Global Agricultural Value Chains and Structural Transformation

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Abstract

Can modern-day developing economies transform their economies by participating in global value chains (GVCs)? The rise of global value chains (GVCs) has changed the nature of production around the world over recent years. Conventionally, companies used to produce goods primarily in one country. That has all changed. Modern-day, a single finished product often results from manufacturing and assembly in multiple countries, with each step in the process adding value to the final product. Although the transition out-of-agriculture is an important aspect of economic development in developing countries, it is unclear whether participation in global value chains (GVCs) fosters a structural transformation ─ the process whereby economic activity is reallocated from agriculture to manufacturing, and then from manufacturing to the services sector. In this paper, I investigate the effect of the participation in agricultural GVCs on the structural transformation. Using multi-region input-output data to measure GVC participation and cross-country data for 183 countries for the period 1990-2013. I find that in response to greater agri-food global value-chain participation, modern-day agrarian economies are leapfrogging manufacturing to directly develop their services sector, which runs counter to conventional structural transformation narratives. This result is strongly robust to (i) various alternative specifications (i.e., regional-year fixed effects, a linear time trend, country-specific time trends, regional-specific time trends, all along with country fixed effects and country-specific year fixed effects), (ii) an alternative measure of structural transformation (GDP and employment shares), and (iii) an alternative measure of GVCs. By slicing the data, I also find that the move of structural transformation is statistically unclear in low-income countries. This is important for agri-food industrial, trade, and development policy by providing original evidence that believing in "one-size-fits-all" might draw the wrong policy recommendations for different countries in the context of global value chains.

1. Introduction

Global value chains (GVCs) have changed the nature of production around the world. In the fields of international trade and industrial organization, the contemporary world economy has gradually transformed over the last two decades. One of the most important characteristics of the transformation is the globalization of production in trade (Gereffi et al., 2005). Conventionally, companies used to produce goods in one country and trade their finished goods with other countries; nowadays, it is rare that the transactions of international trade are based on the exchange of finished goods. Rather, sales of individual components of products and value-added intermediary services dominate most of production in trade.

In the modern production system, a single finished product often results from a multi-national supply chain, with each step in the process adding value to the final product ─ so-called global value chains (GVCs). Global Value Chains refer to the sequences of all dispersed activities over several countries involved in transforming raw materials into the final consumer product, including production, marketing, distributions, and support to the final consumers (Gereffi and Fernandez-Stark, 2011). In other words, GVCs are the sequence of all functional activities required in the process of value creation wherein more than one country is involved. The typical "Made in …" labels s might have become archaic symbols of an old era because disintegration of production processes across borders has gradually spread in the modern economy (Antràs, 2015).

GVCs in agriculture and food industries have been rapidly growing since the last decade. In the 1950s through early 1980s, the agri-food industry went through pre-globalization – shifting from traditional small-scale informal industry to larger-scale – and agricultural GVCs has been modernized since 1990s when trade liberalization expanded more (Reardon et al., 2009). By

rapidly spreading vertical integration, global leading grocery processors and retailers have emerged as dominant players in agricultural GVCs by linking farmers in upstream and customers in downstream ─both are geographically distributed (Sexton, 2012).

Figure 1 empirically shows that the world average participation of agricultural GVCs has increased more than 1.5 times between the early 1990s and 2010s. This dramatic change in the last two decades implies the agricultural GVCs show a different pattern of direction compared to the global manufacturing industry wherein the recent expansion of GVCs seemingly has come to a halt (Rodrik, 2018).

Geographically, less developed regions (i.e., Sub-Saharan Africa, South Asia, and Latin American countries) are relatively more involved in global agricultural production (See Figure 2). Also, in terms of the growth rate of agricultural GVCs participation, China and India are relatively more involved in global agriculture production while the U.S. and Russia are relatively more involved in global food production (See Figure 3).

The rapid increase of global agricultural production is especially important for trade policymaker in poor countries that allocate more than 80 percent of their work force to agriculture (Blanchard Bown, and Johnson, 2016). In the perspective of political economy, some advocate the involvement in global production to achieve trade competitiveness and create potential new opportunities for developing economies; the others oppose their GVCs participation for trade protection against rich countries.

Can poor countries be better off by participating in global agricultural production? While the involvement in global production has been increasing in most of the modern economies, the effects of GVCs on economic development is unclear. GVC optimists argue that the emergence of GVCs

represents a golden opportunity for economic development in poor countries. In the agriculture sector, as these countries participate in the global production, the governance of production environment shifts from local producers to international firms, resulting in local producers becoming more modernized by satisfying global firms' production requirements (Gereffi et al., 2005). Because the modernized agricultural value chains essentially require regulatory transparency controlled by advanced supply chain governance, participation in modern value chains benefit local producers from larger profits by reducing risks from food quality, consistency, and safety issues (Eaton and Shepherd, 2001; Bellemare and Lim, 2018). Another source of optimism is based on the view that GVC participation might have important positive spillovers for small-holder farmers in developing countries. This is because changes from traditional value chains to modern value chains in agriculture are associated with increasing employment, income, better remunerated jobs, use of resources, and governance (Minten et al., 2009; Bellemare, 2012; Cattaneo et al., 2013; Swinnen, 2014; Swinnen and Vandeplas, 2014; Montalbano et al., 2017). Also, offshoring in supply chain governance increases the ability of producers in rich countries to substitute for domestic labor, and thus offshoring is supporting their on-going structural transformation as well as increasing employment in poor countries. (Gereffi et al., 2005; Goger et al., 2014; Greenville et al, 2016).

It is, however, unclear whether the participation of agricultural GVCs necessarily positively influences economic development. More recent studies point out that the upside for GVCs undermines developing countries' economic performance. Rodrik (2018) address that GVCs might make it harder for low-income countries to use their labor cost advantage to offset their technological disadvantage. As the technology progress in production is generally biased towards skilled workers in developed countries, the gains by GVCs might be weaker in developing

countries. Another source of skepticism stems from the fact that unlike the rapid industrialization by Asian "tigers," the structural transformation in Africa originated on the demand side through either transfers or increase in agricultural incomes but not production side (Diao, McMillan, and Rodrick, 2017). Also, Goger et al. (2014) argue that GVC participation is not enough to ensure that small farmers and vulnerable workers will be better off without multi-faceted and strategic policy approaches.

In this paper, I look at the effect of the participation in agricultural GVCs on structural transformation, the process whereby economic activity is reallocated from agriculture to manufacturing, and then from manufacturing to the services sector. Following Kuznets (1957), as economies develop, the share of agriculture in GPD or employment falls and workers migrate to urban areas to find employment in the industrial and service sectors. In development literature, the growth path of most rich economies was accompanied by a process of structural transformation, and thus structural transformation is one of the key characteristics of economic development (Rogerson, 2008; Bustos, Caprettini, and Ponticelli, 2016).

By using linear regression with country and year fixed effects for 183 countries for the period from 1990 to 2013, I find that in response to greater agricultural value chain participation, manufacturing's share of GDP remains stable; agriculture's share of GDP decreases and services' share of GDP increases. This suggests that developing economies are leapfrogging the manufacturing to directly develop their services sector as a consequence of greater participation in agricultural GVCs. In other words, agricultural GVCs transform the structure of modern-day developing economies in way that differs from the way they transformed the structure of economies such as the US, the UK, and Japan, which were dominated in turn by the agricultural, manufacturing, and services sector over the course of the development process.

To ensure that my findings are robust, I first estimate alternative linear specifications with (i) region- year fixed effects, (ii) a linear time trend, (iii) country-specific time trends, and (iv) region-specific time trends. Second, I estimate a dynamic panel regression specification using GMM to account for the dynamic nature of structural transformation (Carkovic and Levine, 2002; Vries et al, 2012; Timmer, and Vries, 2015; Hnatkovska and Lahiri, 2016). Lastly, I use alternative measures of (i) structural transformation which rely on employment shares instead of GDP shares, and (ii) GVC participation by using food industries instead of agricultural industries. My core findings are strongly robust to those various robustness checks.

Before concluding, I conduct two additional analyses. I first compare the effects of GVCs in developed versus developing countries. Second, I look at the effects of the upstream and downstream GVCs participation on structural transformation by decomposing GVCs into backward and forward channels in global production. The results address that the effect is larger when countries are involved in upstream production rather than downstream production in global value chains.

I also use fixed effect model by controlling for trade policy, domestic price policy (Timmer and Akkus, 2008), bordered countries GVCs participation (peer effects), and other economic and demographic covariates to reduce unobserved heterogeneity. For control variables, I use numerous data including World Development Indicator database, CEPII gravity database, FAO database, and DistanceFromTo geographical data.

The remainder of this paper is organized as follows. Section 2 presents the empirical framework I rely on to study the effect of agricultural GVCs participation on structural transformation. In Section 3, I discuss the data and the measures of key variables. In Section 4, I

present the empirical results. Section 5 provides the robustness check, and the extension analysis is addressed in Section 6. I conclude this study in Section 6.

2. Empirical Model

I start this section by presenting my preferred empirical specification based on standard linear methods. I then discuss alternative specifications. Lastly, I discuss my identification strategy by explaining how my empirical approach addresses the main sources of endogeneity.

2.1 Baseline

My equation of interest is such that

$$y_{it} = \alpha + \beta D_{it} + \gamma D_{ot} + X_{it}\delta + \alpha_i + \mu_t + \varepsilon_{it} \qquad (1)$$

where y_{it} is the GDP shares by each sector — agriculture, manufacturing, and service — by country i in year t. This is percentage outcome, taking on the value from 0 to 100. D_{it} is the treatment variable of the participation level of agricultural GVCs by country i in year t. D_{ot} denotes the participation level of agricultural GVCs by neighboring countries of country i and the vector of X_{it} denote time-varying control variables. α_i is a vector of country fixed effects and μ_t is a vector of year fixed effects. ε_{it} is an error term with mean zero.

In applying the fixed effects framework to data, I estimate Equation (1) by the ordinary least squares.[1] The country fixed effects (α_i) are included to control time invariant unobserved heterogeneity within each country i. The year fixed effects (μ_t) controls for all the country-invariant unobserved heterogeneity within each year. Also, I cluster my standard errors at the country level to correct my results robust to heteroskedasticity and autocorrelation by following

[1] In this study, I estimate by using a fixed effect estimator. One might suggest applying the random effect estimator as robustness check. It is, however, inappropriate in this case where the variable of interest — GVC participation — (D_{it}) is not randomly assigned, which violates the random effect hypothesis (i.e., $E(D_{it}\varepsilon_{it}) = 0$).

the recommendations in Bertrand et al. (2004), Angrist and Pischke (2009), Athey, Abadie, Imbens, and Wooldridge (2017).

The objective of empirical framework in this study is estimating the coefficient of β to show the effect of participation in agricultural GVCs by testing the null hypothesis $H_0 : \beta = 0$ and the alternative hypothesis $H_A : \beta \neq 0$.

2.2 Alternative specifications

Although the baseline model controls for country fixed effects, regional fixed effects, and year fixed effects, the baseline specification excludes controls for (i) region year fixed effects, (ii) a linear time trend, (iii) country-specific time trends, and (iv) region-specific time trends. To ensure that findings are robust, comparable alternative specifications are also estimated.

First, the time effects often differ across regions in cross-country analysis. For example, the effects of climate shocks or oil price shock (Baumeister et al., 2010) in a year may be limited to specific regions. In Equation (2), region-specific year fixed effects (μ_{st}) is replaced with year fixed effects (μ_t) in Equation (1) to eliminate all the regional-specific-invariant factors within each year.

$$y_{ist} = \alpha + \beta D_{it} + \gamma D_{ot} + X_{it}\delta + \alpha_i + \mu_{st} + \varepsilon_{it} \quad (2)$$

The second alternative specification includes a linear time trend by adding the time trend variable (θt) on right-hand side of Equation (1) such that

$$y_{it} = \alpha + \beta D_{it} + \gamma D_{ot} + X_{it}\delta + \alpha_i + \mu_t + \theta t + \varepsilon_{it} \quad (3)$$

To ensure the founding from a linear time trend is robust to country-specific time trends or regional-specific time trend, I estimate Equation (4) and (5) such that

$$y_{it} = \alpha + \beta D_{it} + \gamma D_{ot} + X_{it}\delta + \alpha_i + \mu_t + \theta t_i + \varepsilon_{it} \quad (4)$$

$$y_{ist} = \alpha + \beta D_{it} + \gamma D_{ot} + X_{it}\delta + \alpha_i + \mu_t + \theta t_s + \varepsilon_{it} \quad (5)$$

where t_i and $\mathrm{t_s}$ are vectors of country-specific and region-specific time trends, respectively.

2.3 Identification Strategy

It is important to discuss potential treats to identification. Because the extent of GVCs participation by a country is not randomly assigned, and so the treatment is not exogenous to the structural transformation measured in GDP shares by the sectors.

I provide the identification strategy for β in Equation (1) by documenting four primary sources of endogeneity: (i) unobserved heterogeneity, (ii) measurement error, (iii) reverse causality, and (iv) violation of the stable unit treatment value assumption.

2.3.1. Unobserved Heterogeneity

A specification model should include all potentially relevant variables in an estimated model to avoid a biased parameter estimate due to the unobserved heterogeneity. Although it is not feasible to completely include all omitted variables, in many cases, it is important to acknowledge and eliminate the possibility of omitted variables.

In my empirical framework, multiple econometric methods are employed to eliminate the unobserved heterogeneity. First, country fixed effects (α_i) used in the baseline model are expected

to control for the time-invariant factors in each country. The time-invariant factors include country-specific geographical conditions and socio-cultural backgrounds, such as language or history, which have been considered as determinants to the volumes of trade or economic growth. Country fixed effects also control for the initial level of economic conditions (e.g., levels of GDP in the initial year in the panel data) in each country, which often determine the pattern of structural transformation of a country (Vries, Timmer, Vries, 2015; Hnatkovska and Lahiri, 2016; Bustos, Caprettini, and Ponticelli, 2016).

Secondly, year fixed effects (μ_t) in Equation (1) purge the error term of its correlation with the treatment variable due to factors that remain constant across all countries in a given year. For example, structural transformation might be deterred in 2007-2008 for the global financial crisis across countries. One might argue that year fixed effects cannot not capture time-varying unobserved confounding factors unique to a given region in a given year such as regional climate changes (e.g., the impacts of climate change on Sub-Saharan Africa) or political changes (e.g., Arab Spring in the Arab world in 2010). Thus, I include regional-specific year fixed effects (μ_{st}) in the alternative specification (See Equation (2)).

Third, the baseline model controls for an exhaustive set of time-varying confounders at the country-level. The vector of time-varying control variables (X_{it}) includes economic factors (e.g., GDP and arable land area of agriculture) and demographic structure (e.g., population, urban population growth, dependency ratio) by following previous empirical studies of structural transformation (Michaels et al., 2012; Bustos et al., 2016; Duarte and Restuccia, 2010, Alvarez-Cuadrado and Poschke, 2011).

One might concern that the extent of agricultural GVCs is endogenous due to changes in (i) trade policy within a country, (ii) trade competitiveness with other countries, or (iii) domestic

agricultural price policy. To control for the time-varying trade policy and competitiveness, the vector of X_i also contains trade variables (e.g., regional trade agreement (RTA), free trade agreement (FTA), custom union (CU)) and the participation level of agricultural GVCs (D_{ot}) by neighboring countries of country i at year t. I control for domestic agricultural price policy by generating a time-varying variable adopting the method by Timmer and Akkus (2008).

