.

The general form of the estimated models is as follows:

$$GVC_{it} = \alpha_i + \delta_t + \beta_1 GDPpc_{it} + \beta_2 Dev_{it} + \beta_3 DTA_{it} + \beta_4 FDI_{it} + \beta_5 MFN_{it} + \varepsilon_{it} \quad (6)$$

where: GVC_{it} is GVC participation (forward or backward) for country i in year t; α_i are country fixed effects; δ_t are year fixed effects; $GDPpc_{it}$ is the GDP per capita; Dev_{it} is development; DTA_{it} represents deep trade agreements; FDI_{it} represents outflow of foreign direct investments share in sectoral GDP; MFN_{it} is the weighted average of Most-Favored Nation Tariffs; ε_{it} is Driscoll-Kraay robust error term.

3.2.3 Robustness Checks

To ensure the validity of the empirical findings, we conduct a series of robustness checks addressing key statistical concerns: model specification stability, error structure, and time-varying unobserved heterogeneity. We first assess multicollinearity using variance inflation factors (VIF). All VIF values were well below the conventional threshold of 5 (O'brien, 2007), indicating that multicollinearity is not a concern in the specified models (see Tables S3 and S4 in the supplementary files for results).

Second, the presence of cross-sectional dependence (mutual shocks across countries), common in trade models, was tested for each variable and the fixed-effect residuals, using the Pesaran CD test (Pesaran, 2015) (for results, see Tables S5 and S6 in the supplementary files). The CD test showed strong cross-sectional dependence in all variables except FDI outflow across three out of four model specifications. For the GVC backward-food specification, the test does not reject the null of weak dependence, suggesting that common shocks are largely absorbed by the controls and time effects in that equation. Based on the results, we treat cross-sectional dependence as a general feature of our dataset. Therefore, to test for stationarity, the Pesaran Panel Unit Root Test is used (Pesaran, 2007). Several tests were conducted with different lags, considering both trend and non-trend scenarios (for results, see Table S7 in the supplementary files). Together, they showed that non-stationarity cannot be ruled out for GDP per capita, forward GVC participation in the food and agriculture sectors, and backward GVC participation in the food sector. Thus, to bring variables to stationarity, the transformation was conducted. For GDP per capita, the log transformation was applied, and the data were first-differenced to obtain growth rates. For the remaining non-stationary variables (Forward participation agriculture; Backward participation food; Forward participation food), a first difference was applied.

Then, tests for serial correlation and heteroskedasticity were conducted (for results, see Table S8 in the supplementary files). The Modified Wald test for groupwise heteroskedasticity (Greene, 2003) indicates significant heteroskedasticity across countries, while the Wooldridge test (Wooldridge, 2010) confirms the presence of first-order autocorrelation within panels (Drukker, 2003). Based on the conducted tests, the Driscoll-Kraay standard error correction was selected for the baseline models because it is robust to heteroskedasticity, autocorrelation, and general forms of cross-sectional dependence. As a robustness check, we additionally estimate models with panel-corrected standard errors (PCSE) (Greene, 2018), which explicitly allow contemporaneous correlation across panels and can incorporate an autoregressive error process via Prais–Winsten transformation. Consistency of results across these alternative covariance estimators increases confidence that inference is not driven by a particular error-structure correction.

To allow further sensitivity analysis, we also specify alternative DK and PCSE models. Following Newey & West (Newey and West, 1994) and Andrews (Andrews, 1991), the maximum lag truncation parameter in our DK model with around 20 time points is set to 2 (lag 2), consistent with the optimal bandwidth rule. However, we also tested the maximum lag of 1 (lag 1) as a sensitivity check. In the case of the PSCE model, the choice is between allowing a common autoregressive (AR1) serial correlation structure and a panel-specific autoregressive (PSAR1) structure. The common autoregressive specification assumes all units share the same serial autocorrelation, whereas the panel-specific autoregressive specification allows the persistence of shock processes to differ across countries. Although there is no formal test for choosing between these structures in the PCSE literature, allowing for heterogeneous serial dependence is often more realistic in macro, sector panels where units may follow different dynamic processes. We present results under both assumptions to assess robustness and sensitivity of inference.

