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Value adding pathways in agriculture and food global value chains: The role of services

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Note by the Secretariat

This paper forms part of the work mandated under Output Area 3.2.2.2.1 of the 2017-18 PWB as set out in the scoping paper discussed at the 76th session of the Joint Working Party on Agriculture and Trade (TAD/TC/CA/WP(2016)3). This paper builds on the work begun by the committee in the 2015-16 PWB exploring global value chains (GVCs) in agriculture and food sectors (TAD/TC/CA/WP(2016)1/PART1/FINAL and TAD/TC/CA/WP(2016)1/PART2/FINAL) and extends the analysis in (TAD/TC/CA/WP(2017)3/REV2).

This work takes a closer look at the different pathways that countries take to adding value in agricultural production within trade and agro-food global value chains (GVCs) and in doing so, takes a closer look at the role played by services. It seeks to explore differences in ways to create value from agriculture through participation in trade and GVCs – either through exporting primary products, or through exporting agricultural value added as part of processed products. For each of these pathways, the role played by services is explored. The paper also looks at how these pathways and service value use changed between 2004 and 2014.

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Table of contents

Note by the Secretariat 2

Executive summary 5

Value adding pathways in agriculture and food global value chains: the role of services 7

1. Introduction 7
2. Theories on 'value adding' for agriculture 10
3. Value creation in agriculture: more than just moving up the chain 14
4. Are there differences in the contribution to total domestic value added from exports between 'value adding' pathways? 18
5. What differentiates the value adding pathways? The role played by services 23
6. How does GVC participation and services impact agriculture value added growth across the value adding pathways 31
7. Conclusions and policy implications 34

References 37

Annex A. GTAP sector list 38

Annex B. GTAP region list 40

Annex C. Detailed results 42

Tables

Table 1. Average real growth in direct and indirect agricultural domestic value added exports 18
Table 2. Influences on indirect exports of agricultural value added 33
Table 3. Influences on shares of value added indirectly exported 34

Table A A.1. GTAP sector list 38
Table A B.1. GTAP regions 40
Table A C.1. Summary statistics 43
Table A C.2. Detailed results for level of agriculture value added exported equation 44
Table A C.3. Detailed results for level of agriculture value added exported equation 45

Figures

Figure 1. Distribution of returns from final demand along the value chain, 2014 11
Figure 2. Distribution of average gross export value 12
Figure 3. Patterns of specialisation in domestic value added agricultural exports, 2014 14
Figure 4. Patterns of specialisation across major exporters in domestic value added agricultural exports, 2014 15
Figure 5. Growth in the share of direct and indirect agricultural domestic value added exported 16
Figure 6. Growth in the share of direct and indirect agricultural domestic value added exported, world's top agro-food exporters 17
Figure 7. Overall pathway contributions to domestic value added, 2014 21
Figure 8. Multiplier estimates for all countries 22
Figure 9. Multiplier estimates for different pathway cut-offs 23

Figure 10. Services value in agricultural exports and direct exports of agriculture domestic value added24
Figure 11. Distributions of service value added in agro-food exports across countries, 2014 25
Figure 12. Major service inputs into agro-food exports by broad country groupings, 2014 26
Figure 13. Service and industrial shares of export value by value adding pathway, 2014 28
Figure 14. Relative use of services in different agricultural sectors by value adding pathway, 2014... 29
Figure 15. Service addition to agricultural exports by service sector by value adding pathway, 2014. 30
Figure 16. Service addition to food exports by service sector by value adding pathway, 2014 31

Boxes

Box 1. Consistency across GTAP databases 9

Executive summary

1. Increasing trade in agro-food sectors within global value chains (GVCs) has the potential to offer new and enhance existing opportunities to add value to agricultural production. GVCs allow for the various stages of the production of the food we eat and the clothing we wear to be distributed across different countries. Combined with changes in the way products are traded – as products with specific attributes rather than just raw commodities – these developments have potentially given rise to (or re-enforced) a range of value adding opportunities for the agriculture sector. This paper explores the evidence around two possible value adding pathways related to trade and GVC engagement. The first is a processing pathway – where domestic value addition to agriculture and links to trade and GVCs occur through downstream processing sectors. The second is a primary pathway – where domestic value addition occurs to the primary or raw product, and the agricultural sector's engagement in trade and GVCs is direct through exports of these primary products to either foreign processing or foreign final demand.