Lastly, I control for time trends to eliminate the potential bias stemming from unobserved heterogeneity in my data that varies systematically across countries over time. The systematical pattern of structural transformation across country over years ─ increasing shares from the agriculture to manufacturing, and further service sector ─ is commonly observed in literature of economic growth. The dataset I used in this study also shows the pattern (See. Figure 2). Thus, I further estimate alternative specifications in Equation (3) ─ (5) that include (i) a linear time trend (t), (ii) country-specific time trends (t_i), and (iii) region-specific time trends (t_s), respectively.

Although most of the unobserved heterogeneity can be captured by the econometric methods, the identification assumption in this study is that any left omitted variables do not significantly bias the estimate of β.

2.3.2. Measurement Error

Another source of endogeneity issue is measurement error. Measurement error might not be a serious concern if one uses a valid instrument variable. Otherwise, in fixed effects regression, one should avoid overly strong claims when interpreting fixed-effects estimates since the data might have systematic errors, such as under- or over- reporting (Angrist and Pischke, 2008).

In measuring the extent of GVCs, missing information on a division between intermediate and final goods is the major source of measurement error. This is because there are heterogenous custom product codes in cross-border supply chains. Although there are a few trials to measure the extent of GVSs in the literature, the existing measures are still not free from measurement error issue.[2]

In this study, the treatment variable of the extent of agricultural GVCs in each country (D_{it}) is measured using the recent measure developed by Wang, Wei, and Zhu (2017). Their measure eliminates the described missing information source by decomposing value-added production activities in cross-border production. Also, it provides the upstream and the downstream GVC participation index, which supply more detailed GVC involvement in countries compared to other measures (See. Antràs and Chor, 2018). Thus, this study relies on the proven validity of the measure of GVCs (Antràs and Gortari, 2017; Antràs and Chor, 2018; Balié et al., 2017) to reduce measurement error in measuring the treatment variable (D_{it}).

Another concern is on measurement error related to structural transformation. I use the GDP shares of three sectors each country over years as a primary measure of structural transformation. The panel data of GDP used in this study is the assembled collection from statistical offices in 183 countries which is uniquely available. Although the estimates of GDP are comparably reliable in most developed countries, they are likely to be associated with underestimation in many developing countries (Jerven, 2013; Vries et al., 2015). For example, various African countries are subject to large measurement error in estimating GDP due to low quality of statistical management

[2] See Wang et al. (2017) for measurement error issue in the early-stage measures of GVCs, such as vertical specialization (VS) method by Hummels et al. (2001) or import to produce (I2P) and export (I2E) method by Baldwin and Lopez (2013).

— a weak capacity to collect data, inadequate funding of statistical offices, or fragmentation in surveys —, so called "Africa's statistical tragedy" (Devarajan, 2013; Jerven and Johnston, 2015).

The possibility of underestimated GDP in developing countries might affect the identification of β in two ways. First, if GDP data are systematically underestimated for all three sectors — agriculture, manufacturing, and service —, then the estimate of $\hat{\beta}$ is less likely to be biased because the shares of GDP by the sectors are still constant (i.e., the ratio of GDP by the sectors is constant as the total proportion of absolute GDP decreases by the sectors). Secondly, if GDP is relatively more underestimated in a specific sector, then the $\hat{\beta}$ is biased to β. Given that, in developing countries, GDP is seriously underestimated in the service sector (Jerven, 2013), it is likely to argue that the estimate of $\hat{\beta}$ would be $|\hat{\beta}| < |\beta|$ in the service sector. This implies that a rejection of the null hypothesis test (i.e., $H_0 : \beta = 0$) provides a stronger evidence in the service sector because the coefficient of $\hat{\beta}$ is a lower bound of the true coefficient of β.

For the robustness check, I also use alternative measures of structural transformation — employment shares by the sectors. Moreover, in extension analysis, I provide separate estimation only for developed countries (i.e., OECD) whose data is more reliable, excluding developing worlds.

Despite all efforts to eliminate measurement error, there might be random sources due to unobserved quality issues with the data used in this study. Thus, the second identification assumption is that any other random measurement error does not significantly affect biasness of the estimate β.

2.3.3. Reverse Causality

The third concern of the endogeneity issue is reverse causality. If structural transformation leads to participation in agricultural GVCs at the country level (i.e., y_{it} and D_{it} is jointly determined), the estimate of β would obscure the reverse causality. The economic structural transformation is, however, unlikely to be the dominant influence on the participation in GVCs for two reasons.

First, in the literature of growth and trade theories, a country's structural transformation measured by GDP (or employment) shares by the sectors is proved as an outcome variable, which is determined by various economic activities and factors by countries (e.g., production function, land-augmenting technical change (Bustos, Caprettini, and Ponticelli, 2016), labor productivity (Vries et al., 2015), land allocation, population mobility (Michaels, Rauch, and Redding, 2012), or urbanization (AER, 2016). The more recent study by Teignier (2018) contributes to the literature by providing the theoretical model of how trade-related factors determine structural transformation in terms of the shares of economic activities by the sectors.

Secondly, in a year, trade activity is commonly performed before the GDP is calculated. The GDP is an aggregate measure of total economic production including personal consumption, government purchases, paid-in construction costs and the foreign trade balance within a country during the period. Therefore, the GDP in year t that should be calculated after year t can reflect economic production activities ─ including participation in GVCs ─ in a country in year t rather than vice versa.

One might concern that GVCs is influenced by structural transformation through dynamic mechanism. For example, the increased share of GPD (or employment shares) in agriculture might accelerate a country to be more involved in the agricultural value chains in the global trade since the country allocates more economic resources on the agricultural sectors. To explore the

possibility of reverse causality due to the dynamic nature of structural transformation (Carkovic and Levine, 2002; Vries, Michaels, Rauch, Redding, 2012; Timmer, and Vries, 2015; Hnatkovska and Lahiri, 2016), I check the robustness of estimates β by using the dynamic panel linear regression method (See Equation (7) in Section 5).

2.3.4. The Stable Unit Treatment Value Assumption (SUTVA)

The final endogeneity source is the Stable Unit Treatment Value Assumption (i.e., hereafter SUTVA). SUTVA requires that the dependent variable of a particular unit (y_i) depends only on the treatment to which it itself was treated (x_i), not the treatments of others around it (x_j) where $i \neq j$. In panel data analysis, a linear model is often assumed SUTVA without which the statistical theory does not hold (Heckman, 2008), and further violation of SUTVA obviously lead to endogeneity (Pearl, 2009).

In the model specification using Equation (1), SUTVA can be violated if and only if (i) the treatment of GVCs for country i affects the structural transformation for another country j or (ii) there is at least one more version of each treatment level (i.e., country). Especially for the first case, one might be concerned that SUTVA is violated because structural transformation in one country might be influenced by the trade strategies of his neighboring countries as spillover effects in trade. For example, the labor share in agriculture in a country might be increase (or decrease) through cross-border migration or the in-or-out flows of foreign investment as its bordered countries has been highly involved in agricultural GVCs.

In effort to eliminate the potential bias stemming from the violation of SUTVA, I control for the neighboring countries' GVCs for all countries. I define the neighboring countries' GVCs by

taking the average value of GVCs indexes of neighboring countries. In this study, neighboring countries are defined as all bordered countries of each country. For isolated countries ─ both geographically (e.g., Australia or Japan) and politically isolated (e.g., South Korea)─, I use five geographically nearest countries as a proxy for bordered countries. The average GVCs index of neighboring countries can partially control for the within-year spillover effects, and thus the likelihood of violation to SUTVA decreases.

Although the identification strategy is expected to control for most possibility of the violation of SUTVA, it is only limited to contemporary SUTVA. Given that this use panel data, the possibility of violation of SUTVA is still remaining in cases that spillover effects occur within a country over years, or between countries over years is still remaining. Although the dynamic model estimation in Equation (5) marginally check robustness for the former case, this study assumes that the violation of SUTVA between countries over years does not significantly bias the estimate of β.

3. Data Sources and Measurement

This section provides summary information on measurement, data construction, and data sources. The data used in this article is required to be pooled together from various sources in order to estimate Equation (1). Here, I categorize the data information into three parts: (i) GVCs participation, (ii) structural transformation, and (iii) other key variables.

3.1. Participation in Global Value Chains

In trade literature, developing a consistent statistical and conceptual portrait of GVCs has been difficult for two reasons: (i) missing data issue and (ii) lack of reliable measures.

First, unlike conventional trade data that accounts for the final product transaction, data for measuring GVCs essentially requires industry-level data which enables us to track all value-added activities by industries or countries involved in global production. The national accounts data (e.g., gross import or export of final products) are, however, not suitable for measuring GVCs because the national accounts data lack information of value-added intermediate input transaction. National Input-output account data was also considered as alternative data since they describe value chain linkage across industries within a country; it cannot provide any information of cross-border transactions (Johnson, 2017).

To overcome the limitation with both types of conventional data, a multi-country input-output table is required to provide a comprehensive map of international transactions of goods and services in a dataset that combines the national input-output tables of various countries at a given point of time (Inomata, WB, 2017)[3]. In this study, I use the multi-region input-output tables (MRIO)

[3] Reference to be added.

which were recently released in the Eora database. The MRIO data tracks all value-added activities by industries not only within a country but also across countries input-output value-added activities in 26 industries for 183 countries from 1990 to 2013. In this study, I use the industry classification of 'agriculture' industry to measure agricultural GVCs.[4] For detailed information of data structure, see Lunzen et al. (2013).

The other reason for the difficulties of the task for measuring GVCs is due to lack of a coherent measure of GVCs. In the last few decades, researchers have struggled to conceptually define what types of value-added activities should be taken account for GVCs measure (Hummels, Ishii, and Yi, 2001; Chen et al., 2004; Daudin, Rifflart, and Schweisguth, 2006; Johnson and Noguera, 2012; Bems and Johnson, 2012).[5] Because international trade in value-added goods or services is often too complicated to track and the flows of GVCs are heterogeneous depending on products and industries, decomposition of gross exports into various sources of value-added has been recognized as a challenging job.

In this analysis, I adopt one of the most recent measures of GVCs developed by Wang et al. (2017). The primary advantages of their measure of GVCs are characterized in two parts. First, the measure can capture all complicated sources of value-added activities across more than two countries, which are often missed in other measures of GVCs. Second, they provide an empirical method to extract value-added exports from gross exports that enable users to recover each value-added activity by using cross-country input-output data.[6]

[4] For extension study in A5-A8, I use the classification of 'food and beverage' industry to measure food GVCs.
[5] See Inomata (WB-Report, 2017) for more detailed literature review of the development of measures of GVCs. Reference needs to be added.
[6] See Wang et al. (NBER, 2017) for computational analysis of GVCs using the input-output table.

Figure A2 graphically describes the components of GVCs wherein gross exports are decomposed into four broad activities: [7]

(i) Domestic value-added absorbed abroad (DVA)

(ii) Domestic value-added first exported then returned home (DVX) – forward GVC participation (upstream)

(iii) Foreign value added (FVA) – backward GVC participation (downstream)

(iv) Pure double-counted terms (PDC)

For the purpose of the analysis in this study, each activity can be interpreted in the following way[8]: First, DVA is excluded to measure GVCs because this is a conventional transaction of final products between two countries. Second, DVX measures forward GVC participation (or upstream). DVX reflects producer perspective by addressing what extent of production factors employed in a country has been involved in cross country production sharing activities. Third, FVA measures backward GVC participation (or downstream). FVA reflects consumer perspective by addressing what extent of final products produced by a country that is sourced from GVC activities. Lastly, PDC is an accounting component generated where value-added products cross borders multiple times and thus PDC needs to be included when measuring the total GVCs. Finally, we measure the GVC participation (D_{it}) for country i in year t by following:

[7] Figure A2 shows their more recent revised framework where gross exports are decomposed into 7 activities for simplicity (WB-report, 2017).

[8] In Wang et al. (2017), gross exports are decomposed into four broad activities; each activity is then further decomposed into 16 value-added sub-activities by trading mode. For the purpose of this study, my analysis measure the aggregate GVCs participation rather specific sub-activities of GVCs.

$$D_{it} = \frac{DVX_{it}+FVA_{it}+PDC_{it}}{Gross\ Expo_{it}} \quad (6)$$

3.2. Structural Transformation

The structural transformation of countries involves a variety of features. In general, structural transformation is characterized in a country by following economic changes: (i) a falling share of agriculture in economic output and employment, (ii) a rising share of urban economic activity in industry or services, (iii) the migration trend from rural to urban, (iv) a demographic transition from high birth rates to low death rates, and (v) a rising female labor participation from agriculture to service (Timmer, 2009).

In the literature of economic growth and development, three measures of national economic activities by the sectors ─ agriculture, manufacture, and service ─ have been widely used: (i) GDP shares, (ii) employment shares, and (iii) final consumption shares (Herrendorf, Rogerson, and Valentinyi, 2014). For example, one can measure structural transformation in a country by measuring the gap between shares of economic activities across the sectors over given time periods. GDP and employment shares are considered as production approach while final consumption share is as consumption approach.

In this study, the shares of GDP of countries at three sectors ─ agriculture, industry, and service ─ are used as the main measure of structural transformation. To perform the robustness check, the employment shares by the sectors are also used. However, this study excludes the final consumption shares as an alternative measure of structural transformation because of two reasons. First, it is difficult to obtain credible data of expenditure estimates in numerous developing countries such as Sub-Saharan Africa or South Asia (Ravallion, 2001). Also, final consumption in

the service sector has been proved perpetually challenging and underestimated not only for developing countries but also developed countries (Landerfeld, Seskin, and Fraumeni, 2008). Hence, the measure of structural transformation in this study is inevitably limited to production approach.

The data source of structural transformation used as dependent variables is the World Development Indicators database (WDI). The cross-country data contains the value-added GDP shares by the agriculture, industry, and service sectors for 183 countries from 1990 to 2013.[9] Total GDP is measured at purchaser prices. It is not allowable to have the sum of GDP shares over one by its definition. Thus, I dropped 28 observations whose sum of GDP shares by three sectors is larger than one to avoid measurement error.

3.3. Control Variables

Finally, I pool together data from a large number of sources for time-varying control variables (X_{it}) in Equation (1). First, to measure of domestic price policy variable, I generate the variable of the domestic policy agricultural terms of trade (Domestic policy AgToT) by adopting the method by Timmer (2009). I use FAO database and FAO price index to calculate the variable.[10] Secondly, CEPII database is used to have trade policy variables ─ regional trade agreements (RTA) sourced from WTO (2015), custom unions (CU), and free trade agreements (FTA) sourced from Baier and

[9] Value added is the value of the gross output of producers less the value of intermediate goods and services consumed in production, before accounting for consumption of fixed capital in production.

[10] By Timmer (2009), agricultural terms of trade (AgToT) ─ the ratio of GDP deflator in Agricultural value-added to GDP deflator in non-agricultural value-added ─ can be recognized as a proxy for agricultural price policy in trade, which is dominantly influenced by world food price. Domestic price policy is measured by $Domestic\ Policy\ AgToT = \frac{predicted\ AgToT}{actual\ AgT} * 100$. See Timmer (2009) for more description of the calculation.

