Deep Trade Agreements and Agri-Food Global Value Chain Integration*

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Abstract

This paper examines the impact of deep trade agreements on agri-food global value chains (GVCs). Our theory-consistent gravity estimates underscore that those trade deals benefit forward more than backward agri-food GVC integration. An event study analysis unveils a lag of up to four years in the GVC response. Furthermore, we find that deeper trade agreements foster GVC integration more. Clauses related to standard regulations and foreign investment emerge as drivers of increased GVC flows within the agri-food sector. In contrast, provisions concerning intellectual property rights and geographical indicators hinder GVC integration. Developed nations are the key instigators and beneficiaries of GVC integration, suggesting a nuanced distribution of economic benefits. These findings carry importance for policymakers aiming to rectify the uneven benefits of agri-food GVC integration caused by deep trade integration agreements.

Keywords: Deep trade agreements, agri-food global value chains, three-way gravity model, intra-national trade flows, event studies, treatment heterogeneity

JEL codes: F14; Q17; Q18

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1. Introduction

Global value chains (GVCs) have fundamentally reshaped how agricultural and food production operates worldwide and how international trade functions (Lim 2021). While in the past, countries usually made goods entirely within their borders and traded finished products, the present scenario is significantly different. Traditional trade, centered on final products, has given way to a new approach that focuses on trading individual parts of products and services that add value in between. Johnson and Noguera (2012) estimate that trade in intermediate inputs constitutes two-thirds of world trade, allowing the movement of services, raw materials, components, and parts across borders with ease. Once these components come together to create final products, the end products are shipped to consumers worldwide. As a result, the traditional idea of labeling products with their country of origin is no longer accurate, as the complex fragmentation of production processes across different countries has become a defining feature of the modern economy (Antràs 2016).

Several theoretical frameworks have emerged that emphasize the importance of production sequences in the global sourcing decisions of firms. Among others, this literature includes the works of Harms, Lorz and Urban (2012), Baldwin and Venables (2013), Costinot, Vogel and Wang (2013), Antràs and Chor (2013), Kikuchi, Nishimura and Stachurski (2012), and Tyazhelnikov (2022). However, a limitation of these theories is their treatment of trade costs. Some models overlook trade costs, while others oversimplify them by assuming uniformity across trading partners. Several empirical studies have focused on dissecting the value-added segments in trade flows. Johnson and Noguera (2012) pioneered this line of inquiry, aiming to document the rise of GVCs and the roles of different countries. Koopman, Wang and Wei (2014), Johnson (2014), Timmer et al. (2014), and Antràs and De Gortari (2020) have greatly contributed to understanding this phenomenon. Concurrently, another research strand has developed indices to gauge the positioning of industries and countries within GVCs. Antràs et al. (2012), Antràs and Chor (2013), and Alfaro et al. (2019) have been instrumental in this regard. Regarding empirical evidence, the works of Yi (2003, 2010) stand out. Caliendo and Parro (2015) introduce a quantitative framework with input-output connections across nations, albeit without explicitly considering sequential production. Antràs and De Gortari (2020) amalgamate these diverse threads by generalizing value-added and downstreamness formulas in a multi-sector Ricardian model with sequential production. Lastly, Antràs and Staiger (2012) and Bown and Crowley (2016) explore the implications of offshoring and GVCs on trade policies, contributing to a holistic understanding of the intricate interplay between economic trends and policy decisions.

Agri-food GVCs have witnessed a remarkable expansion since the 1950s. Before this period, most sectors shifted from traditional, localized, small-scale operations to larger, more organized industries. This transition set the stage for the emergence of agri-food GVCs, a trend that gained further momentum in the early 1990s, buoyed by China's robust engagement in global trade. This transformative phase prompted nations worldwide to expand their GVC participation (Reardon et al. 2009). The rapid ascent of influential global grocery processors and retailers accentuated this evolution of value chains. These entities harnessed vertical integration to establish dominance within the agri-food GVC landscape, seamlessly connecting upstream farmers with downstream end consumers (Sexton 2013). Much of today's agricultural production embodies intricate multinational supply chains, where each operational step contributes incrementally to the final product's value. GVCs are characterized by a sequence of interconnected activities spanning multiple countries. Encompassing production, marketing, distribution, and end-user support, these activities collectively shape the journey from raw materials to finished goods. Gereffi and Fernandez-Stark (2016) underscores how the essence of a GVC lies in its representation of the entire spectrum of functional operations essential for value creation across international boundaries. It encapsulates the collaborative endeavors of multiple nations, all working towards value generation within a globally interlinked framework.

Numerous studies have examined the impacts of involvement in agri-food GVCs at the global, regional, and local levels. These investigations primarily focus on rural households situated at the initial stages of these value chains. They also explore various economic outcomes, such as income, food security, and productivity (e.g., Mergenthaler, Weinberger and Qaim 2009; Minten, Randrianarison and Swinnen 2009; Bellemare 2012; Cattaneo et al. 2021; Montalbano, Pietrelli and Salvatici 2018). While a substantial body of literature exists in this domain, only a limited number of empirical inquiries have delved into the effects of agricultural GVC participation from the perspective of international trade (Balié et al. 2019*a*). This scarcity can be attributed to the inadequacy of conventional trade data that accurately capture the extent of GVC involvement, given the intricate nature of GVC measurement (Koopman, Wang and Wei 2014). Addressing this gap, a novel approach introduced by Wang et al. (2017), coupled with the release of multi-region input-output (MRIO) data, has furnished empirical insights that enhance our understanding of the interplay between agricultural value chains and global trade. Notably, Lim (2021) has discovered that heightened engagement in agricultural GVCs leads to higher economic growth and employment shares in the farming and services sectors. Contemporary agrarian economies are sidestepping the traditional trajectory of structural transformation by directly advancing their agriculture and services sectors through active participation in agri-food GVCs, representing an important mechanism of economic development around the globe.

This study examines how trade cost changes influence agri-food GVC integration. We utilize comprehensive GVC data to explore how deep trade integration impacts the forward and backward connections within agri-food GVCs. Our empirical investigation employs a three-way gravity framework and sector-level GVC flow information encompassing a wide range of nations from 1991 to 2020. We analyze intra-national and international GVC flows, evaluating the effects of trade agreements and their degree of comprehensiveness on the integration of agri-food GVCs. We employ event studies to gauge the immediate and lasting consequences of DTAs, and we consider potential concerns regarding endogeneity arising from the anticipation of such trade policy shifts. Moreover, we carry out a heterogeneity analysis encompassing various metrics of trade agreement comprehensiveness, delving into the influence of specific provisions related to GVCs embedded within DTAs. To assess differences in the effects of trade integration agreements on agri-food GVC flows based on the level of economic development, we classify countries into North and South categories, using indicator variables to estimate the heterogeneous responses to treatment.

Our main findings demonstrate that trade integration policies positively impact the integration of agri-food GVCs. Among countries participating in the same trade agreement, there is a notable increase in backward and forward agricultural GVC flows, by 16.6 percent and 17.1 percent, respectively, compared to those nations lacking such economic integration pacts. These estimates are comparatively lower than the observed increase of 23.4 percent in gross agricultural exports, which can be attributed to the potential duplication of trade measurements (Koopman, Wang and Wei 2014). Conversely, the influence of trade agreements on GVC flows is more conspicuous within the food industry. Specifically, the backward GVC flows experience a rise of 16.2 percent, while forward GVC flows surge by 21.9 percent. Correspondingly, gross food exports also witness a growth of 9.5 percent. This discrepancy can be attributed to the transfer of domestic value-added processes to foreign locations (Roth et al. 2008). Upon conducting an event study analysis, we ascertain no notable evidence of short-term pre-existing trends for the four measures of agri-food GVC flows. The treatment dynamics unveil a delay in the GVC response to the trade agreement, extending up to four years. Following this period, the treatment effect becomes more pronounced, leading to a rise of 13.1 percent in backward agricultural GVC flows, 13.3 percent in forward agricultural GVC flows, 15.3 percent in backward food GVC flows, and 19.2 percent in forward food GVC flows.

Our heterogeneity analysis reveals marked differences in treatment outcomes based on the depth of trade agreements and the income level of participants participating in agri-food GVCs. To elaborate, the extent of the trade agreement emerges as a pivotal factor in facilitating GVC integration. In particular, our findings indicate a more pronounced influence of the agreement's depth on the forward linkages of agri-food GVC flows. This influence translates to a 0.2 percent expansion for the agricultural sector and a 0.3 percent increase for the food sector, with each incremental unit rise in the depth index (Vollrath, Gehlhar and Hallahan 2009; Disdier, Fontagné and Mimouni 2008). Comparable effects are observed for the backward GVC flows. When utilizing an alternative depth metric, our analysis consistently demonstrates the positive impact of trade policies on agri-food GVC integration (Bahar et al. 2019; Santeramo and Lamonaca 2022*a*). Upon scrutinizing specific provisions within trade agreements that may promote GVCs, our investigation identifies that provisions concerning standard harmonization and investment policies substantiate backward and forward agri-food GVC flows, resulting in an augmentation ranging from 6.5 to 24.5 percent (Disdier, Fontagné and Mimouni 2008). This augmentation is attributed to cooperative investments aimed at regulatory alignment and investment protection, effectively bolstering trade and investment activities and thereby substantially contributing to agri-food GVC integration (Santeramo and Lamonaca 2022*a*). Conversely, clauses within trade agreements addressing intellectual property rights (IPRs) and GVC-related policies emerge as deterrents to value-added trade within the agri-food sector. Our findings concerning safeguarding geographical indications under IPRs align with the previous literature on trade dynamics. The adverse implications of GVC provisions could be attributed to regulations of origin within trade agreements, which confer advantages and safeguards to domestically sourced inputs. Such DTA provisions could potentially disadvantage GVC flows reliant on outsourcing (Campi and nas 2016; Campi and Dueñas 2019; Choi 2010; Geraets, Carroll and Willems 2015). Furthermore, our analysis underscores the variable impact of trade agreements on agri-food GVCs across different income groups. Specifically, trade agreements increase value-added flows, primarily for developed countries. In contrast, such agreements reduce GVC flows among developing countries, consequently accentuating disparities in the benefits of GVC integration (Disdier, Fontagné and Cadot 2014; Cadot and Gourdon 2016; Mujahid and Kalkuhl 2016).

This study contributes to the expanding body of research regarding the relationship between deep trade agreements and the integration of agri-food GVCs. First, we build upon the extensive literature exploring the connection between trade integration agreements and trade flows for agricultural and food products (Grant and Lambert 2008; Sun and Reed 2010; Disdier, Fontagné and Cadot 2014; Mujahid and Kalkuhl 2016; Scoppola, Raimondi and Olper 2018; Huysmans and Swinnen 2019; Duvaleix et al. 2021). While earlier studies predominantly focus on simple trade flows, our analysis diverges by examining the consequences of in-depth trade agreements on value-added trade flows, particularly emphasizing the integration of agri-food GVCs. By employing metrics that gauge the depth of trade deals and investigating the influence of fundamental policy domains (Shepherd and Wilson 2013; Disdier, Fontagné and Cadot 2014; Cadot and Gourdon 2016; Santeramo and Lamonaca 2022*b*; Osnago, Rocha and Ruta 2019; Laget et al. 2020), we quantitatively assess how regional trade agreements affect both upstream and downstream connections within agri-food GVCs. Second, we employ event study methodologies to address endogeneity concerns and evaluate the dynamics of treatment effects (Freyaldenhoven, Hansen and Shapiro 2019*a*). Our findings uncover delayed treatment effects and sustained growth, in contrast to the results of prior studies that suggest gradual implementation effects of trade agreements (Grant and Lambert 2008). The event study analysis also affirms the absence of pre-existing trends, reinforcing the causal interpretation of our research design (Rambachan and Roth 2023; Freyaldenhoven, Hansen and Shapiro 2019*b*; Sun and Abraham 2021; Roth and Sant'Anna 2023). Third, our study speaks to the ongoing debate on the trade policy implications for North-South economic integration within the agri-food sector. Our approach diverges from studies confined to specific regions that rely on GVC participation metrics (Balié et al. 2019*b*; Sanguinet, Alvim and Atienza 2022; Montalbano and Nenci 2022). We use a theory-consistent gravity framework to estimate the deep trade agreement impacts across all transaction directions categorized by income groups. Our results, which unveil the critical role of developed countries in agri-food GVC integration, carry important policy implications for addressing the imbalance of agri-food GVC growth across income groups.

2. Agri-Food Global Value Chain Integration

GVC integration has transformed the nature of global agri-food production and trade. A GVC includes "a series of stages involved in producing a product or service sold to consumers, with each stage adding value, and at least two stages being produced in different countries" (Antràs 2020). This definition implies that agri-food GVCs can encompass all activities from transforming raw materials to final products (Greenville, Kawasaki and Beaujeu 2017). While this broad definition is appealing, Antràs and Chor (2022) argue that it ignores various features that could differentiate agri-food from manufacturing GVCs. First, the structure of agri-food GVCs can be "spider-like" or "snake-like" (Baldwin and Venables 2013). In a spider-like structure, parts are not assembled in a specific order and converge at an assembly plant for export. In contrast, the snake-like structure involves a sequential value-creation process that may involve intermediate products crossing international borders multiple times. Studies examining the agri-food sector found evidence for spider-like and snake-like GVC structures. For example, Daly et al. (2016) suggest that the maize GVC is snake-like. In contrast, de Backer and Miroudot (2013) present evidence that the hazelnut and cocoa spread GVCs have a spider-like structure.

Second, (imperfect) contracts that are difficult to enforce often govern the repeated exchange of intermediates in agri-food GVCs (World Bank 2020). For example, certain GVCs include land use contracts and agreements with commodity cooperatives to supply specified quantities of a commodity, as observed in the cases of biofuel and maize (Daly et al. 2016; Mintz-Habib 2014). Long-term contracts in the agri-food sector are essential as they help improve access to technology and machinery, which can help to increase the quality and yield of local producers, providing higher and more stable prices for farmers (World Bank 2020). Third, agri-food GVCs differ regarding the degree of participation in "backward" and "forward" GVCs. Backward participation is when a country's exports contain value added from previously imported goods. In contrast, forward participation involves a country's exports embodied in the importing country's exports to third countries (Antràs and Chor 2022). According to Greenville, Kawasaki and Beaujeu (2017), most agri-food GVCs are characterized by backward GVC participation.[1]

The introduction of GVCs enhances the conventional interpretation of the factors that influence international trade, which revolves around bilateral flows of goods and services between countries (Antràs 2020). Because GVC activities can encompass production stages spanning two or more countries, assessing their structure with bilateral data on agri-food trade flows proves difficult. The difficulty arises since gross exports need to be decomposed into the value-added incorporated into a good or service at different production stages, which could reside in multiple countries.[2] There are two prominent approaches to measuring the GVC structure (Antràs and Chor 2022). The "macro" approach uses customs data and national input-output tables to determine the amount of intermediate inputs traded between sectors and countries. Related economic theories employing the "macro" approach focus on the structural interpretation of input-output tables. This literature provides a framework for counterfactual trade policy analysis that enhances those ignoring GVC integration.[3]

In contrast to the "macro" approach, the micro GVC literature relies on firm-level data to assess a firm's decision regarding which markets to reach, which countries to source from, or where they will set a "platform" to assemble their products for distant countries (Ekholm, Forslid and Markusen

[1] Although the features above can explain most of the differences between agri-food and manufacturing GVCs, other differences have also been discussed in the literature. First, how value-added is incorporated into production, which could be in the form of raw materials, semi-processed goods, or tasks (Görg and Hanley 2005; Görg, Hanley and Strobl 2008); second, whether the transaction is initiated by the exporter (Melitz 2003), the importer, or both; and third, whether there is a "lead-firm" that controls the GVC (Antràs and De Gortari 2020).