4. Results and discussion

4.1. Descriptive patterns of backward and forward GVC participation

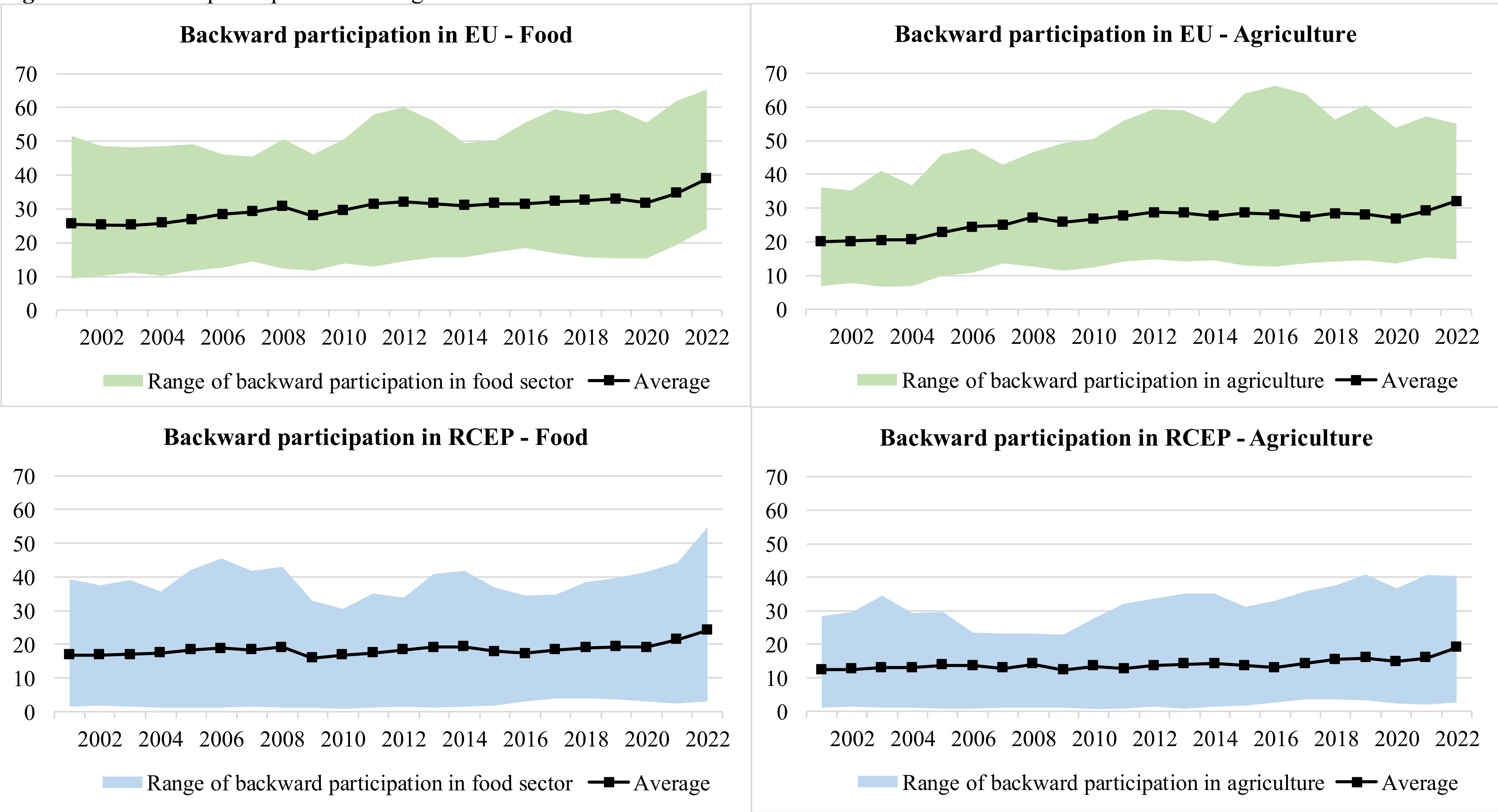
The results indicate broadly similar GVC integration patterns in the agriculture and food sectors across the EU and RCEP, with a clear asymmetry between backward and forward participation (Figures 1–2). In both regions, backward participation dominates. The EU exhibits higher and increasing levels of backward participation in both sectors, whereas RCEP countries show lower and more stable shares (Figure 1). This pattern reflects a stronger reliance on imported intermediate inputs in the EU, which may also increase vulnerability to external shocks. In contrast, RCEP countries rely more on domestically produced or regionally sourced inputs, resulting in lower import dependence. (Jin et al., 2024). (Dellink *et al.*, 2020), in their study of trends in agricultural and food GVCs between 1995 and 2015, also note that Asian countries exhibit lower import dependence and greater use of domestic production inputs within their rapidly developing economies–primarily in agriculture, but also in the food industry.