Bergstrand data. Third, I measure the neighbor countries' GVCs participation by averaging GVCs indexes of all bordered countries of each country. For island countries where bordering country does not exist, I use top five nearest countries as a proxy for bordering country. I use the geographical data from DistanceFromTo to identify the top five nearest countries from each island country. Lastly, I use the World Development Indicator database for the rest of control variables including agricultural land area, population, urbanization, GDP, and dependency ratio.

4. Estimation Results

This section provides the empirical results. Before I discuss the parametric results, I begin by with nonparametric results that present unconditional relationships between structural transformation and participation in agricultural GVCs. After checking the instructive correlation, I then discuss parametric estimation results for the various linear specifications in Equation (1) – (5). In summary, both nonparametric and parametric results provide the robust evidence that structural transformation is positively and significantly correlated with participation in agricultural GVCs by countries. Remarkably, in response to greater agricultural GVCs participation, the economic growth in the manufacturing sectors remains stable, but economic growth in the services sector increases while growth in agriculture consistently decreases. The result is robust to different measures of structural transformation across different model specifications.

4.1 Nonparametric Results

Figure 3 shows scatter plots of the sectoral GDP shares and the index of agricultural GVCs participation for 183 countries from 1990 to 2013. Figure 3 a, b, and c respectively represent each sector ─ agriculture, manufacturing, and service. The index of GVCs is shown on the X-axis and the GDP share by each sector is shown on the Y-axis. Each point in the scatter matches one country in a given year, and each figure include a linear regression of GDP shares on the index of GVSs along with 95% confidence interval.

One noteworthy interpretation from Figure 3 is that structural transformation seemingly occurs from agriculture to service. From the scatter plots in Figure 3a, the negative relationship between the GDP share in agriculture and the participation in the agricultural GVCs. Similarly, the negative relationship is also observed in the manufacturing sector in Figure 3b, along with nearly identical

slope. It is, surprisingly, opposite in the service sector. In Figure 3c, the relationship between the GDP share in the service sector, and the participation in GVCs is positive, along with almost twice higher slope in absolute value. The correlation is robust to an alternative measure of structural transformation ─ the employment shares ─ in the agriculture and service sectors, but the manufacturing sector (See Appendix figures A1a-c).

This is, however, the results only looking at the unconditional correlation between structural transformation and agricultural GVCs. In the next subsection, I then provide the parametric results controlling for confounding factors with different specifications.

4.2 Parametric Results

In this subsection, I begin by presenting the core results from most to least parsimonious specifications in terms of various set of control variables. First, I describe the initial estimation not controlling for confounding factors. Then, I successively discuss how the estimation results are robust by accounting for spillover effect by neighbor countries, trade policies, and a richer set of covariates, including domestic price policy, economic resources, and demographic transformation. By providing the estimation results in these steps, it is more clarified how stable the estimate of interest (β) is with or without controlling for different aspects of time-varying covariates, which are likely correlated with the treatment variable of D_{it}.

4.2.1 Initial Estimates

Table 1 presents the initial estimation results from the linear regression estimation for Equation (1) – (5) without time-varying covariates ─ D_{ot} and X_{it}. Panel 1– 3 show the sectors of agriculture, manufacturing, and service respectively. For all panels, Columns (1) through (5) show results on the full sample along with country fixed effects. Column (1) includes country country-specific

year fixed effects while Column (2) includes regional-specific year fixed effects. From Column (3) to (5) contain (i) a time trend, (ii) country-specific time trends, and (iii) regional-specific time trends respectively, all with country-specific year fixed effects.

Through Panel 1-3, my baseline specification results in Column (1) provides two primary findings. First, the agricultural GVCs participation is negatively and significantly associated with the GDP share in the agricultural sector. On the other hand, the GVCs participation is positively and significantly associated with the GDP share in the service sector when controlling for country fixed effects and country-specific year fixed effects on average. The GDP share in service increases by 0.017 percent while the GDP share in agriculture decreases by 0.015 percent in response to the marginal increase in GVCs participation. No significant effects are found in the manufacturing sector.

Secondly, the result is also robust to other specifications. Similar results are founded in Column (2), (3) and (5) when accounted for regional-specific year fixed effects, a linear time trend, and regional-specific time trends. Although heterogeneous effects between manufacturing and service sectors are, however, observed when controlling for country-specific time trend in Column (4), my initial estimation results overall imply that the agricultural GVCs participation leads to the GDP shares in a country directly from agriculture to service by leapfrogging manufacturing.

4.2.2 Does the neighboring countries GVCs matter?

The results in Table 2 suggest how participation in GVCs by neighboring countries affects the structural transformation in a country. The motivation for controlling the GVCs by neighboring countries is that the economic structure in a country is likely exposed to trade competition or cooperation by its geographically near countries (Acemoglu, Autor, Dorn, Hanson, and Price,

2014). It might be possible that the structural change in economic growth labor shares across the sectors in a country is influenced not only by its GVCs involvement but also by the involvement of its neighboring countries in GVCs. To exam this issue, Table 2 includes the time-varying covariates of the GVCs by neighboring countries $-D_{ot}$ in Equation (1) $-$ (5).

Table 2 yields similar results with Table 1. In Table 2, there are the statistically significant relationships between GVCs participation and each sector by addressing (i) negative effect in the agriculture sector, (ii) no effect in the manufacture sector, and (iii) positive effect in the service sector. Also, the estimated coefficients of our interest variable (β) is stable and more significant.

More importantly, in Panel 1, it appears that the GDP share in the agricultural sector has statistically significant association with its neighbor countries' GVCs participation in the same direction. Further, the effects of neighbor countries' GVCs participation is approximately six times larger than the effect of its own GVCs participation. This association additionally provides the new evidence of the spillover effects of GVCs by neighboring countries.

4.2.3 Controlling for Trade Agreements

One might argue that the effect of GVCs on structural transformation will disappear if trade policies by each country are accounted. Indeed, whether one country is more (or less) involved in GVCs is obviously related to its trade policy such as trade regulations or agreements. For example, trade liberalization in African countries has been dramatically expanding since 2000 through FTAs with major free trade countries or through Southern African Customs Union (SACU) between African countries (Goger et al., 2014). On the other hand, numerous politically unstable countries (e.g., Afghanistan, North Korea) or geographically isolated countries (e.g., Samoa, Solomon

Islands) are limited to access to trade agreements with other countries, and thus their participation in GVCs are likely to be restricted.

To examine whether trade agreements are soaking up the effect of GVCs on structural transformation, Table 3 provides the results of my baseline model in Equation (1) by controlling for three representative trade agreements ─ regional trade agreement, customs unions, and free trade agreement. I control for time-varying dummy variables of trade agreements in Columns (1) – (3) and control for the numbers of each trade agreement in Columns (4) – (6). The results are strongly robust to accounting for trade agreement covariates by addressing the fact that the GDP share in agriculture decreases and the GDP share is service increases while there is no effect on the manufacturing sector.

4.2.4 Robustness to More Covariates

I finally assess the robustness of the core results in Table (1) by controlling for a richer set of time-varying covariates in addition to the GVCs participation by neighbor countries and trade agreements. To alleviate concern about country-specific time-varying covariates, Tables (4) – (6) explores whether the coefficient of interest variable is still statistically significant and stable by controlling for economic conditions (e.g., GDP, agricultural land), demographic changes (age dependency ratio), urbanization (rural population, urban population growth) and domestic agricultural policy (domestic policy agricultural terms of trade[11]). Through Column (1) to (5), I look at specifications in which I control for (i) country-specific year FE, (ii) regional-specific year FE, (iii) a time trend, (iv) country-specific time trends, and (iii) regional-specific time trends

[11] See Timmer (2008).

similar to Table (1). Tables (4) – (6) present estimation results for the agriculture, manufacture, and service sectors, respectively.

Conclusively, the results in Tables (4) – (6) strengthen the evidence that participation in agricultural GVCs drives structural transformation directly from the agriculture to the service sector on average from 1990 to 2013. In all specifications, the estimates of our interest variable β are statistically significant following same directions found in Tables (1) – (3).

5. Robustness Checks

In this section, I conduct additional analyses to check the robustness of the results. The robustness is explored in three techniques: (i) an alternative estimation of dynamic model specification, (ii) an alternative measure of structural transformation, and (iii) an alternative measure of agricultural GVCs. The following results consistently show that the agricultural GVCs participation is negatively associated with the agricultural sector and positively associated with the service sector.

5.1 Alternative Estimation: Dynamic Panel Regression

The alternative estimation considers a dynamic panel regression. Although the parametric results in Tables (4) – (6) address that the baseline model of Equation (1) is robust to four different specifications, one might concern that the effect of GVCs on structural transformation should be accounted for in dynamic model specification. In the literature of economic growth, a few studies often emphasize the dynamic nature of structural transformation (Carkovic and Levine, 2002; Vries, Michaels, Rauch, Redding, 2012; Timmer, and Vries, 2015; Hnatkovska and Lahiri, 2016).

To provide robustness under dynamic growth model, I estimate

$$y_{is,t} = \alpha + \theta y_{is,t-1} + \beta D_{it} + \gamma D_{ot} + X_{it}\delta + \alpha_i + \lambda_s + \mu_t + \epsilon_{it} \qquad (7)$$

where y_{it-} is the lagged dependent variable. Using the OLS estimator to estimate Equation (7) might give rise to autocorrelation because of the presence of the lagged dependent variable (y_{it-1}). Also, the limited sample size in this study ─ the number of countries ─ cause inconsistent estimates by using a fixed effect estimator in dynamic panel regression where the strict exogeneity assumption is mostly violated. To avoid the potential shortcoming, I use the Generalized Method

of Moments (GMM) panel estimator designed by Arellano and Bover (1995) and Blundell and Bond (1997). This dynamic panel estimator offers advantages to OLS estimator for three ways: (i) it eliminates the fixed effects as well as autocorrelation by instrumenting the lagged variables, (ii) it is developed for small T and large N (Mileva, 2007), and (iii) it extracts consistent and efficient estimates of the effect of GVCs participation on the outcome variables (Carkovic and Levine, 2002).[12]

The results shown in Table 7 indicate that coefficient estimates of the interest variable (β) is highly significant both on the GDP shares in agriculture and service and the signs of coefficients are identical with the results found in Table (1) – (6). Under the dynamic model, the negative effect on the GDP share in agriculture is stronger than the result by OLS estimator. The manufacturing sector is still not influenced by GVCs. In other words, the effect of agricultural GVCs on structural transformation is robust to the assumption of a dynamic feature of structural transformation.

5.2 Alternative Measure: Structural Transformation

As discussed in the section of empirical strategy, structural transformation can be measured in different ways due to the various features depending on its definitions. Table (A1) – (A3) shows results from an alternative measure of structural transformation – the employment shares by each sector (Timmer, 2008; Herrendorf, Rogerson, Valentinyi, 2013) – by estimating the baseline model Equation (1) along with four different specifications similar to Tables (4) – (6). The main result from Table (A1) – (A3) represents that the effects of GVCs on structural transformation is robust to an alternative measure of structural transformation which is measured in employment shares.

[12] The moment conditions will be added (Carkovic and Levine, 2002)

Table (A4) provides an additional estimation result to check whether the main results are robust to the assumption of the dynamic panel model. By using the identical GMM method used in Table (7), the results are strongly robust to the core results from Table (4) – (6). Moreover, further distinct results are found: (i) the employment share of the manufacturing sector is significantly and positively associated with the agricultural GVCs, (ii) the effects of GVCs on each sector is approximately one-third smaller compared to the case using the GDP share measure.

Overall, the core results are robust to the alternative measure of structural transformation and the agricultural GVCs have smaller effects on structural transformation where it is measured in terms of the sectoral labor allocation.

5.3 Alternative GVCs: Food Industry

Lastly, one might argue that the overall results does not reflect the characteristics of the modern agricultural value chains because the treatment variable of GVCs in this study is measured by using only the agricultural industry but the food industry. Last two decades, the emergence of a supermarket revolution (See. Reardon, Timmer, and Minten, 2012) has enhanced developing countries to join multinational processed food production, which lies closer to the final consumer in downstream in value chains. A recent study by Balié et al. (2017) consistently showed that not only for rich countries (e.g., EU and North America) but also for many developing countries (e.g., India, Latin, and ASEAN countries), the extent of food GVCs participation exceeds the extent of agricultural GVCs participation.

To explore if structural transformation is also associated with food GVCs, the results shown in Tables (A5) – (A7) provide the robustness check by using food GVCs instead of agricultural GVCs. In short, Tables (A5) – (A7) tell a similar story that the food GVCs also has strongly significant

relationship with structural transformation by passing over the manufacturing sector. The result is also robust to all different specifications in Column (1) – (5) but country-specific time trends in Column (4).

One interesting additional finding is that the estimates of the interested variable (β) in Table (A5) – (A7) is approximately 1.5 times bigger than the estimates in Table (4) – (6). This finding can imply that, on average, the participation in food GVCs is more effective than the participation in agricultural GVCs for structural transformation.

6. Extensions

Before concluding, I conduct two extension analyses. By slicing the data used in this study, this section explores (i) the comparison of the effects of GVCs between developed and developing countries, and (ii) the effects of the upstream and downstream GVCs participation on structural transformation by decomposing GVCs into two channels in global production.

6.1 Developed vs. Developing countries

First, Table (8) presents the different effects agricultural GVCs on structural transformation between developed countries (i.e., OECD countries) and developing countries which includes (i) Sub-Saharan Africa, (ii) South Asia, (iii) Latin America and the Caribbean, and (iv) Central and Western Asia. The outcome variable is the GDP shares in each sector throughout Column (1) to (6). In Column (7) ─ (9), the outcome variable is replaced with the employment shares to check the robustness to an alternative measure of structural transformation. In Columns (1) ─ (3), the coefficients are estimated by the baseline specification of Equation (1). In Columns (4) ─ (6), the dynamic specification in Equation (7) is estimated by using the GMM estimator similar to Table (7). Throughout Column (1) ─ (9), I employ the country FEs and the country-specific year FEs by controlling for all time-varying covariates similar to Table (4) ─ (6). Finally, Panels 1 to 7 present the results of estimation for each group, respectively.

The results in Table (8) shows the agricultural GVCs play differently between developed and developing countries. In Panel 2, the results provide the similar pattern of structural transformation similar to the core results in developing countries. In Panel 1, the pattern is, however, opposite in OECD countries. Unlike developing countries, the employment shares in both agriculture and

service significantly increases in developed countries while the share of employment in manufacture significantly decreases.

Not only for agricultural GVCs, this finding is also robust to the food GVCs. In Table (A8), I use the food GVCs instead of agricultural GVCs. In short, the key results include the following: (i) the relationship between the employment share in agriculture and GVCs are positive in developed countries and negative in developing countries, (ii) the relationship in the manufacture sector is negative in developed countries and positive in developing countries, (iii) the relationships in the service sector are positive in both developed and developing countries.

