Greenville, J., K. Kawasaki and R. Beaujeu (2017-02-27),
“How policies shape global food and agriculture value chains”,
OECD Food, Agriculture and Fisheries Papers, No. 100,
OECD Publishing, Paris.
<http://dx.doi.org/10.1787/aaf0763a-en>

OECD Food, Agriculture and Fisheries Papers No. 100

How policies shape global food and agriculture value chains

Jared Greenville,
Kentaro Kawasaki,
Raphaël Beaujeu

OECD FOOD, AGRICULTURE AND FISHERIES PAPERS

This paper is published under the responsibility of the Secretary-General of the OECD. The opinions expressed and the arguments employed herein do not necessarily reflect the official views of OECD countries.

The publication of this document has been authorised by Ken Ash, Director of the Trade and Agriculture Directorate.

This paper and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Comments are welcome and may be sent to tad.contact@oecd.org.

© OECD (2017)

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgment of OECD as source and copyright owner is given. All requests for commercial use and translation rights should be submitted to rights@oecd.org.

HOW POLICIES SHAPE GLOBAL FOOD AND AGRICULTURE VALUE CHAINS

Jared Greenville, Kentaro Kawasaki and Raphaël Beaujeu
Organisation for Economic Co-operation and Development

Global value chains (GVCs) have changed the nature of production and specialisation around the world, including in agriculture and food sectors. This study takes an in-depth look at the landscape of agro-food GVCs and explores the factors that influence GVC participation by making use of a newly developed database on trade in value added for 20 agro-food sectors derived from the Global Trade Analysis Project (GTAP) database. The study also explores the benefits of GVC participation, viewed through the lens of domestic value added creation and employment, with a focus on the policy factors that influence these benefits. The study points to considerable variation in GVC participation across agro-food sectors, driven not only by product characteristics but also by policy factors related to trade and investment, the agricultural enabling environment and policies influencing service markets. The study shows that for agro-food sectors, trade barriers act as a tax on exports, reducing the domestic value added created from participation in agro-food GVCs.

Keywords: Agriculture; Global Value Chain; GTAP; Multi-Regional Input Output.

JEL Classification: F14, F60, Q17

Acknowledgements

The authors would like to thank Ken Ash, Charles Cadestin, Jo Cadilhon, Carmel Cahill, Koen De Backer, Dorothee Flaig, Julien Gourdon, Emily Gray, Marie-Agnes Jouanjean, Andrzej Kwiecinski, Javier Lopez-Gonzalez, Sébastien Miroudot, Julia Neilson and Silva Sorescu for their comments and help in developing this study. The authors also wish to thank the members of the OECD Joint Working Party on Agriculture and Trade for their valuable feedback and direction received in developing and finalising this study. Finally, the authors thank Anita Lari and Michèle Patterson for preparing this document for publication.

Table of contents

Executive summary	5
Overview	7
Part 1. Introduction	12
Part 2. Past studies on GVCs in the agriculture and food sectors	16
Part 3. Exploring global agro-food value chains	32
References	62
Annex A. GTAP Sectors and regions in the study	66
Annex B. Detailed estimates of the determinants of participation	69

Tables

Table 3.1. Influence of services trade restrictions on GVC participation	45
Table 3.2. Influence of NTMs on GVC participation	55
Table 3.3. Influence of support on GVC participation	57
Table A.1. GTAP sectors in the model	66
Table A.2. GTAP regions in the study	68
Table B.1. Variables used in the benchmark models	70
Table D.2. Detailed regression results	71

Figures

Figure 1. Distribution of final agro-food value added from broad sector source	8
Figure 2. Average forward and backward participation	9
Figure 3. Factors influencing the returns from and participation in GVCs	10
Figure 1.1. Measuring trade in value added	15
Figure 2.1. Global agro-food trade has been growing	18
Figure 2.2. Shares of production traded have trended upwards	18
Figure 2.3. Growth in trade varies significantly among selected agro-food products	19
Figure 2.4. Trade in both intermediate and final agro-food products is increasing	20
Figure 2.5. GVC participation differs for agro-food sectors compared with others	21
Figure 2.6. Backward and forward participation varies across countries	21
Figure 2.7. Significant differences in participation across regions	23
Figure 2.8. Tariffs escalation on agro-food products	23
Figure 2.9. Tariff amplification on value added content in agro-food exports	25
Figure 2.10. The incidence of NTMs in agro-food trade is rising	26
Figure 2.11. Margin services dominate services embodied in exports	28
Figure 2.12. Backward and forward linkages important in determining export domestic value added	30
Figure 3.1. Bilateral flows of value added in agro-food	33
Figure 3.2. Distribution of backward participation by sector across countries	35
Figure 3.3. Distribution of forward participation by sector across countries	36
Figure 3.4. Average forward and backward participation	38
Figure 3.5. Total GVC participation	39

Figure 3.6.	Total GVC participation by country	39
Figure 3.7.	Agro-food GVC participation generally lower than that of other sectors.....	41
Figure 3.8.	Country and sector engagement in GVCs	42
Figure 3.9.	Structural and policy factors underpinning GVC participation	43
Figure 3.10.	Sector-specific differences	46
Figure 3.11.	Agriculture and food sectors dominate share of value added final demand value	47
Figure 3.12.	Differences in share of the final \$1 of agro-food products.....	48
Figure 3.13.	Distribution of value added by broad sector at final demand	49
Figure 3.14.	Domestic value added generated from ongoing GVCs	50
Figure 3.15.	Distribution of ratio of domestic value added in intermediate and final goods exports	50
Figure 3.16.	Source of domestic value added in exports	51
Figure 3.17.	Distribution of value added source in exports	52
Figure 3.18.	Policy factors important for exports of domestic value added	53
Figure 3.19.	AVEs of NTMs by sector	55
Figure 3.20.	Workforce employed in ongoing agro-food GVCs and production sophistication	56
Figure 3.21.	Average total employment shares in ongoing GVCs by sector	58
Figure 3.22.	Employment from GVCs and taxes and subsidies.....	59
Figure 3.23.	Regional differences in importance of ongoing GVCs.....	59

Boxes

Box 1.1.	Developments in contracting and marketing enabling agro-food GVC development.....	13
Box 2.1.	The complex effects of NTMs on agro-food trade	27
Box 3.1.	Case study 1: Services trade restrictions and agro-food GVC participation.....	45
Box 3.2.	Case study 2: The influence of private voluntary standards on GVC participation.....	46
Box 3.3.	Case study 3: Non-tariff measures and GVC participation in greater detail	55
Box 3.4.	Case study 4: Support to agriculture and GVC participation	57

Executive summary

This study takes an in-depth look at the landscape and influences on global value chain (GVC) participation by a range of individual agro-food sectors. It focuses on the flow of products across national borders within GVCs rather than the specific characteristics of individual value chains, making use of a newly developed database on trade in value added for 20 agro-food sectors derived from the Global Trade Analysis Project (GTAP) database.

There are varying patterns of engagement in GVCs by some of the major agricultural trading countries and clear differences in regional engagement. European agro-food value chains source globally but supply locally. By contrast, those of the People's Republic of China have a greater span in both sourcing inputs and supplying other markets. For the United States, sourcing is narrower and more regionally focused, but supply is global. Overall, agro-food global value chains are most developed in Asia and Europe compared with other regional groupings.

Across the 20 sectors examined, GVC participation varies considerably driven by the nature of the product produced. For example, perishable products, such as raw milk, are rarely traded internationally and instead feed into domestic value chains (for further processing) before linking internationally. Others, such as vegetables and fruits, are more likely to go directly to final demand (or final processing in export markets and then to final demand) and thus have shorter and lower levels of observed ongoing GVC engagement. As such, at the country level, the results for broad sector groupings of agriculture and food (as captured in other databases of trade in value added) are highly dependent on the industry mix of those countries – a mix that is most often determined by geographic and other structural factors.

Yet, within individual sectors there is also a wide range of GVC engagement. This suggests that beyond structural factors, policies play a role. The analysis undertaken indicates that trade policies are particularly important in determining GVC engagement and the domestic value added created. Barriers to imports reduce engagement in GVCs along with the domestic returns from agro-food exports. Similarly, for non-tariff measures, the results suggest that if countries maintain more transparent and science based arrangements, that preserve the trade creating effects but avoid concerns being raised by trading partners, they can increase the domestic value added generated in exports.

Agricultural policy and the capabilities of producers are also important. A supportive enabling environment, through factors such as infrastructure, agricultural research and development and education, were all found to enhance GVC participation and its benefits. Further, non-distortive agricultural policies were found to be important: distortive policies not only reduced some forms of GVC engagement but also reduced the domestic value added created from GVC participation.

It is not just the policies directed at the agro-food sector that are important for GVC participation: policies related to service markets were found to influence GVC participation and domestic value added creation. For agro-food products, the services content in exports and in final value is significant – commonly greater than that of industrial inputs. The analysis suggests that barriers to services trade, as measured by the OECD's Services Trade Restrictiveness Index, reduced agro-food GVC participation and domestic value added generated from agro-food exports. The high services share in agro-food value added, and the negative effects of services trade restrictions, show the importance of open trade policies across all sectors for countries being able to access agro-food GVCs and maximise the domestic returns created from participation.

There are some caveats to the approach used in this study. Data is only currently available for 2011, so the study relies on cross-sectional analysis to draw out the influences on GVC participation and domestic value added creation. To minimise the potential for bias and erroneous results, policy and structural factors chosen were based on findings from other studies; however, caveats remain. Looking further ahead, expanding the year coverage of the data will provide one means to overcome the lack of observations and to explore some of the dynamic effects of GVCs, while allowing the effects of structural differences to be better isolated. Such data could also allow exploration of the dynamics of GVC participation over time. That said, as many of the data gaps will not be possible to overcome, alternative approaches could be also explored to complement assessment of the influence of policies on GVC participation. Scenario analysis using the GTAP or METRO models, for example, could provide powerful insights into GVC participation drivers in the absence of better data.

Overview

Global value chains (GVCs) have changed the nature of production and specialisation around the world. Simply defined, GVCs represent all the activities that take place in transforming raw materials into the product delivered at its end use. Transformation activities include the production, marketing and the delivery of a product or service to the final consumer. The fact that these activities are increasingly spread over several countries is what makes these value chains ‘global’. The changes in the international production landscape have been most obvious in manufacturing and services, but similar changes have also occurred in the agricultural and food sector.

The value chains that are the focus of this study relate to the flows of agricultural and food products across borders, rather than value chains within individual countries for individual products. Underlying these international flows is a wide array of value chains in which individual producers, processors and retailers participate. These chains vary in the way different actors interact and contract and how they function, but they have all been successful in developing the trust relationships between actors that has allowed the fragmentation of agro-food production to occur. It is beyond the scope of this study to examine the wide array of global value chains at the individual firm (micro) level and the differences that may be created by the different solutions to developing relationships between value chain actors or the policy factors that have contributed to their development. Instead, this study focuses on the policy factors that underpin the flow of goods within value chains that cross national borders, such as those related to trade and domestic agricultural policy settings.

Compared with manufacturing sectors, less is known about the nature and influences on the international flow of agro-food products within production systems that cross national boundaries. There is strong reason to suspect that across individual agro-food sectors, the development of such GVCs and the factors that drive the benefits from, and the participation in, them will differ. Across individual sectors, for example, multiple factors such as product characteristics, trade distortions, and government intervention will differ and likely lead to differences in the levels of participation of these sectors in GVCs.

Part of the reason less is known about trade within agro-food GVCs is a lack of data. Most of the current data sets on trade in value added – an important underpinning for GVC analysis – have focused on the agriculture and food sector in the aggregate. This study takes an in-depth look at the landscape and determinants of GVC participation for 20 *individual* agro-food sectors by making use of a new data set of trade in value added derived from the 2011 Global Trade and Analysis Project (GTAP) database. This new dataset affords a number of important insights to inform agricultural trade and domestic policy.

Patterns on trade in value added reveal a clear difference in regional engagement in agro-food GVCs: European agro-food value chains source more globally but supply more locally compared with those of People’s Republic of China (hereafter “China”) and the United States. In the China, agro-food GVCs have a greater span in both sourcing inputs and supplying other markets, whereas for the United States, sourcing is more concentrated within its region despite a global span in supply. Overall, agro-food GVCs are most developed in Asia and Europe compared with other regional groupings.

Data on value added also reveal that agriculture remains the dominant source of value in the final product. This is replicated in trade, underscoring the importance of agricultural productivity in underpinning international competitiveness of the agriculture and food sector. However, services also

form an important part of value added in agro-food exports and in the final products. Indeed the service value added component is often greater than that of the industrial sector (as depicted in Figure 1 below, with a distribution further to the right than that of industrial inputs). The functioning of services markets is therefore critically important for agro-food sectors. Indeed, services trade restrictions were found to negatively influence GVC engagement and decrease the domestic value added generated for countries with high levels of restrictions.

Figure 1. Distribution of final agro-food value added from broad sector source

Notes: The distributions indicate the per cent of the final value of agro-food products that is contributed by each broad sector identified. A tight distribution indicates that worldwide, the contribution from a particular sector is relatively similar. A flat distribution indicates considerable heterogeneity in the contribution of a broad sector across the world.

GVC engagement can be analysed through estimates of the forward and backward linkages for each sector in each country. Backward participation rates explore the extent to which exports from a sector in a given country rely on imports from other countries. Forward participation rates explore the extent to which domestic value added from an industry in a given country (both direct and indirect through the exports of other domestic industries) form part of the value of another country's exports. In other words, rates of backward participation look at the internationally sourcing of inputs from value chains (buying from GVCs), whereas forward linkages examine the supply to international value chains (selling into GVCs, as opposed to selling directly to the end user).

In general, agriculture sectors participate in value chains as the supplier of raw materials, with the food sectors participating in terms of sourcing inputs from around the globe (Figure 2). However, across sectors and countries there is considerable variation, particularly for the forward engagement of agriculture sectors. There is a wide range of industry connectedness to international markets across the world. Further, agro-food GVCs are different from those in other areas of the economy, with a much higher proportion of agro-food sectors across countries having lower rates of total GVC participation.

Across the 20 agro-food sectors, of the more heavily traded products, oilseeds and plant-based fibres have the highest rates of forward participation, with some food sectors such as vegetable oils & fats, dairy and wool & silk products having the highest rates of backward participation. There is little correlation between forward and backward participation, suggesting an industry-based specialisation at different parts of the value chain as suppliers or users of intermediates. There are very few industries with high rates of total participation which are positioned in the middle of agro-food GVCs. Part of this

is driven by inherent product characteristics; thus at a country level, this implies that country differences in observed GVC participation relate to structural characteristics that determine their industry mix.

Figure 2. Average forward and backward participation

Notes: Sectors with lighter shading represent those for which there is very little trade and as such only a few observations available. Given this, forward participation is high and it is not representative of most sectors worldwide.

However, not all differences are structural. The significant variation within industries and between countries with similar industry compositions suggests that government policy settings are also important. Many of the factors that underpin trade in general also significantly influence GVC participation in the agro-food sectors (Figure 3). In particular, trade and investment policies are a key influence on GVC participation. Tariffs on imports and those faced on exports reduce a sector's participation in GVCs. Similarly, non-tariff measures (those explored were specific trade concerns raised over sanitary and phyto-sanitary (SPS) and technical barriers to trade (TBT) matters) also reduce participation. For each of these, the cost raising effect of trade barriers reduces industry competitiveness and therefore its ability to participate within value chains. Importantly, tariffs charged and the number of SPS concerns raised also have a negative influence on the total domestic value added gained from exporting agro-food goods (those sold into GVCs and those which make use of inputs from GVCs). Thus a country's own barriers act as a brake on its export earnings.

For other non-tariff measures, the results are more nuanced. Estimates suggest that a complex arrangement in place domestically, which creates problems for international suppliers (represented by the number of SPS concerns), negatively affects the domestic value added generated from exports. On the other hand, the number of TBT concerns raised about a country's own requirements and those raised in that country's export markets are correlated with higher domestic value added generated from exports into GVCs. In relation to TBT arrangements faced in export markets, the number of concerns could be correlated with trading relationships of high value – creating a spurious correlation between the variables. Alternatively, despite the concerns, the higher returns may represent some sharing of market

rents from restrictive TBT regimes. However, combined with the results on the impact of TBT concerns on participation, the results are likely to represent the positive effects that trading and product rules have on markets. For example, the TBT requirements could indicate a situation where TBT measures are necessary to underpin trade, creating confidence in markets and supply. That said, when looking at NTMs in greater detail for a sub-set of countries, high tariff equivalents were associated with lower rates of agro-food GVC participation. Thus in aggregate, the results for SPS and TBT concerns suggest that while these measures may in some cases enable trade to occur, less complex and more transparent and science based arrangements, that avoid concerns being raised by trading partners, can increase the domestic value added generated in exports.

Figure 3. Factors influencing the returns from and participation in GVCs

Note: Standardised coefficients measure the impact of a one standard deviation increase in the variable making comparisons of the absolute value of estimated coefficients not meaningful.

Promoting the agricultural sector's capabilities also contribute to greater levels of GVC participation. Transport infrastructure, education levels and agricultural research and development (R&D) are all positively related to participation and domestic value added creation from GVC participation (the effect of agricultural R&D on forward participation is negative, however, likely driven by a link to a greater production of goods for final demand). Other factors such as the ability to meet private standards (proxied through the number of accredited producers) are also important for a subset of countries.

Non-distortive agricultural policies are also important in GVC participation and the domestic value added generation from exports. For countries covered by the OECD *Producer Support Estimate* database, non-distorting support provided either directly to producers or to the sector as a whole has a positive influence on GVC participation and domestic value added generation. By contrast, the use of distorting support has a negative influence on the benefits from GVC participation, highlighting potential value added losses from protection policies. Indeed the domestic value added contribution from food and agricultural sectors to total earnings was found to be negative in some instances – due to subsidies paid to certain sectors. These create value added losses captured in the exports of other agro-food sectors. In effect, this shows the cost to downstream industries from subsidies. This also has

important implications for policy makers when considering reforms to improve the domestic value added generated from agro-food GVCs. As these ‘taxes’ are more likely to come from inputs sourced from food and agricultural sectors than from services and manufacturing, and given the importance of these industries to agro-food export value added, reforms to limit subsidies and distortions in agro-food sectors are likely to enhance the domestic value added captured through participation in GVCs.

Agro-food GVCs are also a source of employment. For a number of developing countries the share of total employment involved in activities related to agro-food GVCs is significant – for example, in Africa, employment associated with domestic value added in forward participation is particularly significant (that is, the value of employment used in the production of these exports). Sectors that are free from significant subsidies or taxes generally generate the largest employment effects from participation in GVCs. As such, reducing the costs of agro-food policy interventions, through reductions in subsidies and unnecessary taxes, can also improve the positive employment effects from participation in agro-food GVCs. The results suggest it is both industry characteristics and relative engagement in GVCs (which is influenced by policy factors that affect competitiveness) that are important in determining the employment effects of GVC participation.