[2] Bilateral export flows include the total value of goods and services exchanged between countries. An alternative approach to measure GVC participation is decomposing final goods production (Johnson 2018). However, given the scope of our paper, we focus on the decomposition of gross agri-food exports.

[3] A prominent example of a GVC theory that relies on macro data is provided in Caliendo and Parro (2015). Other extensions and variations of this theoretical framework are Alexander (2021), Antràs and Chor (2019), Bagwell, Staiger and Yurukoglu (2021), Baqaee and Farhi (2019), Caliendo et al. (2018), Caliendo, Dvorkin and Parro (2019), Caliendo, Parro and Tsyvinski (2022), Caselli et al. (2020), Di Giovanni, Levchenko and Zhang (2014), Levchenko and Zhang (2016), Morrow and Trefler (2017), and Rodríguez-Clare et al. (2020).

2007; Tintelnot 2017). Economic models relying on "micro" GVC measurements are typically concerned with addressing the challenges that firms face when making global production decisions.[4] In contrast to this evolving literature, our analysis relies on the "macro" approach to study GVC integration because it allows us to cover a wide range of countries and a longer time horizon, which is important for estimating the impact of trade deals. While we do not delve into the specifics of the micro approach, we note that its application has pros and cons, as explained by Antràs and Chor (2022). More disaggregated GVC data enables a deeper analysis of the response to policy shocks and trade liberalization, which allows researchers to take firm heterogeneity into account. However, due to the extensive data involved at a higher level of disaggregation, much of the literature relying on the "micro" approach looks at specific GVCs and single countries (Inomata 2017).

Hummels, Rapoport and Yi (1998) and Hummels, Ishii and Yi (2001) introduced the "macro" approach to capture GVC participation by decomposing gross industry exports (GIE). Follow-up work by Koopman, Wang and Wei (2014) and Borin and Mancini (2019) expanded the methodology and used more detailed GVC data. The first step to decompose GIE is to identify the two main components, which are the domestic and foreign contents. While the domestic content refers to the share of domestic inputs used in producing exported goods, the foreign content refers to the share of imported inputs used in gross exports. A common approach to separate the domestic from the foreign contents is to multiply GIE by the Leontief inverse of the matrix of direct input coefficients of domestic products. A challenge of this approach is that the domestic content could be counted twice.[5] Therefore, to obtain the domestic value-added (DVA) free of double counting, the domestic content is multiplied by the value-added shares of all domestic industries. In contrast, the foreign value-added (FVA) calculation uses the share of value added by the sector generated in the foreign country and imported by the domestic country to obtain the domestic country's exports (Casella et al.

[4] Influential "micro" GVC studies include Antras, Fort and Tintelnot (2017), Blaum, Lelarge and Peters (2018), and Blaum, Lelarge and Peters (2019).

[5] Antràs and Chor (2022) present an intuitive explanation of this concept. Consider a scenario where country A produces iron ore domestically and exports it to country B. Then, country B uses the iron ore to manufacture a car chassis, which it exports back to country A. Finally, country A uses the car chassis to produce the car, which it ships to country B. In this example, the iron ore's value-added is double-counted. First, the ore is exported in its original form, and then when it is incorporated into the car.

2019). Backward GVC participation is often used as a synonym for FVA. Similarly, one can calculate "indirect value-added" (DVX), which represents the domestic value-added contained in intermediates exported to a foreign economy that are re-exported to a third economy and incorporated into other products. The DVX computation uses the exports by each domestic sector to foreign countries along with the exports of those foreign countries. DVX is also commonly referred to as forward GVC participation.

Figure 1 shows the evolution of agri-food GVC integration between 1991 and 2020. All measures are normalized based on the initial year (i.e., 1991 = 100). The three panels show GVC integration for the agricultural sector (a), the food sector (b), and all sectors (c).[6] Across the panels, we observe that FVA and DVX experienced more accelerated growth than the GIE index since 2000. This difference is more prominent for the agricultural sector, where FVA and DVX increased eightfold since 1991. The observed pattern contrasts with the narrative for the manufacturing sector. According to Antràs and Chor (2022), GVC integration in this sector began in the late 1980s.[7] The events that stimulated the rise of GVCs include the information and communication technology (ICT) revolution, an accelerated reduction of trade barriers, and socio-political changes that increased the share of the world population participating in the capitalist system (Antràs 2016). Similarly, increased production in developing regions, global income growth, changing prices on international markets, and trade policy shifts likely drove the development of agri-food GVCs (Greenville, Kawasaki and Beaujeu 2017).

Trade policies are critical drivers of agri-food GVC integration (Greenville et al. 2019). Because GVCs entail multiple international border crossings, with goods often re-entering the same country, tariff barriers could have a magnifying effect on GVC flows compared to their impact on conventional trade flows (Balié et al. 2019*a*; Greenville, Kawasaki and Beaujeu 2017). Similarly, non-tariff measures (NTM) and technical barriers to trade (TBT) can have accumulating effects on agri-food GVC integration (Ferrantino 2012; Maskus, Otsuki and Wilson 2005). Empirical studies have found that

[6] A detailed description of the GVC data used to create the figures is provided in the data section.

[7] Hummels, Rapoport and Yi (1998) and Hummels, Ishii and Yi (2001) suggest that the rise of manufacturing GVCs might extend as far back as the early 1970s.

forward GVC participation negatively correlates to the barriers imposed in export markets, while backward GVC participation is affected by the importing country's tariff policy (Kowalski et al. 2015). Reducing trade barriers goes hand in hand with trade integration via DTAs between countries. Kowalski et al. (2015) find that they positively affect backward and forward GVC participation. They also find that foreign direct investment (FDI) openness, logistics performance, intellectual property protection, and the quality of infrastructure and institutions stimulate GVC integration. Balié et al. (2019*a*) use a structural gravity model to study whether and how bilateral import tariffs and shifts in trade regimes associated with DTAs affect agri-food GVC participation in Sub-Saharan Africa. They find that trade policies affect the food sector more than the agricultural sector.[8]

Figure 2 presents the evolution from 1991 to 2020 of the number of trade agreements in place worldwide.[9] The graph is divided into two panels: panel (a) shows the total number of DTAs, and panel (b) categorizes agreements according to the depth index measure proposed by Dür, Baccini and Elsig (2014).[10] Panel (a) shows that the number of trade agreements has rapidly increased since 1991. By 2020, there were approximately 1,000 trade agreements in place. The rise is faster from 1990 onwards, possibly fueled by the start of the WTO's Uruguay Round, which began in 1986. Laget et al. (2020) and Mattoo, Mulabdic and Ruta (2022) examine the impact of trade agreements on GVCs, specifically focusing on deep trade agreements.[11] These authors find that, compared to shallow trade agreements, DTAs create more trade and, specifically, more GVC-related trade among

[8] A related literature studies the impact that GVC participation has on trade integration between countries. Blanchard, Bown and Johnson (2016) argue that GVC linkages can shape incentives for import protection. When the domestic content in foreign final goods is high, a country has less incentive to manipulate its final goods terms of trade, leading to lower import tariffs. Taxing imports depresses the value of foreign goods produced, reducing revenues to domestic input suppliers (Balié et al. 2019*a*). When foreign content in domestic final goods is high, some of the benefits of protection are passed back up the supply chain to foreign suppliers. This effect also discourages import protection and increases the incentive to participate in trade deals.

[9] A detailed description of the DTA data used to create the figures is provided in the data section.

[10] This index spans from 0 to 7 in one-unit intervals counting the number of substantive provisions across tariff reductions, services trade, investments, standards, public procurement, competition, and intellectual property rights provisions.

[11] Using "shallow" PTAs, countries agree to cut their tariffs, and they may also undertake additional obligations in policy areas covered by the WTO (Mattoo, Mulabdic and Ruta 2022; Laget et al. 2020). However, these agreements can extend into new grounds on policy domains outside the scope of the WTO's regulations, such as investment and competition policies, thereby enhancing the agreements' depth (Laget et al. 2020).

participating countries. From panel (b), we can observe that the number of trade agreements has increased across all depth measures. Moreover, the data series reveals that deeper agreements are less common than shallower ones. This pattern suggests considerable differences in the design of trade agreements that could have considerable implications for agri-food GVC integration. Some provisions in DTAs, such as those related to investment and property rights protection, promote GVC integration Kowalski et al. (2015). However, certain provisions, like rules of origin, within deep trade agreements, protect domestically provided inputs but may also create disadvantages for using foreign inputs (Choi 2010; Geraets, Carroll and Willems 2015).

3. Empirical Strategy and Data

3.1 Empirical Strategy

Our empirical strategy relies on the sectoral structural gravity equation, the prevalent framework for empirical studies investigating the impacts of changes in trade costs on international trade (Head and Mayer 2014; Anderson, Larch and Yotov 2020). Its appeal derives from the fact that a large set of trade models can generate isomorphic gravity equations that preserve the gains from trade (Yotov, Piermartini and Larch 2016).[12] The earlier single-sector gravity models, such as those by Anderson and Van Wincoop (2003) and Eaton and Kortum (2002), do not incorporate GVC participation. Although those models can account for relative prices, they do not allow input-output (IO) relationships across sectors and represent intermediate and final goods as separate and unrelated sectors. Therefore, our analysis of GVC flows builds on the recent contribution of Aichele and Heiland (2018), who extend the multi-sector Ricardian model of Caliendo and Parro (2015) to consider value-added trade in the spirit of Koopman, Wang and Wei (2014). More specifically, we rely on the theoretical framework developed by Shepherd (2022) to conceptualize bilateral GVC flows in a multi-country and multi-sector Ricardian model. This model features a standard structural gravity equation nested within a multi-sector general equilibrium model, providing a conceptual

[12] Arkolakis, Costinot and Rodríguez-Clare (2012) provide an overview of the various trade models used to derive the structural gravity equation. Among them, commonly used microeconomic foundations suitable to explain agri-food trade flows are the Armington-CES model (Anderson and Van Wincoop 2003), the Heckscher-Ohlin model (Bergstrand 1989), and the Ricardian model (Eaton and Kortum 2002).

framework to assess the implications of changes in trade costs on GVC flows.[13]

The GVC flow model features representative consumers in each country consuming the final output of each sector under Cobb-Douglas preferences with fixed expenditure shares on the consumption side. The model by Shepherd (2022) expands the single-sector Ricardian model of Eaton and Kortum (2002) to a multi-sector IO framework, where producers of intermediate goods use two input factors. These factors are labor and a composite intermediate good that can be sourced from all sectors. Perfect competition and constant returns to scale characterize the production of goods in this economy. All countries differ in their underlying productivity, which defines the technology parameters of producing intermediate goods. Producers of the composite intermediate goods rely on a constant elasticity of substitution technology, and the composite goods are used as intermediate input and for final consumption. A producer selects the composite good from a set of intermediate varieties sourced from the lowest-cost supplier. By following standard practice and assuming the Fréchet distribution for Ricardian productivity, one can determine the input sourcing of each intermediate producer (Levchenko and Zhang 2014). Producers can sell their goods domestically and in foreign markets. This feature is important because it implies that producers face iceberg trade costs en route. By introducing trade costs that vary by the end use, intermediate foreign sales can face different trade costs than final good sales (Aichele and Heiland 2018).[14] This theoretical framework yields an expression of bilateral trade flows that aligns with the structural gravity framework:

$$\pi_{ij}^{kv} = \frac{\lambda_j^k \left[c_j^k \kappa_{ij}^{kv}\right]^{-\theta^k}}{\sum_{h=1}^{N} \lambda_h^k \left[c_h^k \kappa_{ih}^{kv}\right]^{-\theta^k}} \tag{1}$$

where π_{ij}^{kv} is the export share of country i in country j's imports for sector k and end use v. The terms λ_j^k and θ^k denote parameters of the Fréchet distribution, c_j^k is the cost of an input bundle, and

[13] The general approach falls into the family of "new quantitative trade models," in which a standard structural gravity equation governs international trade flows. Those models also have a full general equilibrium structure with multiple countries, multiple sectors, and IO relationships across sectors (Arkolakis, Costinot and Rodríguez-Clare 2012; Costinot and Rodríguez-Clare 2014; Gaigné and Gouel 2022).

[14] Appendix 1 in Shepherd (2022) provides a detailed derivation of the GVC flow model and the general equilibrium conditions.

κ_{ij}^{kv} stands for the iceberg trade costs. For estimation purposes, a common approach is to express the equation in terms of bilateral trade costs and exporter-sector and importer-sector fixed effects, which are governed by a single trade elasticity that dictates the response to changes in trade costs. A challenge in studying the impact of changes in iceberg trade costs, such as DTA enforcement, is the potential correlation between the trade cost variables of interest and other unobserved trade costs (Hillberry and Zhang 2018). To account for this identification challenge, we add an explicit time subscript t to the GVC flow model, leading to the following empirical specification of the three-way gravity model:

$$X_{ijt}^{kv} = \exp\left(\alpha_{it}^{kv} + \gamma_{jt}^{kv} + \delta_{ij}^{kv} + \tau_{ijt}^{kv}\beta_{\tau}\right)\eta_{ijt}^{kv}, \tag{2}$$

where X_{ijt}^{kv} stands for bilateral GVC flows from country i to country j in sector k for end use v in year t. By capturing the inward and outward trade resistance terms with the high-dimensional fixed effects α_{it}^{kv} and γ_{jt}^{kv}, we can assess the GVC trade implications of trade policy changes directly, without observing production and consumption decisions in the home and foreign markets. Because the trade shock operates through the trade cost parameter τ_{ijt}^{kv}, it is important to account for unobserved factors correlated with DTAs. Therefore, we include dyadic fixed effects δ_{ij}^{kv}, which account for time-invariant trade costs at the sector and end-use levels. This choice implies that we exploit the time variation in the DTA enforcement to address endogeneity concerns. Because iceberg trade costs change by imposing a DTA, affecting the relative prices of traded goods used as intermediate and for final consumption, such trade treaties alter the GVC structure. The empirical framework enables us to study several dimensions of how changes in the formation and depth of trade agreements affect GVC flows across sectors, the end use, countries, and over time.