2. Across agricultural exporters worldwide, differences in specialisation in relation to the balance of the agricultural value added generated by direct trade in primary products and indirect trade embodied in processed products is evident. While all countries export agricultural value added both in primary and processed forms, many have a clear bias towards one versus the other. Underlying these differences is a mix of production activities, but also a range of other factors that may provide a country with an advantage in primary exports but not processed, or the other way around.

3. Over time, with increasing trade in GVCs it is possible that greater opportunities for direct exports of primary products from the agricultural sector exist. The break-up of production tasks is likely to be more applicable for processing than production due to the primary production's reliance on land and climate. In this way, there might be greater total returns created from primary production by taking advantage of the competitive advantages of foreign processing rather than moving into downstream sectors domestically. For most countries between 2004 and 2014, direct exports of domestic value added from agriculture grew faster than that of indirect exports of agricultural value added embodied in downstream products. This growth was seen for a number of major agricultural traders and for developed and developing countries alike – a total of 86 of 141 countries and regions had stronger growth in primary exports. Furthermore, of these, 72% of those with stronger primary export growth also had positive overall export value added growth, while only 60% of those with growth driven by indirect domestic value added saw positive growth in total exports of agricultural domestic value added.

4. Growth opportunities aside, arguments for downstream value adding often are based on notions of higher total returns with domestic processing versus exports of primary products. But if greater export opportunities for primary products exist within GVCs, and the need to add other inputs – such as services – in order to sell into GVCs, then the balance of total effects is not obvious.

5. To examine the presence and differences across the two links to trade and GVCs by agricultural sectors, countries were split into two groups to explore the possibility of two different value adding pathways. Countries were grouped based on the majority share of their agricultural exports (in value added terms): as either of primary products (primary pathway) or processed products (processing pathway). Agricultural value added measured in the processing pathway represents that which is embodied in downstream sector exports.

Countries in both pathways still export both primary and processed products, but have a bias towards one over the other.

6. For countries grouped into the two pathways, in terms of aggregate domestic value added from all sectors related to agricultural exporting activities, the specialisation in one over the other does not alter the total returns created. In other words, the two pathways appear to offer similar overall economic benefits from trade. Countries that participated in trade and GVCs primarily via the primary pathway generated equivalent overall trade-related domestic value added returns to those which participated primarily through the processing pathway. That is, on average, countries generated similar aggregate domestic value added returns through exports of predominately primary products compared with those which exported primarily processed products. This result held for the average and at the extremes of specialisation. This suggests that a relevant alternative pathway for increasing domestic value added – beyond moving into downstream processing – exists. Understanding the differences between the pathways can shed light on how countries can gain from the adding value to primary products and what the impacts of doing this are over time. This may be particularly important for developing countries to better understand policies that could aid in sector transformation and development.

7. One of the key differences observed in agricultural exports between the pathways is the share of services value added. Overall, services value added was higher in countries that participated in the primary pathway – with higher services value added shares in exports an important determinant of growth in primary export value added for middle income countries. For the processing pathway, GVC engagement by both the agriculture sector and the food sector is an important factor underpinning its growth and may also create transformation opportunities. Greater GVC engagement along with greater trade openness to imported inputs is linked to both growth in agricultural value added indirectly exported as part of processed products, and creates a shift towards a higher share of total agricultural value added indirectly exported. In other words, it helps create a push towards the processing pathway. As part of this, distorting agricultural subsidies were found to have a harmful effect on growth of agricultural value added indirectly exported. Such policies reduce agricultural sector competitiveness and can thus harm downstream sectors over time. They also do not boost primary sector exports of value added.

8. The findings on the value adding pathways have some implications:

- Total trade-related economic gains to an economy from its agricultural sector are found to be equivalent in countries with a bias towards agricultural value added exported by processing sectors and those specialising in exports of primary commodities. Moving into downstream processing thus may not be the only or best option for a number of countries seeking to further develop their agriculture sector or looking to leverage the greatest return from total agricultural production.
- Moving into downstream processing sectors needs to be based around competitive advantages. Policy moves to direct agricultural production into domestic processing activities may reduce growth for the sector and limit the overall economy wide contribution to the economy from agricultural production.
- Services sector input into agricultural exports are the key differentiating and driving aspect of growing agricultural value added in the primary export pathway for some countries. Thus, for the agricultural sector to gain the most from this pathway access to competitive service inputs are critical. In other words, the enabling environment to support agricultural production is likely to be a key determinant of the economy wide gains from agricultural production.