6.2 Upstream and Downstream GVCs

Secondly, Table (9) shows the effects of upstream and downstream GVCs participation on the GDP shares by three sectors, respectively. I use the method to decompose GVCs into up-and-downstream by using the method Balié et al. (2017). By estimating the coefficient of variable of our interest using identical specification with Table (4)-(6), in short, the results provide two main finding: (i) the GDP share is significantly decreases in the agriculture sector and increase in the service sector as a country is more involved in upstream GVCs on average, and (ii) the GDP shares significantly increase in agriculture and decrease in the service sector.

The results marginally provide policy implications that participation in the upstream GVCs leads structural transformation from agriculture to the service sector than the participation in downstream GVCs.

6. Conclusion

Despite their importance for the world economy, it is, however, unclear whether participation in GVCs leads the structural transformation ─ that is, the move from an economy primarily based on agriculture to an economy primarily based on manufacture, and then on service.

I have looked at whether participation in agricultural GVCs can lead structural transformation in countries. To do so, I have used the cross-country panel data analysis including 183 countries from 1990 to 2013. The key finding in this study addresses that modern-day developing economies leapfrog manufacturing sector to directly to service sector as they are participating in global value chains in agriculture industries. This result is strongly and significantly robust to various model specifications with year fixed effects, regional-specific fixed effects, and time monotonicity. Also, by using alternative measures of structural transformation such as GDP shares by sectors or female employment shares, the results are still strongly robust.

This study provides policy implication for developing worlds by providing the original evidence that participating in agricultural global production leads to increase in service sector GDP share and employment share, which indicates structural transformation. The effect is more effective when countries are involved in upstream production rather than downstream production in global value chains.

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Figures and Tables

Figure 1. Trend of Agricultural GVCs, 1990 - 2013

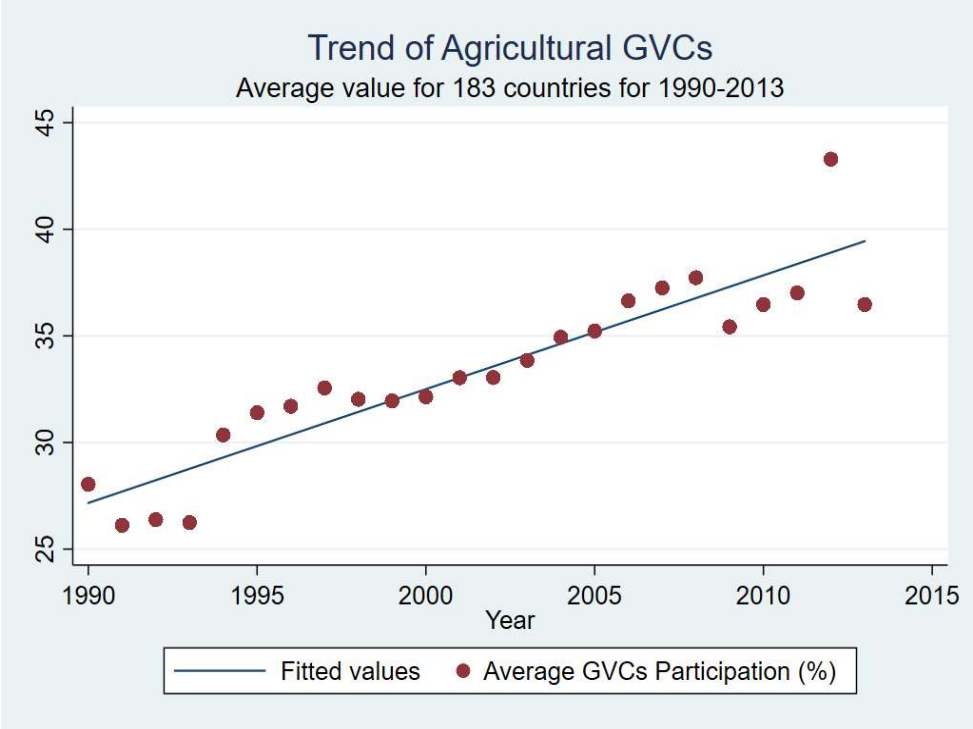
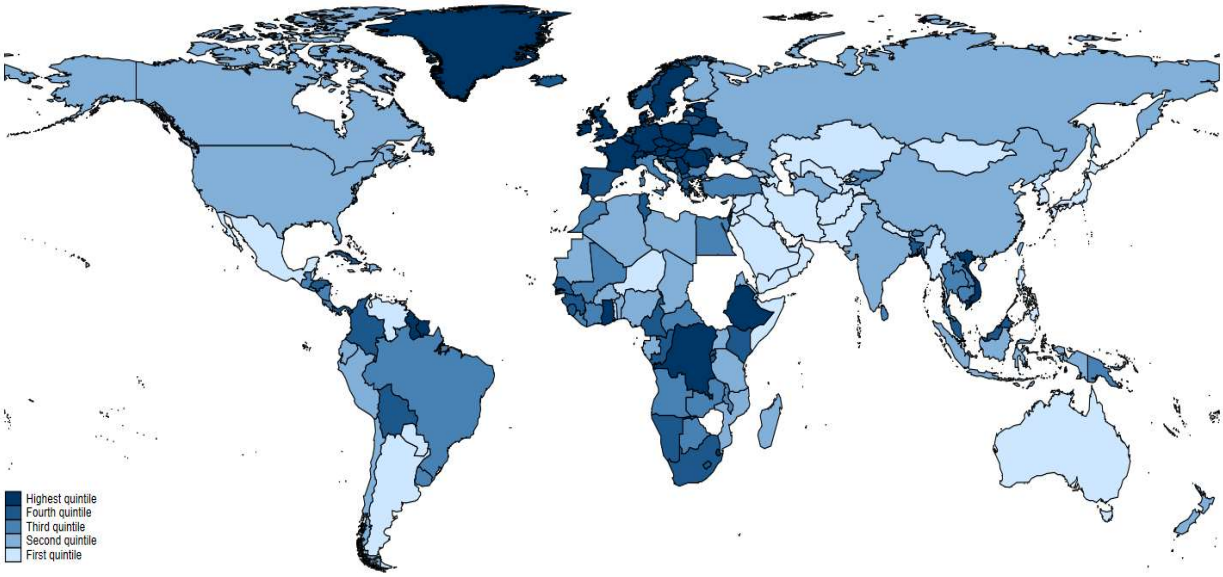


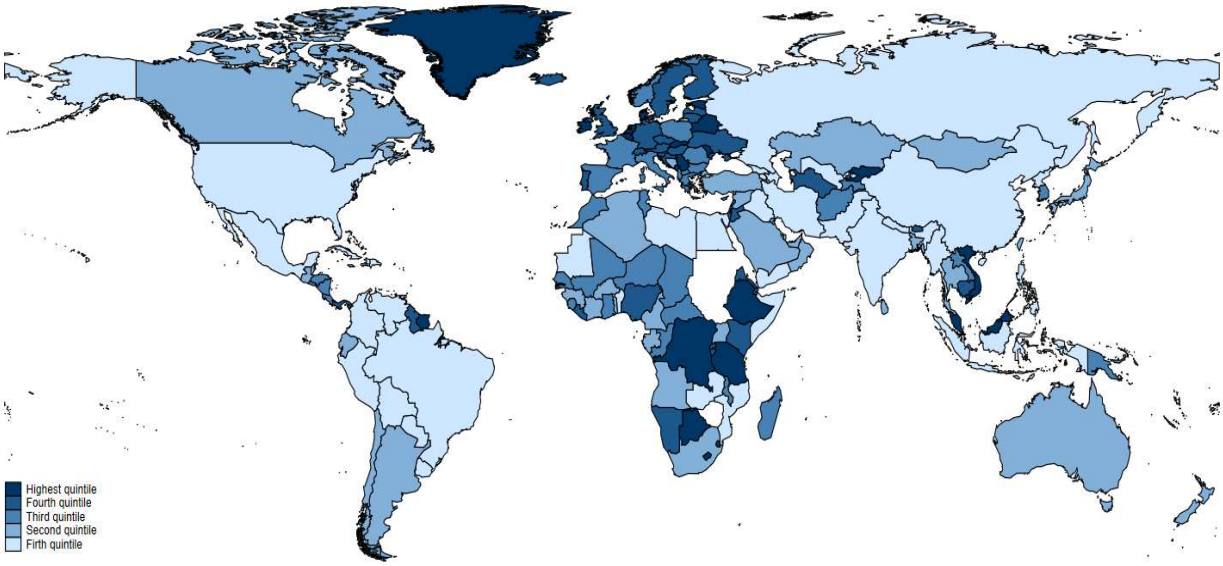
Figure 2. World Map of Global Value Chains Participation in 2013

Figure 2.a Agriculture Industry



Source: Author's own calculation

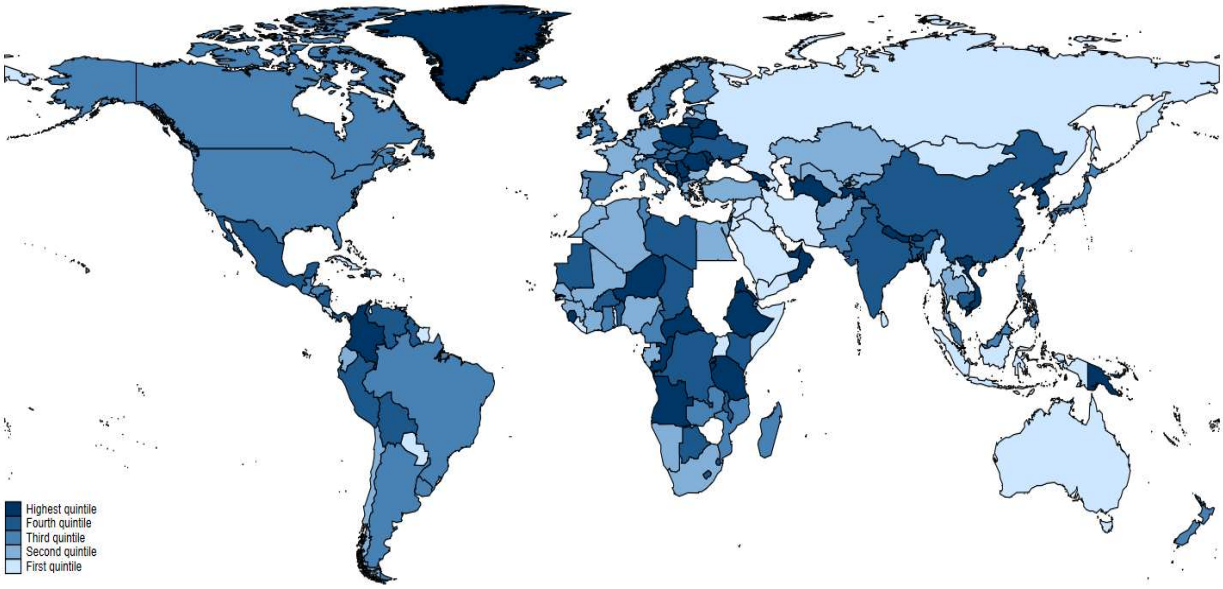
Figure 2.b Food Industry



Source: Author's own calculation

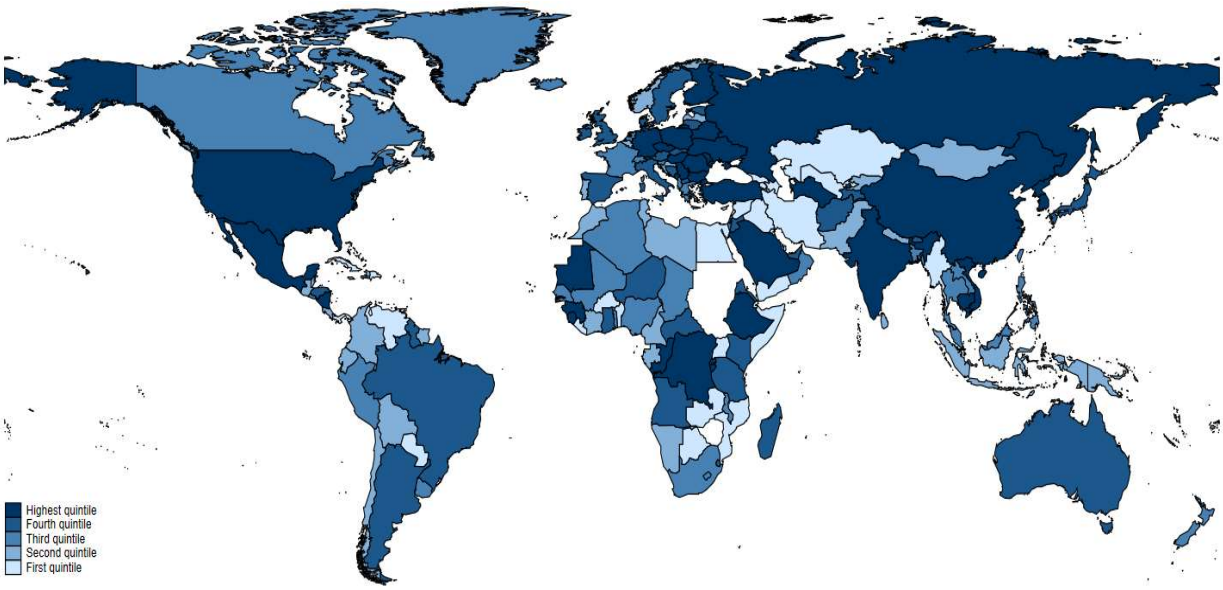
Figure 3. World Map of Global Value Chains Participation Growth Rate, between 1990 – 2013

Figure 3.a Agriculture Industry



Source: Author's own calculation

Figure 3.b Food Industry



Source: Author's own calculation

Figure 3. Structural Transformation and Agricultural GVCs, 1990 – 2013

Figure 3a. GDP Shares in Agriculture and Agricultural GVCs Participation

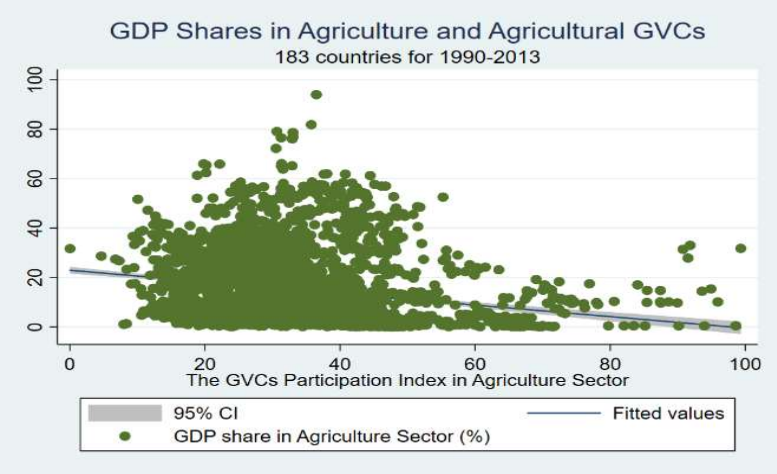


Figure 3b. GDP Shares in Manufacturing and Agricultural GVCs Participation

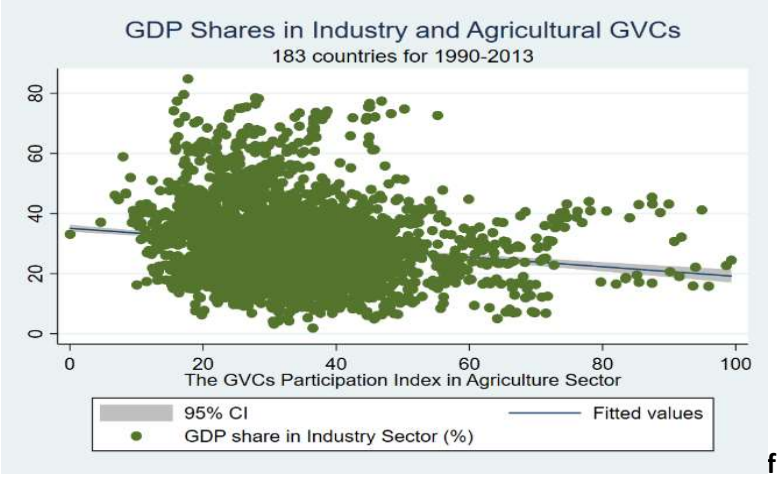


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Figure 3c. GDP Shares in Service and Agricultural GVCs Participation