The dependent variable $\left(X_{ijt}^{kv}\right)$ denotes different measures of GVC flows at the exporter-importer-sector level. Our analysis includes both intra-national and international GVC flows, which is consistent with trade theory and relevant for assessing the response of the trade margins to changes in iceberg trade costs (Yotov 2022). To examine the relationship of primary interest, a linear regression model is unsuitable due to its inability to ensure the positivity of the predicted count outcome (Wooldridge 1999). This is because the discrete nature of the dependent variable makes it difficult to find a transformation with a conditional mean that is linear in parameters. The potential for heteroskedasticity in the error term further exacerbates this econometric challenge, as it could introduce a correlation between the transformed errors and the independent variables, resulting in an inconsistent identification of the treatment effects (Cameron and Trivedi 2013). To account for this issue, we directly model the relationship of interest between the GVC flow measures and the treatment variables in the three-way gravity model by employing a non-linear regression model with an exponential form equation that ensures the positivity of the covariates (Mullahy and Norton 2022).

We follow standard practice in the related trade literature and use the Poisson pseudo-maximum likelihood (PML) estimator to identify the relationship of primary interest in the three-way gravity framework (Gong and Samaniego 1981; Gourieroux, Monfort and Trognon 1984). This estimator is unbiased and consistent in the presence of heteroskedasticity, a characteristic that holds true even when the conditional variance does not exhibit proportionality to the conditional mean (Wooldridge 1999; Cameron and Trivedi 2013). An added merit of the Poisson PML estimator lies in its resilience to changes in the scale of the dependent variable. This feature is vital for consistently treating instances when GVC flows are zero (Silva and Tenreyro 2006). As evidenced in Table A.1, zero observations are abundant at the exporter-importer-industry level. To adequately account for the high-dimensional fixed effects, we implement a modified version of the iteratively re-weighted least-squares algorithm, which is resilient to statistical separation and convergence (Correia, Guimarães and Zylkin 2020). Lastly, we mitigate plausible serial correlation concerns by clustering observations at the exporter-importer-sector level, a strategy aligned with the prevailing approach in the three-way gravity literature (Yotov, Piermartini and Larch 2016; Weidner and Zylkin 2021).

3.2 Data

Our analysis relies on the 2023 Eora global supply chain database (Lenzen et al. 2013). This database is constructed from a multi-region input-output (MRIO) model that provides a time series of sectoral IO tables.[15] Eora covers about 16,000 sectors and 190 countries from 1990 to 2022. The

[15] A detailed discussion of the data sources and procedures to build Eora is provided in Lenzen et al. (2012) and Lenzen et al. (2013).

database has been widely used to study GVC integration (Raimondi et al. 2023; Balié et al. 2019*a*; Montalbano and Nenci 2022), GVC flows (Boffa, Jansen and Solleder 2019; Borin, Mancini and Taglioni 2021; Sanguinet, Alvim and Atienza 2022), disruptions in GVCs (Kejžar, Velić and Damijan 2022; Ayadi et al. 2022), the determinants of GVC participation (Fernandes, Kee and Winkler 2022; Kowalski et al. 2015), and economic upgrading in GVCs (Ndubuisi and Owusu 2021; Lwesya 2022). We use a common industry classification to aggregate the sectors into 26 industries. This aggregation enables us to study a longer horizon and a broader set of countries, which is key to identifying the GVC flow implications of DTAs.[16] The resulting database contains symmetric sector-by-sector IO tables measured in current USD and calculated using basic prices. This measurement choice is important because the GVC flow measures are free on board (FOB), essential when estimating the GVC implications of DTAs in the three-way gravity setting. Although our main analysis focuses on the Eora sectors "agriculture" and "food & beverages," we also compare the estimated treatment effects for all other sectors for robustness.

We rely on three common indicators to analyze the impact of DTAs on agri-food GVC flows, which are foreign value added (FVA), domestic value added (DVA), and indirect value added (DVX). FVA measures the foreign value added in the country's exports, which is also referred to as backward GVC participation, DVA the domestic value added in the country's exports, and DVX the value added by this country in the exports of other countries, which is also referred to as forward GVC participation, respectively. By summing FVA and DVA, we obtain the total value added (TVA) in the country's exports, which indicates the overall relevance of GVCs for an industry. In addition, we use the foreign and domestic indirect value added to define the total indirect value added (TVX). The setting resembles the gold standard of the gravity model since we observe both external and internal GVC flows (Yotov 2022). We also measure gross industry exports (GIE) by summing intermediate and final product export flows. This is done to compare the GVC flow estimates to earlier studies on the impact of DTAs on agri-food exports (Grant and Lambert 2008; Baylis et al. 2022). Table A.1 provides descriptive statistics of those GVC flow measures for the agricultural and

[16] Aggregation bias could make the aggregated Eora database less accurate than the full database, prompting us to conduct the empirical analysis at the sector level instead of aggregating agri-food GVC flows.

food sectors.[17]

We sourced information on trade agreements from the Regional Integration Agreement (RIA) database (Miller and Standaert 2023). The database covers trade agreements and regional organizations involving 235 countries from 1910 to 2021. The database contains information on 898 economic integration agreements, which we classified using a multichotomous index (0-6), where 0 denotes no existing economic integration agreement, and 6 is an economic union. We focus on DTAs that are reciprocal. RIA is the most comprehensive source of DTA data because it combines the main trade policy datasets: The Design of Trade Agreements database (Dür, Baccini and Elsig 2014), the Regional Trade Agreements Database (World Trade Organization 2023), the Global Preferential Trade Agreements Database (World Bank 2023), the Regional Integration Knowledge System (United Nations University 2023), and the Comparative Regional Organizations Project (CROP 2023). Those databases have been widely used to study the reasons why countries engage in economic integration agreements and assess their implications for international trade flows (see, e.g., Baldwin and Jaimovich 2012; Freeman and Pienknagura 2019; Sun and Reed 2010).

One disadvantage of the economic integration measure constructed from the RIA database is that it does not contain information on the policy areas covered by those trade treaties. As noted by Hofmann, Osnago and Ruta (2019) and Kim and Steinbach (2023), the number of provisions in DTAs has grown considerably. To account for the heterogeneous response of GVC flows to the design of DTAs, we rely on the Design of Trade Agreements dataset (Dür, Baccini and Elsig 2014). The dataset measures the horizontal depth (or breadth) of preferential trade agreements by mapping 312 provisions contained in more than 710 trade treaties enforced between 1948 and 2022. The dataset has been widely used to study the drivers of trade treaty formation (Baccini, Dür and Elsig 2015; Su 2021), their design (Baccini and Dür 2015; Dür et al. 2023), and trade flow implications (Freeman and Pienknagura 2019; Kox and Rojas-Romagosa 2020). We use two measures of DTA depth, one that accounts for the number of provisions contained in each trade treaty and another one that focuses on the core policy areas. We also study the trade effects of specific GVC provisions

[17] We compare Eora with alternative data sources in Figure A.1. The GIE data from Eora align closely with UN Comtrade (2023) and the International Trade and Production Database for Estimation by Borchert et al. (2021).

in DTAs. In particular, we focus on provisions related to GVC cooperation, foreign investment, intellectual property rights, and the harmonization of product standards and regulations. Table A.3 provides definitions for the essential policy areas and Table A.2 shows the descriptive statistics for those trade policy measures.

4. Results

4.1 Baseline Results

Table 1 presents the baseline estimates for the impact of trade agreements on agri-food GVC flows. We compare the agricultural and food sectors with all sectors. In addition, we analyze the effects on both global forward (TVX) and backward linkages (TVA) in GVC flows and contrast them with the impact on gross exports (GIE). The first three columns display estimates without intra-national GVC flows, whereas the subsequent columns depict results with intra-national and international GVC flows consistent with the three-way gravity model. Our preferred model includes intra-national flows to align with the structural gravity theory and obtain theory-consistent estimates of the GVC flow effects of DTAs (Dai, Yotov and Zylkin 2014). Threfore, the following discussion of the baseline results centers around the preferred model in the last three columns.[18]

The baseline estimates indicate that trade agreements enhance value-added trade associated with backward and forward linkages in the agricultural sector. As shown in panel (a), the impact of trade agreements on agricultural TVA and TVX is 16.6 percent and 17.1 percent, respectively.[19] This impact is smaller than the 23.4 percent increase found for agricultural GIE flows. One potential explanation is the double-counting nature of gross export statistics, which counts the value multiple times through the value-added process when crossing borders (Johnson and Noguera 2012; Koopman, Wang and Wei 2014). Similarly, we find positive effects of trade agreements for food GVC flows. In panel (b), we find a 16.2 percent increase in TVA flows, a 21.9 percent increase in TVX flows, and a 9.5 percent increase in GIE flows. These results imply that trade agreements have accelerated the

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[18] The results in the first three columns reveal that the "naive" gravity model underestimates the impact of trade agreements on GVC flows (Head and Mayer 2014).

[19] The estimates in the semi-elasticity form can be transformed into the elasticity form using the formula $(\exp(\beta_\tau) - 1) * 100$.

shift of the domestic value-added process abroad for the food sector, which offsets the potential double-counting effects (Roth et al. 2008).[20] In addition, the ratio of final demand to intermediate usage in the food sector is significantly higher than for the agricultural sector, which reduces the likelihood of double counting traded values (Antràs and Staiger 2012; Wang et al. 2017). We assess the impact of trade agreements on GVC flows for all sectors in panel (c). The estimates indicate a 12.4 percent increase in TVA flows, a 13.3 percent increase in TVX flows, and a 17.1 percent increase in GIE flows. Those findings suggest that trade agreements play a more prominent role in GVC development in the agri-food sector than in other sectors of the economy.

4.2 Treatment Dynamics

Understanding the dynamics of GVC flow adjustments to trade policy changes is vital (Anderson and Yotov 2023; Egger, Larch and Yotov 2022). Such dynamics can arise if the response of the outcome to the treatment varies in the short- and long-run. In addition, ignoring treatment dynamics could raise concerns about treatment anticipation and a delayed response to trade policy changes. Related to these concerns, the GVC flow response to trade policy liberalization could be non-linear and involve non-monotonic adjustments over time. Therefore, it is vital to understand how this adjustment process shapes agri-food GVC integration. A causal interpretation of the estimated treatment effects is justified when the exposure to the trade policy shift is exogenous to previous GVC participation (Roth 2022). Although we cannot directly test the validity of this assumption, the outcome trends in the pre-treatment period can be informative in this regard (Rambachan and Roth 2023). Suppose the observed outcomes of treated country pairs have similar trends in the pre-treatment period to those of untreated country pairs. In that case, we can accept that the parallel trends assumption holds and that enforcing a DTA is exogenous to the GVC flow outcomes (Freyaldenhoven, Hansen and Shapiro 2019*b*; Sun and Abraham 2021; Roth and Sant'Anna 2023).

To implement the pre-event test and explore treatment dynamics in the post-treatment period, we rely on an event study design that uses an interaction of the treatment measure with event time

[20] We consider the domestic contribution to the value-addition process by including intra-national GVC flows in the analysis. The estimated outcomes consider the transition of domestic to foreign value-added and the shift of domestic consumption patterns for domestic and foreign goods.

indicators defined relative to the year of the trade policy change:

$$X_{ijt}^{kv} = \exp\left(\alpha_{it}^{kv} + \gamma_{jt}^{kv} + \delta_{ij}^{kv} + \sum_{r\neq 0} \mathbb{1}\left\{\tau_{ijt}^{kv} = r\right\}\beta_{\tau}^{r}\right)\eta_{ijt}^{kv}\,, \tag{3}$$

where the general notation is the same as in Equation 1. The dynamic treatment model includes six lags and twelve leads relative to the event of interest, which enables us to capture pre-trends and assess post-event treatment dynamics (Freyaldenhoven, Hansen and Shapiro 2019*b*).[21] We define the time relative to treatment as $\tau_{ijt}^{kv} = t - G_\tau + 1$, where we run the summation over all possible realizations of τ_{ijt}^{kv} except for zero[22]. The central identifying assumption is that the treatment timing is independent of the error term conditional on the high-dimensional fixed effects that control for the inward and outward trade resistance terms and unobserved trade costs. The term $\sum_{r\neq 0} \mathbb{1}\left\{\tau_{ijt}^{kv} = r\right\}\beta_{\tau}^{r}$ measures the treatment dynamics of enforcing a DTA for the corresponding GVC outcome. The specification allows the magnitude of the treatment response to vary before implementing trade deals and uncovers how GVC flows evolve in the post-treatment period.

We present the event study estimates for the treatment response of the agri-food GVC outcomes to implementing trade agreements in Figure 3. Each subfigure plots the dynamic treatment parameters, 95 percent confidence intervals, and uniform sup-t bands for the event-time of the outcome (Freyaldenhoven et al. 2021; Montiel Olea and Plagborg-Møller 2019).[23] We overlay estimates from the static model represented by the dashed red line. Each subfigure reports the corresponding p-value of Wald tests for pre-event trends and anticipatory behavior in the figure note. We find no evidence of significant short-run pre-trends for the four agri-food GVC flow measures. Since the pre-trend tests are statistically insignificant and the short-run treatment pathways in the

[21] We follow standard practice in the event study literature and bin the endpoints of the event study window. The binned endpoints allow us to check for long-term pre-trends and leveling-off treatment effects.

[22] G_τ indicates the earliest period at which a country-pair entered into a reciprocal trade agreement. Because we are interested in the long-run response of GVC flows to the trade policy change, we use a non-symmetric event window of six lags and twelve leads around G_τ (Freyaldenhoven et al. 2021).

[23] Although various simultaneous confidence bands are available, little statistical theory exists to select among them. We follow Montiel Olea and Plagborg-Møller (2019) and use Bayesian sup-t bands with exact finite-sample simultaneous credibility.

pre-treatment period are flat, the pre-trend test validates the research design. Because the treatment effect could be dynamic at the endpoints of the event window, we also conduct Wald tests for the null hypothesis that the treatment dynamics level off. The Wald tests provide some statistical support for elevated long-run treatment effects for all GVC outcomes. The treatment dynamics reveal intriguing patterns regarding the GVC flow response to implementing trade agreements. First, we find evidence that the response to a trade deal is delayed, with the GVC effect being indifferent from zero up to four years after the trade deal enforcement. Afterward, the treatment effect averages 13.1 percent for agricultural TVA, 15.3 percent for food TVA, 13.3 percent for agricultural TVX, and 19.2 percent for food TVX.[24] This finding implies that the long-run benefits of implementing DTAs outweigh those in the short-run considerably.

One needs to be cautious when interpreting the estimated trade effects as causal due to the potential for pre-trends before the trade policy shift (Freyaldenhoven, Hansen and Shapiro 2019*b*). To account for this identification challenge, we apply the procedure by Dobkin et al. (2018), which estimates Equation (3) under the alternative assumption that the short-run linear pre-trends of the treated units would have continued along their pre-event paths. The results of this analysis are presented in Appendix Figures A.2 and A.3. The dotted red lines in Appendix Figure A.2 overlay the estimated linear trends on top of the baseline event study estimates. The linearity assumption is reasonable for the four agri-food GVC outcomes, as the estimated trend growth falls within the 95% confidence intervals of the non-parametric event study estimates throughout the pre-treatment periods. However, all trend coefficients are not statistically significant, leading us to reject the hypothesis that pre-trends drive the response of agri-food GVC flows to enforcing a regional trade agreement. Subtracting the pre-trends from the estimated post-event treatment estimates results in average post-event GVC flow treatment effects that are smaller for agricultural and food TVA but of similar magnitude than the baseline estimates for agricultural and food TVX. Since we cannot completely rule out that pre-trends drive some of the estimated post-event growth in GVC flows, the actual treatment effects likely lie between the main results and the pre-trend robust estimates.