Value adding pathways in agriculture and food global value chains: the role of services

1. Introduction

9. Global value chains (GVCs) in agriculture and food have expanded over time (Greenville, Kawasaki and Jouanjean, 2019a) through developments in technology, contracting and consumer demand. The development and expansion of GVCs have been heralded as a mechanism for agricultural producers in countries at various stages of development to grow domestic value added. Indeed, evidence for agro-food sectors suggest that greater value creation is possible from GVC participation, with past participation linked to greater growth in value added exports, for the sector overall and in terms of returns to labour (Greenville, Kawasaki and Jouanjean, 2019a;b).

10. There are varying views on the way in which the agriculture sector can gain the most from GVC participation. Arguments have been put forward that, for countries to gain the most from agricultural production, there is a need to move down the value chain into processing sectors – often termed 'value adding' sectors. These sectors ultimately capture a larger share of the final value of the food that is consumed or the clothes worn, generating domestic returns by doing so.

11. However, such a pathway to value adding cannot hold for all countries. This is the notion of comparative advantage – not every agricultural producer can do the same thing and be competitive at doing so. Furthermore, it ignores the opportunities that GVCs have created – the breakup of production into component parts that allows specialisation at various points along the chain rather than having to 'complete' the whole chain in one country (or firm). Beyond this, the nature of the primary good that is traded in agro-food GVCs is also different – trade is occurring in products and not just commodities. These products have a range of different attributes ranging from enhanced traceability to being produced to certain standards – simply put, they are of a different quality. These attributes require additional inputs. The additional inputs, often just considered costs, are actually 'value adding' activities akin to those that a processing sector may add. The difference is the point of the value chain that they are added – one into primary production, the other after primary production.

12. GVCs should thus provide opportunities, or enhance existing opportunities for different forms of value adding. In this paper, a differentiation between two pathways is made. The first is the processing pathway – where links to trade and GVCs and value adding to agricultural production occurs through downstream processing sectors. The second pathway is the primary pathway – where links to trade and GVCs is by the agriculture sector itself through primary product exports and value adding occurs through the application of other inputs into the primary good.

13. This paper explores the evidence around these two pathways. Specifically, it seeks to understand:

1. Do different value adding pathways exist? That is, are different pathways apparent when looking at trade in agricultural value added?
2. Do the two different value adding pathways yield different *total* domestic returns to the economy? That is, can countries 'add value' to primary agricultural products

and gain similar overall economic benefits from doing so as from adding value through downstream activities?

3. If pathways can be identified, what are the key differences between them? That is, are there differences in the composition of domestic value added in the exports in each pathway that extend beyond the value added from downstream processing sectors?
4. How do policies and differences in GVC participation by both agriculture and food sectors (food explored as the key downstream processing sector) influence the benefits from participation in either pathway?

14. Countries are said to be in either pathway if the majority of their exports of agricultural value added are either in the form of primary exports from agriculture sectors themselves (GTAP sectors 1-14) or if the majority of agricultural value added exported is embodied in exports of other sectors (GTAP sectors 15-57).[1] Agricultural sectors are defined as those primary sectors that make use of land in production – that is, the growing of crops and raising of livestock. Food sectors and other sectors use agricultural outputs to produce other goods. Food sectors in particular are defined as those that transform the primary product, for example producing oils from crops, meat from livestock and packaging and preparations for fruits and vegetables.[2] Countries in both pathways export both primary and processed products, but have a higher relatively intensity of exports of one over the other. To explore the third question, the paper then focus on the characteristics of the primary agricultural exports (GTAP sectors 1-14) that occur from countries in each pathways, along with differences that may exist between food sector exports (GTAP sectors 19-26) as representative of the main downstream using sector. Such differences can highlight whether it is characteristics of the underlying agriculture sector exports or food sector exports that may encourage greater primary versus processed product linkages to trade and GVCs. To answer the fourth question, an econometric evaluation is completed focusing on GVC participation, service sector value added use along with trade policy variables.

15. The paper has a particular focus on services due to the observed variation in services inputs into both primary and processing activities across countries (Greenville, Kawasaki and Beaujeu, 2017a), and the importance of increases in services value added in agro-food exports as a driver of domestic value added growth (Greenville, Kawasaki and Jouanjean, 2019a). These factors suggest, prima facie, that services value added is a key aspect in determining the value adding pathways.