Interestingly, the domestic value added share from the agriculture and food sectors of any \$1 of exports is roughly the same. This suggests that increasing agricultural exports by \$1 is likely to yield the same domestic value added as increasing food sector exports by the same amount. Thus government policy should focus on enhancing overall competitiveness and allowing industries to exploit underlying comparative advantages rather than incentivising food sectors (perhaps at the expense of agriculture sectors) in the belief that these provide greater domestic benefits in terms of value added creation. In line with this, policy factors such as agricultural R&D intensity were found to be a critical input that yielded positive results in terms of domestic value added creation. The link here is with productivity and innovation. With agriculture a critical input into the production process of its own and the food sector’s output, the returns from lower costs of production, new production techniques and the development of new products flow through to the creation of domestic value added.

Overall, while structural characteristics are important in explaining country-level differences in GVC participation, this does not imply that promoting changes to the industry mix will yield benefits. The results related to domestic value added show that policy factors are important in shaping the returns from agro-food GVC engagement. That is, policy makers should not be concerned with the overall level of engagement, but rather on maximising the returns from engagement. Examining policies and differences in GVC participation by the same sector across individual countries provides greater insights than overall country-level GVC participation.

There are some caveats to the approach in this study. Data is only currently available for 2011, so the study relies on cross-sectional analysis to draw out the influences on GVC participation and domestic value added creation. To minimise the potential for bias and erroneous results, policy and structural factors chosen were based on finding from other studies; however, caveats remain. Looking further ahead, expanding the year coverage of the data will provide one means to overcome the lack of observations and to explore some of the dynamic effects of GVCs, while allowing the effects of structural differences to be better isolated. Such data could also allow exploration of the dynamics of GVC participation over time. That said, as many of the data gaps will not be possible to overcome, alternative approaches could be also explored to complement assessment of the influence of policies on GVC participation. Scenario analysis using the GTAP or METRO models, for example, could provide powerful insights into GVC participation drivers in the absence of better data. This study also did not explore the functioning of domestic value chains. The functioning of domestic value chains is often an important underpinning to GVC participation, and as such, exploring such linkages represents an opportunity for further work.

Part 1. Introduction

1.1. *Why this study?*

Global value chains (GVCs) have changed the nature of production and specialisation across the world. Simply defined, GVCs represent the “full range of activities that firms and workers do to bring a product from its conception to its end use and beyond” (Gereffi and Fernandez-Stark, 2011). These activities include the production, marketing and delivery of a product or service to the final consumer. The fact that they are increasingly spread over several countries is what makes these value chains ‘global’.

GVCs have contributed to the international fragmentation of production as countries and industries are increasingly contributing elements to a final product rather than completing the production activity solely within domestic boundaries. These developments have been a key factor behind the redistribution of global economic activity towards developing countries (Baldwin, 2012). Underpinning these changes have been advances in technology and logistics performance that have facilitated the break-up of economic activity.

The changes in the international production landscape have been most obvious in the area of manufacturing and services and have been extensively studied (see, for example, OECD, 2013a; 2015a). This has improved the understanding of both the nature of GVCs and the determinants of participation, with important implications for policy makers. Interventions that restrict the movement of products across borders (or market investments) can be even more disruptive to domestic economies as barriers are magnified along GVCs. These effects can flow on to negatively affect the incentives or abilities for new production techniques to be adopted, with implications for productivity. A better understanding of GVCs and their determinants helps policy makers better understand the full impacts of their trade and domestic policy decisions.

Agriculture has seen many of the same changes in the production landscape witnessed in other sectors. Studies describing GVCs for agriculture and food processing activities in the aggregate have shown that many of the influences that have changed the production landscape for other parts of the economy are also at play in the agro-food sectors (OECD, 2015a).

The value chains that are the focus of this study relate to the flows of agricultural and food products across borders rather than the value chains that exist within individual countries. Underlying these international flows is a wide array of value chains in which individual producers, processors and retailers participate. These chains vary in the way different actors interact and contract (Box 1.1) and how they function, but have all been successful in developing the trust relationships between actors that allows the fragmentation of agro-food production to occur. It is beyond the scope of this study to examine the wide array of global value chains at the individual firm (micro) level and the differences arising from the different solutions to developing relationships between value chain actors (including the policy factors that have contributed to their development). Instead, this study focuses on the policy factors that underpin the flow of goods within value chains that cross national borders, such as those related to trade and domestic agricultural policy settings.

Little is known about differences that may exist among various agro-food sectors in GVC participation. Studies of individual agricultural value chains, often at a specific product and locality level, suggest that across industries there could be large differences in the nature of GVCs for different products. Further, agricultural markets are more distorted than many others: products face higher trade barriers (such as tariffs and quotas) and are more likely to face non-tariff measures (such as quarantine, public health, and other technical measures). Agricultural markets in many countries are also subject to greater levels of government intervention (such as through direct budgetary payments or regulated marketing channels and price controls). These factors are all likely to play a significant role in the connectedness of producers to markets. For example, applied weighted average agro-food tariffs in 2014

were 6% compared with 2% for industrial goods.¹ With tariffs shown to be a key determinant of participation in GVCs (OECD, 2013a; 2015a), a priori, it would be expected that the development of agro-food GVCs and the possible benefits to flow from them are likely to be lower.

Other factors may drive differences between the agricultural and other sectors of the economy. Natural resource endowments and the policies that govern their use are likely to be more important for agriculture than for other sectors. For example, agricultural production is significantly dependent on the productivity and availability of non-traded natural assets such as land and water. Agro-food products are also likely to differ from many other traded goods. Agro-food products are fragile and perishable, so supply chains and necessary service inputs also differ. Further, foreign direct investment (FDI) may differ due to differences in the range of business opportunities available to foreign firms and investors.²

To date, analysis of the international flows of food and agricultural products within GVCs has suffered from a lack of data. Global information on trade in value added, such as the OECD-WTO's (2013) Trade in Value Added (TiVA) database,³ has only collected data at an aggregate level – for agriculture and food processing as broad sectors – limiting the analysis to these broad groupings.

The possible differences between individual agro-food and other sectors suggest a need to address the gaps limiting current understanding of agro-food GVCs. Better information on how policies influence participation in GVCs, and identifying the factors that contribute to obtaining greater benefits from GVC participation will be important for future agro-food trade reforms at the multilateral, regional and bilateral level.

Box 1.1. Developments in contracting and marketing enabling agro-food GVC development

A number of forces are suggested to lie behind the international fragmentation of agriculture and food production giving rise to GVCs for these products. These include the shift from the sale of food *commodities* to food *products* (Drabenstott, 1995; Kirsten and Sartorius, 2002). This shift has been accompanied by a change in sourcing from spot markets to direct marketing channels as consumers, and in response sellers of food products, have demanded more differentiated products with higher levels of quality, accountability and safety – driven both commercially and by increasing legal due-diligence requirements (Rhodes, 1993; Royer, 1995; Drabenstott, 1995; Pasour, 1998; Unneveher, 2000; Kirsten and Sartorius, 2002).

However, to deliver on these demands, arrangements through direct marketing channels between producers and other actors in the value chain have had to evolve. In essence, the arrangements have had to allow end sellers to have trust in the value chain and to know that individual actors are accountable. Such arrangements have also led to changes in the agricultural and food sectors. Producers are increasingly interacting not with an intermediary in an arm's length *caveat emptor* transaction, but instead with the final seller and all other value chain participants in between.

Building these arrangements involves transaction costs, influencing the ability of different actors to participate in GVCs. Key developments that have enabled GVC creation include further use of contract farming, the use of specification contracting, the formation of strategic alliances and even the vertical integration of producers and processes (Sartorius and Kirsten, 2007 among others). Studies, however, point to different arrangements working in different industries and specific value chains, and describe the wide array of structural, development and policy factors that are likely to be at play in the development of individual value chains in specific countries and markets.

1. WITS (2016) data (<http://wits.worldbank.org/>).
2. FDI in agriculture, for example, is more likely to be resource-seeking (such as purchases of land and other natural resource rights) rather than market seeking (such as establishing market operations for existing or new business activities). Further, FDI in agriculture can be subject to additional government requirements due to sensitivities over land ownership. These factors can result in differences in the influence on production and GVC participation compared with manufacturing and services.
3. See www.oecd.org/sti/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm.

This study seeks to begin to fill some of the information gaps that surround agro-food GVCs. By making use of a newly developed database of trade in value added derived from the 2011 GTAP database (Greenville et al., 2017), the study maps the landscape of GVCs in agriculture, and explores the factors that influence participation and the benefits, in terms of domestic value added and employment, generated.

In addition to this opening section, this study is structured into a further two parts.

- Part 2 explores the growing importance of trade within GVC structures and presents past findings from the literature on agro-food GVC participation, identifying relevant structural and policy related influences of GVC participation within the agro-food sector.
- Part 3 of the study presents the results of the analysis from the newly created dataset of GVC participation indicators for 20 agro-food sectors. It begins with a description of the landscape of agro-food GVCs across countries and sectors. Following this, an exploration of the influences on agro-food GVC participation is presented, including whether the key variables that influence GVC participation in other sectors of the economy are also at play within agriculture and food. Finally, the study explores aspects of domestic value added created from GVC participation and the policies and other structural variables that influence this. Special attention is paid to the employment effects of agro-food GVCs.

The remainder of this section briefly presents the methodology used to estimate the GVC linkages of individual sectors within individual countries and the measures used to explore the domestic impacts of GVC participation on value added generation and employment.

1.2. How are global value chains measured and described?

Trade flows, in particular, trade values, are composed of a range of inputs. The value of a given product represents the combination of a number of inputs, some of which would have been sourced locally (such as labour, capital and local products) and some that would have been imported (such as intermediate inputs and their embodied labour and capital). Understanding GVCs requires unpacking these various elements so that for any given product traded, the amount of transformation that has occurred locally can be identified. That is, the approach allows the trade in *value added* to be estimated. For example, the joint OECD-WTO (2013) Trade in Value-Added (TiVA) database measures trade flows in terms of the value that is added domestically (labour compensation, other taxes on production and operating surplus, or profits) by a country in the production of any good or service that is exported.

The difference between conventional trade flows and trade in value added is shown in Figure 1.1. In this simple example, Country A exports \$100 worth of goods, produced entirely domestically, to Country B. Country B then further processes these goods before exporting them to Country C where they are consumed. In doing so, Country B adds value of \$10 to the goods and so exports \$110 worth of goods to Country C. Conventional measures of trade show total global exports and imports of \$210 but only \$110 of value-added has been generated in their production. Conventional measures also show that Country C has a trade deficit of \$110 with Country B, and no trade at all with Country A, despite the fact that Country A is the chief beneficiary of Country C's consumption.

Through tracking value added flows instead of absolute flows, it is possible to decompose trade into its value added components. In the example in Figure 1.1, Country C's trade deficit with Country B can be recalculated on the basis of the value-added it 'purchases' from Country B by its final demand. Recalculating in this way reduces C's deficit with Country B to \$10. This now means that Country C has a deficit of \$100 with Country A. As such, Country C's overall trade deficit with the world remains at \$110 but its composition changes.

Figure 1.1. Measuring trade in value added

Source: OECD (2013a).

Once estimates of trade in value added are known, information on how a country participates in a value chain can be estimated. The example above shows that Country B relies heavily on Country A for its exports as the source of most of its inputs. This reveals the GVC and shows that there are two parts from any given country's perspective:

- a 'forward' looking part that shows the extent to which a country's exports form part of a production process in another country, contributing to that other country's exports before the product reaches final demand
- a 'backward' looking part that shows the extent to which imports from other countries are used in the production of a country's exports.

To date, different approaches have been used to characterise the forward and backward participation of a country in GVCs. The most commonly applied approach is to calculate an indicator of "vertical specialisation". This indicator was first described by Hummels et al. (2001) and later refined by Koopman et al. (2011). This approach defines value chain participation in terms of the origin of the value added embodied in exports both looking backward and forward from a reference country: backward when it comes to foreign value added embodied in exports; and forward when relates to domestic value added used as inputs to produce exports in the destination country. Such indicators have been calculated by using harmonised systems of inter-country input-output tables (ICIOs) (as in Timmer et al. 2012; OECD 2013a; De Backer and Miroudot, 2013; and UNCTAD, 2013). The OECD-WTO TiVA database released in 2013 and updated in 2015 is based on this approach and provides, amongst other indicators, a decomposition of gross trade flows into various types of foreign and domestic value added. These indicators, however, have limitations. They represent average results for industries with often very heterogeneous firm structures (or farm types): with some firms solely serving domestic markets and others specialising in exports.

Broadly, the backward participation index is measured as the share of foreign value added that is included in the total export value of a country. The forward GVC participation index is measured as the share of a country's value added arising from its own exports (direct and indirect through the exports of other domestic industries) included in exports of other countries. The indexes measure very different forms of engagement. For example, a country that is predominantly assembling products into final goods and subsequently exporting these will have a strong backward participation index but a small forward participation measure. Conversely, a country which predominantly supplies intermediates to an assembler will have a strong forward participation indicator but a small backward participation measure. These participation measures therefore give us a metric of engagement in the form of buying from (backward participation) and selling to (forward participation) GVCs – in other words, the demand and supply sides of the value chain activity. Differences across countries in forward and backward participation can then be analysed to explore the structural and policy determinants that underpin engagement in GVCs.

1.3. *How to measure the domestic impacts of GVCs?*

Measures of forward and backward participation, however, will not capture all the effects on agro-food sectors from their engagement in GVCs. Due to the nature of some agro-food products, value chains may be short, with the raw agricultural product exported directly for final consumption (for example, some fruits and vegetables).

To gain a better understanding of the effects of participation in GVCs, the analysis of agro-food GVCs needs to be complemented with a broader set of indicators to capture the impacts on domestic economies. For example, exploring further characteristics of domestic value added will shed light on the domestic returns from GVC participation (the range of indicators are described in more detail in Part 3).

The domestic value added embodied in exports obtained from trade in value added data can also provide partial insights into issues related to productivity growth driven by participation in GVCs – termed economic ‘upgrading’. Upgrading has been the focus of much of the GVC literature and refers to the ability of sectors and producers to increase productivity and thereby increase their value added shares in a final product, through their involvement in GVCs (Gereffi, 1999). This concept has sometimes been misinterpreted as a need for a country to capture a growing share of the value in the final product, through policies to increase domestic value-added, particularly in developing countries (Hausmann et al., 2008). In total value terms, however, it is not only the share of domestic value added that matters, but also the volume of trade (OECD, 2015a). A country with a small value added share in exports but with a significant volume of exports may generate more total domestic value than a country with high value added shares but with a low value of exports. Similarly, a country that undertakes a wider range of value adding activities but does so at higher costs may have lower *total* domestic value added from GVC participation.

Apart from domestic value added, the employment effects of GVCs can also shed light on domestic market impacts of GVCs. Through the domestic value added share of exports, and using the factor use of sectors from the inter-country input-output (ICIO) table, the value of employment in each sector associated with sector GVC participation can be derived.

Part 2. Past studies on GVCs in the agriculture and food sectors

GVCs can increase the opportunities for economic activity and specialisation, creating benefits for economies. As such, it is important to understand the nature of GVCs in the agriculture and food sectors and to understand what influences participation in them. This section explores some of the developments in international markets that suggest a rising importance of GVCs in agro-food trade and sets out some of the findings from existing studies on GVCs in agriculture and food. The focus of the review is the international flows of agricultural and food products in line with the objective of this study, rather than on marketing and contracting arrangements within individual agro-food value chains.

2.1. *Developments in international trade suggest a rising importance of agro-food GVCs*

The international trading environment in agro-food products has changed significantly over the past 20 years.⁴ Trading patterns in agro-food products have been influenced by production trends, global income growth, changing prices on international markets and, importantly, policy shifts. The development of agro-food GVCs is likely to be influenced by some of these trends, and in turn, these trends are likely to influence the developments in agro-food GVCs.

Trends in agro-food markets indicate changes in the relative importance of production centres, with a rise in production in a number of developing regions, particular Asia and South America, since 2000 (OECD, 2016a). Developed agricultural producing regions, on the other hand, have seen more modest

4. For a more detailed description of changes in agricultural markets and policies see OECD (2016a).

to neutral growth, particularly in per capita terms. These changes have partially shifted the relative importance of regional agricultural production and thus the location of many segments of potential GVCs.

There has also been a significant shift in prices. The long term trend of declining prices came to an end in the 2000s and was followed by a number of price spikes, most notably in 2007/08. Prices since then, however, appear to have landed at a new higher mean, partly due to rising incomes and demand. Over the medium term, however, prices are expected to decline gradually in real terms for most agricultural products on the back of sustained global productivity growth but remain above pre-2007 levels. Further, while the price spikes during the 2000s also caused a surge in price volatility on world markets, in recent years prices have been stable and for most products have continued with what has been a long term decline (since the 1970s) in variability. There are of course exceptions to this, with world maize prices exhibiting the opposite trend (OECD, 2016a). The future of such trends, however, remains uncertain, especially in the face of the potential effects of climate change.

On the policy front, there have been changes to both border policies and domestic support levels for agriculture. For some, domestic support has been restructured away from distorting forms of support and also reduced. For others, support has increased, along with government intervention in markets. Globally, there has been a convergence in support between emerging and developed countries (OECD, 2015b; OECD, 2016a). For agro-food tariffs, changes have been more uniform, falling globally since 2000.

Accompanying the trends in production, price, demand and policy have been shifts in trade. Agro-food trade has benefited from a rules-based international trading environment, with significant growth in agro-food trade witnessed during the 2000s compared with earlier periods (Figure 2.1). Both World Trade Organisation (WTO) agreements and further liberalisation achieved through bilateral and regional trading agreements have contributed. Along with the increase in trade volumes, has been an increase in the number of exporters and importers of agro-food products (OECD, 2016a) – a trend consistent with the development of GVCs and more interconnected product markets.⁵

Not only have total agro-food trade volumes grown, but so too has the relative share of production traded for a number of commodities (Figure 2.2). That said, there is considerable variation across products, with some (such as soybeans) having very significant amounts of production traded and others (such as rice and pork) considerably less. This would also suggest differences in the development of GVCs across these sectors.

The aggregate changes in trade across different agro-food products, however, differ substantially. For almost all products, the growth in trade was stronger during the 2000s than during prior periods (Figure 2.3). For some, this represents an acceleration of past growth rates, for others there has been a reversal, and yet for others, trade growth rates have been negative but falls have lessened in their intensity.

GVCs combine products traded as intermediates (goods and services used in the production of another good or service) from various sources to produce final products. As such, trends in the trade of final products versus trade in intermediate products can provide insights into the importance of agro-food GVCs. That is, a relatively stronger growth in the trade of intermediates would suggest the possibility of strong growth in the development and importance of agro-food GVCs.

5. Trade in agro-food products is very concentrated, but it is becoming gradually less so over time. Using the Gini coefficient to measure the concentration of trade shows that while the period between 1996 and 2000 saw a further concentration in agro-food trade in terms of exports (and imports) from 0.788 (0.784) to 0.816 (0.805), since then this concentration has begun to fall, most notably since 2007 with the Gini coefficient falling from 0.809 (0.785) to 0.777 (0.753) (OECD, 2016a). A Gini coefficient of 1 represents a situation of complete concentration where there is only one exporter or importer, with 0 representing a situation where all have equal amounts of either exports or imports.

Figure 2.1. Global agro-food trade has been growing

Compound annual growth rates (%) in real values (USD)

Notes: Trade values converted to real terms by applying the US GDP deflator from IMF (2016) International Financial Statistics Online www.imf.org/en/Data. Rates for exports and import differ due to differences and inconsistencies in country reporting.