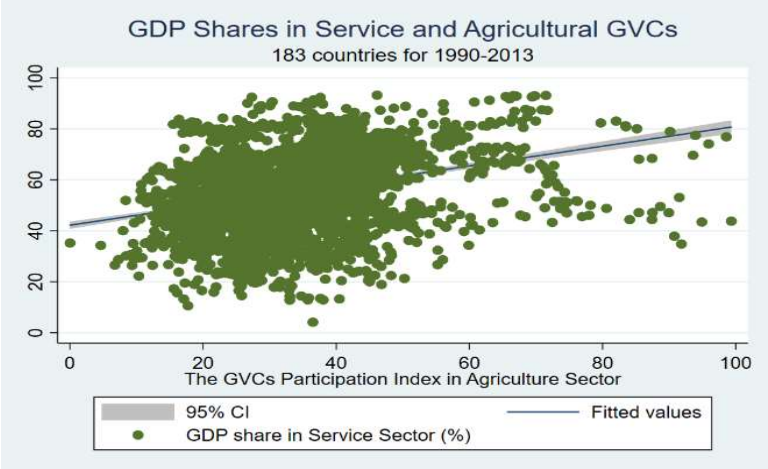


Table 1. Initial Estimation: Structural Transformation and Agricultural GVCs, 1990 -2013

Panel 1	**Dependent Variable: GDP Share in Agriculture (%)**				
	(1)	(2)	(3)	(4)	(5)
GVCs Participation	-0.015**	-0.010	-0.015**	-0.012***	-0.013**
	(0.007)	(0.006)	(0.007)	(0.004)	(0.005)
Constant	18.870***	18.711***	18.870***	19.069***	19.123***
	(0.468)	(0.427)	(0.468)	(0.471)	(0.455)
Observations	3,593	3,593	3,593	3,593	3,593
R-squared	0.262	0.409	0.262	0.632	0.336
Number of country	175	175	175	175	175
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes

Panel 2	**Dependent Variable: GDP Share in Manufacture (%)**				
	(1)	(2)	(3)	(4)	(5)
GVCs Participation	-0.001	-0.004	-0.001	0.011***	0.001
	(0.011)	(0.008)	(0.011)	(0.004)	(0.007)
Constant	31.158***	32.322***	31.158***	31.318***	31.405***
	(0.744)	(0.628)	(0.744)	(0.550)	(0.663)
Observations	3,608	3,608	3,608	3,608	3,608
R-squared	0.021	0.215	0.021	0.538	0.129
Number of country	175	175	175	175	175
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes

Panel 3	**Dependent Variable: GDP Share in Service (%)**				
	(1)	(2)	(3)	(4)	(5)
GVCs Participation	0.017***	0.014**	0.017***	0.001	0.012***
	(0.006)	(0.007)	(0.006)	(0.002)	(0.005)
Constant	49.824***	48.848***	49.824***	49.490***	49.337***
	(0.742)	(0.636)	(0.742)	(0.532)	(0.630)
Observations	3,585	3,585	3,585	3,585	3,585
R-squared	0.200	0.393	0.200	0.619	0.301

Number of country	173	173	173	173	173
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2. Structural Transformation and Agricultural GVCs, 1990-2013: Controlling for the Average participation of Agricultural GVCs by Neighbor Countries

Panel 1	**Dependent Variable: GDP Share in Agriculture (%)**				
	(1)	(2)	(3)	(4)	(5)
GVCs Participation	-0.015**	-0.015***	-0.015**	-0.012***	-0.013***
	(0.007)	(0.005)	(0.007)	(0.004)	(0.005)
GVCs Participation by neighboring countries	-0.084*	-0.086*	-0.084*	-0.032	-0.080*
	(0.047)	(0.049)	(0.047)	(0.038)	(0.043)
Constant	21.144***	21.207***	21.144***	19.946***	21.285***
	(1.380)	(1.480)	(1.380)	(0.990)	(1.250)
Observations	3,593	3,593	3,593	3,593	3,593
R-squared	0.271	0.416	0.271	0.633	0.344
Number of country	175	175	175	175	175
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes

Panel 2	**Dependent Variable: GDP Share in Manufacture (%)**				
	(1)	(2)	(3)	(4)	(5)
GVCs Participation	-0.001	-0.003	-0.001	0.011***	0.001
	(0.011)	(0.007)	(0.011)	(0.004)	(0.007)
GVCs Participation by neighboring countries	0.014	0.015	0.014	0.001	0.031
	(0.031)	(0.034)	(0.031)	(0.015)	(0.024)
Constant	30.775***	31.901***	30.775***	31.282***	30.552***
	(1.169)	(1.202)	(1.169)	(0.659)	(0.963)
Observations	3,608	3,608	3,608	3,608	3,608
R-squared	0.022	0.215	0.022	0.538	0.130
Number of country	175	175	175	175	175
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes

Panel 3	Dependent Variable: GDP Share in Service (%)				
	(1)	(2)	(3)	(4)	(5)
GVCs Participation	0.017***	0.018***	0.017***	0.002	0.013***
	(0.006)	(0.006)	(0.006)	(0.002)	(0.004)
GVCs Participation by neighboring countries	0.069	0.072	0.069	0.031	0.049
	(0.056)	(0.068)	(0.056)	(0.031)	(0.057)
Constant	47.942***	46.767***	47.942***	48.643***	48.018***
	(1.837)	(2.111)	(1.837)	(0.939)	(1.772)
Observations	3,585	3,585	3,585	3,585	3,585
R-squared	0.204	0.397	0.204	0.619	0.303
Number of country	173	173	173	173	173
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3. Structural Transformation and Agricultural GVCs, 1990-2013: Controlling for Trade Policies

	Dependent Variable: GDP Share (%)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	**Agriculture**	**Manufacture**	**Service**	**Agriculture**	**Manufacture**	**Service**	**Agriculture**	**Manufacture**	**Service**
GVCs Participation	-0.015**	-0.001	0.016***	-0.016**	-0.000	0.016***	-0.015**	-0.000	0.016***
	(0.007)	(0.010)	(0.006)	(0.006)	(0.010)	(0.006)	(0.007)	(0.010)	(0.006)
Participation of RTA (Yes= 1)	-0.760	0.520	0.241				-0.472	-0.039	0.515
	(1.156)	(1.166)	(1.294)				(1.191)	(1.166)	(1.291)
Participation of CU (Yes=1)	0.538	-1.246	0.697				-0.132	0.280	-0.183
	(0.662)	(0.864)	(0.902)				(1.143)	(1.558)	(1.623)
Participation of FTA (Yes=1)	-1.082	-0.831	1.916**				-1.558*	-0.036	1.600*
	(0.831)	(0.913)	(0.927)				(0.896)	(0.890)	(0.941)
Numbers of Regional Trade Agreements (RTA)				(0.035)	(0.036)	(0.044)	-0.007	0.035	-0.030
				0.033	-0.091	0.059	(0.035)	(0.040)	(0.045)
Numbers of Custom Unions (CU)				(0.044)	(0.061)	(0.065)	0.035	-0.105	0.073
				0.011	-0.099**	0.089*	(0.065)	(0.096)	(0.095)
Numbers of Free Trade Agreements (FTA)				(0.037)	(0.041)	(0.050)	0.049	-0.100**	0.051
				(0.035)	(0.036)	(0.044)	(0.037)	(0.043)	(0.052)
Constant	21.575***	30.966***	47.323***	20.885***	30.933***	48.061***	21.512***	30.883***	47.491***
	(1.485)	(1.368)	(2.009)	(1.314)	(1.127)	(1.809)	(1.457)	(1.283)	(1.948)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,593	3,608	3,585	3,593	3,608	3,585	3,593	3,608	3,585
R-squared	0.278	0.026	0.214	0.276	0.045	0.210	0.284	0.045	0.216
Number of country	175	175	173	175	175	173	175	175	173

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 4. Key Results – Structural Transformation and Agricultural GVCs, 1990 -2013: Agriculture, Controlling for all Covariates

	Dependent Variable: GDP Shares in Agriculture (%)				
Variables	(1)	(2)	(3)	(4)	(5)
GVCs Participation (%)	-0.020***	-0.020***	-0.020***	-0.005**	-0.018***
	(0.004)	(0.005)	(0.004)	(0.002)	(0.004)
GVCs Participation by neighboring countries	-0.115***	-0.116**	-0.115***	-0.038**	-0.103**
	(0.044)	(0.051)	(0.044)	(0.019)	(0.040)
GDP (log)	-9.608***	-8.921***	-9.608***	-5.962***	-8.442***
	(1.872)	(1.991)	(1.872)	(1.729)	(1.698)
Land Share for Agriculture (%)	0.081	0.047	0.081	0.110**	0.062
	(0.075)	(0.095)	(0.075)	(0.046)	(0.086)
Rural Population (%)	0.126	0.203**	0.126	1.065*	0.234**
	(0.113)	(0.102)	(0.113)	(0.612)	(0.101)
Urbanization (urban population growth, %)	0.125	0.258	0.125	0.379*	0.288
	(0.308)	(0.222)	(0.308)	(0.215)	(0.254)
Age Dependency Ratio (%)	0.056	0.036	0.056	-0.121	0.017
	(0.052)	(0.071)	(0.052)	(0.074)	(0.062)
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	1.976***	2.279***	1.976***	1.924***	2.216***
	(0.203)	(0.332)	(0.203)	(0.230)	(0.285)
Constant	45.371	-3.541	45.371	-75.465	-8.712
	(53.691)	(66.187)	(53.691)	(68.640)	(57.678)
Trade Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes
Observations	3,386	3,386	3,386	3,386	3,386
R-squared	0.402	0.527	0.402	0.705	0.457
Number of country	166	166	166	166	166

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5. Key Results – Structural Transformation and Agricultural GVCs, 1990 -2013: Manufacture, Controlling for all Covariates

	Dependent Variable: GDP Shares in Manufacture (%)				
Variables	(1)	(2)	(3)	(4)	(5)
GVCs Participation (%)	0.006	0.002	0.006	0.008***	0.005
	(0.005)	(0.006)	(0.005)	(0.002)	(0.004)
GVCs Participation by neighboring countries	0.058*	0.040	0.058*	0.026*	0.057*
	(0.032)	(0.035)	(0.032)	(0.013)	(0.030)
GDP (log)	8.171***	8.611***	8.171***	9.130***	7.868***
	(1.781)	(2.207)	(1.781)	(2.229)	(1.864)
Land Share for Agriculture (%)	0.043	-0.018	0.043	-0.031	0.012
	(0.088)	(0.086)	(0.088)	(0.088)	(0.086)
Rural Population (%)	-0.224*	-0.229*	-0.224*	-0.408	-0.233*
	(0.115)	(0.131)	(0.115)	(0.267)	(0.121)
Urbanization (urban population growth, %)	-0.317	-0.323	-0.317	-0.185	-0.251
	(0.278)	(0.277)	(0.278)	(0.191)	(0.253)
Age Dependency Ratio (%)	-0.158***	-0.204***	-0.158***	-0.009	-0.192***
	(0.050)	(0.060)	(0.050)	(0.099)	(0.052)
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	-1.748***	-1.397***	-1.748***	-1.410***	-1.429***
	(0.293)	(0.514)	(0.293)	(0.364)	(0.456)
Constant	26.398	-10.808	26.398	-29.884	6.517
	(48.666)	(69.859)	(48.666)	(78.573)	(60.307)
Trade Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes
Observations	3,386	3,386	3,386	3,386	3,386
R-squared	0.175	0.310	0.175	0.581	0.222
Number of country	166	166	166	166	166

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6. Key Results – Structural Transformation and Agricultural GVCs, 1990 -2013: Service, Controlling for all Covariates

	Dependent Variable: GDP Shares in Service (%)				
Variables	(1)	(2)	(3)	(4)	(5)
GVCs Participation (%)	0.015***	0.018***	0.015***	-0.003	0.012**
	(0.005)	(0.006)	(0.005)	(0.002)	(0.005)
GVCs Participation by neighboring countries	0.057	0.077	0.057	0.013	0.047
	(0.059)	(0.065)	(0.059)	(0.027)	(0.055)
GDP (log)	1.326	0.247	1.326	-3.348	0.472
	(2.307)	(2.608)	(2.307)	(2.114)	(2.244)
Land Share for Agriculture (%)	-0.124	-0.029	-0.124	-0.079	-0.073
	(0.093)	(0.113)	(0.093)	(0.102)	(0.107)
Rural Population (%)	0.096	0.025	0.096	-0.662	-0.004
	(0.140)	(0.131)	(0.140)	(0.618)	(0.121)
Urbanization (urban population growth, %)	0.200	0.070	0.200	-0.185	-0.029
	(0.346)	(0.306)	(0.346)	(0.184)	(0.286)
Age Dependency Ratio (%)	0.101	0.165**	0.101	0.130	0.172**
	(0.065)	(0.082)	(0.065)	(0.101)	(0.072)
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	-0.232	-0.886*	-0.232	-0.514*	-0.774*
	(0.287)	(0.465)	(0.287)	(0.264)	(0.413)
Constant	31.371	116.552	31.371	209.944***	103.537
	(64.966)	(80.783)	(64.966)	(62.518)	(67.927)
Trade Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes
Observations	3,386	3,386	3,386	3,386	3,386
R-squared	0.210	0.401	0.210	0.622	0.301
Number of country	166	166	166	166	166

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 7. Dynamic Panel Regression (the Arellano-Bond GMM): Structural Transformation and Agricultural GVCs, 1990-2013