[24] We transformed the parameter estimates to trade effects using the formula $\big(\exp(\bar{\beta}^r_\tau) - 1\big) * 100$ for the respective treatment period.

4.3 Treatment Heterogeneity

Trade Agreement Depth — To evaluate the impact of deep trade agreements on agri-food GVC flows, we rely on interaction terms between the DTA indicator and the DTA depth measures. This approach allows us to assess how trade agreements with varying levels of integration exert distinct impacts on agri-food GVCs. Given the importance of economic integration for the GVC structure, trade deals with greater depth can contribute more to value-added trade in the agri-food sector via exporting or investment in longer supply chains (Boffa, Jansen and Solleder 2019; Laget et al. 2020; Osnago, Rocha and Ruta 2019). We use two distinct depth measures introduced by Dür, Baccini and Elsig (2014). One employs an ordinal variable that indicates how each agreement addresses essential policy areas. We categorize all trade agreements into six groups based on the extent of coverage, ranging from zero to five for the essential policy areas.[25] The other one takes the form of a traditional index-type continuous variable, "depth index," ranging from 0 to 100, derived from 49 key trade openness provisions.[26]

The estimates in Table 2 reveal that the agreement depth is a crucial driver of agri-food GVC integration. Column (1) shows that the positive effects of trade agreements for the agricultural sector become more prominent when they include additional policy areas. Compared to trade deals with three or fewer essential policy areas, which increase agricultural TVA by 8.1 percent to 14.1 percent, DTAs covering four or more policy areas lead to 17.9 percent to 31.3 percent higher agricultural TVA flows. Employing the alternative depth index in column (2), we find evidence of a positive DTA depth effect alongside the baseline DTA effect of 15.5 percent. However, this depth estimate is not statistically significant at the conventional level for agricultural TVA. The role of DTA depth is more substantial for agricultural forward linkages. The impact of DTAs covering three or fewer policy areas is statistically insignificant, whereas agreements with four or more policy areas increase agricultural TVX flows by 21.0 percent to 27.6 percent. Similarly, TVX flows increase by

[25] The seven policy areas are full trade agreements, standard harmonization, investments, services, procurement, competition, and intellectual property rights.

[26] The index utilizes the Rasch model, which assumes that items are interconnected by a single underlying dimension, prompting the inclusion of theoretically relevant variables (total of 49) linked to DTA depth. Dür, Baccini and Elsig (2014) provide a detailed discussion of those DTA depth measures.

0.2 percent for a 1-unit increase in the depth index, while DTAs with zero depth have a negligible impact on agricultural TVX flows. Columns (3) and (4) show patterns similar to those in the agricultural sector for the food sector, pointing toward the broad relevance of trade agreement depth for backward and forward GVC integration. One difference to the agricultural sector is that DTAs with zero essential policies hurt food TVX flows, underscoring the importance of the agreement content. Interestingly, the level of trade integration holds greater relevance for forward linkages than backward linkages in agri-food GVC integration.

Essential Policy Areas — While the DTA depth estimates highlight the importance of deeper trade deals for promoting agri-food GVC integration, the additive nature of the depth measures makes it difficult to assess the relative importance of different trade policy areas. Consequently, increasing the number of policy areas or the index score does not automatically translate into a one-to-one increase in agri-food GVC integration. To account for this interpretation challenge, we extend the analysis to four distinct policy areas within DTAs relevant to promoting agri-food GVC flows and assess their impact on GVC integration. We accomplish this task by drawing upon insights from the previous literature, which highlights the relevance of DTA provisions on standard harmonization, foreign investment, and intellectual property rights (IPRS) to facilitate GVC integration (see, e.g., Shepherd and Wilson 2013; Disdier, Fontagné and Cadot 2014; Cadot and Gourdon 2016; Santeramo and Lamonaca 2022*b*; Osnago, Rocha and Ruta 2019; Laget et al. 2020). We adjust Equation 2 with an interaction term for these essential policy areas.[27]

Table 3 shows that the four GVC policy areas explain most of the average DTA impact on agri-food GVC flows. We find that the harmonization of standards & regulations and foreign investment policies enhance agri-food GVC flows. The former increases TVA by 6.5 percent and TVX by 19.5 percent for the agricultural sector and raises TVA by 11.5 percent and TVX by 24.5 percent for the food sector. Most deep trade agreements incorporate regulatory cooperation, which aims to

[27] Dür, Baccini and Elsig (2014) provide indicator variables to determine whether the agreements incorporate essential provisions within these three policy domains. For instance, standard harmonization encompasses SPS and TBT provisions, foreign investment includes policies from bilateral investment treaties, and intellectual property rights involve the scope and specific provisions for protecting intellectual properties. The GVC index comprises four main provisions that indicate the exclusive statement of general scope and specific aims towards GVC. We construct an indicator variable if any of these provisions exist for the agreement.

harmonize standards and mitigate regulatory disparities among signatories to stimulate agri-food market integration, which can contribute to GVC development (Vollrath, Gehlhar and Hallahan 2009; Disdier, Fontagné and Mimouni 2008; Santeramo and Lamonaca 2022*b*). The latter enhances TVA by 12.4 percent and TVX by 9.0 percent for the agricultural sector and promotes TVA by 12.3 percent and TVX by 12.6 percent for the food sector. These results align with the previous literature, showing that investment openness attracts foreign investors more inclined to outsourcing, consequently boosting agri-food TVA and TVX flows (Bahar et al. 2019). In contrast, including IPRS in trade agreements reduces agricultural GVC flows and has no statistically significant impact on the food sector. This pattern is consistent with previous empirical trade studies that find a negative relationship between the protection of geographical indications and agri-food trade, consequently impacting GVC flows (Campi and nas 2016; Campi and Dueñas 2019). Lastly, including GVC-specific policy areas in trade deals does not promote agri-food GVC flows. We find that GVC provisions lead to a decrease in TVA flows. An explanation could be related to the rules of origin associated with GVC-related policies. These provisions often confer advantages and protection for domestically sourced inputs, while this mechanism disadvantages products using foreign inputs due to the rules of origin (Choi 2010; Geraets, Carroll and Willems 2015).

Income Classification — The previous literature emphasizes the heterogeneous impact of DTAs across economic development stages. These studies focus on the North-South discourse, highlighting tensions between trade liberalization and GVC barriers, mainly focusing on the unequal distribution of benefits among countries in different stages of economic development (Cadot and Gourdon 2016; Disdier, Fontagné and Cadot 2014; Mujahid and Kalkuhl 2016). Although these studies provide empirical evidence within the trade context, few have extended the discourse to agri-food GVC integration (Lee 2019; Sanguinet, Alvim and Atienza 2022). To study how trade treaty effects differ among income groups, we classify countries into high-income (North) and low-income (South) groups.[28] Table 4 shows that DTAs benefit agri-food GVC integration with high countries more. As a result of enforcing a DTA, North-to-North agri-food GVC flows grow by 18.2 percent to 22.4

[28] We rely on the World Bank's country classifications by income level, categorizing countries into four groups: High, Upper Middle, Lower Middle, and Low income (World Bank 2022). We then designated upper-middle and high-income countries as North and lower-middle and low-income countries as South.

percent, and South-to-North GVC flows increase by 11.2 percent to 32.6 percent. For North-to-South GVC flows, we find limited evidence for positive treatment effects, with only the estimate for food TVX flows being statistically significant and increasing GVC flows by 13.5 percent. In contrast, we find evidence for a negative impact of DTAs on South-to-South agri-food GVC flows. These findings underscore the uneven GVC integration benefits under the current trade regime. Interestingly, the agri-food GVC integration benefits are more prominent than those observed for agri-food GIE flows (e.g., Disdier, Fontagné and Cadot 2014; Cadot and Gourdon 2016; Mujahid and Kalkuhl 2016). These findings imply that GVC integration through DTAs benefits high-income countries more than those in the developing world.

5. Conclusion

This paper assesses the effects of deep trade agreements on agri-food GVC integration. By utilizing comprehensive GVC data and a theory-consistent gravity framework, our analysis reveals the impacts of deep trade integration on both forward and backward linkages in agri-food GVCs. The utilized dataset encompasses sectoral GVC flows for a broad range of countries from 1991 to 2020. We incorporate intra-national and international GVC flows and evaluate the influence of trade agreements and their depth on agri-food GVC integration (Koopman, Wang and Wei 2014). Through event studies and heterogeneity analysis, the study systematically assesses the short- and long-term implications of deep trade agreements, addressing potential concerns related to treatment anticipation. The main findings demonstrated that trade integration policies yield positive outcomes for agri-food GVC integration. Notably, countries engaged in deep economic integration agreements exhibited significantly higher levels of backward and forward agricultural GVC flows than those without such agreements (Disdier, Fontagné and Cadot 2014). Moreover, the impact of trade agreements on GVC flows proves more substantial than on gross exports in the food industry, which can attributed to the offshoring of domestic value-added processes (Roth et al. 2008). The event study analysis also reveals a time-delayed GVC response to deep trade agreements (Freyaldenhoven, Hansen and Shapiro 2019*b*).

Further heterogeneity analysis highlighted differences in treatment effects based on the trade agreement depth and income levels of agri-food GVC participants. Deeper agreements facilitate enhanced GVC flows, particularly forward linkages, with specific provisions such as standard harmonization and investment policies playing a pivotal role (Vollrath, Gehlhar and Hallahan 2009; Disdier, Fontagné and Mimouni 2008; Bahar et al. 2019; Santeramo and Lamonaca 2022*a*). However, provisions related to intellectual property rights and specific GVC-related policies exhibited counterproductive effects on agri-food GVC integration (Campi and nas 2016; Campi and Dueñas 2019). Notably, the study uncovered differing impacts of deep trade agreements on agri-food GVCs across income groups, with developed countries benefiting from increased value-added flows. In contrast, developing nations experienced reduced GVC flows among each other due to such agreements (Disdier, Fontagné and Cadot 2014; Cadot and Gourdon 2016; Mujahid and Kalkuhl 2016). This study contributes significantly to the evolving literature by investigating the influence of deep trade agreements on agri-food GVC integration. Departing from earlier studies focused on agri-food trade flows, this research emphasizes value-added trade flows, offering insights into the distinct effects of trade agreements on backward and forward linkages for agri-food GVCs (Grant and Lambert 2008; Sun and Reed 2010; Scoppola, Raimondi and Olper 2018). Using event studies mitigates endogeneity concerns and provides a nuanced understanding of treatment dynamics. Additionally, the analysis sheds light on North-South economic integration within the agri-food sector, uncovering the role of developed countries in driving agri-food GVC integration and underscoring policy implications for balanced GVC growth across income groups (Balié et al. 2019*b*; Sanguinet, Alvim and Atienza 2022).

The research outcomes carry crucial policy implications for advancing agri-food GVC integration in a balanced and inclusive manner. The demonstrated benefits of trade integration policies underline the significance of pursuing deep trade agreements, particularly those that prioritize standard harmonization and investment provisions, to bolster both forward and backward agri-food GVC linkages. However, careful attention is warranted toward intellectual property rights and GVC-related regulations, which could impede value-added trade flows. Given the divergent impacts on agri-food GVCs across income levels, policymakers are encouraged to tailor trade policies to the needs of different interest groups. This shift involves designing targeted strategies that cater to the distinct needs of developed and developing economies, thus fostering equitable growth of agri-food GVCs and minimizing potential disparities.

Although this study contributes valuable insights for policymakers and researchers alike, several limitations warrant consideration and suggest avenues for future research. First, the analysis primarily relies on aggregated sector-level data, potentially overlooking finer variations within subsectors. Future research could explore more granular data to capture heterogeneity across product categories. Second, the study assumes that trade agreements are exogenously determined, potentially overlooking endogeneity concerns. While the event studies provide limited evidence for such concerns in the pre-event period, there could be compounding trade policy effects in the long run (Lim 2021; Raimondi et al. 2023). Therefore, the likely GVC flow effects of deep trade agreements lie between those adjusting for linear pre-trends and our main results. Third, the empirical analysis focuses on the direct impact of deep trade agreements, neglecting potential spillover effects on non-participant countries (He 2022). Incorporating a broader perspective to capture indirect implications on global agri-food GVCs could offer a more comprehensive understanding (Lim and Kim 2022; Montalbano and Nenci 2022). Lastly, this study does not delve into the role of technological advancements and digitalization, which are increasingly shaping GVC dynamics (Görg, Hanley and Strobl 2008; Madsen 2007; Antràs and Chor 2019). Future research could explore how these factors interact with deep trade agreements to promote further agri-food GVC integration, thus providing a more contemporary and nuanced perspective.

References

Aichele, Rahel, and Inga Heiland. 2018. "Where is the value added? Trade liberalization and production networks." *Journal of International Economics*, 115: 130–144.

Alexander, Patrick. 2021. "Vertical specialisation and gains from trade." *World Economy*, 44(4): 1110–1140.

Alfaro, Laura, Davin Chor, Pol Antras, and Paola Conconi. 2019. "Internalizing global value chains: A firm-level analysis." *Journal of Political Economy*, 127(2): 508–559.

Anderson, James E, and Eric Van Wincoop. 2003. "Gravity With Gravitas: A Solution to the Border Puzzle." *American Economic Review*, 93(1): 170–192.

Anderson, James E, and Yoto V Yotov. 2023. "Estimating gravity from the short to the long run: A simple solution to the 'International Elasticity Puzzle'." *NBER Working Paper*, 30809.

Anderson, James E, Mario Larch, and Yoto V Yotov. 2020. "Transitional Growth and Trade with Frictions: A Structural Estimation Framework." *The Economic Journal*, 130(630): 1583–1607.

Antràs, Pol. 2016. *Global Production: Firms, Contracts, and Trade Structure.* Princeton University Press.

Antràs, Pol. 2020. "Conceptual Aspects of Global Value Chains." *World Bank Economic Review*, 34(3): 551–574.

Antràs, Pol, and Davin Chor. 2019. "On the measurement of upstreamness and downstreamness in global value chains." In *World Trade Evolution: Growth, Productivity and Employment.* Vol. 5, Chapter 5, 126–194. Routledge.

Antràs, Pol, and Davin Chor. 2022. "Global value chains." In *Handbook of International Economics.* Chapter 5. Elsevier.

Antràs, Pol, Davin Chor, Thibault Fally, and Russell Hillberry. 2012. "Measuring the upstreamness of production and trade flows." *American Economic Review*, 102(3): 412–416.

Antras, Pol, Teresa C Fort, and Felix Tintelnot. 2017. "The margins of global sourcing: Theory and evidence from US firms." *American Economic Review*, 107(9): 2514–2564.

Antràs, Pol, and Alonso De Gortari. 2020. "On the geography of global value chains." *Econometrica*, 88(4): 1553–1598.

Antràs, Pol, and Davin Chor. 2013. "Organizing the global value chain." *Econometrica*, 81(6): 2127–2204.