In both analyzed regions, forward participation in the agri-food sector was lower than backward participation. It reflects the limited technological and structural capacity of the agri-food sector to export components that are subsequently used in international production chains. In the EU, the agriculture sector achieved higher forward participation rates–around 10%-11%–whereas the food sector hovered around 4-5%. RCEP's values were comparable: approximately 10-11% for agriculture and 5-6% for food. The limited dynamism of these indicators over the analyzed years and the absence of clear upward trends suggest a constrained ability of the regions to move "upstream" in the GVC. It contributes to the persistence of "low-end dependency," in which countries remain trapped in low-income stages of production (Stojčić and Matić, 2024; Xu et al., 2022). Given the low level of innovativeness and limited investment in research and development in the agri-food sector (Chaparro-Banegas *et al.*, 2024) compared to other industries, investment in innovation is necessary to support the development of forward participation.

At the country level, the EU–RCEP comparison reveals substantial within-region differences. In the EU, average backward participation is relatively high in countries such as Slovakia, Belgium, Estonia, Ireland and Slovenia in agriculture, and Belgium, Estonia, Ireland, the Netherlands and Slovakia in food manufacturing, while Spain, Italy, France and Romania show lower reliance on foreign value added in exports. In RCEP, higher backward participation is observed mainly in Vietnam, Malaysia, Korea, Thailand and Cambodia, whereas China, Indonesia and Australia display lower levels. Forward participation follows a different pattern: in the EU, it is relatively high in Germany, Belgium, Finland, Spain and Italy in agriculture, and in Czechia, Germany, Romania, Slovakia and Poland in food manufacturing. In RCEP, forward participation is most visible in agriculture in Cambodia, Lao, Myanmar, Japan and Indonesia, and in food manufacturing in Myanmar, Lao, Japan and the Philippines. These patterns confirm that backward and forward participation reflect different forms of sectoral specialization and value-chain positioning.