	Dependent Variable: GDP Shares (%)		
	(1)	(2)	(3)
Variables	Agriculture	Manufacture	Service
GVCs Participation (%)	-0.027***	0.006	0.017***
	(0.004)	(0.006)	(0.006)
Lagged GDP Share (%)	0.689***		
Agriculture	(0.018)		
		0.815***	
Manufacture		(0.018)	
			0.810***
Service			(0.020)
	-0.015	0.125***	-0.077***
Numbers of Regional Trade Agreements (RTA)	(0.019)	(0.027)	(0.026)
	-0.006	-0.105**	0.102**
Numbers of Custom Unions (CU)	(0.035)	(0.047)	(0.045)
	0.023	-0.137***	0.087***
Numbers of Free Trade Agreements (FTA)	(0.021)	(0.029)	(0.028)
	-1.133**	-1.329*	0.430
Participation of RTA (Yes= 1)	(0.496)	(0.693)	(0.695)
	-0.251	-0.528	0.256
Participation of CU (Yes=1)	(0.571)	(0.788)	(0.810)
	0.796**	1.921***	-1.356***
Participation of FTA (Yes=1)	(0.385)	(0.503)	(0.510)
	1.867***	-1.044***	-0.692***
Domestic Policy Agricultural	(0.132)	(0.186)	(0.200)
Terms of Trade (DPAgTOT)	-0.013	-0.056***	-0.038**
GVCs Participation by neighboring countries (%)	(0.011)	(0.016)	(0.016)
	-0.993***	-0.599	-2.308***
GDP (log)	(0.316)	(0.532)	(0.542)
	-0.156***	-0.024	0.011
Land Share for Agriculture (%)	(0.023)	(0.029)	(0.030)
	0.153***	-0.092***	-0.076**
Rural Population (%)	(0.020)	(0.029)	(0.039)
	-0.161*	0.524***	-0.183
Urbanization (urban population growth, %)	(0.090)	(0.124)	(0.117)
	0.115***	0.003	-0.107***
Age Dependency Ratio (%)	(0.018)	(0.023)	(0.024)
	-164.350***	128.965***	148.917***
Constant	(14.877)	(21.860)	(25.241)
Country FE	YES	YES	YES
Country Year FE	YES	YES	YES
Observations	3,236	3,236	3,236
Number of country	165	165	165

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 8. Extension Analysis: Regional Structural Transformation and Agricultural GVCs, 1990-2013

Dependent Variable:	GDP Shares (%)						Employment Shares (%)		
	Linear Model (FE)			Dynamic Model (GMM)			Linear Model (FE)		
Panel	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Agriculture	**Manufacture**	**Service**	**Agriculture**	**Manufacture**	**Service**	**Agriculture**	**Manufacture**	**Service**
1. OECD									
GVCs Participation	0.006	0.000	-0.007	0.003	-0.125***	0.125***	0.091	-0.301***	0.210***
	(0.005)	(0.009)	(0.010)	(0.009)	(0.025)	(0.032)	(0.076)	(0.097)	(0.066)
Observations	726	726	726	693	693	693	767	767	767
R-squared	0.748	0.512	0.637				0.735	0.750	0.889
2. Developing Countries †									
GVCs Participation	-0.024***	0.011**	0.014***	-0.029***	0.014*	0.013	-0.000	-0.005	0.005*
	(0.004)	(0.005)	(0.005)	(0.006)	(0.008)	(0.008)	(0.004)	(0.003)	(0.003)
Observations	1,955	1,955	1,955	1,868	1,868	1,868	2,065	2,065	2,065
R-squared	0.399	0.149	0.153				0.368	0.129	0.368
3. Sub-Saharan Africa									
GVCs Participation	-0.049	0.108	-0.053	-0.092	-0.114**	0.098*	-0.045	0.099**	-0.053
	(0.120)	(0.154)	(0.135)	(0.060)	(0.055)	(0.058)	(0.081)	(0.048)	(0.050)
Observations	853	853	853	810	810	810	928	928	928
R-squared	0.365	0.217	0.166				0.305	0.129	0.402
4. South Asia									
GVCs Participation	-0.047	0.106	-0.058	-0.051	0.093*	-0.062	-0.356*	0.132	0.224
	(0.052)	(0.080)	(0.049)	(0.051)	(0.056)	(0.054)	(0.164)	(0.107)	(0.190)
Observations	193	193	193	185	185	185	186	186	186
R-squared	0.910	0.649	0.780				0.837	0.567	0.779
5. Latin America and the Caribbean									
GVCs Participation	0.009	0.093	-0.102	-0.000	0.032	-0.066**	0.078	0.047	-0.125
	(0.065)	(0.123)	(0.108)	(0.024)	(0.039)	(0.033)	(0.098)	(0.060)	(0.098)
Observations	557	557	557	533	533	533	547	547	547
R-squared	0.516	0.245	0.373				0.418	0.366	0.581
6. Central and Western Asia									
GVCs Participation	-0.016***	0.012**	0.005	-0.035***	0.014	0.018*	-0.003	0.004	-0.001
	(0.005)	(0.005)	(0.007)	(0.005)	(0.010)	(0.010)	(0.005)	(0.005)	(0.006)
Observations	352	352	352	340	340	340	404	404	404
R-squared	0.681	0.430	0.513				0.566	0.358	0.373
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

† Developing countries include Sub-Saharan Africa, South Asia, Latin America and the Caribbean, and Central and Western Asia.

Table 9. Extension Analysis: Upstream and Downstream GVCs and Structural Transformation, 1990-2013

Panel 1. Agriculture Sector

	Dependent Variable: GDP Shares in Agriculture									
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Upstream Participation	0.244**	0.191**	0.244**	0.053	0.152*					
	(0.107)	(0.096)	(0.107)	(0.059)	(0.082)					
Downstream Participation						-0.046***	-0.038***	-0.046***	-0.012	-0.036***
						(0.012)	(0.012)	(0.012)	(0.007)	(0.011)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes	No	No	No	No	Yes
Observations	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880
R-squared	0.384	0.534	0.384	0.692	0.445	0.377	0.532	0.377	0.692	0.444
Number of country	138	138	138	138	138	138	138	138	138	138

Panel 2. Manufacture Sector

	Dependent Variable: GDP Shares in Manufacture									
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Upstream Participation	-0.031	-0.071	-0.031	-0.031	-0.102					
	(0.081)	(0.105)	(0.081)	(0.049)	(0.098)					
Downstream Participation						0.013	0.010	0.013	0.012**	0.019
						(0.011)	(0.012)	(0.011)	(0.006)	(0.012)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes	No	No	No	No	Yes
Observations	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880
R-squared	0.077	0.197	0.077	0.676	0.117	0.078	0.197	0.078	0.677	0.117
Number of country	138	138	138	138	138	138	138	138	138	138

Panel 3. Service Sector

	Dependent Variable: GDP Shares in Service									
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Upstream Participation	-0.249**	-0.171*	-0.249**	-0.013	-0.116					
	(0.107)	(0.102)	(0.107)	(0.056)	(0.091)					
Downstream Participation						0.035**	0.029**	0.035**	0.000	0.023*
						(0.015)	(0.013)	(0.015)	(0.007)	(0.012)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Trade Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes	No	No	No	No	Yes
Observations	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880
R-squared	0.193	0.394	0.193	0.608	0.287	0.185	0.392	0.185	0.608	0.286
Number of country	138	138	138	138	138	138	138	138	138	138

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix

Figure A1. Structural Transformation and Agricultural GVCs (Employment shares), 1990 – 2013

Figure A1 a. Employment Shares in Agriculture and Agricultural GVCs Participation

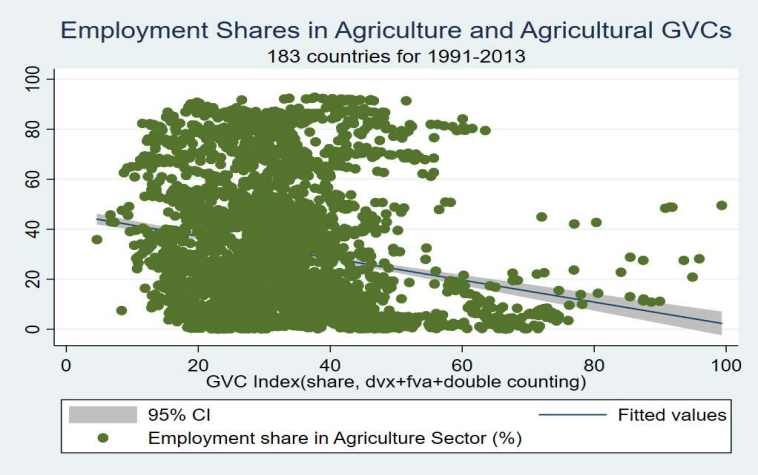


Figure A1 b. Employment Shares in Manufacture and Agricultural GVCs Participation

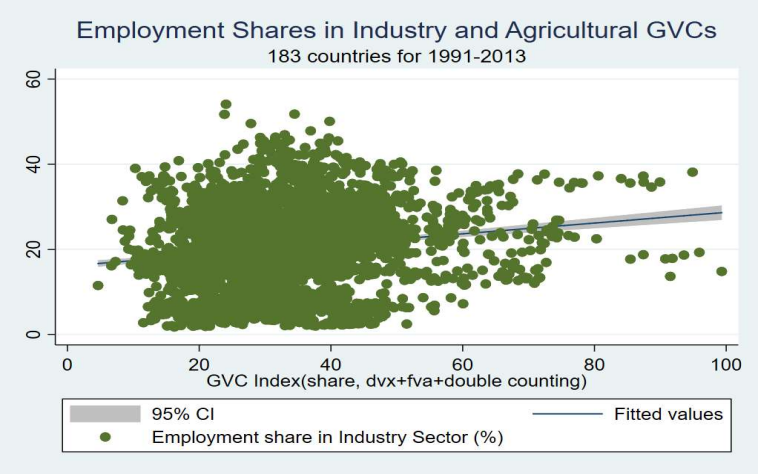


Figure A1 c. Employment Shares in Service and Agricultural GVCs Participation

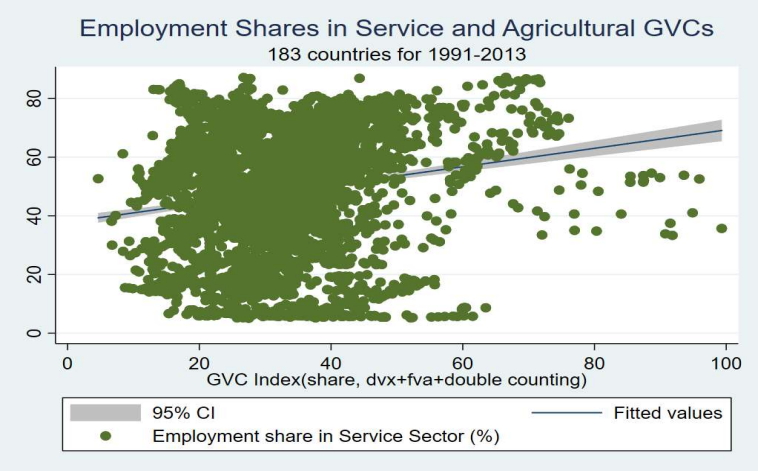
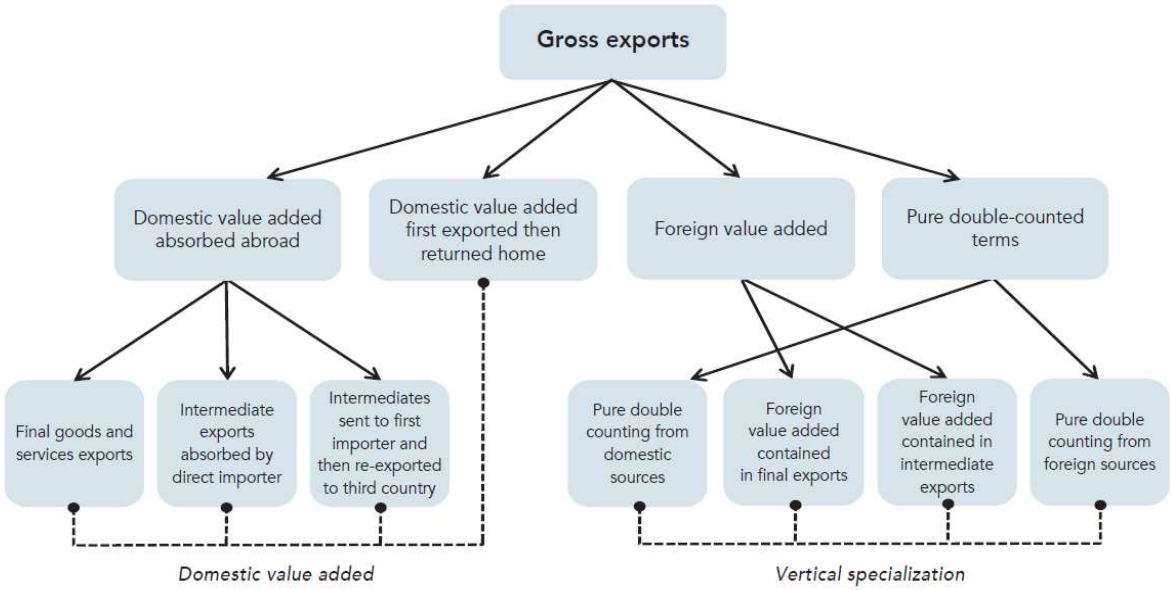


Figure A2. Decomposition of Gross Exports to measure GVCs



Source: This figure is a revised version by Inomata (2017) based on Wang et al. (2017).

Table A1. Robustness Checks: Alternative Measure of Structural Transformation

Employment Share in Agriculture Sector, 1991 -2013

	Dependent Variable: Employment Shares in Agriculture (%)				
Variables	(1)	(2)	(3)	(4)	(5)
GVCs Participation (%)	-0.023***	-0.020**	-0.023***	0.005	-0.021***
	(0.008)	(0.008)	(0.008)	(0.005)	(0.008)
GVCs Participation by neighboring countries	0.009	-0.004	0.009	0.000	-0.000
	(0.014)	(0.015)	(0.014)	(0.009)	(0.013)
GDP (log)	-9.557***	-9.965***	-9.557***	-10.740***	-10.233***
	(0.548)	(0.586)	(0.548)	(0.542)	(0.529)
Land Share for Agriculture (%)	0.042	-0.044	0.042	0.081***	-0.041
	(0.031)	(0.034)	(0.031)	(0.030)	(0.031)
Rural Population (%)	0.237***	0.388***	0.237***	0.579***	0.403***
	(0.037)	(0.041)	(0.037)	(0.081)	(0.039)
Urbanization (urban population growth, %)	0.106	0.124	0.106	0.092*	0.122*
	(0.079)	(0.079)	(0.079)	(0.054)	(0.073)
Age Dependency Ratio (%)	0.147***	0.164***	0.147***	0.031	0.149***
	(0.018)	(0.022)	(0.018)	(0.030)	(0.021)
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	-0.131	0.161	-0.131	0.690***	0.206
	(0.213)	(0.213)	(0.213)	(0.194)	(0.201)
Constant	260.695***	236.850***	260.695***	198.098***	240.619***
	(25.704)	(26.267)	(25.704)	(23.796)	(24.405)
Trade Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes
Observations	3,076	3,076	3,076	3,076	3,076
R-squared	0.419	0.563	0.419	0.816	0.529
Number of country	139	139	139	139	139

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A2. Robustness Checks: Alternative Measure of Structural Transformation