16. This paper makes use of the inter-country input-output (ICIO) table developed by Greenville, Kawasaki and Beaujeu (2017b) using the GTAP database which contains information on 22 agro-food sectors over a 10 year period between 2004 and 2014. It builds on the work exploring the dynamic impacts of GVC participation on agro-food sectors set out in (Greenville, Kawasaki and Jouanjean, 2019a). As for the other studies making use of the GTAP database as the source data, for this study, the caveats associated with the data used in the analysis need to be noted. This study makes use of version 10, pre-release 2 of the GTAP database which has had recent updates based on new input-output data for the 28 European Union member states, Canada, Switzerland, Venezuela, Thailand, Uganda,

[1] See Annex A for sectoral definitions.

[2] It is often hard to classify enterprises within categories and errors will exist at the margin. For example, for fruits and vegetables, if packing occurs on farm within the same farming enterprise, it is likely this would get consider farm output and thus part of the agricultural sector. Whereas if this occurs in a separate packaging business, that activity would be part of the food sector.

Philippines, Costa Rica, Tunisia, New Zealand, China, India and the Ukraine (compared with version 9).

17. The advantage of using the GTAP database is that it reconciles data from different sources into one consistent database. The disadvantage, however, is that for a number of countries the underlying input-output tables are dated and there have been limited updates (Box 1). This means that within the analysis, while trade patterns and size (absolute and relative) of sectors are captured, changes in the production technology (or production function in terms of the ways industries combine inputs to produce outputs) are not.

Box 1. Consistency across GTAP databases

The GTAP database provides a consistent representation of the world economy in any given year for which it is constructed. The database is constructed on underlying national input-out tables but incorporates data on trade, macroeconomic variables and taxes and subsidies from a range of different sources (GTAP, 2016a). The database is balanced and is compiled to ensure that trade and domestic production data are consistent and that world supply and demand balance.

However, despite the primacy of input-output tables in database construction, variation exists in the statistical methods used to compute these, the base years used and the sectoral detail of the individual tables (GTAP, 2016a). As such, the database is not a repository of input-output tables for any given year. In order to overcome the differences and construct the GTAP database a number of assumptions and adjustments must be made (for full details of the documentation see GTAP, 2016b). These are likely to influence the results of any analysis that seeks to exploit this source of information to derive statistics that use input-out tables as a base – such as constructing an inter-country input-output table for analysis of GVCs.

A further complication is created if comparisons are to be made across years. Not all of the underlying input output tables are updated regularly and therefore some do not differ across various years in the database. Instead, adjustments are made with respect to changes in macroeconomic and trade variables in order to update the database to more current years (GTAP, 2016a). This means that for some sectors in some countries the underlying production technology (the way, relative proportions and types of value added and intermediate factors are combined in the production of the good or service) does not change and that much of the variability over time comes from adjustment processes based on the changes to macroeconomic aggregates and to trade flows. That said, even within regularly updated input-output tables, production technology is slow to change and over relatively close time periods, such as those from 2004 to 2014. Despite this, it remains a limitation of the data used.

For the this study, little can be done to correct for the issues associated with consistency of the underlying input-output tables and those related to changes over time. Thus these remain a caveat of the analysis undertaken.

18. Additionally, issues relate to differences in the underlying data, including the sectoral coverage within national input-output tables. As a result, changes over time for some sectors in some countries are driven by changes in macroeconomic conditions and trading patterns rather than changes in the production technologies of individual sectors. That said, over a relatively close span of years in the absence of a major new disruptive

technology, such changes may be small. However, these shortcomings cannot be overcome and adjustments cannot be made to the data. Given this, as highlighted when the study was proposed, these caveats remain and should be borne in mind when viewing the results.

Concepts of GVCs used in this study

19. For the purpose of the study, GVCs are explored through the lens of trade in value added. As per other papers in this series, the approach adopted is to examine the flows of value added from agro-food sectors across countries. This is explored through the various sector-to-sector and sector-to-final demand linkages that occur between countries. In this way, the study does not explore individual value chains for specific products. Nor does it seek to explore the influences that the changes in contracting, falls in transportation costs and changes in consumer demand have had on the nature and extent of the linkages observed.