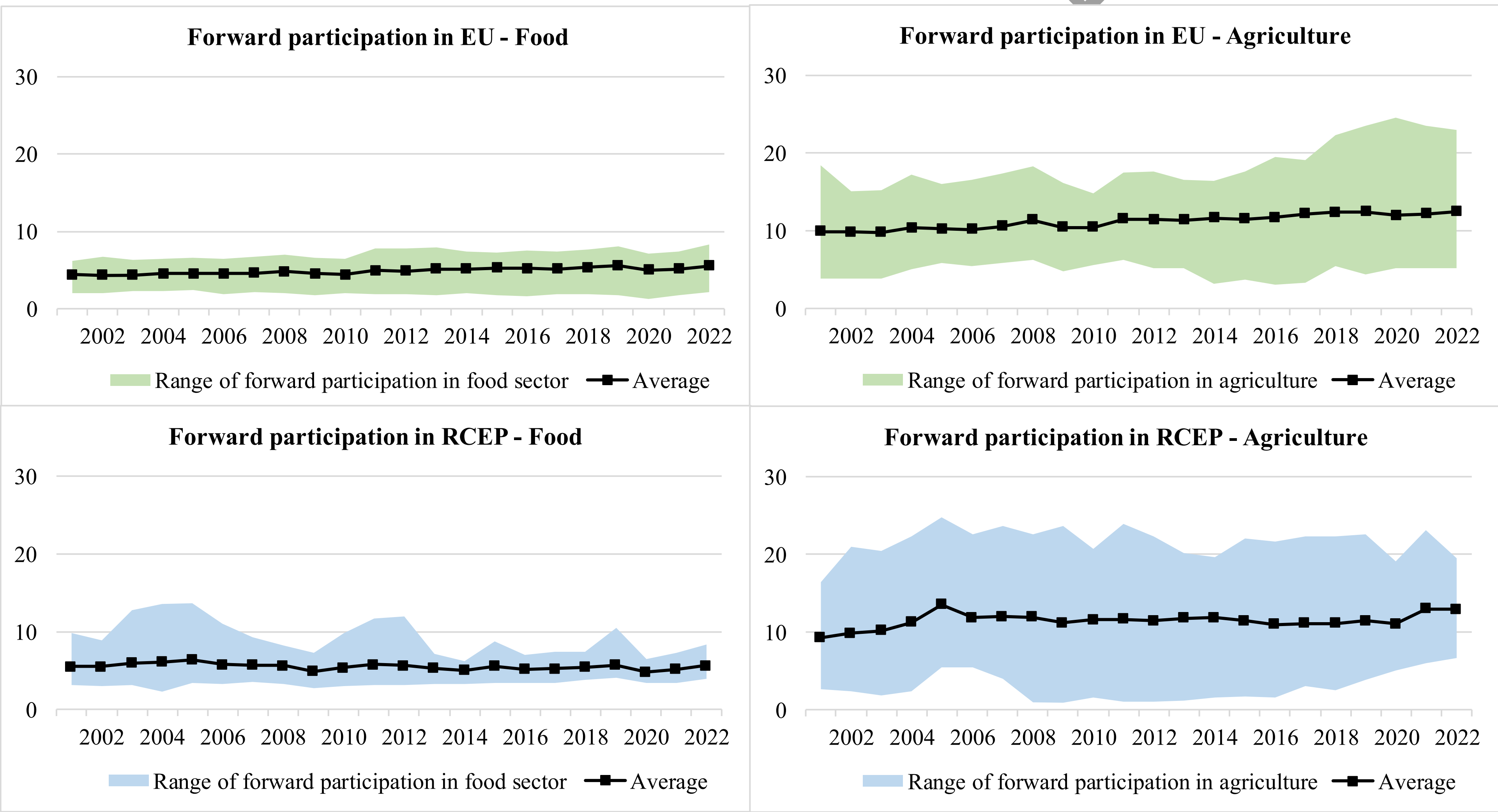
In both the EU and RCEP, the food sector is characterized by greater backward participation, stemming from the greater use of imported components in processing and the higher complexity of supply chains. Notably, higher forward participation in agriculture is observed in countries belonging to the RCEP bloc, which can be explained by the fact that several RCEP countries (e.g., Vietnam, Indonesia, Malaysia) are major exporters of agricultural raw materials such as coffee, tea, or rice, which are subsequently processed abroad and enter further stages of global value chains (GVCs). In contrast, in the EU, agri-food supply chains are more regionally embedded, with a strong internal-market orientation and short supply-chain arrangements (Kneafsey *et al.*, 2013). As a result, agricultural products are less frequently involved in complex international production processes. Consequently, the EU's forward participation in the agricultural sector is relatively lower–its raw materials cross borders less frequently, thereby limiting their role in subsequent stages of global production.