Source: Author calculations based on WITS (2016), World Integrated Trade Solution, (<http://wits.worldbank.org/>).

Figure 2.2. Shares of production traded have trended upwards

% production exported selected commodities

Note: WMP represents whole milk powder.

Source: Author calculations based on USDA (2016), Production, Supply and Distribution Online (<http://apps.fas.usda.gov/psdonline/psdquery.aspx>).

Figure 2.3. Growth in trade varies significantly among agro-food products

Compound annual growth rates (%) in real values (USD)

Notes: Trade values converted to real terms by applying the US GDP deflator from IFS Online. Trade growth estimated on change in reported imports. Growth rates may be biased by changes in relative real prices over the period.

Source: Author calculations based on WITS (2016), World Integrated Trade Solution (<http://wits.worldbank.org/>).

The acceleration in agro-food trade growth is also replicated in the growth observed in intermediate and final goods trade (Figure 2.4). However, interesting differences are observed between intermediate and final goods trade and between agricultural and food products. Trade growth in intermediates has been stronger for both agricultural and food products between 1995 and 2011, suggesting the importance of GVCs in agro-food trade has increased over time, and that factors at play in other sectors leading to the fragmentation of production are also affecting agro-food industries.

In aggregate, the policy and market shifts suggest that international markets and agro-food GVCs are potentially playing an increasing role in producer incomes and in global food supply. With the future production environment uncertain due to pressures from rising and changing demand and climate change, the role played by trade in agro-food products in balancing demand and supply and in generating farmer incomes will become relatively more important (Greenville, 2015). Well-functioning agro-food markets and GVCs will thus become more important, underscoring the need for policy makers to have a better understanding of what they are, what influences participation and the benefits from involvement.

Figure 2.4. Trade in both intermediate and final agro-food products is increasing

Notes: Trade values converted to real terms by applying the US GDP deflator from IFS Online. Trade growth estimated on change in exports recorded in the OECD Inter-Country Input-Output Tables.

Source: Author calculations based on OECD (2015c), Inter-Country Input-Output Tables

(<http://www.oecd.org/sti/ind/input-outputtablesedition2015accessstodata.htm>).

2.2. Past evidence on GVC participation by agro-food sectors

At the aggregate level, the development of agro-food GVCs has occurred alongside those in other sectors.⁶ However, the observed rates of participation are often lower than those for other sectors. Aggregate results suggest the agriculture and food sectors have different GVC structures – both compared to each other and with other sectors (Figure 2.5). Agriculture is linked to GVCs more as an upstream provider of materials used in other production processes, with the food sector more of a downstream user of materials. This is demonstrated through the relatively high level of forward participation by the agriculture sector compared with relatively low levels of backward participation. The results suggest that many food manufacturing industries source inputs internationally but sell their products domestically or directly to foreign consumers. For the agricultural sector, significant forward linkages suggest that it is a starting point for many GVCs. In contrast to other sectors, exports from agriculture are more likely to be further processed in an export market and then exported again.

Over time, GVC participation by agriculture and food sectors has increased at a similar rate to that seen in other industries. For the agriculture sector, forward linkages have increased more than backward linkages. These changes in the linkages are likely to be associated with changes in production technologies and international market conditions, including changes in relative prices. For backward linkages in agriculture, the greater use of intensive production systems (for example feedlots for cattle) that source more inputs from the sector itself than before (such as crop output for feed), as well as more open markets, are likely to be playing a role.

6. Many ICIOs depict the agriculture and food sectors as distinct but aggregate sectors. This is the case for the OECD-WTO TiVA database. UNCTAD (2013) uses the EORA GVC database (Timmer et al., 2015) and the WIOD database, and shows similar results for the agricultural and food sectors' GVC participation. For more detail on GVC indicators across the various ICIO sources, see OECD (2015a).

Figure 2.5. GVC participation differs for agro-food sectors compared with others

Notes: 1. Food includes food products, beverages and tobacco. 2. Services include construction. 3. Agriculture includes agriculture, hunting, forestry and fisheries.

Source: OECD (2015d), TiVA database, (<https://stats.oecd.org/index.aspx?queryid=66237>).

Figure 2.6. Backward and forward participation varies across countries

Top 25 agro-food traders (importers and exporters) by trade volume in 2011

Source: OECD (2015d), TiVA database, (<https://stats.oecd.org/index.aspx?queryid=66237>).

There is considerable variation in the levels of GVC participation by agro-food sectors across countries (Figures 2.6 and 2.7). Across the world, there appear to be regional differences in GVC participation, with level of development possibly playing a role. For example, a number of European countries have high rates of backward participation in agriculture based GVCs likely reflecting higher input use (and international sourcing) from more intensive farming practices. In contrast, China and India have relatively high forward participation rates (similar for all countries in Asia). In both sets of countries, the agricultural sector is highly engaged in GVCs, but in different ways. European countries engage mainly in the form of buying from GVCs, while China and India participate more by selling to GVCs. In the food sector, most European countries along with China, Southeast Asia, and Canada show high backward participation rates.

2.3. Influences on participation in GVCs

The drivers of trade in general are significant factors underpinning participation in value chains. However, some factors may be more influential due to the potential for effects to be compounded through the value chain (for example, tariffs or other border restrictions). Similarly, some of the enabling factors that promote trade may be even more powerful for value chains due to their influence on competitiveness.

Structural factors

Trade between two countries, and by extension participation in GVCs, will be influenced by geographic, economic (including infrastructure), social and political (institutions, governance and policy settings) factors. Comparative advantages due to endowments such as land and water resources are likely to play a role, given their influence on agricultural production and trade (Bojnec and Ferto, 2015). Similarly, bilateral trade volumes and the landscape of GVCs will be influenced by the relative size of markets and the economic distance between them, along with cultural factors, such as shared history, a shared language and shared borders (Anderson, 1979). Empirical studies have shown that these structural factors are strong determinants of trade, including for agro-food trade (Barbalet et al., 2015; Carrere, 2006; Cheng and Wall, 2005, Anderson, 1979 among others). However, backward and forward participation indexes pick up different effects. The OECD (2015a) shows that in the food sector, market size is significantly and negatively correlated with backward GVC participation: a larger domestic market, while increasing trade in general, creates a larger pool of domestic intermediates to source from, lowering the measured participation index.

The level of development also influences participation, and the form of that participation. Countries at low levels of development generally have relatively large agricultural sectors that account for a large share of GDP and an even larger share of employment. These countries tend to specialise in production of primary products that serve as inputs – boosting the potential for forward engagement. As countries develop, the process of structural transformation involves the rising productivity of agricultural labour, a declining share of agriculture in total employment, and a declining share of agriculture in GDP, with a shift to manufacturing and the service sector. At this stage of industrialisation, production technologies and processes are changing through increasing use of intensive production systems that need more inputs, encouraging countries to develop backward linkages. The OECD (2015a) found that higher per capita income corresponds to higher backward food GVC participation; but the level of industrialisation is not found to be a strong determinant of aggregate agricultural and food sector GVC participation.

Figure 2.7. Significant differences in participation across regions

Trade weighted averages 2011

Source: OECD (2015d), TiVA database, (<https://stats.oecd.org/index.aspx?queryid=66237>).*Trade and investment policies*

Since the 1994 WTO Agreement on Agriculture, tariffs on agro-food products have dramatically decreased and were as low as 6% on average (weighted) across all WTO members in 2014, down from 12% a decade earlier. Despite the fall in average applied tariffs, pockets of high applied tariffs remain. Further, tariffs remain on average higher than those in other sectors. Tariffs are highest on agro-food goods for final consumption and lowest on goods used for capital accumulation (Figure 2.8).

Figure 2.8. Tariffs escalation on agro-food products

Weighted average tariffs by end use category %, 1996 to 2012

Source: Author calculations based on WITS (2016), World Integrated Trade Solution, (<http://wits.worldbank.org/>).

In GVC trade, the tariff effect is likely to be magnified as each time intermediate inputs are exported they potentially attract tariffs before being transformed and re-exported. Both the tariffs imposed and faced play a role. On the tariffs charged side, the foreign value added in total export value has potentially been already taxed in the process of crossing the border to be used in the production of the export good. The rate of taxation (including through policy settings that distort the real exchange rate) will influence the cost of the export good and the international competitiveness of the sector (Miroudot et al., 2013). Similarly, the tariffs faced will influence the competitiveness of exports in foreign markets. Recent analysis has shown that both the tariffs imposed and faced by countries have a significant negative impact on their participation in agricultural GVCs (in aggregate). Forward participation is negatively correlated to the barriers imposed in export markets, while backward participation is affected by the country's own tariff policy (OECD, 2015a). For food GVCs, Chevassus-Lozza et al. (2013) showed that lower tariffs on imported intermediate inputs increased the exports of high-productivity French food firms over the 2001-04 period.

The significance of this amplification in tariffs can be explored through looking at trade in value added terms. Tariffs are applied on the aggregate value of the product and not on the value addition made by an exporting country. However, for the exporting country, the tariff applied represents a tax on the value added that it is exporting. In this sense, the nominal tariff can be re-expressed as a tax on the domestic value added of the exporter embodied in its exports (Figure 2.9) – that is, it represents the tariff rate faced by each exporter listed on Figure 2.9 expressed as a percent of their domestic value added exported. Adopting this approach reveals that a relatively low nominal tariff applied on trade flows can translate into a relatively high tariff on the value-added traded. For example, the average tariff rate applied to agricultural domestic value added exports is 38% from the China while the corresponding gross tariff is 22%. As such, in terms of participation in GVCs, small nominal tariffs may have large effects on the competitiveness of a sector if its value addition is small before the product is exported for further transformation or consumption in another country.

The higher rates applied on final goods suggest potentially greater limits on the fragmentation of production. With smaller domestic value added additions to more final products, the effective tariff on the domestic value added exported may be very large. This may limit the length and number of players in the value chain and overall value chain participation.

Other aspects of the international trading environment may influence GVC participation. Part of the fall in tariffs on agricultural and food products has been due to the proliferation of bilateral and regional trade agreements (generally termed preferential trade agreements (PTAs)), with a higher proportion of global agricultural trade now covered by these agreements. Between 1998 and 2009, the share of global trade in agricultural products flowing between countries connected through PTAs grew from just over 20% to nearly 40% (Bureau and Jean, 2013). Across all products, evidence suggests that there is a positive relationship between GVC participation and the share of trade covered by a PTA (OECD, 2015a). However, these results do not specifically concern agricultural and food GVCs. In addition, the results do not provide any information on causal links between GVC participation and PTA membership. In particular, it is unclear whether PTAs stimulate the creation of production networks by facilitating trade among potential members of the value chain. Countries already involved in GVCs may be more willing to sign PTAs with their partners in order to secure their relationships as providers of intermediate goods (WTO, 2011). In this sense, it is unclear whether PTAs are the product of existing trading relationships or whether they create them. Despite this, it is likely that in either case, PTAs deepen trading relationships at a faster rate than would have occurred without them (irrespective of whether trading patterns existed beforehand) and as such are likely to be playing a role in GVC participation.

Figure 2.9. Tariff amplification on value added content in agro-food exportsApplied *ad valorem* equivalent tariffs faced by countries, 2009

Note: Applied *ad valorem* equivalent tariffs faced by exporters, weighted by the share of each sector and destination market in the country's agricultural or manufacturing exports.

Sources: OECD (2013a); OECD (2015c); WITS (2016), World Integrated Trade Solution, (<http://wits.worldbank.org/>).

Contrary to the falls in agro-food tariffs, the number of concerns raised over non-tariff measures (NTMs) has increased (Orefice, 2015) (Figure 2.10). NTMs include domestic interventions to protect consumers (such as safety and traceability) and measures targeted specifically at products sourced from overseas such as sanitary and phyto-sanitary (SPS) measures and technical barriers to trade (TBT). The extent to which NTMs distort trade depends on their design, their enforcement, and importantly on the underlying motivation (Box 2.1). Agricultural exports are particularly influenced by such measures with 94% of SPS concerns brought before the WTO related to the agro-food sector (WTO, 2012). As with tariffs, the cumulative imposition of NTMs at several stages of the production process can have an amplifying negative effect on GVC trade (Ferrantino, 2012). SPS and TBT measures impact at least two stages of the supply chain – the original production stage from increased costs related to compliance with product standards (Maskus et al., 2005), and the import stage due to inspection and testing processes which may cause delays. Analysing the determinants of participation in GVCs in Latin America, a recent study showed that specific trade concerns related to the SPS measures imposed and faced by countries correlates negatively to GVC participation. Although this conclusion is not specific to the agro-food sector, this study also showed that the trade restricting effect of NTMs, and in particular for the import of primary intermediaries, is highest for agricultural and food products (Cadestin et al., 2016).

Figure 2.10. The incidence of NTMs in agro-food trade is rising

Number of specific trade concerns raised over SPS and TBT measures, 1995-2010

Source: WTO (2012).

Along with government-set NTMs, agro-food trade also faces a number of private voluntary standards (PVSs). PVSs include a wide range of collective and company-owned initiatives ranging from pre-farm-gate and business-to-business schemes such as good agricultural practices (GAPs), to labelling for consumers (for example, the Fairtrade and GlobalGap certification programmes). The increased role of large international food and retail enterprises that has contributed to the development of agro-food GVCs, has increased the importance of private standards. For example, consumers, and therefore supermarkets, want to be able to verify the conditions in which products are grown and harvested to ensure the quality and safety of the products they sell. In this regard, private standards can act as catalysts for necessary investments in production and processing practices which can enhance productivity and the competitiveness of particular sectors (Smith, 2009; OECD, 2013b). To date, little empirical evidence exists on the relationship between private standards and a country's participation in GVCs. However, some studies have found that compliance with private standards can have trade creating effects on firms. For example, Colen et al. (2012) found that GlobalGAP certification increased the length of the export season for certified enterprises exporting vegetables from Senegal. Volpe-Martincus et al. (2010) and Otsuki (2011) found that ISO certification (a non-government organisation standard setting agency but with links to quasi-government bodies) improved the export performance of firms in Argentina and Central Asia. While individual value chain specific, these have facilitated the international fragmentation of food production. That said, producers in developing countries can face particular challenges with regards to the necessary investment for compliance with standards. This is particularly so for small family agricultural holdings (FAO, 2014).

Investment policies (and other services policies as previously discussed) that influence the connectedness of a country to world markets are also likely to play an indirect role in participation in agro-food GVCs. FDI played a key role in the increasing fragmentation of production (OECD, 2013a) and can influence participation in both forward and backward markets (Hummels, 2001; Miroudot and Ragoussis, 2009). For example, FDI for the acquisition or long-term leasing of agricultural land for agricultural production, although not without controversy, can foster forward GVC linkages for countries with limited land resources.⁷ FDI directed at establishing an export processing facility can

7. Issues surrounding foreign investment in agricultural land included those related to dispute over title (such as issues of land grabbing) have led rise to international standards in this area. In particular, the *Principles for*

boost backward linkages, especially in the case of vertical multinational businesses that import intermediates for production and export a large share of their production (Hummels, 2001; Miroudot and Ragoussis, 2009). In particular, recent results suggest that the growing presence of multinational retailers in a country can increase exports to the home country of the retailer and at the same time increase imports from the retailer's home country (Head et al., 2014; Emlinger and Poncet, 2016). The OECD (2015a) also found a positive and significant correlation between FDI openness and GVC backward participation in agricultural and food sectors.

Box 2.1. The complex effects of NTMs on agro-food trade

The extent to which behind the border, SPS and TBT measures distort efficient trade depends on their design, the underlying market failures which they address, the extent of coordination across countries and, importantly, their implementation and enforcement. Unpacking these effects is difficult and contentious. What has been highlighted is that in aggregate, such measures do impact trade flows (justifiably or not). Disdier et al. (2008), for example, estimate that the effect of SPS and TBT arrangements on the whole is to negatively influence trade flows. This effect was more pronounced for trade between OECD and non-OECD members than between OECD members. Despite this, comparisons between different sectors indicate that SPS and TBT arrangements may also foster trade – highlighting the difficulty in attempting to determine the distortions potentially created by such measures. In a similar vein, Winchester (2009) suggests that reforms to trading arrangements that only focus on tariff and other border measures will produce much smaller gains than if non-tariff barriers are included. For New Zealand, Winchester (2009) finds that welfare gains from agro-food trade reform including the elimination of non-tariff barriers was more than 4 times greater for a range of possible bilateral agreements than if only tariff barriers were removed.

Making use of a meta-analysis of a range of econometric studies exploring the effects of non-tariff barriers, Li and Beghin (2012) also find that agro-food trade is most likely to be negatively affected by such barriers. Further, the effects of these measures imposed by developed countries are significantly greater on products sourced from developing countries, compared with those from other developed countries.

Services and the agricultural enabling environment

GVCs not only link agro-food sectors across the world, they create global linkages between other industries and the agro-food sector. These linkages can be an important determinant of competitiveness and it may not always be the policy settings directed at agro-food sectors that determine their engagement in GVCs, but rather the policies directed at other sectors.

The service content of agro-food exports is significant and rising – particularly in exports from the food sector. The competitiveness of the service sector is thus an important determinant of agro-food production and export costs and GVC participation. Service inputs such as transport and storage logistics, communication services, and other business services facilitate the efficient functioning of GVCs as they help transfer goods, data, technology and (managerial) know-how across borders and can help co-ordinate dispersed activities quickly and smoothly. Increased service use, such as specialised logistics, management or engineering services, can save on production time through improved coordination of activities and reduce material inputs through the resulting reductions in wastage (Nordås, 2010). While subject to caveats, studies have found a positive relationship between the use of services and total factor productivity across a range of sectors, including some agro-food sectors – in OECD countries, for example, Seok and Saghalian (2016) found a positive link between service use and food sector productivity.

Another driver of the variation in services content, and its relationship to GVC participation, relates to the changing nature of competition and demand in agro-food markets. Agro-food sectors are using service content as a form of product differentiation. In the presence of stronger competition, services help differentiate, customise and improve product quality, helping develop closer, more longstanding relationships with customers (Kommerskollegium, 2012). Firms may differentiate their

Responsible Investment in Agriculture and Food Systems were developed to help guide investors. For more information see: www.fao.org/cfs/cfs-home/activities/rai/en/.

offers by adding services to products, bundling them with products, or offering them in connection with the sale of manufactures (Kelle, 2013). On the input side, for example, large international seed companies like Limagrain and Pioneer do not simply provide seeds, but also ensure that wherever customers purchase seeds, they have access to a range of services, including financing, agronomic and nutritional expertise, marketing insight and services, risk management solutions, and field mapping. These companies also build relationships with those who purchase grain from crops grown from their seed, and work directly with processors, livestock producers and others to help enhance the value of their products across the agricultural value chain.

Agro-food sectors make use of a range of service inputs. Greatest use is made of ‘margin’ services – those of wholesale and retail trade (Figure 2.11). In aggregate, services delivered by the wholesale and retail trade, hotels and restaurants sector account for the largest share of service content in the final value of agriculture and food products. Business services also account for a large share (26% and 28%).