2. Theories on 'value adding' for agriculture

Why might different value adding pathways exist? Moving beyond the appeal of downstream processing

20. The possibility of alternative value adding pathways in a GVC context has some theoretical merit. While many of these factors will exist irrespective of GVCs, it is likely that growing trade within GVCs is re-enforcing them.

21. GVCs can grow the volume produced and potentially increase the price received. Firms or countries need not master an entire production process but instead can specialise in a smaller aspect of a production process, thereby increasing opportunities for value creation. GVCs then provide producers with access to new markets and potentially higher returns, allowing them to expand the size of this more specialised production and grow. In this way, GVCs can have a volume and possible value effect on the goods currently produced.

22. GVCs can also provide opportunities to move into higher value activities. Beyond the static opportunities from specialisation in tasks, GVCs may provide opportunities to grow value added over time through processes generally termed as 'upgrading' in the value chain. Upgrading is a term with various interpretations both at the firm and sector level.[3] At the sector level, for agriculture, a focus on strategies for value adding has been through moving into downstream sectors – particularly food processing sectors – with a view to increase the *share* of final value added captured. For the economy as a whole, this is representative of thinking around economies of scope – if efficient in agriculture, then why not also in these downstream activities? If true, GVCs can also help to create new value by moving into new sectors and thus create additional employment and returns from the use of factors of production in these new sectors.

23. The opportunities to move into new activities have been particularly appealing for policy makers as they both create new economic activity and the potential to grow demand for agricultural inputs, increasing agriculture sector activity. Much of the perceived benefits from moving into downstream activities are the observed higher prices of more transformed

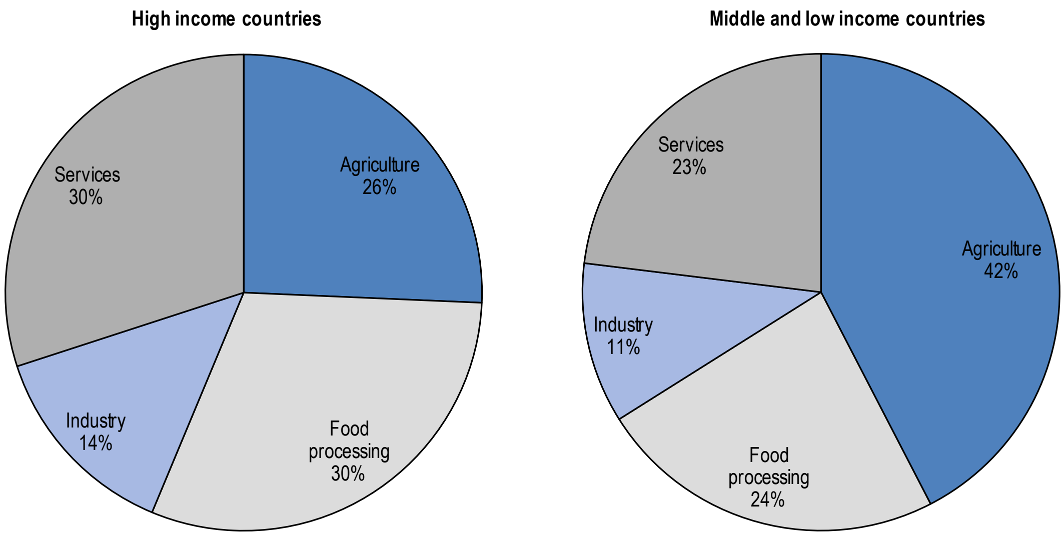
[3] In a general sense, upgrading represents a process of improving productivity through organisational change or improved production techniques that may be driven by the use of intermediates that come from GVCs, or through the GVC related creation of economies of scale or scope.

products, suggesting to policy makers and producers that this price represents a potential higher aggregate domestic return. Thus in the context of agriculture, it is often argued that governments should pursue value addition by moving into downstream food manufacturing activities.

24. However, it may not always be the case that downstream activities generate greater total domestic value added – even if the observed unit values are higher. For example, Krugman (2008) suggests that different trade unit values do not provide an indication as to the wage impacts from trade nor the value added per unit of worker. The higher value of food and other final products represents the expanding number of non-agricultural sectors that contribute to food production (Figure 1). Looking at the average share (globally) of $1 of agro-food products consumed shows that while agriculture is important, it may not represent the largest value addition to the food we eat or the clothing we wear. In developed countries, the value contributed by the agriculture sector is on average 26% of the final value, with the contribution of food processing sectors at around 30%. In developing countries, agriculture represents a larger share of the value of the final product – most likely associated with the level of product transformation that occurs rather than due to differing market structures with, for example, a much higher share of production going straight from producers to consumers through local markets.