Figure 1. Backward participation in the agriculture and food sector in the EU and RCEP countries



Source: own calculations based on OECD TiVA.

Figure 2. Forward participation in the agriculture and food sector in the EU and RCEP countries



Source: own calculations based on OECD Tiva.

4.2. Econometric results for forward and backward participation

The estimation results (Tables 4-5) indicate clear, largely stable relationships between economic growth and the degree of GVC backward participation in agriculture and the food sector across EU and RCEP countries. In all model specifications, GDP per capita exerts a negative and statistically significant associated with backward participation (agriculture: −6.239, $p < 0.05$ in the DK model and −3.164, $p < 0.01$ in the PCSE model; food: approximately −4.96, $p < 0.01$ in both). It means that as GDP per capita increases, the share of foreign value added in exports declines. While GDP growth is associated with lower backward participation in agriculture, in the food sector, it mainly affects the speed at which backward participation adjusts over time, since backward participation in the food sector is modeled in first differences.

This relationship can be interpreted as a structural effect: growing economies typically have more developed domestic supplier networks and a higher share of domestic value added, thereby reducing reliance on imported inputs in export production. Conversely, less affluent countries are more often participants in GVCs that depend on foreign inputs, resulting in a higher backward participation share. These findings are consistent with (Razzaq *et al.*, 2024), who, when analyzing the relationship between forward and backward participation and GDP per capita, found that in low-income countries, a decline in per capita income is associated with an increase in backward participation.

In turn, the development variable is not statistically significant in any of the models for backward participation, suggesting that changes in countries' income-group classification does not provide additional explanatory power for differences in backward participation. In other words, the effects of being a developed country are largely captured by the income variable and by unobserved, time-invariant country-specific characteristics.

Table 4. Fixed effect models for backward GVC participation

Variable	Backward Agri (DK lag 2 / lag 1)	Backward Agri (PCSE AR1 / PSAR1)	Backward Food (DK lag 2 / DK lag 1)	Backward Food (PCSE AR1 / PSAR1)
D_ln_GDP per capita	-6.239(2.426)** / (2.377)**	-3.164(1.208)*** / (1.114)***	-4.964(0.998)*** / (1.220)***	-4.952(1.106)*** / (1.056) ***
Development	0.722(0.435) / (0.419)	-0.159(0.497) / (0.446)	-0.403(0.299) / (0.289)	-0.405(0.267) / (0.261)
Deep trade agreements	-0.085(0.036)** / (0.036)**	-0.120(0.084) / (0.079)*	-0.040(0.030) / (0.031)	-0.041(0.034) / (0.034)
FDI share of GDP	0.700(1.803) / (1.786)	0.006(0.975) / (0.944)	-0.194(0.084)** / (0.082)**	-0.198(0.097)** / (0.099)**
Tariffs	-0.123(0.059)* / (0.061)*	-0.173(0.086)** / (0.062)***	-0.003(0.004) / (0.004)	-0.003(0.005) / (0.005)
Year fixed effects	Highly significant throughout	Highly significant throughout	Highly significant throughout	Mostly significant
Country fixed effects	Yes	Yes	Yes	Yes
R^2	0.3340	0.9397 / 0.9621	0.3251	0.3748 / 0.3948

Source: own compilation based on the STATA 15 calculations.

Note: Robust standard errors in parentheses. DK = Driscoll-Kraay estimator; PCSE = Panel corrected standard errors, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Backward Agri is in levels, Backward Food is differentiated.