The other major service input into agro-food sector exports comes from the transport and logistics sectors. Hsiao and Van der Vorst (2006) showed that one consequence of more complex supply chains is the need for more detailed inventory planning, transportation planning and asset utilisations. The agro-food sector uses new types of logistics service providers that offer complete supply chain solutions. Compared with traditional transportation providers who provide standard services such as carrier-based, warehouse-based or forward-based, these supply chain solution providers play a part in the strategic direction and performance of the entire supply chain. Interestingly, over time the services share contributed by the transport sector has fallen (between 1995 and 2011), possibly representing productivity improvements in this sector.

Agricultural and food industry exports make use of both foreign and domestic services. In 2011, domestic services (either sourced directly from service providers or embodied in physical inputs sourced from other sectors) and foreign services accounted for respectively 16.2% and 9.7% of the value added embodied in agricultural exports. For food sector exports it was higher – at 23.3% and 12.9% respectively. Although domestic services account for the largest share of the service-related value added embodied in exports, foreign services serve an important function in many countries. In 2011, they accounted for 65% of the services embodied in food exports in Cambodia, 53% in Viet Nam, 48% in Thailand, 46% in China, 20% in India, and 18% in South Africa.

Figure 2.11. Margin services dominate services embodied in exports

Source: OECD (2015d), TiVA database, (<https://stats.oecd.org/index.aspx?queryid=66237>).

While the links between service content and GVC participation have been explored in some sectors, recent results suggest that the source of service inputs may also matter. Looking at a cross-section of 40 countries in 2012-13, Nordås and Rouzet (2015) found that restrictions on the import of services, as measured by the OECD services trade restrictiveness index (STRI), are associated with less trade in manufacturing products. This result was also seen for trade in food products. Similarly, Pasadilla and Wirjo (2014) have shown negative correlations between the STRI and gross manufacturing exports of Asia-Pacific Economic Cooperation economies in 2009, suggesting that restrictions may have a potentially negative impact on manufacturing exports. Further, a recent study has also shown that the use of foreign services as inputs in export production has a greater beneficial impact on domestic capacity to export than the use of foreign inputs from non-service sectors (Lopez-Gonzalez, 2016).

Participation in agricultural GVCs is potentially influenced by a large number of other domestic agricultural policy and enabling environment factors. Agricultural policy plays a significant role in determining the competitiveness of agricultural and food sectors and their involvement in trade. As such, the domestic policy settings of a country are likely to play an important role in determining GVC participation and its potential effects (discussed in the following section). Similarly, the quality of the agricultural enabling environment, based around governance quality, market effectiveness, and the availability of human and physical capital (Diaz-Bonilla et al., 2014), is likely to be important. Good governance, in particular institutional quality, can be an important determinant of value chain trade because it can determine firms' ability to enforce contracts (Nunn, 2007; Swinnen, 2007). Similarly, education levels and training, access to finance, and the quality of available infrastructure and logistics are likely to play an important role in agricultural GVC participation. Previous results across a range of sectors have demonstrated that logistics performance, access to loans, education levels, and the quality of institutions and infrastructure have a positive impact on bilateral value added flows (OECD, 2015a).

2.4. Effects on countries from GVC participation

The development of GVCs in the agricultural and food sectors has the potential to increase opportunities for economic activity within a country due to increased opportunities to access new markets and gains in competitiveness from the use of more efficiently produced inputs, along with potential productivity gains resulting from spillovers in the value chain. With increased economic activity, and possible flow-on effects on productivity, the potential exists to increase domestic value added from job creation and capital generation as has been seen in other sectors of the economy (Moser et al., 2015; Wright, 2014).

However, as with participation, both structural and policy factors are likely to shape the level of benefits, in terms of the total domestic value added created from participation in value chains. Further, the interplay between volumes and value shares in exports need to be considered.

Recent OECD analysis highlighted that not only the share of domestic value added matters, but also the volume of trade (OECD, 2015a). While the value added generated by firms in downstream activities may be higher than the value added at less 'sophisticated' stages, a country with a small value added share in exports that has a significant volume of exports may generate more total domestic value than a country with a high value added share but a low volume of exports. This runs counter to policy approaches which seek to 'capture' higher levels of value added by moving up the chain if such a move is not underpinned by comparative advantages. Such moves often target specific high-value products or production stages and can seek to develop new downstream functions within given value chains, for example by replacing livestock with meat exports.

The effect of GVC participation on domestic value added depends on both backward and forward linkages. Using a panel of 58 countries across a seven-year period, estimates by Lopez-Gonzalez (2016) suggest that backward linkages in GVCs in the agricultural and food sectors are important determinants

of positive changes total domestic value added generated from exports (Figure 2.12).⁸ This result was seen for both developed and emerging countries.

GVC participation can also have positive effects on the overall level of employment. For agriculture, the use of foreign content was important for growth in export jobs (Lopez-Gonzalez, 2016). Beyond agriculture, for both manufacturing (including food) and services, the use of foreign content in exports was further associated with positive changes in the *share* of employment involved in the production of exports (Lopez-Gonzalez, 2016). The mechanism for these changes is through the effect that international outsourcing has on productivity – it raises the productivity and competitiveness of activities that are not outsourced, creating more gainful employment opportunities. However, for overall employment the effects vary. For some sectors and economies, the additional hiring due to improved competitiveness and higher sales may be sufficiently large to offset the job losses due to the drop in labour intensity (Wright, 2014). For example, Wright (2014) finds that, outsourcing to China in the US manufacturing sector (including the food sector) resulted in a net increase in total employment in the US labour market of 2.6% over the period, with a drop of about 6% in low skill jobs and a 1% increase in the employment of non-production workers (high skill jobs).⁹ However, for individual sectors the results can differ. For example, manufacturing jobs in the United States fell over the same period due to these same pressures (Autor et al., 2013; 2014; 2016).

Figure 2.12. Backward and forward linkages important in determining export domestic value added s

Note: Standardised coefficients are estimated by standardising all variables by subtracting the sample mean and dividing by the sample standard deviation. The coefficient measures the impact of one standard deviation increase in each variable and as such the absolute values of the coefficients cannot be directly compared.

Source: Lopez-Gonzalez (2016).

8. Lagged backwards participation is used to avoid endogeneity as the domestic value added share of exports is just one minus the backwards indicator in any given year.
9. Moreover, given that it is not the same type of workers who necessarily benefit from the job creation, attention to adjustment mechanisms and safety nets is warranted.

In the longer term, one key issue is how the reorganisation of international trade and production affects countries' capability to improve their economic performance. This question has often been addressed through the notion of industrial upgrading, which refers to the process through which economic actors perform the same activities but do so more productively (Humphrey and Schmitz, 2002). Trade in intermediate goods is expected to have a positive impact on industries' total factor productivity for two reasons. First, imported intermediate goods embody foreign technologies. Where better technologies are available in the foreign country, switching from a domestic supplier to a foreign supplier can allow access to better technologies. In addition, trade in intermediates can also help companies improve their own technologies, thus leading to a more efficient use of production factors (Miroudot et al., 2009).

Most recent empirical analyses tend to conclude that the use of foreign intermediates positively affects a firms' productivity. A series of studies using the firm-level data of French, Italian, and Hungarian food firms over several years showed that import penetration in intermediate inputs contributed to firm-level total factor productivity. The positive effect increased with the initial level of firms' productivity (Olper et al., 2015) but decreased with the degree of substitutability between foreign and domestic inputs (Halpern et al., 2015). Finally, seeking to establish the link between foreign intermediates, productivity and exports, Bas et al. (2014) found that productivity gains from the use of imported intermediates increased the probability that firms would enter the export market.

While GVC participation by agro-food sectors has the potential to improve countries' economic performance overall, the capacity to participate in beneficial ways may vary significantly across workers and firms. This will depend on the nature of competition along the value chain. Differences in market power can alter the nature of spillovers and potential productivity gains from GVC participation. In agricultural and food sectors, some researchers have argued that value chain coordination is characterised by 'quasi-hierarchical' (or 'captive') relationships (Humphrey and Dolan, 2004). This, it is argued, is demonstrated through an increasingly concentrated set of global buyers who have the potential to exercise a high degree of control over a large number of suppliers in the chain. This control frequently consists of specifying the characteristics of the product, the processes to be followed, and the control mechanisms to be enforced in order to reduce the risks associated with non-compliance with standards. This type of structure is argued to have both positive and negative effects on productivity. On the positive side, it can promote the faster application of better practices and adoption of better technologies, spurring productivity in upstream firms. On the negative side, dominant global buyers may not support efforts to move into higher value activities, such as design and marketing, because they fear that advancing into these activities would encroach on their own core competence and can create issues in price negotiations (Humphrey and Schmitz, 2002).

Part 3. Exploring global agro-food value chains

This Part explores the findings from the new database of trade in value added for 20 agro-food sectors. It begins with an exploration of the landscape of trade in value added and of GVC participation across 20 agro-food sectors (see Annex A for the full list and definition of sectors). Following this, the various influences on GVC participation are analysed with reference to those identified in Part 2 as being important for GVC participation. Finally, it explores the domestic effects of GVC participation with respect to domestic value added and employment.

3.1. The landscape of global agro-food GVCs

How does agro-food value added flow around the world?

For a given country, the use and consumption of foreign value added and the use of its value added consumed elsewhere indicates its connectedness within global agro-food value chains. For the agro-food sector as a whole, these linkages are drawn out in Figure 3.1. The relative intensity of the shading indicates the share of the total value added imported or exported associated with any country pair. Exploring trade data in this format shows a number of interesting relationships in terms of bilateral flows.

Going across the rows to the right in Figure 3.1 shows how a country's exports of agro-food value added is used in other countries exports – that is, selling into GVCs. Going down the columns, shows the source of foreign value added used in a country's own exports – that is, buying from GVCs. The figure can further be dissected into a range of regional blocks: three square blocks on the diagonal capture intra-regional trade (that is, intra-America, intra-Asia, and intra-Europe), while six off-diagonal blocks capture inter-regional trade.

At first glance, the data on trade in value added highlights the concentration in agro-food trade. The United States and China dominate global trade in agro-food value added on both the demand and supply side. These two countries are the leading suppliers of agro-food value added to the rest of the world. The figure also shows the importance of geography. This is particularly true for Europe,¹⁰ where intra-regional trade is more widespread. It is also strong in Asia; however trade is much more concentrated among the larger countries in the region. Intra-regional trade accounts for 85% of total trade in value added for Europe, 56% for Asia and 21% for the Americas (measured from the supply side, that is selling into GVCs).

Within bilateral flows, three countries stand out as having a greater reach in their trade in value added – the United States, China and Germany. For the United States, the value added created by its producers goes across the world, reaching most regions – shown by the larger number of shaded cells along the USA row on Figure 3.1. However, value added is more concentrated – shown by the fewer number of shaded cells in the USA column on Figure 3.1. The results are similar for China, with the difference that China has a greater sourcing of value added from around the world. Germany, on the other hand, has fairly limited breadth in its exports (concentrated in markets in Europe) but sources internationally. The result for Germany can be somewhat generalised for all countries in Europe (but particularly for the Netherlands and France) which are seen to source value added from a wide range of countries worldwide but export value added to a narrower set located within Europe. These results are influenced by both the structure of production within regions along with the effects of policy (discussed below).

10. In this study, as in other ICIO's, each European Union member is treated as a separate country in the analysis. As such the higher intra-regional trade will also be influenced by the regional policy settings.

Figure 3.1. Bilateral flows of value added in agro-food

Shading represents relative size measured in USD millions (2011)

[illegible]

Notes: The table shows the value-added created in agro-food sectors in Origin country, that is included in Destination country's (total) export. Africa has been omitted from the table for presentational purposes and as the trading patterns are less visible. N. S. America represents North and South America.

Source: Author estimates.

What does the landscape of agro-food GVC participation look like?

Backward and forward linkages

GVC participation is also explored from each individual country's sector perspective.¹¹ The representation of GVCs explores the extent to which exports of that industry in a given country rely on imports from other countries, and the extent to which its exports (both direct and indirect through the exports of other domestic industries) form part of another country's exports. For the forward linkages, as both direct and indirect exports of value added are captured, for industries with only small direct exports but relatively large indirect exports, the measured forward participation effect can be large – ranging well above the value of direct exports themselves (and so well above an indicator value of 1).¹² However, at the same time, if an industry has no direct exports, its indirect linkages through other domestic industries will not be captured.

Not all sectors in all countries are involved in international trade. The reasons for this vary, and are related to factors such as the nature of the product and issues of perishability. Of the sectors examined, there are three which only have a small number of observed trade interactions: raw milk (the raw unprocessed product) and sugarcane and beet – due to the perishability of the product; and paddy rice (unprocessed rice) – due to the small number of producers involved in the international trade of the raw material.

One way to depict the differences in GVC participation is to look at the distribution of participation in a given sector *across the 70 regions* examined.¹³ Information can then be summarised in terms of the shape of the distributions estimated. A narrow distribution that is has its peak close to zero, for example, indicates that participation of most countries for a sector is low. A narrow distribution which has its peak around values closer to 1, on the other hand, suggests that most countries' sectors participate to a very significant degree in value chains. A flat distribution then tells us that there is significant variation across countries for a given sector, suggesting that the nature of participation is very different in different parts of the world. The distribution of backward participation of the agro-food sectors in GVCs is given in Figure 3.2 and the forward in Figure 3.3 (broadly grouped into similar production categories).¹⁴ The distributions represent probability distributions and show the proportion of observations that are likely to exist for any given participation value.

-
11. There are a number of sectors which have no trade flows for particular commodities and so the backward and forwards indicators are not computed. The averages presented are based on sectors for which trade is observed. For some sectors, there are only a very limited number of observations.
 12. In contrast, the backward indicator is capped at one as the foreign input share of exports is bound by the gross value. A value of one could only arise if there was transshipment of a product through a country using foreign supplied transport services.
 13. As such, the distributions do not explore the heterogeneity of participation across firms within sectors of each country.
 14. For presentational purposes, the distributions of the forward indicators are truncated at 1 so that more detail can be seen. Across industries there are only a small number of observations with calculated forward participation greater than 1.

Figure 3.2. Distribution of backward participation by sector across countries

Notes: Distributions estimated via univariate kernel density estimation (epanechnikov). It is a non-parametric approach that estimates the shape of the distribution by calculating the relative density of the number of observations for any given value of the variable of interest. Density estimates are produced using a similar method to histograms, except that intervals are allowed to overlap. In this way estimates are produced by collecting 'centre point densities' through 'sliding' the interval, or window, across the data range.

Source: Author estimates.

Figure 3.3. Distribution of forward participation by sector across countries

Notes: Distributions estimated via univariate kernel density estimation (epanechnikov). It is a non-parametric approach that estimates the shape of the distribution by calculating the relative density of the number of observations for any given value of the variable of interest. Density estimates are produced using a similar method to histograms, except that intervals are allowed to overlap. In this way estimates are produced by collecting 'centre point densities' through 'sliding' the interval, or window, across the data range. Forward distributions are truncated at 1 for presentational purposes.

Source: Author estimates.

The distributions of GVC participation reveal significant differences across agro-food sectors. Differences exist across sectors, the GVC measures explored (forward and backward) and across countries. Overall, the results point to significant structural differences between sectors driven largely by the nature of the product produced. However, for sectors with ‘flat’ distributions, it is likely that differences are significantly influenced by policy and other factors distinct from the product itself (or potentially due to differences within the sector level product aggregation). The significant differences between industries suggest that industry composition within a country is likely to be the main driver of differences across countries in GVC participation for agro-food sectors in aggregate. For policy makers it is not absolute participation levels that are of interest, but rather relative levels of participation for individual sectors compared to the same sector in other countries and, more importantly, understanding the make-up and drivers of total domestic value added that is obtained from participation in GVCs (discussed later).

Food sectors have a greater variation than agricultural sectors in their backward participation in GVCs. For many agricultural sectors, backward participation is relatively low with strong similarities across different regions. This is especially true for crop-based activities. The exceptions to this are livestock-based industries (with more significant and varied backward participation), likely due to the international sourcing of feed inputs, and plant based fibres and vegetables and fruits. On the food side, sugar is the exception. The concentrated and low backward participation suggests that most of the inputs used in sugar refining are sourced locally – likely due to the perishable nature of sugarcane and sugar beet crops.

For forward participation, outcomes are reversed. The forward participation of agricultural sectors is less uniform (indicated by the flatness of the distributions) and in general a higher proportion of sectors across the countries examined have higher levels of forward participation than for food sectors. Vegetables, fruits and nuts are the exception, with much lower forward participation on average across countries than for other agricultural sectors (likely due to the nature of the product with much of the output consumed directly in final demand, either domestically or internationally).

While some agro-food sectors can show very large levels of forward participation due to strong indirect linkages from a sector to GVCs, across agro-food sectors this is relatively uncommon. Worldwide, only 15 sectors among both agriculture and food sectors were found to have forward indicators whose value exceeds 1 – that is, the indirect linkages to GVCs mean that the value added contributed to other countries’ exports exceed the direct exports of the sector. These strong indirect linkages are most common for the oilseed and wheat sectors, and in country terms, most common in China. For these industries, agricultural production also undergoes further domestic processing before linking to global value chains.

In general, the results indicate that agricultural sectors participate in value chains as the supplier of raw materials and food sectors in terms of sourcing these inputs from around the globe (consistent with other studies). However, within each sector there is significant variation, with plant-based fibres, wool (and silk), along with some animal products countering the general trend in terms of their greater backward participation. Across the sectors, the raw milk sector has the highest rates of forward participation (on average but only including those which trade internationally) with wool and silk having the highest rates of backward participation (on average) (Figure 3.4). However, it should be noted that there are only very few countries involved in the export of raw milk – this is also true for paddy rice, with the results driven by indirect linkages for these sectors.

On average, there is little correlation between forward and backward participation for individual countries and sectors (Figure 3.4). While the effects of large forward participation bias sector and country averages, in general, those with higher forward participation have lower backward participation, suggesting a high degree of export orientation of some industries in some countries and high import sourcing from others.

Figure 3.4. Average forward and backward participation

Note: Sectors with lighter shading represent those with limited trade observations. As such, while for those sectors where trade exists, forward participation is high, it is not representative of most sectors worldwide.
Source: Author estimates.

Total participation in GVCs

Total GVC participation can be proxied by the sum of the backward and forward indicators. This measure provides a partial insight into the length of value chains for a given sector, as if a given industry has high backward *and* forward participation GVCs may be considered relatively long. However, this remains only a partial view as it does not account for domestic linkages within countries. By this measure, GVCs of the oilseeds, plant-based fibres and wheat sectors are relatively long; while those for sugarcane & beet, other meat products and sugar are relatively short (Figure 3.5). A number of staple crops have relatively higher levels of total GVC participation, potentially because these products can be shipped more easily for processing in other countries, which are then further exported. By contrast, sugar has relatively low levels (on average) of GVC participation linked both the nature of the raw product (perishability requires local sourcing) and heavy market intervention in this sector that limits trade. For the significantly less traded products, such as raw milk, paddy rice and sugar cane & beet, while the average of the observed estimates is large, it is not representative of the engagement of most sectors across the countries examined.

Figure 3.5. Total GVC participation

Notes: GVC length is proxied by the sum of the forward and backward indicators for each sector. The simple average is computed by taking the average across all regions for each sector. Sectors with lighter shading represent those with limited trade observations. As such, while for those sectors where trade exists, forward participation is high, it is not representative of most sectors worldwide.