Figure 1. Distribution of returns from final demand along the value chain, 2014

For agro-food in aggregate, average share of $1 paid by consumers



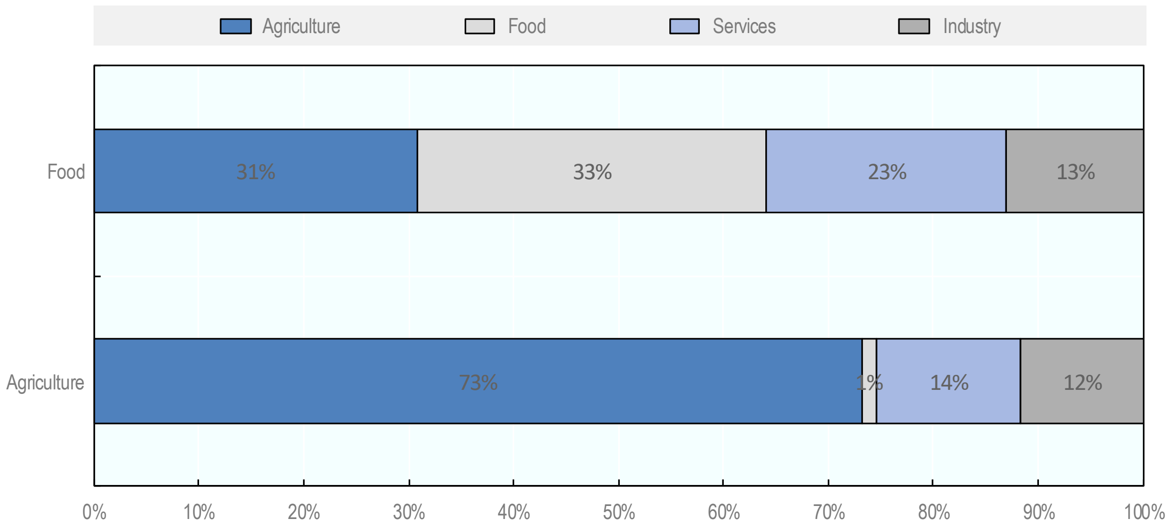
Note: Simple averages across country groups.
Source: Updated based on Greenville, Kawasaki and Beaujeu (2017b).

25. More importantly, comparative advantage remains inescapable. For agricultural producing countries, this means that not every country will have a comparative advantage in downstream processing of primary products – just as not all countries with large deposits of natural resources have a comparative advantage in turning these into processed materials. Simply put, not all countries can do the same thing and still grow domestic value added.

26. But a lack of comparative advantage in processing sectors may not mean that total value added created by agricultural production need be less than that created in countries which do enjoy such comparative advantages. This is because GVCs have also altered, or reinforced, the way that agro-food trade is occurring. For agriculture, accessing GVCs with primary products often comes with a range of tasks to make products more competitive (which may be reputational), along with other requirements or activities to meet the demands from both foreign processors and consumers. In both these cases, other sector inputs are usually used. Often these other inputs are thought of as higher costs imposed on producers in accessing modern value chains. However, in the same manner as food manufacturing activities, these additional inputs essentially 'add value' to the primary product. Thus, from an economy wide point of view, they can be considered as value adding activities akin to food sector processing. Indeed, what is also noticeable from Figure 1 is the value addition by other industries in the value chain. Thus the total value created for an economy from these other sectors will be influenced by the volume of agricultural production. In 2014, services sector inputs into the final value of agro-food products made up 30% of the final value in high income countries and 23% in developing. In exports, the value contribution by services and industrial sectors is also large, accounting for an average of around one-third of agriculture export value (Figure 2). This also varies considerably across countries – discussed in detail in section 5.

Figure 2. Distribution of average gross export value

Share of USD of export value across broad sector groupings



Note: Shares are total agricultural value added weighted average shares of the gross value of agricultural exports. Weighted averages taken for consistency with remaining paper. Unweighted averages differ, with higher service and lower agriculture shares seen due to the greater total value of exports from high income countries.
Source: Author estimates.