Surprisingly, deep trade agreements (DTAs) are negatively and statistically significantly associated with backward participation only in agriculture ($\beta = -0.0851$, $p < 0.05$). It means that being a part of one more deep trade agreement is associated with a 0.085 percentage-point lower backward participation in agriculture. It is worth noting that this variable loses significance when the PCSE model is fitted with a common autoregressive (AR1) serial correlation structure. However, for the panel-specific autoregressive structure (PSAR1), significance remains at the 10% level. Considering PSAR1 to be more realistic in the analyzed case, we interpret the results for DTAs as significant.

These results contradict Kim et al. (2024), who demonstrated that DTAs can support both forward and backward participation in GVCs, particularly through investment-related provisions. In our study, they do not support either backward participation or forward participation (Table 5). This discrepancy may stem from the heterogeneity of the agreements. While specific clauses–such as those facilitating investment–promote integration into GVCs, others, such as the protection of geographical indications (GIs) or strict regulations concerning intellectual property rights (IPRs), may constrain flexibility in GVC development. This is particularly relevant for lower income economies that lack advanced infrastructure or standardized quality systems–factors that are especially important in regions such as the EU and RCEP.

Tariffs have a significant negative effect on backward participation only in agriculture, indicating that higher tariffs reduce the use of imported inputs in export production. This relationship is not observed in the food sector, where non-tariff barriers, quality standards, and sanitary regulations may play a more important role in shaping import intensity. This is consistent with the broader link between trade openness and GVC participation, particularly in developing countries (Rahman *et al.*, 2024). Similarly, (Török, Sándor Kovács, *et al.*, 2025) found a positive and significant relationship between trade openness and participation in agri-food GVCs across 54 countries from different regions during the period 2014–2023. The tariff variables are not significant for forward participation in any of the models, which is consistent with trade theory, as tariffs primarily affect the cost of imported inputs and, consequently, the import intensity of production–i.e., backward participation.

In the case of the FDI outward share of GDP, a significant and negative relationship was observed only with backward participation in the food sector (approximately $\beta = 0.19$-0.20 for both DK and PCSE models; $p < 0.05$). Therefore, +1 percentage-point higher outward FDI intensity in the food sector is associated with a contemporaneous reduction in backward participation in food by a 0.19–0.20 percentage-point. It may indicate that firms in the food sector invest less abroad and more often serve target markets through exports from the home country, rather than producing goods in foreign affiliates.

In the models for forward participation (Table 5), GDP per capita is not statistically significant in either sector, indicating that growth alone is not systematically associated with countries' ability to generate value added for re-export. In contrast, the development variable is positive and significant only in agriculture, suggesting an association between higher income-group status and forward linkages in this sector. This may reflect their capacity to process inputs into higher-value products for export. However, this result should be interpreted with caution, as fixed effects absorb time-invariant country characteristics, and the estimates capture within-country variation over time.

Table 5. Fixed effect models for forward GVC participation

Variable	**Forward Agri (DK lag 2 / lag 1)**	**Forward Agri (PCSE AR1 / PSAR1)**	**Forward Food (DK lag 2 / DK lag 1)**	**Forward Food (PCSE AR1 / PSAR1)**
D_ln_GDP per capita	0.236(0.727) / (0.745)	0.310(0.890) / (0.849)	-0.021(0.393) / (0.437)	-0.108(0.484) / (0.448)
Development	0.420(0.154)** / (0.156)**	0.408(0.178)** / (0.172)*	-0.002(0.080) / (0.079)	-0.006(0.075) / (0.069)
Deep trade agreements	-0.001(0.019) / (0.020)	-0.003(0.027) / (0.031)	-0.005(0.016) / (0.017)	-0.005(0.012) / (0.011)
FDI share of GDP	-0.144(0.061)** / (0.064)**	-0.151(0.190) / (0.187)	0.014(0.011) / (0.011)	0.013(0.012) / (0.012)
Tariffs	-0.014(0.022) / (0.028)	-0.016(0.034) / (0.032)	-0.001(0.001) / (0.001)	-0.001(0.004) / (0.036)
Year fixed effects	Mostly significant	Mostly significant	Highly significant throughout	Mostly significant
Country fixed effects	Yes	Yes	Yes	Yes
Within R²	0.0996	0.1339 / 0.1431	0.1541	0.1612

Source: own compilation based on the STATA 15 calculations.