Source: Author estimates.

Figure 3.6. Total GVC participation by country

Average by selected countries (highest 15, lowest 5)

Notes: Total GVC participation is proxied by the sum of the forward and backward indicators for each sector. The average results are computed by taking the average of the sum across all sectors for each country. Averages are computed on observed observations and so are influenced by production mix.

Source: Author estimates.

Across the different countries and regions examined, total participation varied considerably (Figure 3.6).¹⁵ China had the highest rate of average total agro-food GVC participation (associated with food processing sectors) and Sri Lanka the lowest. China has relatively large forward participation rates for its agro-food sectors suggesting its products are used in the production of a range of other products worldwide. Sri Lanka, by contrast, has relatively low levels of backward participation with many sectors also not exporting, suggesting that its agro-food industries are not well connected to world markets.

The reason for observed lower total participation, however, of the other countries with low average total participation is different. For the other countries shown in Figure 3.6 it is not low connections to international markets that drive the results. Many of the other countries with low total participation, measured as the average across all individual sectors, are large agro-food traders and trade across a wide range of products. With the large volumes of direct exports from each sector, and a large number of sectors involved in international trade, the instances of high observed participation (in particular forward participation) is very low. Such results point further to the need for caution in exploring participation rates in isolation or making policy judgements solely based on GVC participation indicators.

Average total GVC participation also varies across geographic regions. Although biased by China, total participation in agro-food GVCs by countries in Asia (broadly defined to include Australia and New Zealand) is, on average, greater than that of other regions. Europe has the second highest average total GVC participation,¹⁶ followed by Africa/Middle East (grouped together in this analysis) and the Americas (north and south combined).

Participation in GVCs by agro-food sectors around the world is generally lower than for other sectors (Figure 3.7). While not discussed in this paper, GVC participation indicators were calculated for all 57 sectors within the GTAP database. The relative differences in the distribution of agro-food sector total GVC participation and that of other industries shows a higher proportion of agro-food industries with lower participation rates. This suggests that there are significant differences between GVCs in agro-food sectors and those in other sectors, with differences driven by both policy (explored in detail later) and product characteristics.

-
15. On a trade weighted basis, however, the results change and some of the world's largest agro-food traders have relatively low rates of total GVC participation, due to often large bias from particular commodities. Despite this, there is less change in the highest participation countries which are dominated by countries in Europe and Asia.
 16. Europe results include intra-European Union trade. The policy measures brought about to establish the common market have had a significant impact on internal agro-food trade between members but at the same time they have also likely diminished extra-region trade with the creation of a common external barrier.

Figure 3.7. Agro-food GVC participation generally lower than that of other sectors

Notes: Distributions estimated via univariate kernel density estimation (epanechnikov). It is a non-parametric approach that estimates the shape of the distribution by calculating the relative density of the number of observations for any given value of the variable of interest. Density estimates are produced using a similar method to histograms, except that intervals are allowed to overlap. In this way estimates are produced by collecting 'centre point densities' through 'sliding' the interval, or window, across the data range. Total participation represents the sum of the forward and backward indicators. The distributions have been truncated at 1.4 for presentational purposes. Higher total participation values exist, however, the number of observations are small.

Source: Author estimates.

Position within GVCs

Another way of exploring GVCs is to examine the 'position' of countries and sectors in the value chain (Koopman et al., 2011).¹⁷ The position of a country and sector is represented by relative forward and backward participation: a figure less than zero meaning a country or sector is relatively more involved in backward participation and a figure greater than zero meaning it is relatively more involved in forward participation. Those around zero show roughly equal forward and backward participation.

Matching information on the position of countries and sectors in GVCs to total participation reveals that those sectors more heavily involved through forward participation also have the highest rates of total participation (Figure 3.8, top panel) – however, greater total participation is also related to greater specialisation at either end of the value chain (high or low position score). This result is repeated in the average results across sectors (Figure 3.8 bottom right panel). For example, the oilseeds sector which has high rates of total participation is also relatively more involved in forward participation (with a relatively high position score). Those with less forward participation, such as other food products, are much less involved in GVC participation. That is, from an industry viewpoint, some sectors have relatively 'long' global linkages, and others less so. Across countries, however, the general trends disappear (Figure 3.8, bottom left panel). The exceptions to this are Indonesia and China who both are relatively more involved in forward participation and also have high total participation.

17. Position is measured as the difference of $\ln(1+\text{forwards indicator}) - \ln(1+\text{backward indicator})$.

Figure 3.8. Country and sector engagement in GVCs

Total participation vs position

Notes: Total participation represents the sum of backward and forward participation. Position is a measure of relative engagement: negative represents relatively higher backward; positive relatively higher forward. In the top panel, total participation and position have been truncated at 1.5 for presentational purposes.

Source: Author estimates.

3.2. What influences participation in agro-food GVCs?

To gain a better understanding of the influences on GVC participation, this section explores the effect of a range of policy and structural influences on GVC participation through a regression analysis of backward and forward linkages (results are shown in Figure 3.9). The analysis conducted is cross-sectional (only 1 year – 2011)¹⁸ in nature which makes it difficult to draw out causal relationships. Despite this, the policy and structural variables included in the analysis were chosen on the basis of the theoretical underpinnings of trade and findings from other studies in order to reduce the chances of spurious relationships (Part 2). As such, the analysis provides a reasonably robust indication of the factors that are likely to play an important role in influencing GVC participation. Full details are set out in Annex B. The analysis has been complemented by four ‘case studies’ that seek to explore specific policy areas in greater detail through the use of more detailed data for a subset of countries (Boxes 3.1, 3.2, 3.3 and 3.5).

Figure 3.9. Structural and policy factors underpinning GVC participation

Note: Only estimates significant at 10% significance level are shown with the exception of tariffs faced and SPS faced for forward participation and TBT charged for backward which were weakly significant (between 10% and a 16% level). Estimates are based on standardised coefficients and as such the absolute values of the coefficients cannot be directly compared.

Source: Author estimates.

18. The cross-sectional nature of the analysis also means that only the direct effects of policies are captured. This ignores some of the dynamic effects of policies, and as past policies will shape some structural variables (such as GDP) the true impact of policies is not captured. Better capturing the longer term effects of policies on GVC participation remains an area for further work.

The influences on GVC participation were analysed using three broad categories of variables. These include: i) trade and investment policies: such as tariffs and non-tariff measures, FDI flows and quality of customs processes; ii) domestic agricultural capacities: related to transport infrastructure, availability of finance and cost, education and food safety systems; and iii) structural characteristics of the economies examined: such as levels of development, distance from markets, agricultural land availability. Industry differences, through industry-specific fixed effects, were also controlled for.

i) Trade and investment policies

A number of trade and investment policy factors were found to influence levels of agro-food GVC participation (with the above caveats in mind). For both backward and forward participation, domestic trade policy and that of trading partners was found to be important. Levels of tariffs charged and faced, along with SPS and other TBT barriers were correlated with lower GVC participation. The results suggest that higher levels of barriers to the flow of agro-food products across borders were associated with lower levels of agro-food GVC participation as the cost of being part of GVCs for individual countries increased and thereby decreased their competitiveness. Similarly, higher quality customs processes were associated with greater participation. For many perishable products, customs procedures are particularly important in determining the cost and ability to participate in value chains, and thus better systems at the border provide a means to improve GVC participation.

For forward participation, the depth of regional trade agreements was found to be important. Countries which had a greater coverage of their trade within PTAs (defined as the share of intermediates trade that occurs between PTA partners for each country – see Annex B) had higher overall rates of forward participation. The reason for this is likely linked with the additional regulatory cooperation arrangements that are present in a number of PTAs allowing for greater confidence and trust in the products being sourced from PTA partners compared with that sourced from non-partners.

FDI was found to significantly influence GVC participation. FDI inflows were found to positively influence backward participation, while outflows positively influenced forward participation. These links pick up on some of the service related linkages that underpin the trade in physical agro-food products with GVCs and highlight the importance of policy settings outside the sector in influencing the outcomes within the sector. Indeed, looking more closely at investment and services policy and its influence on GVC participation suggests that barriers to services trade negatively influence agro-food GVC participation and the benefits from doing so (Box 3.1).

ii) Domestic agricultural capabilities

Domestic agricultural capabilities were also found to be important. Higher levels of primary school education (proxied by data on enrolments) were found to enable greater forward participation, potentially through links to productivity of producers or through enabling them to better access export markets (that is, allowing producers to better overcome the informational barriers that exist in trading internationally).

Similarly, partial evidence from private voluntary standards suggests that these could play a role (Box 3.2). Based on data on GlobalGap certification, the results suggest that compliance with private standards increases GVC participation. Further, the effects are potentially broader than for just the producers themselves. In terms of forward linkages, certification positively influenced GVC participation by food sectors, potentially through the ability to source domestically certified produce, and thereby potentially creating spillovers for the local processing industry.

Other areas of the enabling environment were also found to influence GVC participation, such as agricultural R&D intensity. Greater R&D intensity was found to increase backward participation but lower forward participation. The reasons for the mixed results are likely to rest in effects R&D have on the nature of the product produced. With greater R&D, it is possible that production shifts towards final consumption goods (thereby requiring more inputs, some which are sourced internationally, increasing

backward participation), reducing the ongoing linkages in GVCs as more products are exported directly to foreign consumers (and thereby reducing forward participation).

Box 3.1. Case study 1: Services trade restrictions and agro-food GVC participation

To get a better understanding of the relationship between competitive service markets and GVC participation, a regression analysis of backward linkages, forward linkages, and domestic value added was conducted by exploring the effects of restrictions on services trade, as measured by the OECD's Service Trade Restrictiveness Index (STRI). The STRI provides a comprehensive regulatory database of measures affecting trade in different services sectors from zero to one (where 0 is the absence of any restriction, and 1 is a completely closed sector). For each sector, it covers five policy areas: restrictions on foreign entry, restrictions to the movement of people, other discriminatory measures, barriers to competition and regulatory transparency.

Overall, trade restrictiveness in the services sector was found to negatively influence agro-food GVC participation. Due to the high service content of many agro-food products (Section 3.3), and the use of sophisticated logistics operations within a number of GVCs, a competitive and well-functioning service market is important in sourcing competitive inputs for the sector or for being able to supply competitively into GVCs. Of the restrictions to individual service sub-sectors examined, trade restrictions on freight and insurance services negatively influenced backward participation, while a greater number of sectors negatively influenced forward participation. The greater influence on forward participation suggests that for agro-food exports to ongoing GVCs, access to foreign service inputs is important. For example, in the area of business services, apart from the competition effects from greater trade on domestic service delivery, due to the required contracting across a range of countries that occurs within GVCs, access to foreign service supplies is likely to help reduce transaction costs and thereby increase the competitiveness of a country's exports. For backward participation, the sectors that were found to negatively influence participation are those which are likely to directly influence the cost of imported inputs.

For domestic value added embodied in exports, restrictions at the sector level were not found to be significant. However, when narrowed to those related to restrictions on foreign entry, restrictions to both transport (rail) and legal services were found to decrease domestic value added created. This result is consistent with previous findings (Lopez-Gonzalez, 2016) and may suggest that the use of foreign services is not only important in enabling producers to participate in GVCs but also in enhancing the domestic benefits from doing so.

Table 3.1. Influence of services trade restrictions on GVC participation

	STRI (All policy areas aggregated)			STRI (Restriction on foreign entry)
	Backward	Forward	Domestic value added	Domestic value added
Transport (Rail)	0.001	-0.127*	-0.060	-0.155*
Logistics (Customs)	0.008	-0.173**	-0.045	-0.031
Logistics (Freight)	-0.015*	0.273	0.114	-0.132
Finance (Insurance)	-0.016*	-0.177*	0.132	-0.224
Business Services (legal)	0.009	-0.067	-0.009	-0.130*
Business Services (accountability)	-0.006	-0.127**	0.121	0.054

Notes: A number of variables from the benchmark model were omitted, including FDI, quality of transport infrastructure, access to finance, as they were related to the STRI index. Significance levels: * 10%, ** 5% and *** 1%. Estimates are based on standardised coefficients and as such the absolute values of the coefficients cannot be directly compared.

Source: Author estimates.

iii) Structural characteristics

Agricultural land availability, a measure of the agricultural production capacity of a country, was seen to negatively influence backward participation but positively influence forward participation. With greater land availability, the ability to source domestically produced competitive agricultural inputs is increased, thereby decreasing the demand for imported inputs (but likely increasing involvement in domestic value chains). At the same time, greater production also increases the likelihood of exports and the participation in ongoing value chains. GDP per capita, a measure of development, was associated with lower levels of both backward and forward participation. This result is likely driven by influence of market size on participation. As found in other studies (such as OECD, 2015a), in contrast to trade in general, market size generally lowers observed levels of GVC participation due to increased opportunities for domestic sourcing of inputs and sale of final products, both domestically and

internationally. While such patterns increase involvement in *domestic* value chains and the export of final goods, they decrease the share of trade involved with GVCs.

Box 3.2. Case study 2: The influence of private voluntary standards on GVC participation

The increasing importance of traceability and the management of food safety from ‘farm-to-fork’ has led to the evolution of private voluntary standards (PVS) within agro-food value chains. These standards have been created as a means to develop trust with consumers, by guaranteeing the range of actors that exist across agro-food GVCs. An example of PVS is the GlobalGAP system (Henson, 2007), which was originally conceived by a group of European supermarkets to ensure traceability of their products and has evolved into a body that sets standards on the basis of creating ‘an equal partnership of agricultural producers and retailers’ (Bain, 2010).

PVS such as GlobalGAP have the potential to positively influence GVC participation as they help the co-ordination between various supply chain actors by, for example, standardising product requirements. By specifying and harmonising the product and delivery attributes of inputs, PVS help to lower the transaction costs for downstream actors in the value chain despite the cost increase associated with compliance, allowing them to access inputs from a wider array of individual producers (Reardon and Timmer, 2007). They also have the potential to improve the capabilities of individual producers; farmers may receive assistance programs that allow them to improve supply management or increase their access to technology or other inputs (Dries and Swinnen, 2004). Under certain conditions, some spillovers may be created as farmers outside the value chain adopt the better practices through observing their peers (Rao and Qaim, 2011).

The role of PVS on GVC engagement was explored for a subset of countries by making use of data obtained from GlobalGAP. Data were obtained on the share of harvested areas certified by GlobalGAP in participating countries as a proxy for the level of participation in PVS schemes. However, given the nature of the scheme, the number of farmers covered, and that only one year (2011) is examined, the results will only provide partial insights into the role of PVS in agro-food GVCs. Given this, more work is required to further understand the influence of PVS on the benefits from GVC participation. For the analysis conducted, the results suggest that GlobalGAP certification positively influences backward participation (albeit weakly), likely through changes in production intensity and methods of producers involved leading them to buy more from agro-food GVCs as a means to enhance their own value added and competitiveness. For forward participation, the effects were less evident and were only seen for the food sector. The cause of this is unclear but may result from initial processing by retailers in source country before being exported to logistics hubs and subsequently re-exported to other destinations. For domestic value added, the results were inconclusive, likely because only a small number of observations in each country are present which do not get captured in the aggregate levels of domestic value added examined.

Across the different sectors, the industry-specific fixed effects highlighted the observed difference between agriculture and food sectors for forward participation. Forward participation for most food sectors was significantly lower, with most agricultural sectors not showing any significant differences (all relative to paddy rice in the regression) (Figure 3.10).

Figure 3.10. Sector-specific differences

Note: Only estimates significant at 10% significance level are shown.

Source: Author estimates.

3.3. Domestic value added and GVCs

What is the make-up of the final value of agro-food products?

By the time agro-food products reach final demand they have used a number of further inputs from a wide range of different sectors along their path from raw materials to a final good. For example, production of a specific food product first requires labour, land, and capital in primary agriculture as well as various intermediate inputs such as seed, fertilisers, and pesticides. In going to the final point of sale, the product may be processed and various services are likely to be employed in delivering the product to consumers (such as wholesale and retail trade and transport). All these other inputs also require labour, land and capital along with other intermediate inputs. This process continues across the economy. The ICIO provides a means to trace back through value added factors and intermediate input use to split the final value observed at end use for agro-food products between returns to labour, capital and other value added inputs across the sectors examined. This breakdown is shown in Figure 3.11 for all agro-food products in aggregate.

For every \$1 of aggregate agro-food products consumed, varying proportions of the value of the product will accrue to different sectors in the economy. The amounts will vary by relative demand (for example, sectors with relatively higher volume and value of sales will potentially see higher shares) but also with the various production technologies used across industries and the accompanying market structures.

Figure 3.11. Agriculture and food sectors dominate share of value added final demand value

Share of world total value added in agro-food final consumption, 2011

Notes: The figure shows each sector's contribution to value added in final demand of agro-food products. Estimates include fisheries and forest products. The contribution is measured as share so that sum of all 57 sectors is equal to 1. Final consumption does not include demand for intermediate products.

Source: Author estimates.

Worldwide a significant number of industries contribute to the final value of the output from agro-food sectors (at the point of final demand). Key sectors include those from within the sector such as other food products (food processing activities); vegetables, fruits and nuts; beverages and tobacco along with service sectors such as retail and wholesale trade; and business services. However, when viewed by broad sector category, it is agriculture that contributes and captures the greatest share of total value added in the final value of agro-food products consumed. In total, across the world, agriculture captures 35% of the final \$1, either directly or indirectly (that is, through supplies to other agricultural activities such as feed into livestock production). Importantly, services account for around 22% of the

total value added in final agro-food consumption (in aggregate terms) – more than that contributed by industrial inputs (such as machinery, fertilisers, petrol fuel, amongst others).

Comparing high to middle and low income countries reveals significant differences in the composition of final value added and therefore, the likely make up of agro-food value chains (Figure 3.12). In high income countries, agriculture's average share of the final value of an agro-food product is below the world average and stands at around 22%, while in low to middle income countries it stands at 46%. Key differences are seen in service inputs and from the food industry. In low to middle income countries, in the final value (at point of consumption) of agro-food products there is significantly less value generated from the food industry, pointing to a much less transformed or differentiated product that is consumed. In line with this, there are fewer inputs from other services. However, the share of value is higher from margin services (retail and wholesale), likely representing the provision of a similar level of service as seen in developed countries, but to a less transformed and therefore lower gross value product. In terms of value chains, these results suggest that for final agro-food goods in low to middle income countries, both the global and domestic value chains that support these products are significantly different than those which serve high income country consumers.

Across countries, the make-up of the shares in final agro-food demand varies. In some cases, specific country results are quite different from those observed at the global level. However, across all countries and regions examined, the share of final value sourced from the industrial sector is relatively similar – depicted by the tight distribution in Figure 3.13. There is greatest variability in the share of final value added from the agricultural and food sectors, likely reflecting differing consumption patterns across countries – with higher income countries consuming more transformed food products and less primary production output. The services share is also more uniform, but still more varied than that for industrial inputs. What is also noticeable is that the share of services inputs into the final value of agro-food products is higher than that of industrial inputs in most countries.