27. Ultimately, what is important for a country is the total domestic value added created. This is determined by both the share of the final value captured and the volume of trade that is occurring. Following the logic set out above, agricultural sectors and countries, in the context of GVCs, may have multiple value adding pathways which will be determined by both comparative advantage and other factors. Moreover, the development of GVCs has possibly opened the door to taking advantage of another country's

comparative advantages as not all tasks required to produce food need to take place in the same country leading countries to specialise in different ways along the value chain or in the value adding pathways. It is possible that countries can pursue domestic value added growth through direct primary sector exports or (and possibly 'and') through downstream sector exports – that is, indirect exports of agricultural domestic value added.

Evidence on value addition in and around agriculture

28. The potential for GVC participation to increase domestic value added from job creation and capital generation has been seen in other sectors of the economy (Moser et al., 2015; Wright, 2014). Part of this growth is due to increased opportunities for specialisation which flow from the potential for GVCs to allow economic actors to perform the same activities more productively (Humphrey and Schmitz, 2002). In particular, GVCs promote trade in intermediate goods which can have a positive impact on industries' total factor productivity in two ways. First, through using embodied foreign technologies and second, through learning from these which can allow companies improve other locally held technologies, thus leading to a more efficient use of production factors (Miroudot et al., 2009).

29. Beyond opportunities for specialisation and productivity improvements in existing activities, GVCs may provide opportunities to move along the value chain – for example, moving from selling fruit to making fruit juice. For countries looking to increase domestic value addition that stems from agriculture, there is a view that moving into these downstream sectors may grow the total value created. This form of upgrading has been the focus of much of the GVC literature and refers to the ability of sectors and producers to increase their share of the value added 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).

30. However, recent OECD analysis has highlighted that it is not only the share of domestic value added in traded goods that matters, but also the volume of trade (Kowalski, et al, 2015). 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 but 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.

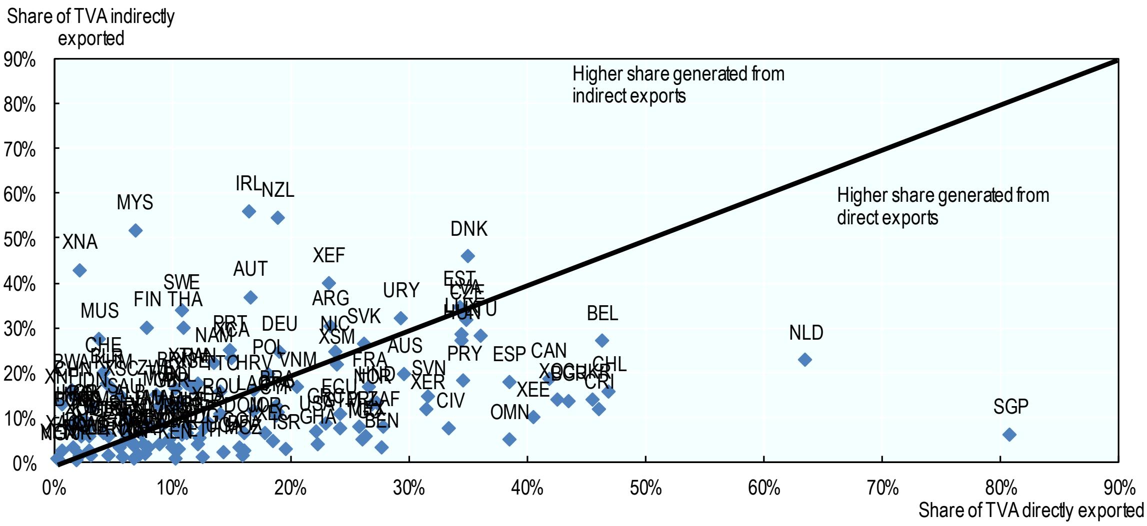
31. A further issue, but one not examined in this paper, relates to the market structure of the value chain. In agricultural and food sectors, some researchers have argued that value chain coordination is characterised by 'quasi-hierarchical' (or 'captive') relationships (Humphrey and Dolan, 2004), with some sectors seeing an increasingly concentrated set of global buyers who may be able to exercise a high degree of control over a large number of suppliers in the chain. This control may take the form of specifying the characteristics of the product, the production processes to be followed, and/or the mechanisms to be used to reduce the risks associated with non-compliance with standards. This structure, it is argued, may 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 (Greenville, Kawasaki and Beaujeu, 2017a). On the negative side, dominant global buyers may not support efforts to move into higher value activities, such as new product design and innovation activities, 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).