Antràs, Pol, and Robert W. Staiger. 2012. "Offshoring and the role of trade agreements." *American Economic Review*, 102(7): 3140–3183.

Arkolakis, Costas, Arnaud Costinot, and Andrés Rodríguez-Clare. 2012. "New trade models, same old gains?" *American Economic Review*, 102(1): 94–130.

Ayadi, Rym, Giorgia Giovannetti, Enrico Marvasi, Giulio Vannelli, and Chahir Zaki. 2022. "Demand and supply exposure through global value chains: Euro-Mediterranean countries during COVID." *World Economy*, 45(3): 637–656.

Baccini, Leonardo, and Andreas Dür. 2015. "Investment discrimination and the proliferation of preferential trade agreements." *Journal of Conflict Resolution*, 59(4): 617–644.

Baccini, Leonardo, Andreas Dür, and Manfred Elsig. 2015. "The politics of trade agreement design: Revisiting the depth–flexibility nexus." *International Studies Quarterly*, 59(4): 765–775.

Bagwell, Kyle, Robert W. Staiger, and Ali Yurukoglu. 2021. "Quantitative analysis of multiparty tariff negotiations." *Econometrica*, 89(4): 1595–1631.

Bahar, Dany, Samuel Rosenow, Ernesto Stein, and Rodrigo Wagner. 2019. "Export take-offs and acceleration: Unpacking cross-sector linkages in the evolution of comparative advantage." *World Development*, 117: 48–60.

Baldwin, Richard, and Anthony J. Venables. 2013. "Spiders and snakes: Offshoring and agglomeration in the global economy." *Journal of International Economics*, 90(2): 245–254.

Baldwin, Richard, and Dany Jaimovich. 2012. "Are free trade agreements contagious?" *Journal of International Economics*, 88(1): 1–16.

Balié, Jean, Davide Del Prete, Emiliano Magrini, Pierluigi Montalbano, and Silvia Nenci. 2019*a*. "Does trade policy impact food and agriculture global value chain participation of Sub-Saharan African countries?" *American Journal of Agricultural Economics*, 101(3): 773–789.

Balié, Jean, Davide Del Prete, Emiliano Magrini, Pierluigi Montalbano, and Silvia Nenci. 2019*b*. "Does trade policy impact food and agriculture global value chain participation of Sub-Saharan African countries?" *American Journal of Agricultural Economics*, 101(3): 773–789.

Baqaee, David, and Emmanuel Farhi. 2019. "Networks, barriers, and trade." National Bureau of Economic Research.

Baylis, Kathy, Lia Nogueira, Linlin Fan, and Kathryn Pace. 2022. "Something fishy in seafood trade? The relation between tariff and non-tariff barriers." *American Journal of Agricultural Economics*, 104(5): 1656–1678.

Bellemare, Marc F. 2012. "As you sow, so shall you reap: The welfare impacts of contract farming." *World Development*, 40(7): 1418–1434.

Bergstrand, Jeffrey H. 1989. "The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade." *The Review of Economics and Statistics*, 143–153.

Blanchard, Emily J., Chad P. Bown, and Robert Christopher Johnson. 2016. "Global supply chains and trade policy." *World Bank Policy Research Working Paper*, 7536.

Blaum, Joaquin, Claire Lelarge, and Michael Peters. 2018. "The gains from input trade with heterogeneous importers." *American Economic Journal: Macroeconomics*, 10(4): 77–127.

Blaum, Joaquin, Claire Lelarge, and Michael Peters. 2019. "Firm size, quality bias and import demand." *Journal of International Economics*, 120: 59–83.

Boffa, Mauro, Marion Jansen, and Olga Solleder. 2019. "Do we need deeper trade agreements for GVCs or just a BIT?" *World Economy*, 42(6): 1713–1739.

Borchert, Ingo, Mario Larch, Serge Shikher, and Yoto V Yotov. 2021. "The international trade and production database for estimation (ITPD-E)." *International Economics*, 166: 140–166.

Borin, Alessandro, and Michele Mancini. 2019. "Measuring what matters in global value chains and value-added trade." *World Bank Policy Research Working Paper*, 8804.

Borin, Alessandro, Michele Mancini, and Daria Taglioni. 2021. "Measuring exposure to risk in global value chains." *World Bank Policy Research Working Paper*, 9785.

Bown, Chad P., and Meredith A. Crowley. 2016. "The empirical landscape of trade policy." *Handbook of Commercial Policy*, 1: 3–108.

Cadot, Olivier, and Julien Gourdon. 2016. "Non-tariff measures, preferential trade agreements, and prices: New evidence." *Review of World Economics*, 152: 227–249.

Caliendo, Lorenzo, and Fernando Parro. 2015. "Estimates of the trade and welfare effects of NAFTA." *The Review of Economic Studies*, 82(1): 1–44.

Caliendo, Lorenzo, Fernando Parro, and Aleh Tsyvinski. 2022. "Distortions and the structure of the world economy." *American Economic Journal: Macroeconomics*, 14(4): 274–308.

Caliendo, Lorenzo, Fernando Parro, Esteban Rossi-Hansberg, and Pierre-Daniel Sarte. 2018. "The impact of regional and sectoral productivity changes on the US economy." *The Review of Economic Studies*, 85(4): 2042–2096.

Caliendo, Lorenzo, Maximiliano Dvorkin, and Fernando Parro. 2019. "Trade and labor market dynamics: General equilibrium analysis of the China trade shock." *Econometrica*, 87(3): 741–835.

Cameron, Colin, and Pravin Trivedi. 2013. *Regression Analysis of Count Data.* Cambridge: Cambridge University Press.

Campi, Mercedes, and Marco Due nas. 2016. "Intellectual property rights and international trade of agricultural products." *World Development*, 80: 1–18.

Campi, Mercedes, and Marco Dueñas. 2019. "Intellectual property rights, trade agreements, and international trade." *Research Policy*, 48(3): 531–545.

Casella, Bruno, Richard Bolwijn, Daniel Moran, and Keiichiro Kanemoto. 2019. "Improving the analysis of global value chains: the UNCTAD-Eora Database." *Transnational Corporations*, 26(3): 115–142.

Caselli, Francesco, Miklos Koren, Milan Lisicky, and Silvana Tenreyro. 2020. "Diversification through trade." *Quarterly Journal of Economics*, 135(1): 449–502.

Cattaneo, Olivier, G. Gereffi, S. Miroudot, and Daria Taglioni. 2021. "Joining, Upgrading and being competitive in global value chains: A strategic framework." *World Bank Policy Research Working Paper*, 6406.

Choi, Won-Mog. 2010. "Defragmenting fragmented rules of origin of RTAs: A building block to global free trade." *Journal of International Economic Law*, 13(1): 111–138.

Correia, Sergio, Paulo Guimarães, and Tom Zylkin. 2020. "Fast Poisson estimation with high-dimensional fixed effects." *The Stata Journal*, 20(1): 95–115.

Costinot, Arnaud, and Andrés Rodríguez-Clare. 2014. "Trade theory with numbers: Quantifying the consequences of globalization." In *Handbook of International Economics*. Vol. 4, 197–261. Elsevier.

Costinot, Arnaud, Jonathan Vogel, and Su Wang. 2013. "An elementary theory of global supply chains." *Review of Economic Studies*, 80(1): 109–144.

CROP. 2023. "Comparative Regional Organizations Project." https://comparativeregionalorganizations.org.

Dai, Mian, Yoto V Yotov, and Thomas Zylkin. 2014. "On the trade-diversion effects of free trade agreements." *Economics Letters*, 122(2): 321–325.

Daly, Jack, Danny Hamrick, Gary Gereffi, and Andrew Guinn. 2016. "Maize value chains in East Africa." *Center on Globalization, Governance & Competitiveness, Duke University*, 1–49.

de Backer, Koen, and Sébastien Miroudot. 2013. "Mapping global calue chains." *OECD Trade Policy Papers*, 159.

Di Giovanni, Julian, Andrei A Levchenko, and Jing Zhang. 2014. "The global welfare impact of China: Trade integration and technological change." *American Economic Journal: Macroeconomics*, 6(3): 153–183.

Disdier, Anne-Célia, Lionel Fontagné, and Mondher Mimouni. 2008. "The impact of regulations on agricultural trade: Evidence from the SPS and TBT agreements." *American Journal of Agricultural Economics*, 90(2): 336–350.

Disdier, Anne-Célia, Lionel Fontagné, and Olivier Cadot. 2014. "North-South standards harmonization and international trade." *World Bank Economic Review*, 29(2): 327–352.

Dobkin, Carlos, Amy Finkelstein, Raymond Kluender, and Matthew J Notowidigdo. 2018. "The economic consequences of hospital admissions." *American Economic Review*, 108(2): 308–352.

Dür, Andreas, Leonardo Baccini, and Manfred Elsig. 2014. "The design of international trade agreements: Introducing a new dataset." *The Review of International Organizations*, 9(3): 353–375.

Dür, Andreas, Robert A Huber, Gemma Mateo, and Gabriele Spilker. 2023. "Interest group preferences towards trade agreements: Institutional design matters." *Interest Groups & Advocacy*, 12(1): 48–72.

Duvaleix, Sabine, Charlotte Emlinger, Carl Gaigné, and Karine Latouche. 2021. "Geographical indications and trade: Firm-level evidence from the French cheese industry." *Food Policy*, 102: 102118.

Eaton, Jonathan, and Samuel Kortum. 2002. "Technology, geography, and trade." *Econometrica*, 70(5): 1741–1779.

Egger, Peter H, Mario Larch, and Yoto V Yotov. 2022. "Gravity estimations with interval data: Revisiting the impact of free trade agreements." *Economica*, 89(353): 44–61.

Ekholm, Karolina, Rikard Forslid, and James R. Markusen. 2007. "Export-platform foreign direct investment." *Journal of the European Economic Association*, 5(4): 776–795.

Fernandes, Ana Margarida, Hiau Looi Kee, and Deborah Winkler. 2022. "Determinants of global value chain participation: Cross-country evidence." *World Bank Economic Review*, 36(2): 329–360.

Ferrantino, Michael J. 2012. "Using supply chain analysis to examine the costs of non-tariff measures (NTMs) and the benefits of trade facilitation." *World Trade Organization Working Paper*, ERSD 2012–02.

Freeman, Rebecca, and Samuel Pienknagura. 2019. "Are all trade agreements equal? The role of distance in shaping the effect of economic integration agreements on trade flows." *Review of World Economics*, 155(2): 257–285.

Freyaldenhoven, Simon, Christian Hansen, and Jesse M. Shapiro. 2019*a*. "Pre-event Trends in the Panel Event-study Design." *American Economic Review*, 109(9): 3307–38.

Freyaldenhoven, Simon, Christian Hansen, and Jesse M Shapiro. 2019*b*. "Pre-event trends in the panel event-study design." *American Economic Review*, 109(9): 3307–3338.

Freyaldenhoven, Simon, Christian Hansen, Jorge Pérez Pérez, and Jesse M Shapiro. 2021. "Visualization, identification, and estimation in the linear panel event-study design." *NBER Working Paper*, 29170.

Gaigné, Carl, and Christophe Gouel. 2022. "Trade in agricultural and food products." , ed. Christopher B. Barrett and David R. Just Vol. 6, Chapter 88, 4845–4931. Elsevier.

Geraets, Dylan, Colleen Carroll, and Arnoud R Willems. 2015. "Reconciling rules of origin and global value chains: The case for reform." *Journal of International Economic Law*, 18(2): 287–305.

Gereffi, Gary, and Karina Fernandez-Stark. 2016. "Global value chain analysis: A primer." `https://hdl.handle.net/10161/12488`.

Gong, Gail, and Francisco J. Samaniego. 1981. "Pseudo maximum likelihood estimation: Theory and applications." *The Annals of Statistics*, 861–869.

Gourieroux, C., A. Monfort, and A. Trognon. 1984. "Pseudo maximum likelihood methods: Applications to Poisson models." *Econometrica*, 52(3): 701–720.

Grant, Jason H, and Dayton M Lambert. 2008. "Do regional trade agreements increase members' agricultural trade?" *American Journal of Agricultural Economics*, 90(3): 765–782.

Greenville, Jared, Kentaro Kawasaki, and Raphaël Beaujeu. 2017. "How policies shape global food and agriculture value chains." *OECD Food, Agriculture and Fisheries Papers*, 100.

Greenville, Jared, Kentaro Kawasaki, Dorothee Flaig, and Caitlyn Carrico. 2019. "Influencing GVCs through agro-food policy and reform." *OECD Food, Agriculture and Fisheries Papers*, 58.

Görg, Holger, and Aoife Hanley. 2005. "International outsourcing and productivity: Evidence from the Irish electronics industry." *The North American Journal of Economics and Finance*, 16(2): 255–269.

Görg, Holger, Aoife Hanley, and Eric Strobl. 2008. "Productivity effects of international outsourcing: Evidence from plant-level data." *Canadian Journal of Economics/Revue canadienne d'économique*, 41(2): 670–688.

Harms, Philipp, Oliver Lorz, and Dieter Urban. 2012. "Offshoring along the production chain." *Canadian Journal of Economics/Revue canadienne d'économique*, 45(1): 93–106.

Head, Keith, and Thierry Mayer. 2014. "Gravity equations: Workhorse, toolkit, and cookbook." In *Handbook of International Economics*. Vol. 4, 131–195. Elsevier.

He, Xi. 2022. "Regional Trade Agreements and Excluded Countries." *American Journal of Agricultural Economics*, 104(1): 428–449.

Hillberry, Russell, and Xiaohui Zhang. 2018. "Policy and performance in customs: Evaluating the trade facilitation agreement." *Review of International Economics*, 26(2): 438–480.

Hofmann, Claudia, Alberto Osnago, and Michele Ruta. 2019. "The content of preferential trade agreements." *World Trade Review*, 18(3): 365–398.

Hummels, David, Dana Rapoport, and Kei-Mu Yi. 1998. "Vertical specialization and the changing nature of world trade." *Economic Policy Review*, 4: 79–99.

Hummels, David, Jun Ishii, and Kei-Mu Yi. 2001. "The nature and growth of vertical specialization in world trade." *Journal of International Economics*, 54(1): 75–96.

Huysmans, Martijn, and Johan Swinnen. 2019. "No terroir in the cold? A note on the geography of geographical indications." *Journal of Agricultural Economics*, 70(2): 550–559.

Inomata, Satoshi. 2017. "Analytical frameworks for global value chains: An overview." In *Measuring and Analyzing the Impact of GVCs on Economic Development.* Chapter 1, 15–35. World Bank.

Johnson, Robert C. 2014. "Five facts about value-added exports and implications for macroeconomics and trade research." *Journal of Economic Perspectives*, 28(2): 119–142.

Johnson, Robert C. 2018. "Measuring global value chains." *Annual Review of Economics*, 10(1): 207–236.

Johnson, Robert C., and Guillermo Noguera. 2012. "Accounting for intermediates: Production sharing and trade in value added." *Journal of International Economics*, 86(2): 224–236.

Kejžar, Katja Zajc, Alan Velić, and Jože P. Damijan. 2022. "COVID-19, trade collapse and GVC linkages: European experience." *World Economy*, 45(11): 3475–3506.