Figure 3.12. Differences in share of the final \$1 of agro-food products

High versus low to middle income countries, average share of total value added in agro-food final consumption 2011

Notes: The figure shows each sector's contribution to value added in final demand of agro-food products. The contribution is measured as share so that sum of all 57 sectors is equal to 1. The sectors with small shares have been aggregated. Final consumption does not include demand for intermediate products. Agro-food total value includes final fisheries and forestry goods. Country classification based on World Bank High Income Country classification.

Source: Author estimates.

Figure 3.13. Distribution of value added by broad sector at final demand

% of total value across 70 countries and regions

Notes: Distributions estimated via univariate kernel density estimation (epanechnikov). It is a non-parametric approach that estimates the shape of the distribution by calculating the relative density of the number of observations for any given value of the variable of interest. Density estimates are produced using a similar method to histograms, except that intervals are allowed to overlap. In this way estimates are produced by collecting 'centre point densities' through 'sliding' the interval, or window, across the data range.

Source: Author estimates.

What are the domestic value added effects of GVCs?

Domestic value added generated from exports to ongoing GVCs

Depicting the benefits from increased income generation opportunities created from GVC participation effects in a meaningful way is difficult. Domestic value added in relative terms will vary by the nature of the production technology and the use of foreign intermediates in the production of exports. Having high shares of foreign intermediates (high backward participation) does not mean that income generation opportunities are limited, especially if part of the source of competitiveness within a chain is in sourcing efficiently produced inputs from abroad. This suggests that the domestic value added share of exports does not provide a complete picture of income opportunities.

One way to partially capture the importance of GVCs in income generation in agro-food sectors across countries is to focus on the destination of the exported value added. Looking at the share of domestic value added embodied in exports of intermediate inputs relative to that embodied in exports of products for final demand from a given industry provides an indication of the importance of GVCs in total trade for agro-food sectors, and as such, the importance of ongoing GVCs to income.

For agro-food sectors, exports to ongoing value chains are critically important. For most sectors, the domestic value added generated from agro-food trade comes predominately from involvement in GVCs rather than servicing final demand – a ratio higher than 1 (Figure 3.14). There are exceptions related mostly processed products and vegetables, fruits and nuts. But overall, ratios are generally high, highlighting the importance of ongoing GVCs for the agro-food sector. This is also true across countries, with only 4 countries having ratios less than 1 (higher importance of domestic value added from final demand bound exports). Further, as a number of the processing sectors with low ratios are at the end of the value chain and source from GVCs, this measure understates the importance of domestic value added generated from GVC participation.

Figure 3.14. Domestic value added generated from ongoing GVCs

Ratio of domestic value added from intermediate to final goods trade by sector

Note: Ratios computed for products where exports to final demand exceed USD 1 million.

Source: Author estimates.

However, at the sector-country level, the results are more varied (Figure 3.15). Close to half of all the sectors across different countries obtain greater amounts of domestic value added in exports directly to final demand. Despite this, at the country level, those industries that participate in GVCs generate greater levels of domestic value added making the overall importance of GVCs to domestic income greater.

Figure 3.15. Distribution of ratio of domestic value added in intermediate and final goods exports

Proportion

Notes: Distributions estimated via univariate kernel density estimation (epanechnikov). It is a non-parametric approach that estimates the shape of the distribution by calculating the relative density of the number of observations for any given value of the variable of interest. Density estimates are produced using a similar method to histograms, except that intervals are allowed to overlap. In this way estimates are produced by collecting 'centre point densities' through 'sliding' the interval, or window, across the data range. Ratios computed for products where exports to final demand exceed USD 1 million.

Source: Author estimates.

Domestic value added generated from all exports

Exploring the source of domestic value added in all exports (those to both ongoing GVCs and those to final demand) reveals that most of the domestic value added comes from the individual sector itself (Figure 3.16). This is stronger for agricultural products than for food products. Within agriculture, animal related production activities rely more heavily on other sectors for domestic value added, particularly that derived from industrial inputs (as is seen for food sectors). These results suggest that for agriculture, a key element in obtaining greater domestic value added is through productivity improvements *within* the sector. For both the agriculture and food sectors, the service sector contributes an important share of domestic value added in exports – around 6% for both.

Looking at the relative domestic value added share contained in exports from agricultural and food sectors also reveal some interesting insights. In particular, the domestic value added share embodied in exports from both sectors is roughly the same – depicted by the total bar value for each activity. That is, the domestic value added share of any \$1 of agricultural exports is roughly the same as that generated from \$1 of food exports (at the global level). This suggests that attempts to force resources from primary production to more processing will not necessarily yield higher rates of domestic value added within the value chain unless movements are underpinned by relative comparative advantages (in which case it would be better to remove impediments to the natural movement of resources that would otherwise be expected to flow from the agriculture to the food sector). Indeed, to enhance value added, productivity improvements within sectors are likely to be more beneficial, including by generating greater volume of activity, than moving vertically up the value chain – especially as the effects will be compounded through both agricultural exports and improved competitiveness of food sectors that rely heavily on domestically sourced agricultural inputs.

Figure 3.16. Source of domestic value added in exports

Source: Author estimates.

Across sectors and countries there is variability in the sources of domestic value added embodied in exports (Figure 3.17). Interestingly, for only a few sectors, the domestic value added contributed from some inputs is negative due to subsidies paid to certain sectors,¹⁹ yielding value added losses captured in the exports of other industries. Negative value added is generated when the production of goods in a sector comes at a net cost to the economy. In effect, it shows the cost to downstream industries of subsidies in other areas of the economy by showing the level of forgone activity and therefore the domestic costs related to shifting resources from more productive to less productive sectors. This also has important implications for policy makers when considering reforms that seek to improve the domestic value added and therefore agro-food incomes. These ‘taxes’ are more likely to be seen coming through inputs sourced from food and agricultural sectors than from services and manufacturing. As such, for agro-food sectors, reforms that limit subsidies and distortions to agro-food markets are likely to enhance the domestic value added captured through participation in agro-food GVCs.

Figure 3.17. Distribution of value added source in exports

Notes: Distributions estimated via univariate kernel density estimation (epanechnikov). It is a non-parametric approach that estimates the shape of the distribution by calculating the relative density of the number of observations for any given value of the variable of interest. Density estimates are produced using a similar method to histograms, except that intervals are allowed to overlap. In this way estimates are produced by collecting ‘centre point densities’ through ‘sliding’ the interval, or window, across the data range. Total participation represents the some of the forward and backward indicators.

Source: Author estimates.

19. The domestic subsidies included in the analysis relate to those captured in the GTAP database. For agriculture, these are based on the production distorting elements of the producer support estimates. That is, they relate to subsidies paid on factors of production (land, labour, capital and natural resources), intermediate inputs and outputs. For more details see the GTAP database documentation (www.gtap.agecon.purdue.edu/databases/v9/v9_doco.asp) and OECD (2016a).

3.4. What influences the domestic value added generated from agro-food exports?

The influences on domestic value added creation due to participation in GVCs were also explored following the same approach used to explore the influences on observed participation levels. Total domestic value added created from exports was examined rather than specific value added associated with either forward participation or that of intermediate exports in order to capture both the backward and forward nature of GVC participation. As stated in Section 3.2, the results need to be caveated as the analysis undertaken is cross sectional in nature. This means that it is difficult to draw out causal relationships. Despite this, in order to minimise potential bias and erroneous results, the factors included in the analysis were based on the findings from other studies and, as such, the results presented here, in conjunction with the analysis of others, provides an indication of the factors that are likely to be important in the creation of domestic value added from GVC participation (see Annex B for details on the approach used).

Policy determinants also appear to be important in influencing exports of domestic value added from agricultural and food sectors (Figure 3.18). In particular, policy variables related to trade play a significant role: tariffs imposed on imports of intermediates had a negative effect on the competitiveness of domestic sectors and ultimately the potential for domestic value added to be generated from agro-food exports. Similarly, tariffs faced also decreased the domestic value added generated from GVC participation.

Figure 3.18. Policy factors important for exports of domestic value added

Note: Only estimates significant at 10% significance level are shown. Estimates are based on standardised coefficients and as such the absolute values of the coefficients cannot be directly compared.

Source: Author estimates.

The results also reveal the complex effects of NTMs (as represented through SPS and TBT concerns). Estimates suggest that a complex arrangement in place domestically, which creates problems for international suppliers as represented through the number of SPS concerns, negatively affects the domestic value added generated from exports. On the other hand, the number of TBT concerns on domestic imports and those faced in export markets is correlated with higher domestic value added generated from exports into GVCs. In relation to TBT arrangements faced, the number of concerns could be correlated with those trading relationships which are of high value – creating a false correlation between the variables. Alternatively, despite the concerns, the higher returns may represent some sharing of market rents created through restrictive TBT regimes. However, combined with the results for TBT concerns on imports, the results may indicate the positive effects that trading and product rules have on markets. For example, the TBT requirements could indicate a situation where trading rules are necessary to underpin trade, by creating confidence in markets and supply. Indeed, when looking at NTM in greater detail for a sub-set of countries, high tariff equivalents are associated with lower rates of agro-food GVC participation (Box 3.3). In aggregate, the results of the SPS and TBT concerns, and the presence of relatively high tariff equivalents for NTMs in agro-food sectors (Box 3.3), suggest that less complex and more transparent and science-based arrangements for individual countries, that avoid concerns being raised by trading partners, can increase the domestic value added generated in exports. Such conflicting influences have also been found in other studies looking at NTMs (Part 2).

R&D is also shown to be important. Countries with agro-food sectors that have higher agricultural R&D intensity also generate greater amounts of domestic value added when exporting. The reasons for this lie in the links between R&D and productivity. R&D spending has been shown on a number of occasions to be an important determinant of agricultural productivity growth. Further, as discussed in Section 3.2, agriculture sector productivity is critical to the competitiveness of both agricultural and food sectors.

The effects of FDI on domestic value added created from agro-food exports is also complex. FDI outflows were found to have a positive influence, as the linkages created help enable forward participation in agro-food GVCs. However, counter to this, inward FDI had a negative influence. It is possible that this inward flow is associated with market size and greater levels of non-agricultural production, and hence as market size generally decreases GVC participation (given availability of domestic sourcing and sales – OECD, 2015a), it is also associated with lower domestic value added from agro-food exports. As such, some caution is needed in interpreting this result and remains an area for further work.

Agricultural policy was also found to influence GVC participation and domestic value added (Box 3.4). Exploring the effects of various forms of support as measured by the OECD's Producer Support Estimate data, showed that overall, non-distorting support, provided either directly to producers or to the sector as a whole had a positive influence on GVC participation and domestic value added generation. By contrast, the use of distorting support had a negative influence on the benefits from GVC participation, highlighting the potential value added losses from protective policies.

Box 3.3. Case study 3: Non-tariff measures and GVC participation in greater detail

In the benchmark model (see Annex B for details), the frequency of SPS and TBT specific trade concerns were used to represent the impact of NTMs on GVC participation. Generally, it was found that these measures negatively influenced GVC participation. However, SPS and TBT concerns only represent a subset of NTMs. As such, to further investigate the role of NTMs on GVC engagement, data from the World Bank's Ad-Valorem Equivalent of NTMs dataset for a subset of countries was examined (Kee et al., 2009). The ad-valorem equivalent (AVE) represents the estimated effect that NTMs have on the domestic price of imported goods. In this way, the AVE is directly comparable to a tariff. AVEs were calculated across a range of different NTMs including price control measures, quantity restrictions, monopolistic measures and technical regulations such as SPS and TBT. Tariffs were taken from the Kee et al. (2009) dataset as the GTAP tariff variables also included quantitative restrictions related to quotas. AVEs for NTMs and tariffs "faced" were calculated by averaging partners' trade restrictions using export values as weights.

AVEs were calculated for each product by simple average of six-digit tariff line level AVEs (see Kee et al. (2009) for details of the estimation). The data reveal that NTMs are significant, with those on food products higher than agriculture, mirroring the escalation seen in tariffs.

Figure 3.19. AVEs of NTMs by sector

Source: Author estimates based on Kee et al. (2009).

On backward participation, the influence of NTMs is negative, in line with the effect of tariffs charged in the benchmark regression. The results suggest if current average NTMs (25.6%) were removed, backward participation would increase by 1.3%. As the average backward participation ratio is about 20%, this is not trivial. For forward participation, the influence of NTMs was found to be weakly positive. This was also replicated in the results for domestic value added used for export and repeats the findings seen for TBT concerns in the benchmark model, again potentially related to the complex function that some NTMs fulfil.

Table 3.2. Influence of NTMs on GVC participation

	Backward	Forward	Domestic Value-Added
NTM charged	-0.050**	0.394*	0.705***
	[-1.85]	[1.52]	[2.16]
NTM faced (weighted by export value. %)	-0.059	0.759	-0.080
	[-1.01]	[1.38]	[-0.11]

Notes: Variables were not standardized here in order to ease comparison and interpretation of the coefficients. All control variables except SPS, TBT variables were maintained from the benchmark model. Domestic value added is log of billion USD. Numbers in brackets represent t-values. Significance levels: *10% **5% *** 1%.

Source: Author estimates.

3.5. What are the domestic employment effects of ongoing GVCs?

One way to measure the influence that GVCs have on domestic employment is to explore the embodied employment that exists within exports of agro-food products going to ongoing GVCs (measured as the employment associated with exports of intermediate products).

In essence, the domestic value added that is exported can be broken up into the shares associated with value added factors of production such as labour, land, capital along with taxes and subsidies. This can be done by tracing the domestic value added exported back to its source industry (for both direct and indirect exports) and then using the respective industry production functions (as depicted in the ICIO) to explore the employment effects.

For a number of countries, the employment, in value terms, associated with ongoing agro-food GVCs is significant. Developing countries have the highest shares, with Cote d'Ivoire having the largest share of the workforce associated with ongoing agro-food GVCs – just over 9%. The lowest rate is seen in Japan, with 0.01% of the workforce involved in ongoing agro-food GVCs (despite more than 3% of Japan's workforce being employed in agriculture). The employment effects are also related to the level of production sophistication (Figure 3.20). As expected, countries with higher production sophistication also have lower employment effects, as more capital is used in the production of agro-food products.

Across industries, it is generally those with greater levels of GVC participation which also have the highest employment shares (on average across all countries). An exception to this is vegetables, fruits and nuts (Figure 3.21): while this sector has relatively low total participation, GVC participation generates relatively high employment effects. This is likely due to the labour intensive nature of production in the industry, particularly associated with harvesting. The results therefore suggest that it is both the industry characteristics (and economy-wide production sophistication) and relative engagement (which is related to competitiveness amongst other factors) that are important in determining the employment effects of GVC participation.

Figure 3.20. Workforce employed in ongoing agro-food GVCs and production sophistication

% of total employment in value terms employed and index (0-7)

Note: Production sophistication refers to a ranking in the Global Competitiveness Index with 0 being the lowest and 7 the highest.

Source: Author estimates and Global Competitiveness Index (<http://reports.weforum.org/global-competitiveness-report-2014-2015/>).

Box 3.4. Case study 4: Support to agriculture and GVC participation

The role of agricultural support on GVC engagement and the domestic value added created was explored for a subset of countries making use of the OECD's data collected in its annual *Monitoring and Evaluation of Agricultural Policies* (OECD, 2016b). Data are collected on all transfers to the agriculture sector through either direct government payments or indirectly through policies such as tariffs and other market restrictions.

The effects on backward, forward and domestic value added of the most distortionary payments to individual producers (those related to outputs, market price support, variable input use and current area where production is required), least distortionary payments to individual producers (such as those for the provision of environment services and other decoupled payments) and general services support to the sector were examined. Payments to individual producers were expressed as a percentage of gross farm receipts (see OECD 2016b for details on gross farm receipts) while general services were expressed as a percentage of GDP. The individual payments represent the components of the *Producer Support Estimate* (PSE) while the general services payments represent those captured by the *General Services Support Estimate* (GSSE). Control variables not related to aspects by the PSE and GSSE were maintained from the benchmark model (see Annex B for details).

On backward participation, while the effects of individual categories of payments were not significant, the share of general services support payments in total support provided to the sector was. The correlation suggests that agricultural support policies geared towards general services support payments are likely to promote backward participation in GVCs and it enhances the sectors ability to source competitive inputs from overseas (an import driver of domestic benefits generated from participation). That is, supporting the agricultural sector through non-distortionary means and providing services that have been found to promote competitiveness increases participation in GVCs. Indeed, in the benchmark model one aspect of general services support, agricultural R&D, was found to be associated with higher levels of GVC participation.

On forward participation and domestic value added creation the results are more complex. For forward participation, all payments (distortionary, non-distortionary and general services) were correlated with higher levels of participation. However, higher levels of distortionary payments *decrease* the domestic value added creation from GVC participation (a negative correlation). That is, while distortionary payments increase forward GVC participation, likely through subsidies to output, they decrease the domestic returns from being part of agro-food GVCs (as the subsidy is effectively a tax on other contributing sectors). In this sense, increased GVC participation is *not* associated with better outcomes (in terms of domestic value added) for the economy. But for least distortionary payments, the participation effect does not come with a negative effect on domestic value added creation. It is possible that these payments are allowing producers to enter value chains either through correcting market failures they face or by allowing them to produce in a more sustainable and traceable fashion (that is, correcting the market failures from their own production). In this way, they do not take away from the benefits created (in terms of domestic value added) from GVC participation.

For general services provided to the sector, while there are links to increasing GVC participation (both backward and forward), no relationship was found with domestic value added creation. Despite this, from the benchmark model, it was found that agricultural R&D intensity was related to higher domestic value added creation indicating that at least in part there is also a link to improving value added creation. The lack of significance in this instance is likely to be related to the range of other measures included, which in some instances also pick up support for public stockholding.

Table 3.3. Influence of support on GVC participation

	Backward	Forward	DVA
Most distorting support	n.s	Positive	Negative
Least distorting support	n.s	Positive	n.s
General services to agriculture	n.s	Positive	n.s
Share of general service support in total support	Positive	n.a	n.a

Notes: n.s is not significant; n.a is not applicable. Significance taken at 10% level.

Source: Author estimates.

Figure 3.21. Average total employment shares in ongoing GVCs by sector

Note: Average share of total employment is taken as the simple average across all countries.

Source: Author estimates.

Looking at the possible influence of policy factors, the level of intervention by governments also appears to play a role. It is generally sectors which are free from significant subsidies (production distorting subsidies and not those which represent transfers to households such as decoupled payments) or taxes that generate the largest employment effects from participation in GVCs (Figure 3.22). Sectors within countries that are either relatively heavily taxed or subsidised have lower employment effects arising from participating in ongoing GVCs. Further, the lack of correlation between support levels (on the subsidy side) and outcomes suggest that the employment effects from GVC participation may be the same if the subsidies were removed.

Regional differences

Across regions differences in the importance of ongoing GVCs to domestic value added creation and employment can be seen (Figure 3.23). In terms of domestic value added embodied in total agro-food exports, ongoing GVCs are most important for North and South America and Asia (broadly defined to include Australia and New Zealand). That is, the relative share of value added created from exports to ongoing GVCs is greater in these regions than in others. However, in terms of employment, ongoing GVCs have the greatest impact (on average) on countries in Africa and the Middle East. For these countries, close to 2.5% of total employment (in value terms) is involved in activities directly related to ongoing GVCs. As it is likely that for agro-food sectors, wages are on average below those elsewhere in the economy, it is likely that the share in terms of numbers employed is greater.