Employment Share in Manufacture Sector, 1991 -2013

	Dependent Variable: Employment Shares in Manufacture (%)				
Variables	(1)	(2)	(3)	(4)	(5)
GVCs Participation (%)	0.003	0.005	0.003	0.006	0.007
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)
GVCs Participation by neighboring countries	0.004	0.008	0.004	0.007	0.002
	(0.009)	(0.010)	(0.009)	(0.006)	(0.008)
GDP (log)	4.087***	3.238***	4.087***	4.373***	3.793***
	(0.340)	(0.378)	(0.340)	(0.347)	(0.342)
Land Share for Agriculture (%)	0.101***	0.032	0.101***	-0.023	0.017
	(0.019)	(0.022)	(0.019)	(0.019)	(0.020)
Rural Population (%)	-0.136***	-0.180***	-0.136***	-0.176***	-0.186***
	(0.023)	(0.027)	(0.023)	(0.052)	(0.025)
Urbanization (urban population growth, %)	0.215***	0.188***	0.215***	0.174***	0.224***
	(0.049)	(0.051)	(0.049)	(0.034)	(0.047)
Age Dependency Ratio (%)	-0.203***	-0.225***	-0.203***	-0.039**	-0.211***
	(0.011)	(0.014)	(0.011)	(0.019)	(0.013)
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	-0.828***	-0.750***	-0.828***	-0.599***	-0.798***
	(0.132)	(0.137)	(0.132)	(0.124)	(0.130)
Constant	19.504	39.295**	19.504	-15.940	29.014*
	(15.950)	(16.929)	(15.950)	(15.229)	(15.771)
Trade Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes
Observations	3,076	3,076	3,076	3,076	3,076
R-squared	0.265	0.404	0.265	0.752	0.354
Number of country	139	139	139	139	139

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A3. Robustness Checks: Alternative Measure of Structural Transformation

Employment Share in Service Sector, 1991 -2013

	Dependent Variable: Employment Shares in Service (%)				
Variables	(1)	(2)	(3)	(4)	(5)
GVCs Participation (%)	0.020***	0.015**	0.020***	-0.010**	0.014**
	(0.007)	(0.007)	(0.007)	(0.005)	(0.006)
GVCs Participation by neighboring countries	-0.013	-0.004	-0.013	-0.007	-0.002
	(0.012)	(0.012)	(0.012)	(0.008)	(0.011)
GDP (log)	5.470***	6.727***	5.470***	6.367***	6.440***
	(0.477)	(0.479)	(0.477)	(0.486)	(0.439)
Land Share for Agriculture (%)	-0.143***	0.012	-0.143***	-0.058**	0.024
	(0.027)	(0.028)	(0.027)	(0.027)	(0.026)
Rural Population (%)	-0.102***	-0.208***	-0.102***	-0.403***	-0.217***
	(0.032)	(0.034)	(0.032)	(0.072)	(0.032)
Urbanization (urban population growth, %)	-0.321***	-0.312***	-0.321***	-0.266***	-0.345***
	(0.068)	(0.064)	(0.068)	(0.048)	(0.061)
Age Dependency Ratio (%)	0.056***	0.061***	0.056***	0.008	0.062***
	(0.015)	(0.018)	(0.015)	(0.027)	(0.017)
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	0.959***	0.588***	0.959***	-0.091	0.593***
	(0.186)	(0.174)	(0.186)	(0.174)	(0.167)
Constant	-180.196***	-176.142***	-180.196***	-82.157***	-169.630***
	(22.377)	(21.484)	(22.377)	(21.319)	(20.271)
Trade Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes
Observations	3,076	3,076	3,076	3,076	3,076
R-squared	0.461	0.643	0.461	0.819	0.603
Number of country	139	139	139	139	139

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A4. Robustness Checks: Alternative Measure of Structural Transformation using Dynamic Panel Regression (GMM), 1990-2013

	Dependent Variable: Employment Shares (%)		
	(1)	(2)	(3)
	Agriculture	Manufacture	Service
GVCs Participation (%)	-0.010***	0.008***	0.006*
	(0.003)	(0.002)	(0.003)
Lagged Employment Share (%)	0.857***		
Agriculture	(0.013)		
		0.946***	
Manufacture		(0.016)	
			0.946***
Service			(0.016)
	-0.414	0.694***	-0.130
Numbers of Regional Trade Agreements (RTA)	0.044***	-0.014	-0.019
	(0.013)	(0.010)	(0.014)
Numbers of Custom Unions (CU)	0.025	-0.020	0.021
	(0.022)	(0.016)	(0.023)
Numbers of Free Trade Agreements (FTA)	-0.040***	0.007	0.027*
	(0.014)	(0.010)	(0.015)
Participation of RTA (Yes= 1)	-0.414	0.694***	-0.130
	(0.286)	(0.239)	(0.291)
Participation of CU (Yes=1)	-1.114***	0.505*	0.009
	(0.339)	(0.270)	(0.350)
Participation of FTA (Yes=1)	0.100	-0.164	-0.242
	(0.226)	(0.181)	(0.232)
Domestic Policy Agricultural	0.489***	-0.271***	-0.084
Terms of Trade (DPAgTOT)	(0.091)	(0.074)	(0.094)
GVCs Participation by neighboring countries (%)	-0.004	-0.010*	0.016**
	(0.007)	(0.006)	(0.007)
GDP (log)	-1.502***	0.137	0.918***
	(0.157)	(0.125)	(0.144)
Land Share for Agriculture (%)	-0.050***	0.026***	0.013
	(0.012)	(0.009)	(0.012)
Rural Population (%)	-0.032***	0.052***	0.049***
	(0.010)	(0.009)	(0.015)
Urbanization (urban population growth, %)	-0.301***	-0.105***	0.278***
	(0.052)	(0.039)	(0.049)
Age Dependency Ratio (%)	0.054***	-0.040***	-0.049***
	(0.012)	(0.010)	(0.010)
Constant	-6.871	24.746***	-12.340
	(10.137)	(8.229)	(10.518)
Country FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	3,457	3,457	3,457
Number of country	164	164	164

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A5. Robustness Checks: Alternative GVCs (Food Industry)

Agriculture Sector, 1990 -2013

	Dependent Variable: GDP Shares in Agriculture (%)				
Variables	(1)	(2)	(3)	(4)	(5)
GVCs Participation (%)	-0.036***	-0.033**	-0.036***	-0.011	-0.032***
	(0.012)	(0.013)	(0.012)	(0.007)	(0.012)
GVCs Participation by neighboring countries	-0.117**	-0.120**	-0.117**	-0.042**	-0.108***
	(0.045)	(0.050)	(0.045)	(0.019)	(0.040)
GDP (log)	-9.228***	-9.047***	-9.228***	-5.672***	-8.398***
	(2.063)	(2.146)	(2.063)	(1.770)	(1.827)
Land Share for Agriculture (%)	0.104	0.077	0.104	0.112**	0.089
	(0.094)	(0.113)	(0.094)	(0.054)	(0.101)
Rural Population (%)	0.132	0.277**	0.132	1.135*	0.323***
	(0.138)	(0.123)	(0.138)	(0.648)	(0.119)
Urbanization (urban population growth, %)	0.222	0.396**	0.222	0.409**	0.398*
	(0.289)	(0.198)	(0.289)	(0.190)	(0.223)
Age Dependency Ratio (%)	0.064	0.066	0.064	-0.106	0.046
	(0.058)	(0.077)	(0.058)	(0.077)	(0.069)
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	1.889***	1.978**	1.889***	2.161***	2.055***
	(0.631)	(0.759)	(0.631)	(0.622)	(0.634)
Constant	45.603	25.392	45.603	-108.110	1.743
	(90.473)	(100.455)	(90.473)	(91.087)	(81.536)
Trade Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes
Observations	2,880	2,880	2,880	2,880	2,880
R-squared	0.374	0.531	0.374	0.692	0.443
Number of country	138	138	138	138	138

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A6. Robustness Checks: Alternative GVCs (Food Industry)

Manufacture Sector, 1990 -2013

	Dependent Variable: GDP Shares in Manufacture (%)				
Variables	(1)	(2)	(3)	(4)	(5)
GVCs Participation (%)	0.011	0.005	0.011	0.011	0.013
	(0.012)	(0.012)	(0.012)	(0.007)	(0.012)
GVCs Participation by neighboring countries	0.054	0.022	0.054	0.030*	0.054
	(0.038)	(0.046)	(0.038)	(0.017)	(0.037)
GDP (log)	4.637	3.811	4.637	10.573***	3.765
	(3.997)	(5.235)	(3.997)	(2.604)	(4.427)
Land Share for Agriculture (%)	0.014	-0.099	0.014	-0.097	-0.057
	(0.105)	(0.108)	(0.105)	(0.084)	(0.103)
Rural Population (%)	-0.233	-0.300*	-0.233	-0.222	-0.279*
	(0.141)	(0.161)	(0.141)	(0.359)	(0.152)
Urbanization (urban population growth, %)	-1.048	-1.127	-1.048	-0.895	-1.027
	(0.769)	(0.817)	(0.769)	(0.667)	(0.764)
Age Dependency Ratio (%)	-0.099	-0.148	-0.099	-0.004	-0.140
	(0.083)	(0.109)	(0.083)	(0.111)	(0.102)
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	-0.078	0.212	-0.078	-1.336	0.033
	(1.919)	(2.088)	(1.919)	(0.881)	(2.009)
Constant	-54.166	-47.651	-54.166	-77.987	-36.074
	(140.955)	(157.457)	(140.955)	(146.737)	(144.321)
Trade Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes
Observations	2,880	2,880	2,880	2,880	2,880
R-squared	0.078	0.197	0.078	0.677	0.116
Number of country	138	138	138	138	138

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A7. Robustness Checks: Alternative GVCs (Food Industry)

Service Sector, 1990 -2013

	Dependent Variable: GDP Shares in Service (%)				
Variables	(1)	(2)	(3)	(4)	(5)
GVCs Participation (%)	0.025**	0.025**	0.025**	0.002	0.020*
	(0.012)	(0.012)	(0.012)	(0.008)	(0.012)
GVCs Participation by neighboring countries	0.055	0.083	0.055	0.014	0.053
	(0.060)	(0.064)	(0.060)	(0.029)	(0.055)
GDP (log)	0.789	0.428	0.789	-2.986	0.332
	(2.567)	(2.917)	(2.567)	(2.185)	(2.440)
Land Share for Agriculture (%)	-0.073	0.056	-0.073	-0.017	0.016
	(0.105)	(0.129)	(0.105)	(0.103)	(0.120)
Rural Population (%)	0.165	0.102	0.165	-0.665	0.036
	(0.163)	(0.148)	(0.163)	(0.648)	(0.142)
Urbanization (urban population growth, %)	-0.075	-0.231	-0.075	-0.311*	-0.287
	(0.303)	(0.286)	(0.303)	(0.162)	(0.250)
Age Dependency Ratio (%)	0.107	0.174*	0.107	0.144	0.187**
	(0.073)	(0.090)	(0.073)	(0.111)	(0.080)
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	0.358	0.142	0.358	-0.056	0.224
	(0.985)	(1.091)	(0.985)	(0.571)	(0.993)
Constant	-21.778	-1.284	-21.778	150.952	-0.945
	(125.369)	(142.867)	(125.369)	(91.625)	(122.102)
Trade Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	No	Yes	Yes	Yes
Sub-regional Year FE	No	Yes	No	No	No
Time Trend	No	No	Yes	No	No
Country-specific Time Trend	No	No	No	Yes	No
Regional-specific Time Trend	No	No	No	No	Yes
Observations	2,880	2,880	2,880	2,880	2,880
R-squared	0.184	0.392	0.184	0.608	0.286
Number of country	138	138	138	138	138

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A8. Extension Analysis: Regional Structural Transformation and Food GVCs, 1990-2013

Dependent Variable:	GDP Shares (%)						Employment Shares (%)		
	Linear Model (FE)			Dynamic Model (GMM)			Linear Model (FE)		
Panel	(1) Agriculture	(2) Manufacture	(3) Service	(4) Agriculture	(5) Manufacture	(6) Service	(7) Agriculture	(8) Manufacture	(9) Service
1. OECD									
GVCs Participation	0.049	0.006	-0.055	0.004	-0.098***	0.084***	0.072	-0.155**	0.083
	(0.030)	(0.104)	(0.111)	(0.008)	(0.024)	(0.026)	(0.070)	(0.057)	(0.061)
Observations	641	641	641	612	612	612	675	675	675
R-squared	0.782	0.504	0.650				0.738	0.728	0.887
2. Developing Countries †									
GVCs Participation	-0.058	0.091	-0.027	0.004	0.010	0.018	-0.146	0.107	0.039
	(0.057)	(0.055)	(0.065)	(0.023)	(0.027)	(0.026)	(0.108)	(0.065)	(0.051)
Observations	1,996	1,996	1,996	1,906	1,906	1,906	2,104	2,104	2,104
R-squared	0.297	0.116	0.193				0.385	0.268	0.555
3. Sub-Saharan Africa									
GVCs Participation	-0.081	0.044	0.044	0.005	0.037	0.057	-0.222	0.137	0.086
	(0.053)	(0.068)	(0.068)	(0.040)	(0.041)	(0.040)	(0.155)	(0.090)	(0.072)
Observations	760	760	760	725	725	725	824	824	824
R-squared	0.295	0.186	0.163				0.319	0.158	0.377
4. South Asia									
GVCs Participation	-0.046	0.150**	-0.104	-0.057	0.142**	-0.050	0.130	-0.018	-0.112**
	(0.081)	(0.058)	(0.127)	(0.054)	(0.070)	(0.052)	(0.114)	(0.110)	(0.044)
Observations	156	156	156	149	149	149	150	150	150
R-squared	0.927	0.788	0.778				0.867	0.717	0.814
5. Latin America and the Caribbean									
GVCs Participation	0.096	0.301	-0.397**	0.036	0.020	-0.088	-0.092	0.173**	-0.081
	(0.108)	(0.214)	(0.162)	(0.043)	(0.061)	(0.063)	(0.187)	(0.073)	(0.137)
Observations	439	439	439	420	420	420	455	455	455
R-squared	0.557	0.207	0.389				0.412	0.450	0.597
6. Central and Western Asia									
GVCs Participation	-0.031**	-0.019	0.015	-0.058***	0.033	0.010	-0.008	0.004	0.004
	(0.011)	(0.036)	(0.019)	(0.009)	(0.025)	(0.020)	(0.011)	(0.007)	(0.009)
Observations	335	335	335	325	325	325	369	369	369
R-squared	0.701	0.224	0.532				0.598	0.381	0.424
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

† Developing countries include Sub-Saharan Africa, South Asia, Latin America and the Caribbean, and Central and Western Asia.