Kikuchi, Tomoo, Kazuo Nishimura, and John Stachurski. 2012. "Coase meets Tarski: New insights from Coase's theory of the firm." *KIER Discussion Paper*, 828.

Kim, Dongin, and Sandro Steinbach. 2023. "Preferential trading in agriculture: New insights from a structural gravity analysis and machine learning." *Available at SSRN 4412389.*

Koopman, Robert, Zhi Wang, and Shang-Jin Wei. 2014. "Tracing value-added and double counting in gross exports." *American Economic Review*, 104(2): 459–494.

Kowalski, Przemyslaw, Javier Lopez Gonzalez, Alexandros Ragoussis, and Cristian Ugarte. 2015. "Participation of developing countries in global value chains: Implications for trade and trade-related policies." *OECD Food, Agriculture and Fisheries Papers*, 179.

Kox, Henk LM, and Hugo Rojas-Romagosa. 2020. "How trade and investment agreements affect bilateral foreign direct investment: Results from a structural gravity model." *World Economy*, 43(12).

Laget, Edith, Alberto Osnago, Nadia Rocha, and Michele Ruta. 2020. "Deep trade agreements and global value chains." *Review of Industrial Organization*, 57: 379–410.

Lee, Woori. 2019. "Services liberalization and global value chain participation: New evidence for heterogeneous effects by income level and provisions." *Review of International Economics*, 27(3): 888–915.

Lenzen, Manfred, Daniel Moran, Keiichiro Kanemoto, and Arne Geschke. 2013. "Building Eora: A global multi-region input–output database at high country and sector resolution." *Economic Systems Research*, 25(1): 20–49.

Lenzen, Manfred, Keiichiro Kanemoto, Daniel Moran, and Arne Geschke. 2012. "Mapping the structure of the world economy." *Environmental Science & Technology*, 46(15): 8374–8381.

Levchenko, Andrei A, and Jing Zhang. 2014. "Ricardian productivity differences and the gains from trade." *European Economic Review*, 65: 45–65.

Levchenko, Andrei A, and Jing Zhang. 2016. "The evolution of comparative advantage: Measurement and welfare implications." *Journal of Monetary Economics*, 78: 96–111.

Lim, Sunghun. 2021. "Global agricultural value chains and structural transformation." *NBER Working Paper*, 29194.

Lim, Sunghun, and Sie Won Kim. 2022. "Global agricultural value chains and employment growth." *Journal of the Agricultural and Applied Economics Association*, 1(4): 402–418.

Lwesya, Francis. 2022. "Integration into regional or global value chains and economic upgrading prospects: an analysis of the East African Community (EAC) bloc." *Future Business Journal*, 8(1): 33.

Madsen, Jakob B. 2007. "Technology spillover through trade and TFP convergence: 135 years of evidence for the OECD countries." *Journal of International Economics*, 72(2): 464–480.

Maskus, Keith E., Tsunehiro Otsuki, and John S. Wilson. 2005. "The cost of compliance with product standards for firms in developing countries: An econometric study." *World Bank Policy Research Working Paper*, 3590.

Mattoo, Aaditya, Alen Mulabdic, and Michele Ruta. 2022. "Trade creation and trade diversion in deep agreements." *Canadian Journal of Economics/Revue canadienne d'économique*, 55(3): 1598–1637.

Melitz, Marc J. 2003. "The impact of trade on intra-industry reallocations and aggregate industry productivity." *Econometrica*, 71(6): 1695–1725.

Mergenthaler, Marcus, Katinka Weinberger, and Matin Qaim. 2009. "The food system transformation in developing countries: A disaggregate demand analysis for fruits and vegetables in Vietnam." *Food Policy*, 34(5): 426–436.

Miller, Justine, and Samuel Standaert. 2023. "Towards an exhaustive regional integration agreements database." *UNU-CRIS Working Papers*, WP-2023-02.

Minten, Bart, Lalaina Randrianarison, and Johan F. M. Swinnen. 2009. "Global retail chains and poor farmers: Evidence from Madagascar." *World Development*, 37(11): 1728–1741.

Mintz-Habib, Nazia. 2014. "The political economy of joining in the global value chain (GVC) of biodiesel: Comparative case study analysis of Jatropha production." *Renewable Energy Law and Policy Review*, 5(2): 107–120.

Montalbano, Pierluigi, and Silvia Nenci. 2022. "Does global value chain participation and positioning in the agriculture and food sectors affect economic performance? A global assessment." *Food Policy*, 108: 102235.

Montalbano, P., R. Pietrelli, and L. Salvatici. 2018. "Participation in the market chain and food security: The case of the Ugandan maize farmers." *Food Policy*, 76: 81–98.

Montiel Olea, José Luis, and Mikkel Plagborg-Møller. 2019. "Simultaneous confidence bands: Theory, implementation, and an application to SVARs." *Journal of Applied Econometrics*, 34(1): 1–17.

Morrow, Peter M, and Daniel Trefler. 2017. "Endowments, skill-biased technology, and factor prices: A unified approach to trade." *NBER Working Paper*, 24078.

Mujahid, Irfan, and Matthias Kalkuhl. 2016. "Do trade agreements increase food trade?" *World Economy*, 39(11): 1812–1833.

Mullahy, John, and Edward C Norton. 2022. "Why transform Y? A critical assessment of dependent-variable transformations in regression models for skewed and sometimes-zero outcomes." *NBER Working Paper*, 30735.

Ndubuisi, Gideon, and Solomon Owusu. 2021. "How important is GVC participation to export upgrading?" *World Economy*, 44(10): 2887–2908.

Osnago, Alberto, Nadia Rocha, and Michele Ruta. 2019. "Deep trade agreements and vertical FDI: The devil is in the details." *Canadian Journal of Economics/Revue canadienne d'économique*, 52(4): 1558–1599.

Raimondi, Valentina, Andreea Piriu, Johan Swinnen, and Alessandro Olper. 2023. "Impact of global value chains on tariffs and non-tariff measures in agriculture and food." *Food Policy*, 118: 102469.

Rambachan, Ashesh, and Jonathan Roth. 2023. "A more credible approach to parallel trends." *Review of Economic Studies*, rdad018.

Reardon, Thomas, Christopher B. Barrett, Julio A. Berdegué, and Johan F. M. Swinnen. 2009. "Agrifood industry transformation and small farmers in developing countries." *World Development*, 37(11): 1717–1727.

Rodríguez-Clare, Andrés, Mauricio Ulate, José P Vásquez, et al. 2020. "New-Keynesian trade: Understanding the employment and welfare effects of trade shocks." *NBER Working Paper*, 27905.

Roth, Aleda V, Andy A Tsay, Madeleine E Pullman, and John V Gray. 2008. "Unraveling the food supply chain: Strategic insights from China and the 2007 recalls." *Journal of Supply Chain Management*, 44(1): 22–39.

Roth, Jonathan. 2022. "Pretest with caution: Event-study estimates after testing for parallel trends." *American Economic Review: Insights*, 4(3): 305–322.

Roth, Jonathan, and Pedro HC Sant'Anna. 2023. "When is parallel trends sensitive to functional form?" *Econometrica*, 91(2): 737–747.

Sanguinet, Eduardo Rodrigues, Augusto Mussi Alvim, and Miguel Atienza. 2022. "Trade agreements and participation in global value chains: Empirical evidence from Latin America." *World Economy*, 45(3): 702–738.

Santeramo, Fabio Gaetano, and Emilia Lamonaca. 2022*a*. "On the trade effects of bilateral SPS measures in developed and developing countries." *World Economy*, 45(10): 3109–3145.

Santeramo, Fabio Gaetano, and Emilia Lamonaca. 2022*b*. "Standards and regulatory cooperation in regional trade agreements: What the effects on trade?" *Applied Economic Perspectives and Policy*, 44(4): 1682–1701.

Scoppola, Margherita, Valentina Raimondi, and Alessandro Olper. 2018. "The impact of EU trade preferences on the extensive and intensive margins of agricultural and food products." *Agricultural Economics*, 49(2): 251–263.

Sexton, Richard J. 2013. "Market power, misconceptions, and modern agricultural markets." *American Journal of Agricultural Economics*, 95(2): 209–219.

Shepherd, Ben. 2022. "Modelling global value chains: From trade costs to policy impacts." *World Economy*, 45(8): 2478–2509.

Shepherd, Ben, and Norbert LW Wilson. 2013. "Product standards and developing country agricultural exports: The case of the European Union." *Food Policy*, 42: 1–10.

Silva, J. M. C. Santos, and Silvana Tenreyro. 2006. "The log of gravity." *The Review of Economics and Statistics*, 88(4): 641–658.

Sun, Lin, and Michael R Reed. 2010. "Impacts of free trade agreements on agricultural trade creation and trade diversion." *American Journal of Agricultural Economics*, 92(5): 1351–1363.

Sun, Liyang, and Sarah Abraham. 2021. "Estimating dynamic treatment effects in event studies with heterogeneous treatment effects." *Journal of Econometrics*, 225(2): 175–199.

Su, Yi-hao. 2021. "Trade plants the flag: Sanctions-busting and the signing of new preferential trade agreements." *Foreign Policy Analysis*, 17(1): oraa009.

Timmer, Marcel P., Abdul Azeez Erumban, Bart Los, Robert Stehrer, and Gaaitzen J. De Vries. 2014. "Slicing up global value chains." *Journal of economic perspectives*, 28(2): 99–118.

Tintelnot, Felix. 2017. "Global production with export platforms." *Quarterly Journal of Economics*, 132(1): 157–209.

Tyazhelnikov, Vladimir. 2022. "Production clustering and offshoring." *American Economic Journal: Microeconomics*, 14(3): 700–732.

UN Comtrade. 2023. "United Nations Comtrade Database." *https://comtradeplus.un.org/*.

United Nations University. 2023. "Regional Integration Knowledge System." *https://cris.unu.edu/riks*.

Vollrath, Thomas L., Mark J. Gehlhar, and Charles B. Hallahan. 2009. "Bilateral import protection, free trade agreements, and other factors influencing trade flows in agriculture and clothing." *Journal of Agricultural Economics*, 60(2): 298–317.

Wang, Zhi, Shang-Jin Wei, Xinding Yu, and Kunfu Zhu. 2017. "Characterizing global value chains: Production length and upstreamness." *NBER Working Paper*, 23261.

Weidner, Martin, and Thomas Zylkin. 2021. "Bias and consistency in three-way gravity models." *Journal of International Economics*, 132: 103513.

Wooldridge, J.M. 1999. *Handbook of Applied Econometrics Volume II: Quasi-likelihood Methods for Count Data.* Oxford: Blackwell Publishing Inc.

World Bank. 2020. "The new face of trade." In *Trading for Development in the Age of Global Value Chains: World Development Report 2020.* Chapter 1. World Bank, Washington, DC.

World Bank. 2022. "New World Bank Country Classifications by Income Level: 2021-2022." *https://blogs.worldbank.org/opendata/new-world-bank-country-classifications-income-level-2021-2022/*.

World Bank. 2023. "Global Preferential Trade Agreement Database." *https://wits.worldbank.org/gptad/trade_database.html*.

World Trade Organization. 2023. "Regional Trade Agreements Database." *http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx*.

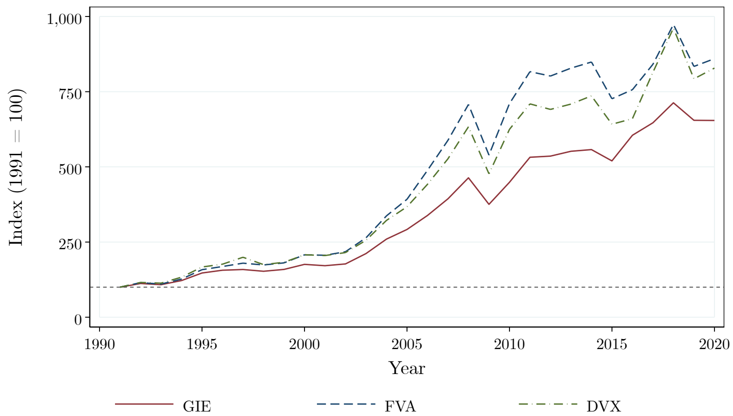
Yi, Kei-Mu. 2003. "Can vertical specialization explain the growth of world trade?" *Journal of political Economy*, 111(1): 52–102.

Yi, Kei-Mu. 2010. "Can multistage production explain the home bias in trade?" *American Economic Review*, 100(1): 364–393.

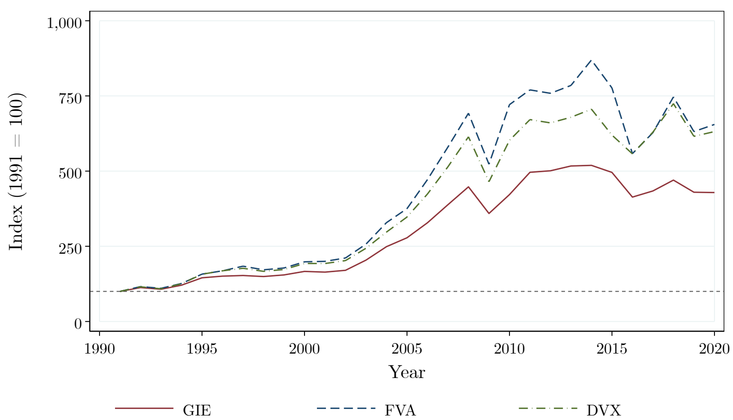
Yotov, Yoto, Roberta Piermartini, and Mario Larch. 2016. *An Advanced Guide to Trade Policy Analysis.* World Trade Organization and United Nations Conference on Trade and Development.

Yotov, Yoto V. 2022. "On the role of domestic trade flows for estimating the gravity model of trade." *Contemporary Economic Policy*, 40(3): 526–540.

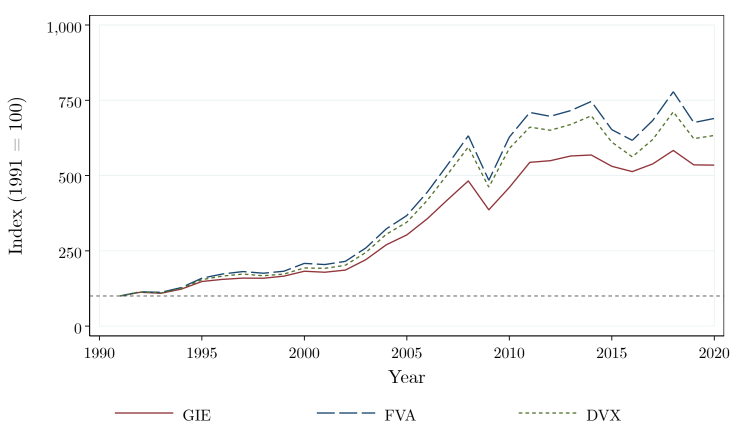
Figures and Tables



(a) Agricultural Sector.