Figure 3.22. Employment from GVCs and taxes and subsidies
Share of sector employment in value terms and share of industry output value

Source: Author estimates.

Figure 3.23. Regional differences in importance of ongoing GVCs

Average share of total employment in value terms and share value of domestic value added in total exports

Source: Author estimates.

3.6 Concluding comments

This study has explored the landscape and determinants of GVC participation for 20 individual agro-food sectors by making use of a new data set of trade in value added derived from the 2011 GTAP database (Greenville et al., 2017). A number of findings can be drawn from the analysis related to the landscape of GVC participation by agriculture and food sectors.

- Agriculture sectors participate in value chains as the supplier of raw materials, with the food sectors participating in terms of sourcing inputs from around the globe. However, across agro-food sectors and countries there is considerable variation. Further, underpinned by product and policy differences, agro-food sectors have lower rates of total GVC participation than other sectors.
- Of the more heavily traded agro-food products, oilseeds and plant-based fibres have the highest rates of forward participation, with some food sectors such as vegetable oils & fats, dairy and wool & silk products having the highest rates of backward participation.
- Regional differences exist in agro-food GVCs: European agro-food value chains source more globally but supply more locally compared with those of China and the United States. In China, agro-food GVCs have a greater span in both sourcing inputs and supplying other markets, whereas for the United States, sourcing is much more concentrated domestically despite a global span in supply.
- Agriculture remains the dominant source of value in the output from agro-food sectors when it is consumed by final demand. This is replicated in trade, underscoring the importance of agricultural productivity in underpinning international competitiveness of the agriculture and food sector.
- Services form an important part of value added in agro-food exports and in final products, with the service value added component often greater than that of the industrial sector. The functioning of services markets is therefore critically important for agro-food sectors; services trade restrictions negatively influence both GVC participation and the benefits created (in terms of domestic value added).
- Agro-food GVCs were also seen to be an important source of employment for some. For a number of developing countries the share of total employment involved in activities related to agro-food GVCs is significant – for example, in Africa, employment associated with domestic value added in forward participation is particularly significant. Sectors that are free from significant subsidies or taxes generally generate the largest employment effects from participation in GVCs. The results suggest that it is both industry characteristics and relative engagement in GVCs (which is influenced by policy factors that affect competitiveness) that are important in determining the employment effects of GVC participation.

Differences across agro-food sectors are driven heavily by the nature of the product produced. Variations across countries, therefore, will be dependent on the climatic, geographical and social factors that influence agricultural production potential. However, differences within individual sectors across countries suggest that government policy settings also influence GVC participation and domestic value added generation. This study found a number of important policy effects, including:

- Trade and investment policies are a key influence on GVC participation. Tariffs on imports and those faced on exports reduce participation in GVCs and the domestic value added generated. Thus lower import barriers are an important element in promoting the participation in and returns from agro-food GVCs.
- Non-tariff measures (those explored were specific trade concerns raised over SPS and TBT matters) also reduce participation. For each of these, the cost raising effect of such measures

reduces industry competitiveness and therefore its ability to participate within value chains. The number of SPS concerns raised also has a negative influence on the total domestic value added generated, but in contrast, TBT regulations were found to positively influence the domestic returns obtained. In aggregate, the results for SPS and TBT concerns suggest that while these measures may in some cases enable trade to occur, less complex and more transparent and science based arrangements, that avoid concerns being raised by trading partners, can increase the domestic value added generated in exports.

- The agricultural sector's capabilities also contribute to greater levels of GVC participation. Transport infrastructure, education levels and agricultural R&D are all positively related to participation and domestic value added creation from GVC participation. Other factors such as the ability to meet private standards (proxied through the number of accredited producers) are also important for a subset of countries.
- Non-distortive agricultural policies (those that do not provide subsidies for the use of inputs or subsidise outputs) provided either directly to producers or to the sector as a whole were found to have a positive influence on GVC participation and domestic value added generation. By contrast, the use of distorting support has a negative influence on the benefits from GVC participation, highlighting potential value added losses from protection policies. These create value added *losses* captured in the exports of other agro-food sectors and represent 'taxes' from inputs sourced from supported food and agricultural sectors. Thus reforms to limit subsidies and distortions in agro-food sectors are likely to enhance the domestic value added captured through participation in GVCs.
- The domestic value added share from the agriculture and food sectors of any \$1 of exports is roughly the same. This suggests that increasing agricultural exports by \$1 is likely to yield the same domestic value added as increasing food sector exports by the same amount. Thus government policy should focus on enhancing overall competitiveness and allowing industries to exploit underlying comparative advantages rather than incentivising food sectors (perhaps at the expense of agriculture sectors) in the belief that these provide greater domestic benefits in terms of value added creation.

References

- Anderson, J.E. (1979), “A Theoretical Foundation for the Gravity Equation”, *The American Economic Review*, Vol. 69(1), pp. 106–16.
- Autor, D., D. Dorn and G. Hanson (2016), “The China Shock: Learning from Labor Market Adjustments to Large Changes in Trade”, *NBER Working Papers*, No. 21906, National Bureau of Economic Research, Massachusetts.
- Autor, D., D. Dorn and G. Hanson (2013), “The China Syndrome: Local Labor Market Effects of Import Competition in the United States”, *American Economic Review*, American Economic Association, Vol. 103(6), pp. 2121–2168, October.
- Autor, D., D. Dorn, G. Hanson and J. Song (2014), “Trade Adjustment: Worker Level Evidence”, *The Quarterly Journal of Economics*, Vol. 129(4), pp. 1799–1860.
- Bain, C. (2010), “Governing the Global Value Chain: GLOBALGAP and the Chilean Fresh Fruit Industry”, *International Journal of Sociology of Agriculture and Food*, Vol. 17(1), pp. 1–23.
- Baldwin, R. (2012), “Trade and Industrialisation after Globalisation’s Second Unbundling: How Building and Joining a Supply Chain are Different and Why it Matters”, in *Globalization in an Age of Crisis: Multilateral Economic Cooperation in the Twenty-First Century*, R. Feenstra and A. Taylor (eds.), University of Chicago Press.
- Barbalet, F., J. Greenville, W. Crook, P. Gretton and R. Breunig (2015), “Exploring the Links Between Bilateral and Regional Trade Agreements and Merchandise Trade”, *Asia & the Pacific Policy Studies*, Vol. 2(3), pp. 467–84.
- Bas, M. and V Strauss-Kahn (2014), “Does Importing More Inputs Raise Exports? Firm-Level Evidence from France”, *Review of World Economics*, 150(2): 241–475.
- Bojnec, S. and I. Ferto (2015), “Global Agri-Food Export Competitiveness”, Paper presented at the International Conference of Agricultural Economists, Milan, Italy, 8–14 August 2015.
- Bureau, J. and S. Jean (2013), “The Impact of Regional Trade Agreements on Trade in Agricultural Products”, *OECD Food, Agriculture and Fisheries Papers*, No. 65, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5k3xznkz60vk-en>.
- Carrere, C. (2006), “Revisiting the Effects of Regional Trade Agreements on Trade Flows with Proper Specification of the Gravity Model”, *European Economic Review* 50(2), 223–47.
- Cadestin, C., J. Gourdon and P. Kowalski (2016), “Participation in Global Value Chains in Latin America: Implications for Trade and Trade-Related Policy”, *OECD Trade Policy Papers*, No. 192, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5jlpq80ts8f2-en>.
- Cheng, I-H. and H.J. Wall (2005), “Controlling for Heterogeneity in Gravity Models of Trade and Integration”, *Federal Reserve Bank of St. Louis Review* 87(1), 49–63.
- Chevassus-Lozza et al. (2013), “Does Input Trade Liberalization Boost Downstream Firms' Exports? Theory and Firm-level Evidence”, *Journal of International Economics*, 90 (2013) 391–402.
- Colen, L., M. Maertens and J. Swinnen (2012), “Private Standards, Trade and Poverty: GlobalGAP and Horticultural Employment in Senegal”, *The World Economy* 35(8):1073–88.
- De Backer, K. and S. Miroudot (2013), “Mapping Global Value Chains”, *OECD Trade Policy Papers*, No. 159, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5k3v1trgnbr4-en>.
- Diaz-Bonilla, E., D. Orden and A. Kwieciński (2014), “Enabling Environment for Agricultural Growth and Competitiveness: Evaluation, Indicators and Indices”, *OECD Food, Agriculture and Fisheries Papers*, No. 67, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5jz48305h4vd-en>.
- Disdier, A-C., L. Fontagné and M. Mimouni (2008), “The Impact of Regulations on Agricultural Trade: Evidence from the SPS and TBT Agreements”, *American Journal of Agricultural Economics*, Vol. 90/2, Oxford University Press, Oxford, pp. 336–350.

- Drabenstott, M. (1995), “Agricultural Industrialization: Implications for Economic Development and Public Policy”, *Journal of Agricultural and Applied Economics*, Vol. 27(1), pp. 13–20.
- Dries, L. and J. Swinnen (2004), “Foreign Direct Investment, Vertical Integration, and Local Suppliers: Evidence from the Polish Dairy Sector”, *World Development*, Vol. 32(9), pp. 1525–44.
- Emlinger, C. and S. Poncet (2016), “With a Little Help from My Friends: Multinational Retailers and China's Consumer Market penetration”, *CEPII Working Paper* No. 2016-01, January.
- FAO (2014), *Impact of International Voluntary Standards on Smallholder Market Participation in Developing Countries – A Review of the Literature*, FAO, Rome.
- Ferrantino, M.J. (2012), “Using Supply-Chain Analysis to Analyse the Costs of NTMs and the Benefits of Trade Facilitation”, *World Trade Organization Working Paper* ERSD 2012–02.
- Gereffi, G. (1999), “International Trade and Industrial Upgrading in the Apparel Commodity Chain”, *Journal of International Economics*, 48(1), pp. 37–70.
- Gereffi, G. and K. Fernandez-Stark (2011), “Global Value Chain Analysis: A Primer”, Center on Globalization, Governance & Competitiveness (CGGC), Duke University, Durham, NC.
- Greenville, J. (2015), “Issues in agricultural trade policy: An overview”, in *Issues in Agricultural Trade Policy: Proceedings of the 2014 OECD Global Forum on Agriculture*, OECD Publishing, Paris, <http://dx.doi.org/10.1787/9789264233911-2-en>.
- Greenville, J., K. Kawasaki and R. Beaujeu (2017), “Estimating GVC Participation in the Agriculture and Food Sectors”, *OECD Food, Agriculture and Fisheries Working Papers*, OECD Publishing, Paris.
- Halpern, L., M. Koren and A. Szeidl (2015), “Imported Inputs and Productivity”, *American Economic Review* 2015, 105(12): 3660–3703.
- Hausmann, R., B. Klinger and R. Lawrence (2008), Examining Beneficiation, *CID Working Paper* No. 162, Cambridge: Harvard University Center for International Development.
- Head, K., R. Jing and D. Swenson (2014), “From Beijing to Bentonville: Do Multinational Retailers Link Markets?”, *Journal of Development Economics*, 110, 79–92.
- Henson, S.J. (2007), “The Role of Public and Private Standards in Regulating International Food Markets”, *Journal of International Agricultural Trade and Development*, Vol. 4(1), pp. 52–66.
- Hsiao, H.I. and J. Van der Vorst (2006), “Logistics Outsourcing in Food Supply Chain Networks: Theory and Practices”, Paper presented at the 7th International Conference on Management in AgriFood Chains and Networks, Ede, The Netherlands, 31 May–2 June, 2006.
- Hummels, D., J. Ishii, and K.-M. Yi (2001), “The Nature and Growth of Vertical Specialization in World Trade”, *Journal of International Economics*, 54(1): 75–96.
- Humphrey, J. and C. Dolan (2004), “Changing Governance Patterns in the Trade in Fresh Vegetables Between Africa and the United Kingdom”, *Environment and Planning A*, Vol. 36, pp. 491–509.
- Humphrey, J. and H. Schmitz (2002), “How Does Insertion in Global Value Chains Affect Upgrading in Industrial Clusters?”, *Regional Studies*, Vol. 36(9), pp. 1017–1027.
- IMF (2016), *International Financial Statistics Online* (database), IMF, Washington D.C., <https://www.imf.org/en/Data> (accessed 15 November 2015).
- Kee, H.L., A. Nicita and M. Olarreaga (2009), “Estimating Trade Restrictiveness Indices”, *The Economic Journal*, Vol. 119(534), 172–199.
- Kelle, M. (2013), “Crossing Industry Borders: German Manufacturers as Services Exporters”, *The World Economy* 36(12), 1494–1515, DOI: 10.1111/twec.12111.
- Kirsten, J. and K. Sartorius (2002), “Linking Agribusiness and Small-scale Farmers in Developing Countries: is There a New Role for Contract Farming?”, *Development Southern Africa*, Vol. 17(4).
- Kommerskollegium (2012), “Everybody is in Services: The Impact of Servicification in Manufacturing on Trade and Trade Policy”, National Board of Trade, Stockholm.
- Koopman, R., W. Powers, Z. Wang and S.-J. Wei (2011), “Give Credit Where Credit Is Due: Tracing Value Added in Global Production Chains”, *NBER Working Paper*, No. 16426.

- Li, Y. and J.C. Beghin (2012), “A Meta-Analysis of Estimates of the Impact of Technical Barriers to Trade”, *Journal of Policy Modeling*, Vol. 31/ 6, Elsevier, Amsterdam, pp. 497-511.
- Lopez-Gonzalez, J. (2016), “Using Foreign Factors to Enhance Domestic Export Performance: A Focus on Southeast Asia”, *OECD Trade Policy Papers*, No. 191, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5jlpq82v1jxw-en>.
- Maskus, K. E., T. Otsuki and J.S. Wilson (2005), “The Cost of Compliance with Product Standards for Firms in Developing Countries: An Econometric Study”, *World Bank Policy Research Working Paper*, No. 3590.
- Miroudot, S., D. Rouzet and F. Spinelli (2013), “Trade Policy Implications of Global Value Chains: Case Studies”, *OECD Trade Policy Papers*, No. 161, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5k3tp2t0zs1-en>.
- Miroudot, S. and A. Ragoussis (2009), “Vertical Trade, Trade Costs and FDI”, *OECD Trade Policy Papers*, No. 89, OECD Publishing, Paris, <http://dx.doi.org/10.1787/222111384154>.
- Miroudot, S., R. Lanz and A. Ragoussis (2009), “Trade in Intermediate Goods and Services”, *OECD Trade Policy Papers*, No. 93, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5kmlcxtldk8r-en>.
- Moser, C., D. Urban and B. Weder di Mauro (2015), “On the Heterogeneous Employment Effects of Offshoring: Identifying Productivity and Downsizing Channels”, *Economic Inquiry* 53(1), pp. 220-239.
- Nordås, H.K. (2010), “Trade in Goods and Services: Two Sides of the Same Coin?”, *Economic Modelling*, Vol. 27, pp. 496-506.
- Nordås, H.K. and D. Rouzet (2015), “The Impact of Services Trade Restrictiveness on Trade Flows: First Estimates”, *OECD Trade Policy Papers*, No. 178, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5js6ds9b6kjb-en>.
- Nunn N. (2007), “Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade”, *Quarterly Journal of Economics* 122 (2), 569–600.
- OECD (2016a), *Evolving Agricultural Policies and Markets: Implications for Multilateral Trade Reform*, OECD Publishing, Paris, <http://dx.doi.org/10.1787/9789264264991-en>.
- OECD (2016b), *Agricultural Policy Monitoring and Evaluation 2016*, OECD Publishing, Paris, http://dx.doi.org/10.1787/agr_pol-2016-en.
- OECD (2015a), *Participation of Developing Countries in Global Value Chains: Implications for Trade and Trade-Related Policies*, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5js33lfw0xxn-en>.
- OECD (2015b), *Agricultural Policy Monitoring and Evaluation 2015*, OECD Publishing, Paris, http://dx.doi.org/10.1787/agr_pol-2015-en.
- OECD (2015c), *OECD Inter-Country Input-Output (ICIO) Tables, edition 2015: Access to data*, OECD Publishing, Paris, www.oecd.org/sti/ind/input-outputtablesedition2015accesstodata.htm.
- OECD (2015d), *TiVA database*, OECD Publishing, Paris, <https://stats.oecd.org/index.aspx?queryid=66237>.
- OECD (2013a), *Interconnected Economies: Benefiting from Global Value Chains*, OECD Publishing, Paris, <http://dx.doi.org/10.1787/9789264189560-en>.
- OECD (2013b), “Summary of the 5th OECD Food Chain Analysis Network Meeting, Competition along the Food Chain”, 30-31 October 2013, OECD Conference Centre.
- OECD-WTO (2013), “Trade in Value-Added: Concepts, Methodologies and Challenges”, Joint OECD-WTO Note.
- Olper, A., D. Curzi and V. Raimondi (2015), “Import Penetration, Intermediate Inputs and Firms’ Productivity in the EU Food Industry”, *2015 Allied Social Sciences Association (ASSA) Annual Meeting*, January 3-5, 2015, Boston, Massachusetts.
- Orefice, G. (2015), “Non-Tariff Measures, Specific Trade Concerns and Tariff Reduction”, *CEPII Working Paper* No. 2015-30 – December.
- Otsuki, T. (2011), “Effect of International Standards Certification on Firm-Level Exports: An Application of the Control Function Approach”, *Osaka School of International Public Policy Discussion Paper* No. 11E005.
- Pasadilla, G.O. and A. Wirjo (2014), “Services and Manufacturing: Patterns of Linkages Policy Brief”, APEC: APEC Policy Support Unit.
- Rao, E. and M. Qaim (2011), “Supermarkets, Farm Household Income, and Poverty: Insights from Kenya”, *World Development*, Vol. 39(5), pp. 784-96.