Note: Robust standard errors in parentheses. DK = Driscoll-Kraay estimator; PCSE = Panel corrected standard errors, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Both dependent variables are differentiated.

In contrast to models of backward participation, the FDI variable proved significant only for agriculture in the model of forward participation. However, the result is not conclusive, as significance was observed only in the DK specification. Similar findings were reported by Rahman and Sharma (2025), who analyzed the role of inward and outward FDI in shaping GVC participation across the EU, RCEP, and the United States-Mexico-Canada Agreement (USMCA) over the period 2008–2020. Their study also found a limited impact of both inward and outward FDI on GVC integration. A different perspective is provided by Adarov and Stehrer (2021), who identified a positive relationship between FDI and sectoral integration into GVCs. According to their findings, inward FDI plays a key role in supporting backward integration, while outward FDI contributes more significantly to forward integration. In our study, inward FDI was not statistically significant for either form of participation. However, outward FDI was significant for backward participation in the food sector and for forward participation in agriculture. These differences in results may point to sector-specific dynamics. While Rahman and Sharma (2025) conducted their analysis at the level of entire economies, Adarov and Stehrer (2021) focused on high-tech sectors, where the role of FDI tends to be more prominent. In contrast, our analysis focuses on the agriculture and food sectors, which may rely less on advanced technologies compared to other parts of the economy.

Importantly, in the case of forward participation in the food industry, none of the variables in our models proved statistically significant. It may be attributed to the sector's structural characteristics and complexity, which make it particularly difficult to capture the factors associated with GVC integration. An additional challenge is that the food sector largely serves final demand, which naturally limits its involvement in upstream stages of GVCs (Figure 3) and reduces the variability of forward participation indicators, thereby making causal modelling more difficult. This issue has also been highlighted by (Greenville *et al.*, 2017).

The results reveal clear asymmetries across sectors and between forward and backward GVC participation. The most robust finding is that higher GDP per capita is associated with lower backward participation in both sectors, suggesting reduced reliance on imported inputs in more developed economies (Kim et al., 2024). In agriculture, backward participation is also negatively affected by tariffs, highlighting the cost channel of imported inputs, whereas this relationship is not observed in the food sector. Instead, in food, backward participation appears more closely linked to trade openness and institutional factors, in line with previous findings (Kim and Steinbach, 2025; Taguchi and Thet, 2021).

In contrast, forward participation is more difficult to explain and shows weaker model fit, with variable significance observed mainly in agriculture, while in the food sector, no significant determinants are identified. In our results, forward participation remains more challenging to strengthen. This appears to reflect the importance of sector-specific production structures and value-chain positioning in agriculture and food sectors (Montalbano and Nenci, 2022), as well as the broader role of functional specialization and value-added creation within GVCs (Stöllinger, 2021).) These results imply the need for differentiated policy tools targeting backward and forward GVC participation, respectively.