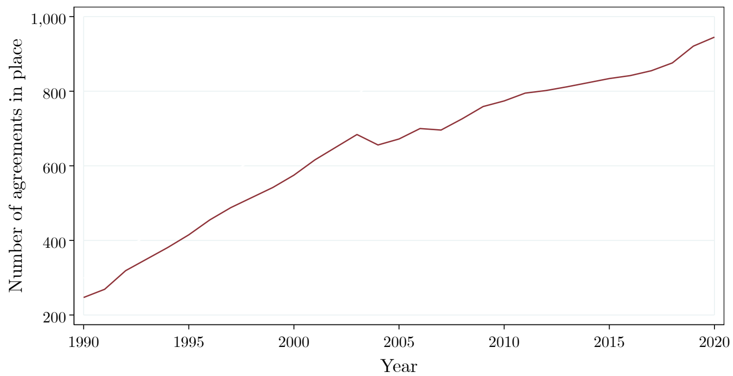
(b) Food Sector.



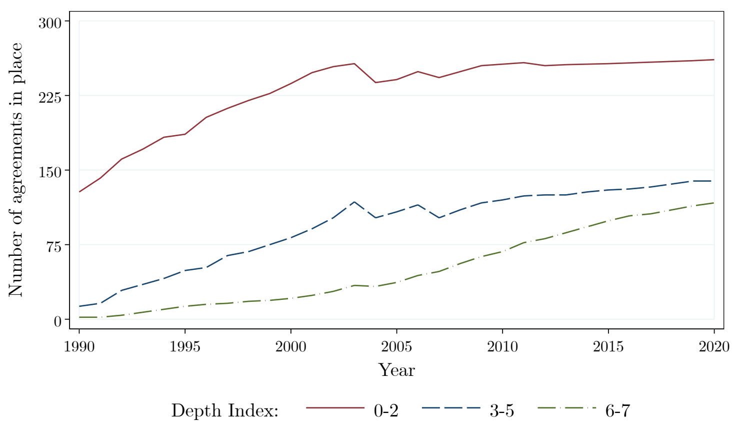
(c) All Sectors.

Figure 1: Evolution of GIE and GVC Flows.

Note. The figure shows the evolution of GIE and GVC flows between 1991 and 2020. All flow measures are normalized to 1991.



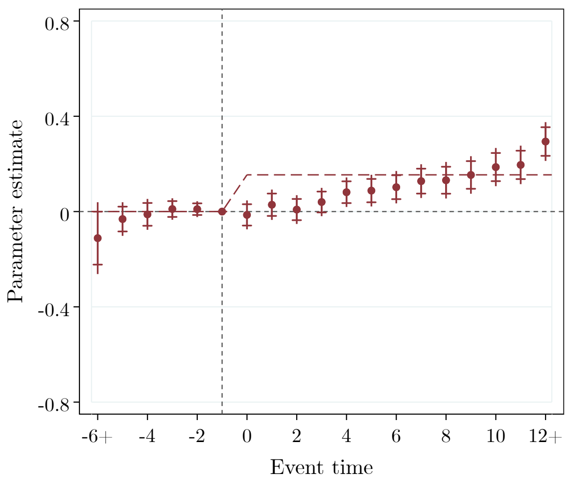
(a) Number of DTAs.



(b) DTA Depth.

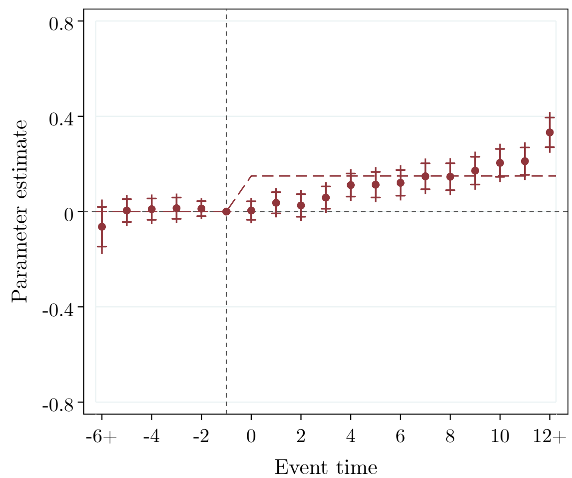
Figure 2: Evolution of Trade Agreement Depth.

Note. The figure shows the number of DTAs and the depth of those agreements. We utilize the depth index measure by Dür, Baccini and Elsig (2014) that ranges from 0 to 7 in increments of one and counts the number of substantive provisions across tariff reductions, services trade, investments, standards, public procurement, competition, and intellectual property rights provisions.



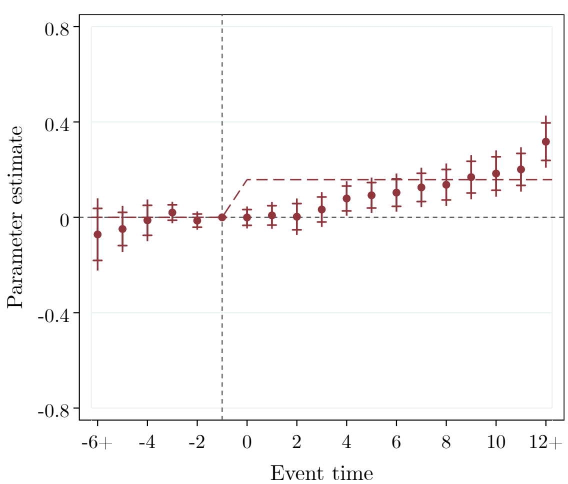
Pre-trends p-value: 0.730 -- Leveling off p-value: 0.000 -- Static effect p-value: 0.000
Pseudo R-squared: 0.999 -- Observations: 889,494

(a) Agricultural TVA.



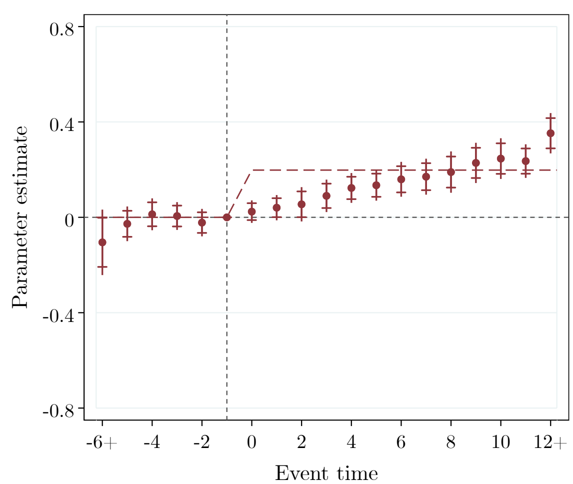
Pre-trends p-value: 0.598 -- Leveling off p-value: 0.000 -- Static effect p-value: 0.000
Pseudo R-squared: 0.999 -- Observations: 629,457

(b) Food TVA.



Pre-trends p-value: 0.523 -- Leveling off p-value: 0.000 -- Static effect p-value: 0.000
Pseudo R-squared: 0.999 -- Observations: 766,845

(c) Agricultural TVX.



Pre-trends p-value: 0.718 -- Leveling off p-value: 0.000 -- Static effect p-value: 0.000
Pseudo R-squared: 0.999 -- Observations: 833,053

(d) Food TVX.

Figure 3: Event Studies for Trade Deal Enforcement and GVC Flows.

Note. The figure shows the dynamic treatment parameters, 95 percent confidence intervals, and uniform sup-t bands for the event-time coefficients. We report several Wald tests and regression statistics in the figure notes and overlay static estimates as dashed lines. All standard errors are clustered at the exporter-importer-sector level.

Table 1: Trade Agreement Effects on Agri-food GVC Flows.

	Without Intra-national Flows			With Intra-national Flows		
	GIE	TVA	TVX	GIE	TVA	TVX
(a) Agricultural Sector						
Trade Agreements	0.035***	-0.007	0.002	0.210***	0.154***	0.158***
	(0.011)	(0.014)	(0.013)	(0.040)	(0.027)	(0.037)
Observations	1,027,026	875,666	746,016	1,035,300	889,494	766,845
Pseudo R-squared	0.998	0.997	0.995	0.999	0.999	0.999
(b) Food Sector						
Trade Agreements	0.002	-0.002	0.034***	0.091***	0.150***	0.198***
	(0.013)	(0.015)	(0.012)	(0.029)	(0.030)	(0.036)
Observations	1,017,567	608,166	814,554	1,025,580	629,457	833,053
Pseudo R-squared	0.999	0.995	0.998	0.999	0.999	0.999
(c) All Sectors						
Trade Agreements	0.014**	0.009	0.006	0.158***	0.117***	0.125***
	(0.007)	(0.011)	(0.009)	(0.038)	(0.032)	(0.026)
Observations	25,277,920	16,598,688	16,678,427	25,571,618	17,240,015	17,473,175
Pseudo R-squared	0.999	0.998	0.999	0.999	0.999	0.999

Note. This table shows estimates of trade agreement impact on agricultural, food, and all GVC flows. We compare the results for total value added (TVA) and total domestic value added in exports (TVX) with those of gross industry exports (GIE). Without intra-national flows, the value-added measures become the indirect domestic value added in export (DVX) and foreign value added (FVA). All standard errors are clustered at the exporter-importer-sector level.

Table 2: Trade Agreement Depth and Agri-food GVC Flows.

	Agricultural Sector				Food Sector			
	TVA		TVX		TVA		TVX	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
DTA Index 0	0.078*		-0.059		0.062		-0.124**	
	(0.044)		(0.046)		(0.075)		(0.056)	
DTA Index 1	0.132***		0.105*		0.118**		0.179***	
	(0.048)		(0.054)		(0.058)		(0.063)	
DTA Index 2	0.100*		0.020		-0.011		-0.015	
	(0.054)		(0.052)		(0.047)		(0.047)	
DTA Index 3	0.085		0.007		0.043		0.033	
	(0.052)		(0.063)		(0.080)		(0.079)	
DTA Index 4	0.272***		0.244***		0.329***		0.335***	
	(0.044)		(0.066)		(0.042)		(0.058)	
DTA Index 5	0.165***		0.191***		0.156***		0.232***	
	(0.028)		(0.035)		(0.029)		(0.034)	
Trade Agreements		0.144***		0.003		0.129**		-0.044
		(0.041)		(0.048)		(0.062)		(0.061)
– Depth Index		0.015		0.204***		0.028		0.319***
		(0.049)		(0.058)		(0.076)		(0.074)
Observations	889,494	889,494	766,845	766,845	629,457	629,457	833,053	833,053
Pseudo R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999

Note. This table presents estimates of the impact of DTA depth on GVC flows. We use two DTA depth measures developed by (Dür, Baccini and Elsig 2014). One employs an ordinal variable that indicates how each agreement addresses essential policy areas. We categorize all trade agreements into six groups based on the extent of coverage, ranging from zero to five for the essential policy areas. The other depth measure ranges from 0 to 100 and relies on 49 key trade openness provisions. All standard errors are clustered at the exporter-importer-sector level.

Table 3: Essential Policy Areas in Trade Agreements.

	Agricultural Sector		Food Sector	
	TVA	TVX	TVA	TVX
Trade Agreements	0.078*	-0.014	0.034	-0.071
	(0.040)	(0.047)	(0.056)	(0.051)
– Standard	0.063*	0.178***	0.109**	0.219***
	(0.036)	(0.046)	(0.050)	(0.050)
– Investment	0.117***	0.086**	0.116***	0.119***
	(0.033)	(0.042)	(0.039)	(0.045)
– IPRS	-0.097***	-0.102**	-0.049	-0.014
	(0.034)	(0.041)	(0.039)	(0.043)
– GVC	-0.094**	0.036	-0.177***	-0.054
	(0.047)	(0.057)	(0.044)	(0.070)
Observations	889,494	766,845	629,457	833,053
Pseudo R-squared	0.999	0.999	0.999	0.999

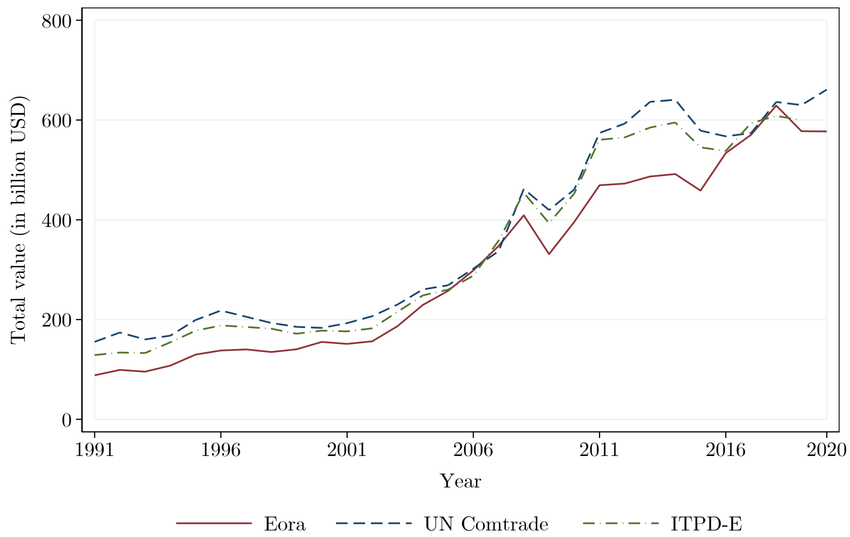
Note. This table presents estimates of the GVC flow effects of essential policy areas in DTAs. The four essential policy areas are indicator variables from Dür, Baccini and Elsig (2014). All standard errors are clustered at the exporter-importer-sector level.

Table 4: Differential GVC Effects of Trade Agreements by Income Level.

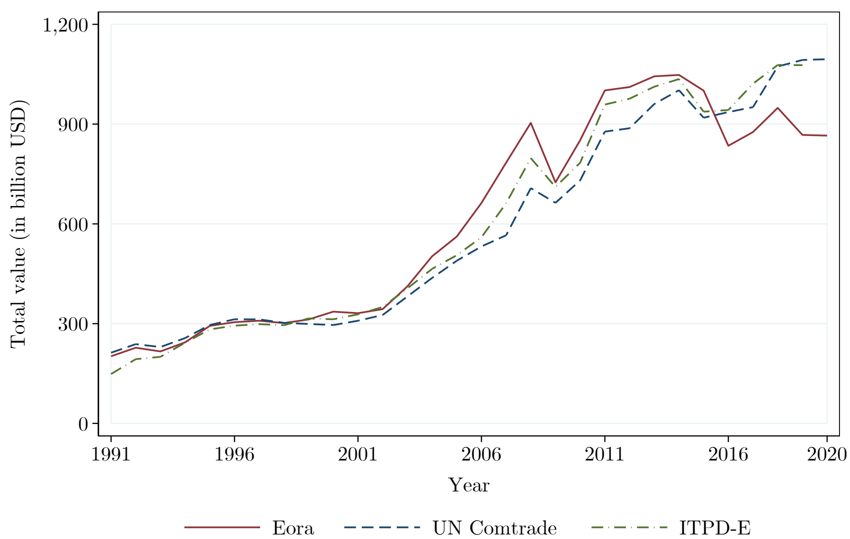
	Agricultural Sector				Food Sector			
	TVA		TVX		TVA		TVX	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Trade Agreements	0.154***		0.158***		0.150***		0.198***	
	(0.027)		(0.037)		(0.030)		(0.036)	
South-to-North		0.106***		0.159***		0.137***		0.282***
		(0.028)		(0.041)		(0.037)		(0.074)
South-to-South		-0.045		-0.115*		-0.106**		-0.146*
		(0.056)		(0.062)		(0.046)		(0.084)
North-to-South		0.102		0.032		0.041		0.135**
		(0.066)		(0.059)		(0.051)		(0.066)
North-to-North		0.177***		0.174***		0.167***		0.202***
		(0.029)		(0.041)		(0.033)		(0.037)
Observations	871,462	871,462	753,199	753,199	618,716	618,716	816,816	816,816
Pseudo R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999

Note. This table presents estimates of the GVC flow effects of DTAs by income level. All countries were divided into two groups, North and South, and we then assessed the treatment heterogeneity using interaction terms. All standard errors are clustered at the exporter-importer-sector level.