- Reardon, T. and C. P. Timmer (2007), “Transformation of Markets for Agricultural Output in Developing Countries Since 1950: How has Thinking Changed?”, in Evenson and P. Pingali (eds.), *Handbook of Agricultural Economics*, Volume 3, Elsevier, [http://dx.doi.org/10.1016/S1574-0072\(06\)03055-6](http://dx.doi.org/10.1016/S1574-0072(06)03055-6).
- Rhodes, V.J. (1993), “Industrialization of Agriculture: Discussion”, *American Journal of Agricultural Economics*, Vol. 75(5), pp. 1137–40.
- Royer, J.S. (1995), “Potential for Cooperative Involvement in Vertical Coordination and Value Added Activities”, *Agribusiness*, Vol. 11(3), pp. 473–81.
- Sartorius, K. and J. Kirsten (2007), “A Framework to Facilitate Institutional Arrangements for Smallholder Supply in Developing Countries: An Agribusiness Perspective”, *Food Policy*, Vol. 32(5), pp. 640–55.
- Seok, J.H., and S.H. Saghaian (2016), “Does Service Trade Liberalization Benefit Agriculture and Food Industry?”, Paper presented at the Southern Agricultural Economics Association’s Annual Meeting, San Antonio, Texas, 6–9 February 2016.
- Smith, G. (2009), “Interaction of Public and Private Standards in the Food Chain”, *OECD Food, Agriculture and Fisheries Working Papers*, No. 15, OECD Publishing, Paris, <http://dx.doi.org/10.1787/221282527214>
- Swinnen (2007), “Quality, Efficiency Premia, and Development”, *LICOS Discussion Paper Series* No. 184/2007.
- Timmer, M., A.A. Erumban, R. Gouma, B. Los, U. Temurshoev, G.J. de Vries, I. Arto, V.A.A. Genty, F. Neuwahl, J.M. Rueda-Cantuche, A. Villanueva, J. Francois, O. Pindyuk, J. Pöschl, R. Stehrer and G. Streicher (2012), *The World Input-Output Database (WIOD): Contents, Sources and Methods*, Version 0.9 April 2012, WIOD Background document, www.wiod.org.
- UNCTAD (2013), *World Investment Report 2013: Global Value Chains: Investment and Trade for Development*, United Nations Conference on Trade and Development.
- Unneveher, L.J. (2000), “Food Safety Issues and Fresh Food Product Exports from LDCs”, *Agricultural Economics*, Vol. 23(September), pp. 231–240.
- USDA (2016), *Production, Supply and Distribution Online* (database), United States Department of Agriculture, Washington, DC, <http://apps.fas.usda.gov/psdonline/psdquery.aspx> (accessed on 1 September 2015).
- Volpe-Martincus, C., S. Castresana, and T. Castagnino (2010), “ISO Standards: A Certificate to Expand Exports? Firm-Level Evidence from Argentina”, *Review of International Economics* 18(5):896–912.
- Winchester, N. (2009), “Is There a Dirty Little Secret? Non-Tariff Barriers and the Gains from Trade”, *Journal of Policy Modeling*, Vol. 31/ 6, Elsevier, Amsterdam, pp. 819–834.
- WITS (2016), *World Integrated Trade Solution* (database), World Bank, Washington, DC, <http://wits.worldbank.org/default.aspx> (accessed on 15 November 2015).
- Wright, G.C. (2014), “Revisiting the Employment Impact of Offshoring”, *European Economic Review*, Vol. 66, pp. 63–83.
- WTO (2011), *The WTO and Preferential Trade Agreements: From Co-Existence to Coherence*, World Trade Report.
- WTO (2012), *Trade and Public Policies: A Closer Look At Non-Tariff Measures in the 21st Century*, World Trade Report.

Annex A.

GTAP Sectors and regions in the study

Table A.1. GTAP sectors in the model

No.	Code	Description
1	pdr	Paddy Rice: rice, husked and unhusked
2	wht	Wheat: wheat and meslin
3	gro	Other Grains: maize (corn), barley, rye, oats, other cereals
4	v_f	Vegetables, fruit & nuts: vegetables, fruit, fruit and nuts, potatoes, cassava, truffles,
5	osd	Oilseeds: oil seeds and oleaginous fruit; soy beans, copra
6	c_b	Sugarcane & beet: sugar cane and sugar beet
7	pfb	Plant-based Fibres: cotton, flax, hemp, sisal and other raw vegetable materials used in textiles
8	ocr	Other Crops: live plants; cut flowers and flower buds; flower seeds and fruit seeds; vegetable seeds, beverage and spice crops, unmanufactured tobacco, cereal straw and husks, unprepared, whether or not chopped, ground, pressed or in the form of pellets; swedes, mangolds, fodder roots, hay, lucerne (alfalfa), clover, sainfoin, forage kale, lupines, vetches and similar forage products, whether or not in the form of pellets, plants and parts of plants used primarily in perfumery, in pharmacy, or for insecticidal, fungicidal or similar purposes, sugar beet seed and seeds of forage plants, other raw vegetable materials
9	ctl	Livestock: cattle, sheep, goats, horses, asses, mules, and hinnies; and semen thereof
10	oap	Other animal products: swine, poultry and other live animals; eggs, in shell (fresh or cooked), natural honey, snails (fresh or preserved) except sea snails; frogs' legs, edible products of animal origin n.e.c., hides, skins and furskins, raw , insect waxes and spermaceti
11	rmk	Raw milk
12	wol	Wool & silk: wool, silk, and other raw animal materials used in textile
13	frs	Forestry: forestry, logging and related service activities
14	fsh	Fishing: hunting, trapping and game propagation including related service activities, fishing, fish farms; service activities incidental to fishing
15	coa	Coal: mining and agglomeration of hard coal, lignite and peat
16	oil	Oil: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
17	gas	Gas: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
18	omn	Other Mining: mining of metal ores, uranium, gems. other mining and quarrying
19	cmt	Bovine meat: fresh or chilled meat and edible offal of cattle, sheep, goats, horses, asses, mules, and hinnies. raw fats or grease from any animal or bird.
20	omt	Other meat: pig meat and offal. preserves and preparations of meat, meat offal or blood, flours, meals and pellets of meat or inedible meat offal; greaves
21	vol	Vegetable oils & fats: crude and refined oils of soya-bean, maize (corn),olive, sesame, ground-nut, olive, sunflower-seed, safflower, cotton-seed, rape, colza and canola, mustard, coconut palm, palm kernel, castor, tung jojoba, babassu and linseed, perhaps partly or wholly hydrogenated, inter-esterified, re-esterified or elaidinised. Also margarine and similar preparations, animal or vegetable waxes, fats and oils and their fractions, cotton linters, oil-cake and other solid residues resulting from the extraction of vegetable fats or oils; flours and meals of oil seeds or oleaginous fruits, except those of mustard; degreas and other residues resulting from the treatment of fatty substances or animal or vegetable waxes.
22	mil	Dairy: dairy products
23	pcr	Processed rice: rice, semi- or wholly milled
24	sgf	Sugar: processed sugar

Table A.1. GTAP sectors in the model (continued)

No.	Code	Description
25	ofd	Other Food: prepared and preserved fish or vegetables, fruit juices and vegetable juices, prepared and preserved fruit and nuts, all cereal flours, groats, meal and pellets of wheat, cereal groats, meal and pellets n.e.c., other cereal grain products (including corn flakes), other vegetable flours and meals, mixes and doughs for the preparation of bakers' wares, starches and starch products; sugars and sugar syrups n.e.c., preparations used in animal feeding, bakery products, cocoa, chocolate and sugar confectionery, macaroni, noodles, couscous and similar farinaceous products
26	b_t	Beverages & tobacco
27	tex	Textiles: textiles and man-made fibres
28	wap	Wearing Apparel: Clothing, dressing and dyeing of fur
29	lea	Leather: tanning and dressing of leather; luggage, handbags, saddlery, harness and footwear
30	lum	Lumber: wood and products of wood and cork, except furniture; articles of straw and plaiting materials
31	ppp	Paper & Paper Products: includes publishing, printing and reproduction of recorded media
32	p_c	Petroleum & Coke: coke oven products, refined petroleum products, processing of nuclear fuel
33	crp	Chemical Rubber Products: basic chemicals, other chemical products, rubber and plastics products
34	nmm	Non-Metallic Minerals: cement, plaster, lime, gravel, concrete
35	i_s	Iron & Steel: basic production and casting
36	nfm	Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
37	fmp	Fabricated Metal Products: Sheet metal products, but not machinery and equipment
38	mvh	Motor vehicles and parts: cars, lorries, trailers and semi-trailers
39	otn	Other Transport Equipment: Manufacture of other transport equipment
40	ele	Electronic Equipment: office, accounting and computing machinery, radio, television and communication equipment and apparatus
41	ome	Other Machinery & Equipment: electrical machinery and apparatus n.e.c., medical, precision and optical instruments, watches and clocks
42	omf	Other Manufacturing: includes recycling
43	ely	Electricity: production, collection and distribution
44	gdt	Gas Distribution: distribution of gaseous fuels through mains; steam and hot water supply
45	wtr	Water: collection, purification and distribution
46	cns	Construction: building houses factories offices and roads
47	trd	Trade: all retail sales; wholesale trade and commission trade; hotels and restaurants; repairs of motor vehicles and personal and household goods; retail sale of automotive fuel
48	otp	Other Transport: road, rail ; pipelines, auxiliary transport activities; travel agencies
49	wtp	Water transport
50	atp	Air transport
51	cmn	Communications: post and telecommunications
52	ofi	Other Financial Intermediation: includes auxiliary activities but not insurance and pension funding
53	isr	Insurance: includes pension funding, except compulsory social security
54	obs	Other Business Services: real estate, renting and business activities
55	ros	Recreation & Other Services: recreational, cultural and sporting activities, other service activities; private households with employed persons (servants)
56	osg	Other Services (Government): public administration and defense; compulsory social security, education, health and social work, sewage and refuse disposal, sanitation and similar activities, activities of membership organizations n.e.c., extra-territorial organizations and bodies
57	dwe	Dwellings: ownership of dwellings (imputed rents of houses occupied by owners)

Table A.2. GTAP regions in the study

No.	Code	Description	No.	Code	Description
1	AUS	Australia	43	SVK	Slovakia
2	NZL	New Zealand	44	SVN	Slovenia
3	CHN	China	45	ESP	Spain
4	JPN	Japan	46	SWE	Sweden
5	KOR	Korea	47	GBR	United Kingdom
6	KHM	Cambodia	48	CHE	Switzerland
7	IDN	Indonesia	49	NOR	Norway
8	MYS	Malaysia	50	RUS	Russian Federation
9	PHL	Philippines	51	UKR	Ukraine
10	SGP	Singapore	52	KAZ	Kazakhstan
11	THA	Thailand	53	ISR	Israel
12	VNM	Viet Nam	54	SAU	Saudi Arabia
13	BGD	Bangladesh	55	TUR	Turkey
14	IND	India	56	EGY	Egypt
15	PAK	Pakistan	57	MAR	Morocco
16	LKA	Sri Lanka	58	TUN	Tunisia
17	CAN	Canada	59	CMR	Cameroon
18	USA	United States of America	60	CIV	Cote d'Ivoire
19	MEX	Mexico	61	GHA	Ghana
20	ARG	Argentina	62	NGA	Nigeria
21	BRA	Brazil	63	ETH	Ethiopia
22	CHL	Chile	64	KEN	Kenya
23	COL	Colombia	65	MDG	Madagascar
24	CRI	Costa Rica	66	MWI	Malawi
25	AUT	Austria	67	MUS	Mauritius
26	BEL	Belgium	68	MOZ	Mozambique
27	CZE	Czech Republic	69	ZAF	South Africa
28	DNK	Denmark	70	ROW	Rest of the World
29	EST	Estonia			
30	FIN	Finland			
31	FRA	France			
32	DEU	Germany			
33	GRC	Greece			
34	HUN	Hungary			
35	IRL	Ireland			
36	ITA	Italy			
37	LVA	Latvia			
38	LTU	Lithuania			
39	LUX	Luxembourg			
40	NLD	Netherlands			
41	POL	Poland			
42	PRT	Portugal			

Annex B.

Detailed estimates of the determinants of participation

GVC participation and effects to stem from it vary considerably across countries and products. This Annex presents the detailed results of the analysis of the determinants of GVC participation. A range of structural factors, along with policy factors covering trade and investment policy as well as agricultural policy are explored.

B.1. Estimating what drives GVC involvement and its effects

The three ‘benchmark’ equations used in this study are given below:

$$FWD_{ij} = f(Struct, TIPol, AgCap) \quad (1)$$

$$BWD_{ij} = f(Struct, TIPol, AgCap) \quad (2)$$

$$DVA_{ij} = f(Struct, TIPol, AgCap) \quad (3)$$

Where FWD_{ij} and BWD_{ij} are the forward and backward indicators respectively and DVA_{ij} is the total domestic value added exported by industry j in country i ; $Struct$ the structural indicators for country j ; and $TIPol$ and $AgCap$ the trade and investment policy and agricultural capacity indicators for country i . Due to data availability the policy variables used in this study are at the country level with the exception of the tariffs faced by exports from industry j in country i . This is a limitation of the analysis as some of the country level policy factors may not be relevant to certain industries. However, the policies in one sector will also influence activities in the other and thus it is not unreasonable to expect that they may influence the GVC outcomes of other industries. Further, this approach allows for comparisons to be made of the influence on structural and policy variables across industries. The specific variables used in the study and their brief description are given in Table B.1.

B.2. Detailed results on GVC participation and domestic value added

The influences on participation in value chains have been analysed using three broad categories of variables: structural characteristics of the economies examined; domestic agricultural capacities; domestic agricultural policies; and trade and investment policies. Each of these areas has the potential to influence trade and therefore GVC participation in a number of ways (Part 2). The contributions of the different factors to backward and forward participation are presented in Table B.2. Similarly, the influence of these variables on domestic value added generated from the export of *intermediate* products in total was explored with detailed results also shown. It should be noted that the absolute values of the coefficients estimated cannot be directly compared as they relate to the values and distribution of the underlying explanatory used in the analysis. Of interest is the significance and direction (negative or positive) of the estimated coefficients.

The PTA variable used was constructed to limit the potential endogeneity with the forward and backward participation index. To go beyond the presence of a PTA and look at its importance for GVCs for a particular country, the share of intermediates trade in total trade, measured as gross flows, was used. This was done at the country level so as to capture the importance and depth of PTAs to that country.

Table B.1. Variables used in the benchmark models

Variable	Description
Structural factors	
GDP/capita	To represent market size (GCI)
Distance to economic activity	To represent the cost of trading, taken from CEPII and weighted by GDP to obtain country estimates (relative distance to large markets)
Agricultural land (sq km)	To represent relative agricultural endowments (WDI)
Trade and investment policy	
Tariffs charged	Trade weighted tariffs charged from GTAP database
Tariffs faced	Trade weighted tariffs faced from GTAP database
FDI inflows	To represent openness to foreign capital (WDI)
FDI outflows	To represent openness to foreign capital and linkages in facing markets (WDI)
Transport Infrastructure availability and quality	To represent the cost of logistics and accessing markets, from the (GCI)
Depth of preferential trade agreements: export and import share	Measured by the share of intermediates trade (total) between PTA partners for each country to partially measure international integration (WTO)
Quality of customs	Rated quality of customs procedures for goods trade to represent levels of trade facilitation by governments (GCI)
TBT charged	As a proxy of the non-tariff barriers charged on agro-food trade (WTO)
TBT faced	As a proxy of the non-tariff barriers faced on agro-food trade (WTO)
SPS charged	As a proxy of the non-tariff barriers charged on agro-food trade (WTO)
SPS faced	As a proxy of the non-tariff barriers faced on agro-food trade (WTO)
Domestic agricultural capabilities	
Agricultural R&D intensity	As a proxy of agricultural innovation (GFSI)
Affordability of finance	As a proxy to of quality of financial sector inputs to the sector (GCI)
Food safety	Levels of food safety as proxy of domestic food safety and traceability standards (GFSI)
Primary education	Levels of primary enrolments (%) as a proxy of basic education levels (GCI)

Notes: Where GCI is the Global Competitiveness Index (available at <http://reports.weforum.org/global-competitiveness-report-2015-2016/>); CEPII (available at www.cepii.fr/CEPII/en/bdd_modele/bdd.asp); WDI is the World Bank's World Development Indicators (available at <http://data.worldbank.org/data-catalog/world-development-indicators>); WTO is the World Trade Organization PTA Database (available at <http://ptadb.wto.org/?lang=1>) and the TBT Specific Trade Concerns database (available at www.wto.org/english/res_e/publications_e/wtr12_dataset_e.htm); and GFSI is the Global Food Security Index (available at <http://foodsecurityindex.eiu.com/>).

Table B.2. Detailed regression results

Variable	Backward	Forward	DVA
Agricultural land	-0.1050*** [-3.96]	0.3363*** [2.14]	0.2472*** [2.31]
GDP per capita	-0.0177*** [-2.44]	-0.3467*** [-2.75]	-0.0263 [-0.22]
Distance	-0.0278*** [-5.65]	-0.0049 [-0.06]	0.0137 [0.15]
PTA export share	0.0079 [0.76]	0.1200** [1.74]	-0.0041 [-0.04]
PTA import share	-0.0058 [-0.55]	-0.0991 [-1.20]	0.521 [0.51]
Finance	0.0068 [0.99]	0.0077 [0.15]	-0.1353 [-1.15]
Primary education	0.0034 [0.81]	0.1658*** [3.05]	0.1132** [1.69]
Ag. R&D intensity	0.0069** [1.66]	-0.2309*** [-3.41]	0.3183*** [2.66]
Transport infrastructure	-0.0036 [-0.50]	0.1428** [1.87]	0.2808** [1.79]
Customs	0.0336*** [3.91]	0.1818~ [1.38]	
Food safety	0.0021 [0.30]	0.0116 [0.25]	-0.0283 [-0.33]
FDI inflow	0.0233*** [4.23]		-0.2432*** [-2.50]
FDI outflow		0.7919** [1.79]	3.9896** [1.74]
SPS charged (lag 1)	-0.0022*** [-2.08]		-0.0614*** [-2.09]
SPS faced (lag 1)		-0.0260~ [-1.40]	0.0430 [0.76]
Tariff charged	-0.0149*** [-2.61]		-0.1692*** [-3.37]
Tariff faced		-0.0951~ [-1.42]	0.0592 [0.41]
TBT charged (lag 3)	-0.0014* [-1.50]		0.2467** [1.66]
TBT faced (lag 2) (3)		-0.0369** [-1.76]	0.3288*** [6.56]
Observations	996	973	972
R-squared	0.287	0.171	0.396

Notes: Estimated by ordinary least squares (OLS). All explanatory variables were standardized by subtracting their sample means and dividing by standard deviations. Therefore, the coefficient measures the impact of one standard deviation increase in each variable. To reduce the influence of outliers, the observations having forward indicator greater than 99th percentile were not used. Sector specific fixed effects were also included in the model and are discussed below. Heteroskedasticity-robust standard errors are in parenthesis. *** p<0.05, ** p<0.1, * p<0.15 ~ significant at p<0.16.

Source: Author estimates.

B.3. Key caveats

The analysis undertaken was cross-sectional in nature. As such, it is difficult to draw out causal relationships. Despite this, in an effort to reduce the likelihood of erroneous results, the decisions on the factors chosen to explain participation and domestic value added creation were made on the basis of the findings from other studies (Part 2). Given this, the results from the analysis provide some evidence in support or otherwise of the findings from past studies of the possible influences that are an important role in determining GVC participation.

The low significance found in the analysis for a number of variables is likely to rest on several factors. First, there is a lack of specific information that may shed more light on the characteristics of exports from individual sectors that can explain their production and exporting patterns. Second, the forward participation indicator rests not only on the domestic characteristics of a sector but also on the characteristics of the importing country. The analysis does not account for such characteristics and the lack of observations makes a bilateral analysis not possible. Third, the nature of production and the relationship between agricultural and food sectors plays a role. As discussed in Part 3, agricultural production is a major input into the food industry; however, the food sector appears to predominately serve final demand with much lower levels of intermediate trade. This fact will naturally limit the potential for much variation in forward participation. Despite this last influence, it remains unclear whether the limited trade in food intermediates is due to policy or not.

Many of the data gaps will not be easily or possible to overcome. As such, an alternative form of analysis would be worthwhile pursuing. As the data for the ICIO was constructed using the GTAP database, it is possible to explore the influence of policies as analysed by the computable general equilibrium model on GVC participation. The approach adopted here provides a mechanism to re-estimate the levels and landscape of GVC participation post a policy shock. Such ‘what-if’ analysis could provide powerful insights into GVC participation drivers in the absence of data.