Table A9. Extension Analysis: Regional Structural Transformation and Upstream Participation, 1990-2013

Dependent Variable:	GDP Shares (%)						Employment Shares (%)		
	Linear Model (FE)			Dynamic Model (GMM)			Linear Model (FE)		
Panel	(1) Agriculture	(2) Manufacture	(3) Service	(4) Agriculture	(5) Manufacture	(6) Service	(7) Agriculture	(8) Manufacture	(9) Service
1. OECD									
Upstream Participation	-0.225***	-0.259	0.484*	-0.007	-0.129*	0.124	-0.141	-0.168	0.309
	(0.076)	(0.236)	(0.263)	(0.024)	(0.070)	(0.077)	(0.289)	(0.268)	(0.235)
Observations	641	641	641	612	612	612	675	675	675
R-squared	0.787	0.508	0.658				0.737	0.719	0.887
2. Developing Countries †									
Upstream Participation	0.263*	-0.094	-0.158	0.142***	-0.162***	-0.049	0.041	0.083	-0.124
	(0.138)	(0.121)	(0.140)	(0.031)	(0.040)	(0.037)	(0.181)	(0.089)	(0.107)
Observations	1,996	1,996	1,996	1,906	1,906	1,906	2,104	2,104	2,104
R-squared	0.312	0.113	0.197				0.375	0.253	0.558
3. Sub-Saharan Africa									
Upstream Participation	0.250	-0.038	-0.200	0.240***	-0.135**	-0.061	0.032	0.039	-0.071
	(0.166)	(0.166)	(0.184)	(0.058)	(0.063)	(0.060)	(0.228)	(0.106)	(0.131)
Observations	760	760	760	725	725	725	824	824	824
R-squared	0.305	0.186	0.169				0.294	0.110	0.372
4. South Asia									
Upstream Participation	0.017	0.075	-0.092	0.025	0.097	-0.082	0.025	0.018	-0.043
	(0.072)	(0.133)	(0.188)	(0.062)	(0.087)	(0.069)	(0.106)	(0.053)	(0.089)
Observations	156	156	156	149	149	149	150	150	150
R-squared	0.927	0.783	0.777				0.866	0.717	0.812
5. Latin America and the Caribbean									
Upstream Participation	-0.086	-0.054	0.140	0.099*	-0.089	-0.072	0.031	0.317*	-0.348
	(0.173)	(0.415)	(0.346)	(0.052)	(0.076)	(0.069)	(0.219)	(0.180)	(0.238)
Observations	439	439	439	420	420	420	455	455	455
R-squared	0.556	0.196	0.373				0.411	0.447	0.601
6. Central and Western Asia									
Upstream Participation	0.293**	-0.183	-0.247	0.370***	-0.255	-0.084	0.005	-0.044	0.039
	(0.124)	(0.315)	(0.244)	(0.080)	(0.186)	(0.163)	(0.109)	(0.143)	(0.194)
Observations	335	335	335	325	325	325	369	369	369
R-squared	0.702	0.224	0.535				0.597	0.381	0.424
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

† Developing countries include Sub-Saharan Africa, South Asia, Latin America and the Caribbean, and Central and Western Asia.

Table A10. Extension Analysis: Regional Structural Transformation and Downstream Participation, 1990-2013

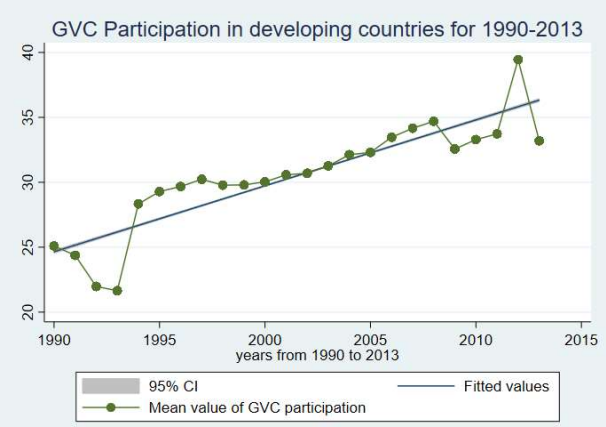
Dependent Variable:	GDP Shares (%)						Employment Shares (%)		
	Linear Model (FE)			Dynamic Model (GMM)			Linear Model (FE)		
Panel	(1) Agriculture	(2) Manufacture	(3) Service	(4) Agriculture	(5) Manufacture	(6) Service	(7) Agriculture	(8) Manufacture	(9) Service
1. OECD									
Downstream Participation	0.058*	0.064	-0.122	0.002	-0.068**	0.055*	0.014	-0.074	0.060
	(0.031)	(0.094)	(0.103)	(0.009)	(0.028)	(0.030)	(0.067)	(0.051)	(0.065)
Observations	641	641	641	612	612	612	675	675	675
R-squared	0.783	0.506	0.654				0.736	0.720	0.886
2. Developing Countries †									
Downstream Participation	-0.174***	0.145	0.032	-0.132***	0.148***	0.101***	-0.181**	0.063*	0.119
	(0.054)	(0.089)	(0.075)	(0.032)	(0.037)	(0.038)	(0.083)	(0.035)	(0.072)
Observations	1,996	1,996	1,996	1,906	1,906	1,906	2,104	2,104	2,104
R-squared	0.309	0.120	0.194				0.385	0.253	0.560
3. Sub-Saharan Africa									
Downstream Participation	-0.176**	0.054	0.126	-0.163***	0.128**	0.142***	-0.225*	0.100**	0.124
	(0.067)	(0.120)	(0.099)	(0.050)	(0.052)	(0.053)	(0.117)	(0.043)	(0.084)
Observations	760	760	760	725	725	725	824	824	824
R-squared	0.305	0.186	0.168				0.312	0.128	0.381
4. South Asia									
Downstream Participation	-0.245	0.258	-0.013	-0.281**	0.137	0.069	0.345	-0.127	-0.218
	(0.192)	(0.263)	(0.326)	(0.111)	(0.133)	(0.122)	(0.397)	(0.359)	(0.249)
Observations	156	156	156	149	149	149	150	150	150
R-squared	0.929	0.786	0.775				0.868	0.719	0.814
5. Latin America and the Caribbean									
Downstream Participation	0.100	0.324	-0.423**	-0.081	0.142	0.009	-0.177	0.109	0.068
	(0.109)	(0.239)	(0.193)	(0.057)	(0.089)	(0.077)	(0.262)	(0.115)	(0.179)
Observations	439	439	439	420	420	420	455	455	455
R-squared	0.557	0.204	0.385				0.413	0.438	0.597
6. Central and Western Asia									
Downstream Participation	-0.031***	-0.015	0.016	-0.057***	0.035	0.009	-0.006	0.004	0.002
	(0.010)	(0.033)	(0.019)	(0.009)	(0.024)	(0.020)	(0.010)	(0.007)	(0.009)
Observations	335	335	335	325	325	325	369	369	369
R-squared	0.701	0.224	0.532				0.598	0.381	0.424
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors clustered at the country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

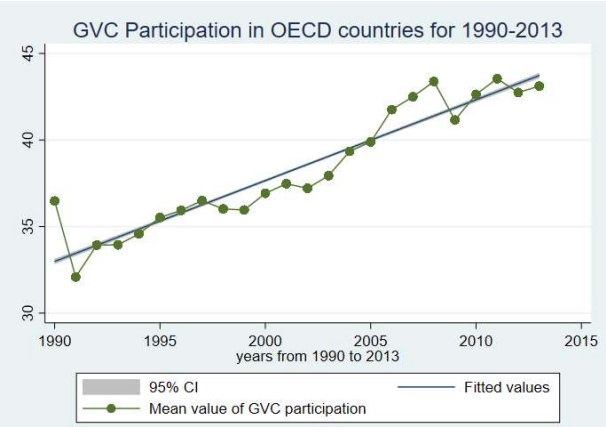
† Developing countries include Sub-Saharan Africa, South Asia, Latin America and the Caribbean, and Central and Western Asia.

Table A11. Trends of Agricultural GVC Participation by country groups, 1990-2013

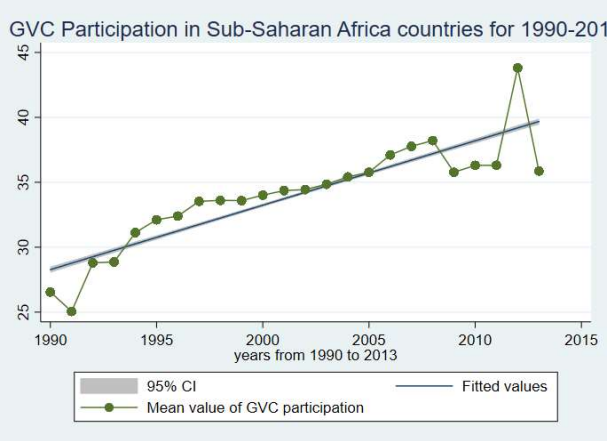
A1 a. OECD countries



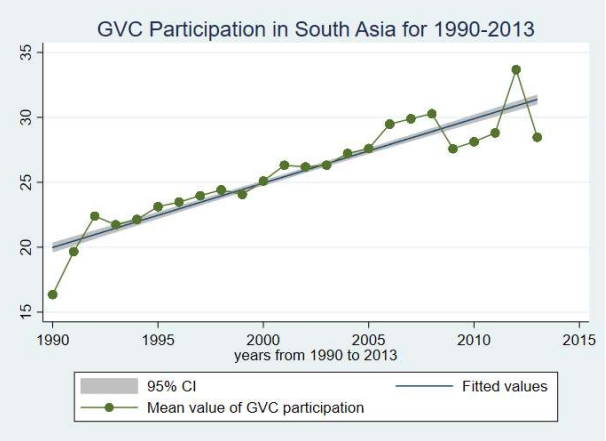
A1 b. Developing countries†



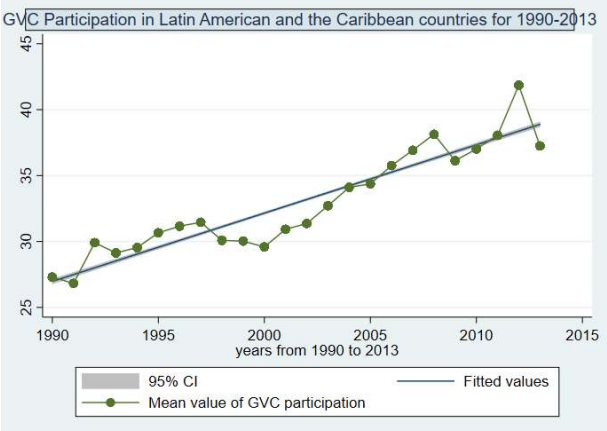
A1 c. Sub-Saharan Africa countries



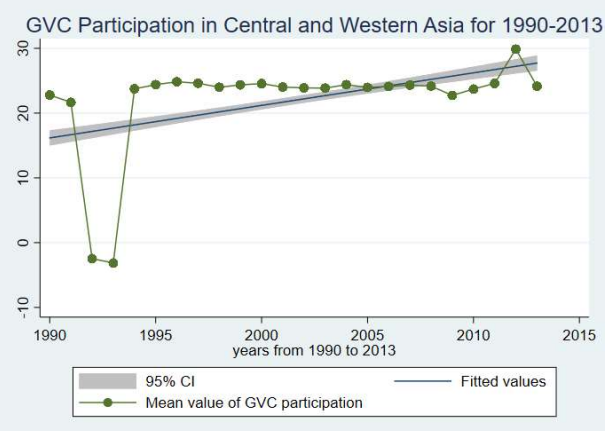
A1 d. South Asia



A1 e. Latin American and the Caribbean countries



A1 f. Central and Western Asia



† Developing countries include Sub-Saharan Africa, South Asia, Latin America and the Caribbean, and Central and Western Asia.

Table A12. Descriptive Statistics for 183 Countries for the Period 1990–2013

Variables	Obs.	Mean	Std.Dev.	Min.	Max.
Dependent Variable					
GDP share in Agriculture (%)	3,593	15.04	14.24	0.0354	93.98
GDP share in Manufacture (%)	3,608	29.67	11.86	1.882	84.80
GDP share in Service (%)	3,585	55.26	15.11	4.141	93.22
Employment share in Agriculture (%)	3,943	31.58	26.62	0.0110	92.84
Employment share in Manufacture (%)	3,943	20.23	9.459	1.741	54.10
Employment share in Service (%)	3,943	48.19	20.43	5.069	87.23
Global Value Chains (GVCs)					
Agriculture Industry					
GVC Participation	4,364	33.31	18.14	-515.7	282.2
GVC Participation by Neighboring countries	4,364	31.92	9.687	-111.7	116.6
Downstream Participation	4,364	21.68	9.747	-88.34	154.9
Downstream Participation	4,364	8.566	15.20	-535.1	249.0
Food Industry					
GVC Participation					
GVC Participation by Neighboring countries					
Upstream Participation	4,364	21.68	9.747	-88.34	154.9
Downstream Participation	4,364	8.566	15.20	-535.1	249.0
Control Variables					
Participation of RTA (Yes= 1)	4,364	0.871	0.335	0	1
Participation of CU (Yes= 1)	4,364	0.498	0.500	0	1
Participation of FTA (Yes= 1)	4,364	0.553	0.497	0	1
Numbers of RTA	4,364	29.24	24.91	0	110
Numbers of CU	4,364	7.418	9.416	0	31
Numbers of FTA	4,364	13.40	18.33	0	108
GDP (log)	3,905	24.79	2.056	19.44	30.42
Land share for Agriculture (%)	4,218	39.07	22.28	0.449	85.49
Rural Population (%)†	4,362	44.32	24.10	0	94.58
Urban Population Growth (%)	4,357	2.262	2.021	-7.115	17.63
Age Dependency Ratio (%)	4,167	65.27	19.93	16.45	119.1
Domestic Policy Agricultural Terms of Trade (DPAgTOT)	4,301	100.0	0.556	95.32	112.0

† The zero values of rural population are associated with countries including Bermuda, Cayman Islands, Hong Kong, Macao, Monaco, and Singapore.

Table A13. Top 30 Highest and Lowest GVC participation countries, 1990–2013†

Top 30 Highest GVC Participation Countries			Top 30 Lowest GVC Participation Countries		
Rank	**Country Name**	**GVC Participation**	**Rank**	**Country Name**	**GVC Participation**
1	Greenland	42.99	1	Armenia	-21.81
2	Germany	43.06	2	Kazakhstan	11.45
3	British Virgin Islands	43.18	3	Tajikistan	12.57
4	Austria	43.38	4	North Korea	13.24
5	France	43.41	5	Nepal	14.35
6	Israel	44.13	6	Uzbekistan	14.53
7	Denmark	44.21	7	Mexico	16.10
8	Czech Republic	44.8	8	Korea, Rep.	16.62
9	Sweden	44.94	9	Oman	17.57
10	United Kingdom	45.29	10	Belize	17.82
11	Singapore	45.37	11	Paraguay	18.19
12	Hungary	46.76	12	Mongolia	18.35
13	Switzerland	48.19	13	Haiti	18.80
14	Swaziland	48.28	14	Yemen, Rep.	18.94
15	Belgium	51.98	15	Afghanistan	19.55
16	Congo, Dem. Rep.	52.50	16	Iraq	19.87
17	Malta	53.10	17	Trinidad and Tobago	20.22
18	Hong Kong SAR, China	56.70	18	Philippines	20.71
19	Latvia	60.58	19	Fiji	20.83
20	Luxembourg	61.58	20	Bahamas, The	20.94
21	Estonia	62.06	21	Pakistan	20.94
22	Suriname	71.64	22	Somalia	21.08
23	Belarus	79.54	23	Iran, Islamic Rep.	21.53
24	Aruba	82.73	24	Japan	21.80
25	Moldova	100.65	25	Georgia	22.27
26	Niger	22.25	26	China	22.29
27	Turkmenistan	27.77	27	Argentina	22.34
28	Angola	35.51	28	Jamaica	22.60
29	Qatar	23.80	29	United Arab Emirates	22.72
30	Seychelles	38.87	30	Venezuela, RB	22.75

† GVC participation is a mean value from 1990–2013. Shaded rows represent OCDE countries.