Appendix Figures and Tables



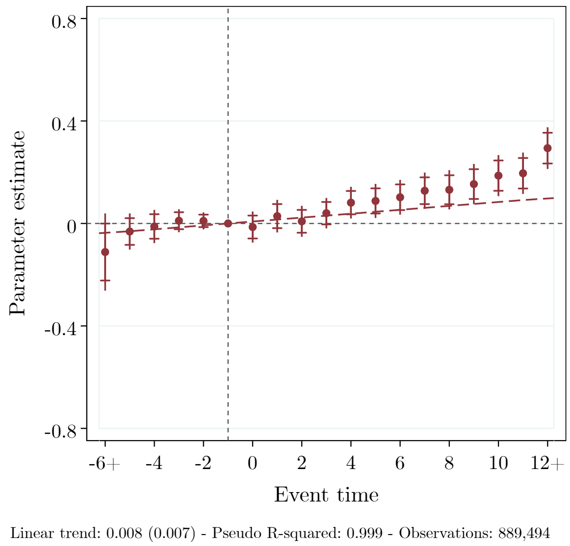
(a) Agricultural Sector Gross Exports.



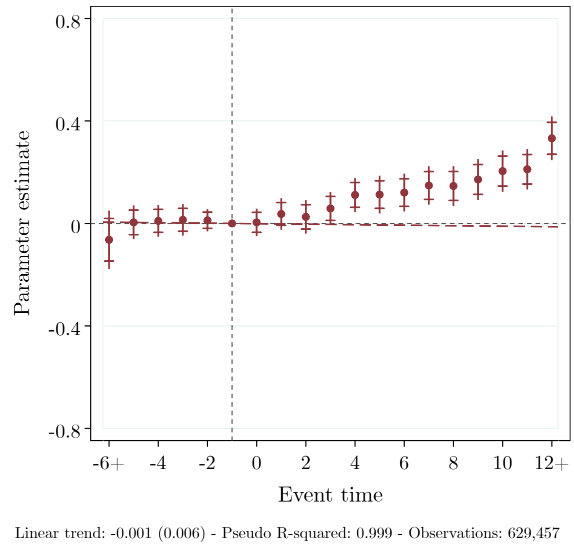
(b) Food Sector Gross Exports.

Figure A.1: Data Source Comparison.

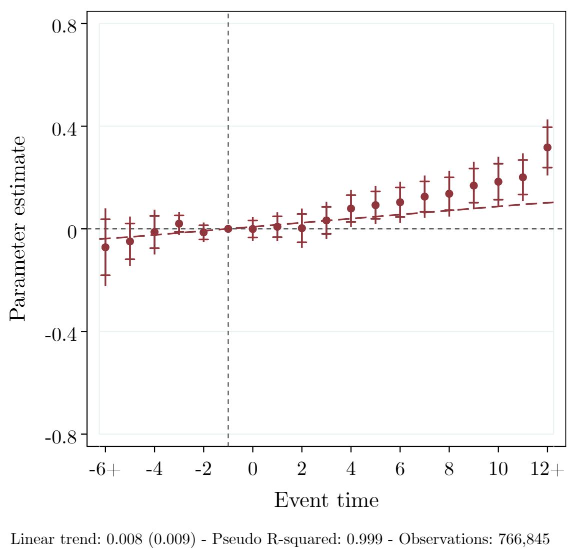
Note. The figure compares agricultural and food sector gross exports based on the 2023 Eora global supply chain database (Lenzen et al. 2013) with UN Comtrade (2023) and the International Trade and Production Database for Estimation by Borchert et al. (2021).



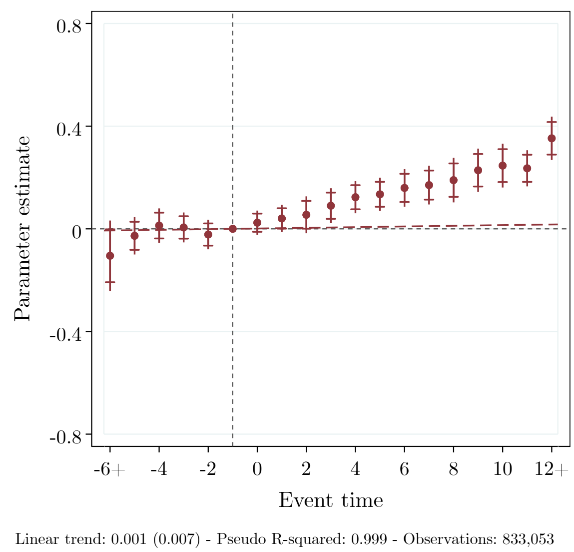
(a) Agricultural TVA.



(b) Food TVA.



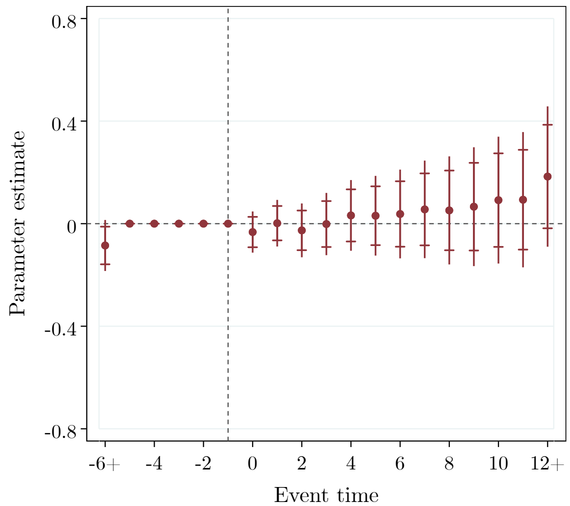
(c) Agricultural TVX.



(d) Food TVX.

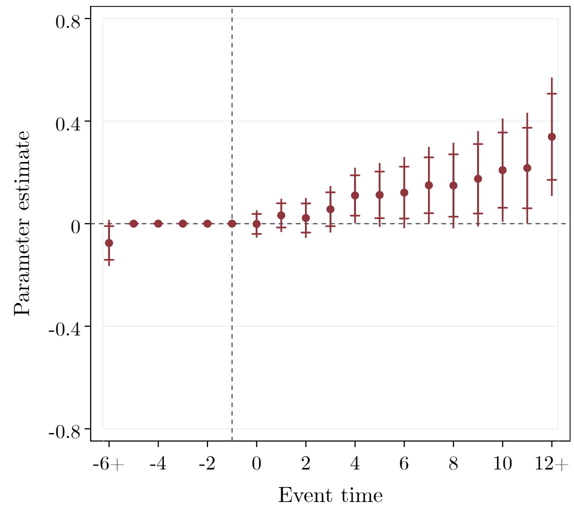
Figure A.2: Overlaid Linear Pre-Trends.

Note. The figure shows the dynamic treatment parameters, 95 percent confidence intervals, and uniform sup-t bands for the event-time coefficients. We report the slope and standard error of the overlaid linear pre-trend and several regression statistics in the figure notes. All standard errors are clustered at the exporter-importer-sector level.



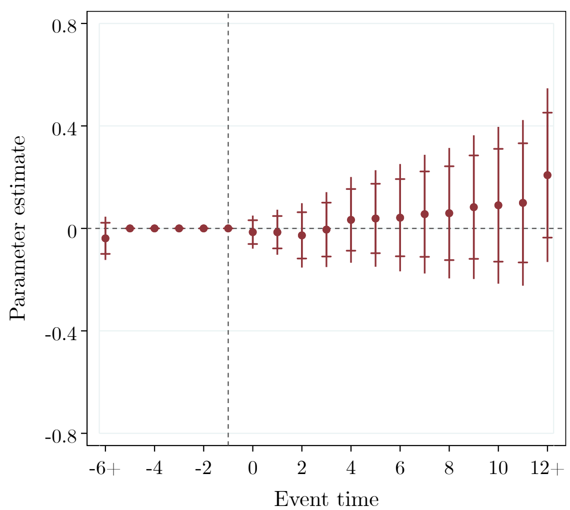
Linear trend: 0.008 (0.007) - Pseudo R-squared: 0.999 - Observations: 889,494

(a) Agricultural TVA.



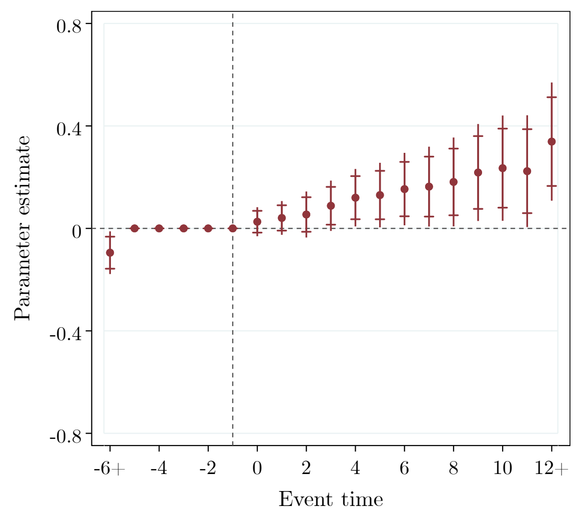
Linear trend: -0.001 (0.006) - Pseudo R-squared: 0.999 - Observations: 629,457

(b) Food TVA.



Linear trend: 0.008 (0.009) - Pseudo R-squared: 0.999 - Observations: 766,845

(c) Agricultural TVX.



Linear trend: 0.001 (0.007) - Pseudo R-squared: 0.999 - Observations: 833,053

(d) Food TVX.

Figure A.3: Subtracted Linear Pre-Trends.

Note. The figure shows the dynamic treatment parameters, 95 percent confidence intervals, and uniform sup-t bands for the event-time coefficients. We report the slope and standard error of the overlaid linear pre-trend and several regression statistics in the figure notes. The post-event treatment coefficients are adjusted for linear pre-trends. All standard errors are clustered at the exporter-importer-sector level.

Table A.1: Descriptive Statistics I.

	Mean	SD	Δ(1991/2020)	Min.	Max.
(a) Agricultural Sector					
TVA	12.50	457.00	0.21	0	101,210
TVX	8.39	296.00	0.17	0	56,923
GIE	8.92	554.00	0.23	0	146,149
(b) Food Sector					
TVA	12.90	804.00	0.18	0	597,204
TVX	13.50	890.00	0.20	0	612,959
GIE	11.30	1,076.00	0.16	0	914,631
(c) All Sectors					
TVA	12.90	804.00	0.18	0	597,204
TVX	13.50	890.00	0.20	0	612,959
GIE	11.30	1,076.00	0.16	0	914,631

Note. This table presents summary statistics for multiple outcome variables. We report the intranational and international trade in this table separately, while the sum of these variables represents GIE in the manuscript. Panels (a) and (b) use data for the agricultural and food sectors and panel (c) uses data from all sectors. Δ(1991/2020) represents the annual growth rate. The units for the remaining statistics are scaled in million USD.

Table A.2: Descriptive Statistics II.

	Mean	SD	Min	Max	Observations
(a): South-to-South					
DTA	0.12	0.32	0	1.00	241,414
# Essential policy	0.18	0.69	0	6.00	241,414
Depth	0.02	0.09	0	100.00	241,414
Standard harmonization	0.02	0.13	0	1.00	241,414
Investment	0.01	0.12	0	1.00	241,414
IPRS	0.01	0.08	0	1.00	241,414
GVC	0.00	0.02	0	1.00	241,414
(b): South-to-North					
DTA	0.17	0.38	0	1.00	279,513
# Essential policy	0.23	0.60	0	6.00	279,513
Depth	0.03	0.08	0	90.12	279,513
Standard harmonization	0.03	0.18	0	1.00	279,513
Investment	0.00	0.07	0	1.00	279,513
IPRS	0.00	0.03	0	1.00	279,513
GVC	0.00	0.00	0	1.00	279,513
(c) North-to-North					
DTA	0.16	0.36	0	1.00	241,964
# Essential policy	0.66	1.75	0	6.00	241,964
Depth	0.08	0.22	0	100.00	241,964
Standard harmonization	0.11	0.31	0	1.00	241,964
Investment	0.09	0.29	0	1.00	241,964
IPRS	0.06	0.23	0	1.00	241,964
GVC	0.01	0.09	0	1.00	241,964
(d) North-to-South					
DTA	0.14	0.35	0	1.00	241,414
# Essential policy	0.25	0.82	0	6.00	241,414
Depth	0.03	0.11	0	100.00	241,414
Standard harmonization	0.03	0.16	0	1.00	241,414
Investment	0.02	0.15	0	1.00	241,414
IPRS	0.01	0.12	0	1.00	241,414
GVC	0.00	0.03	0	1.00	241,414
(e): Overall					
DTA	0.14	0.35	0	1.00	1,049,070
# Essential policy	0.31	1.05	0	6.00	1,049,070
Depth	0.04	0.13	0	100.00	1,049,070
Standard harmonization	0.04	0.20	0	1.00	1,049,070
Investment	0.03	0.17	0	1.00	1,049,070
IPRS	0.02	0.13	0	1.00	1,049,070
GVC	0.00	0.05	0	1.00	1,049,070

Note. This table presents the descriptive statistics for the trade policy variables. The countries are classified into “North” for high-income and “South” for low-income economies.

Table A.3: Essential DTA Policy Areas.

Policy Areas	Description
Full trade agreement	Determined by whether the matched agreement is classified as a full free trade agreement (FTA) or a broader scope agreement according to the Hufbauer and WTO coding scheme.
Standard harmonization	Derived from 4 provisions coded for the SPS and TBT chapters, including mutual recognition and harmonization.
Investments	Derived from 3 provisions coded for the Investment chapter, including the reference to bilateral investment treaty.
Services	Derived from the Service chapter, whether the agreement includes specific provisions stipulating the liberalization of trade in services.
Procurement	Determined by whether the agreement contains a substantive provision on public procurement.
Competition	Determined by whether the agreement includes a competition chapter, including scopes of transparency and anti-discriminatory principles.
IPRS	Derived from 5 provisions coded for the intellectual property rights chapter, including the treatment toward NT and MFN listed countries and specific scope and enforcement of the law.
GVC	Derived from 4 provisions coded for the GVC chapter, discussing a mechanism and cooperation explicitly about the global value chain.

Note. This table describes the essential policy areas used for the depth index construction. Dür, Baccini and Elsig (2014) detail all the provisions used in these policy areas.