4.3. Policy implications

These findings have important policy implications. Factors that support backward participation do not necessarily strengthen forward integration, which requires more advanced technological and organizational capacities. This suggests the need for differentiated policy approaches, particularly across sectors. In agriculture, improving market access and reducing non-tariff barriers remain important, alongside investments in certification systems, SPS standards, and agrotechnological innovation. The relevance of SPS measures in this context stems from their dual role in agri-food GVCs: they may facilitate market access and value creation when producers are able to comply with them, but they may also constrain upgrading when compliance costs and technical requirements are high. Ghodsi and Stehrer (2022) showed that SPS measures implemented by a given country positively influence its exports across all sectors. When producers comply with these regulations, the value added embodied in their exports is also expected to increase. A similar positive effect of SPS measures was confirmed by Eum (2023) in the context of ASEAN countries; however, the study noted that this positive impact tends to diminish in sectors engaged in forward GVC participation. This effect is likely because forward participation requires more advanced technologies and greater complexity than backward participation (Yang and Otsuki, 2020). As a result, complying with all requirements and standards may be more difficult–particularly in technologically intensive sectors such as food processing. Consequently, SPS measures and certification requirements may act as barriers to strengthening participation in GVCs in the food sector. For this reason, support in the areas of automation and digitalization may be necessary (Jithin *et al.*, 2024), as it could enhance agri-food producers' capacity to access higher segments of GVCs.

In the context of the EU's trade policy, so-called mirror clauses–regulations requiring imported products to comply with the same environmental and sanitary standards as those applied to EU-produced goods–are gaining increasing importance (Rees, 2022). While these mechanisms reinforce the internal consistency of the EU market and protect its regulatory standards, they may also act as non-tariff barriers for third countries, including those within the RCEP bloc. Given the ongoing deepening of trade cooperation between the EU and RCEP regions, such regulatory asymmetries may hinder the balancing of trade flows and reduce the ability of developing economies within RCEP to upgrade their positions in global value chains. Also Iannucci and Sacchi (2022) point out that certification systems can enhance trust and facilitate market access, but at the same time may generate additional costs, and, if not properly designed, unnecessary technical barriers to trade.

5. Conclusions

The study examined the patterns and factors associated with forward and backward GVC participation in the agriculture and food manufacturing sectors in the EU and RCEP countries. Forward participation was consistently lower than backward participation throughout the period analyzed, reflecting the structure of agri-food trade, which remains strongly dependent on imported raw materials and production inputs. As a result, backward linkages play a more prominent role in both regions. At the same time, backward participation is more pronounced in the EU than in RCEP, particularly in the food sector, reflecting a stronger reliance on imported inputs and specialization in processing them into higher-value products for export. In contrast, RCEP countries show relatively higher forward participation, driven by greater self-sufficiency and specialization in the export of agricultural raw materials.

As shown by the regression results, effective integration into agri-food GVCs requires differentiated policy tools tailored to sector-specific characteristics and the distinct mechanisms shaping backward and forward participation. Attempts to promote GVC integration without accounting for existing production and export specializations may be inconsistent with the underlying logic of agricultural trade. In the context of ongoing trade negotiations and agreements in force between the EU and RCEP countries, policymakers must recognize that boosting forward linkages requires targeted interventions, including investments in agrotechnology and digital infrastructure, as well as support mechanisms to meet stringent international standards, such as SPS requirements.

Moreover, facilitating compliance with certification and quality norms can help producers add greater value to their exports. In the case of backward participation in agriculture, the significance of the tariff variable suggests that trade policy should focus on reducing the cost of access to key inputs by lowering tariffs or ensuring stable import conditions. For countries whose exports rely on imported components, such measures may be crucial for maintaining competitiveness. In turn, to strengthen forward participation in agriculture, where a country's development status proves significant, it is recommended to support certification and compliance with SPS requirements, so that domestic value added can be recognized and accepted at subsequent stages of the value chain. In the food sector, where forward participation shows no significant association with the variables analyzed, there is likely a need to go beyond traditional macroeconomic instruments and consider microeconomic tools to support the standardization and automation of production processes.

However, such measures must be accompanied by efforts to lower the technological and regulatory barriers that disproportionately affect forward participation, particularly in food-related sectors. In this context, the increasing use of mirror clauses in EU trade policy–while advancing environmental and health objectives–may restrict market access for developing countries. To support more balanced GVC engagement, international cooperation should aim to harmonize standards and provide technical assistance to lower-income partners, ensuring that sustainability goals are pursued without reinforcing structural asymmetries.

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