3. Value creation in agriculture: more than just moving up the chain

32. Exploring trade in value added provides a means to explore the different types of value creation from trade for the agriculture sector (Figure 3). Direct exports of agricultural value added through primary product exports (hereafter termed direct exports) represent those that occur from the sector itself – for example, direct exports of wheat or soybeans as primary product exports. Indirect exports of agricultural value added embodied in other exports (hereafter indirect exports) represent the agricultural value added that is exported by other domestic industries – for example, indirect exports of wheat exported in the form of flour and for soybeans as oil or other transformed products.

Figure 3. Patterns of specialisation in domestic value added agricultural exports, 2014

Domestic value added in direct and indirect exports as a share of total industry value added



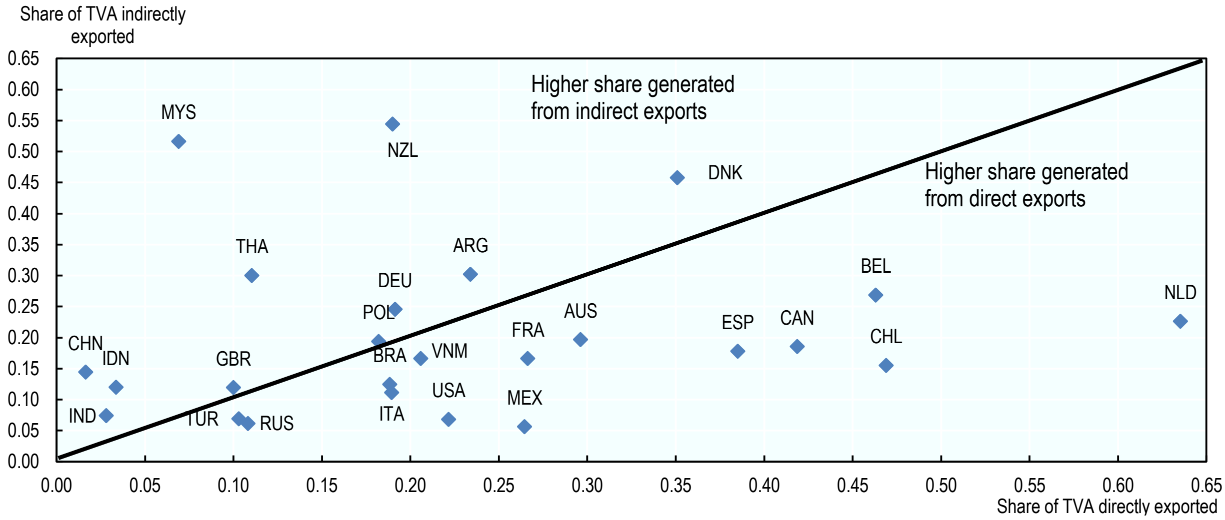
Note: Shares are calculated as the total sector domestic value added in direct and indirect exports divided by the total sector value added.
Source: Author estimates.

33. Across agricultural exporters worldwide, differences in the specialisation between agricultural value added generated by trade directly and indirectly can be seen (Figure 2). Looking at the shares of total value added of the agricultural sector exported, either directly or indirectly, shows that for a number of countries the main source of export related value added is direct exports from the agricultural sector itself.

34. This pattern of differences in specialisation is repeated when looking at the world's largest agro-food traders in 2014 (based on gross trade values). Around half (14), trade a higher share of their total industry domestic value added in the form of direct agricultural exports – that from the primary sectors themselves (Figure 4). Two countries trade roughly equal amounts of direct and indirect – the United Kingdom (GBR) and Poland – while for the remaining 13 countries, agricultural sector exports are largely indirect through other domestic downstream sectors. These patterns suggest that the generation of domestic value added in agriculture is not only driven by the creation of downstream processing, with countries placed along a spectrum.

Figure 4. Patterns of specialisation across major exporters in domestic value added agricultural exports, 2014

Domestic value added in direct and indirect exports as a share of total industry value added, top 25 agro-food exporters



Note: Shares are calculated as the total sector domestic value added in direct and indirect exports divided by the total sector value added.
Source: Author estimates.

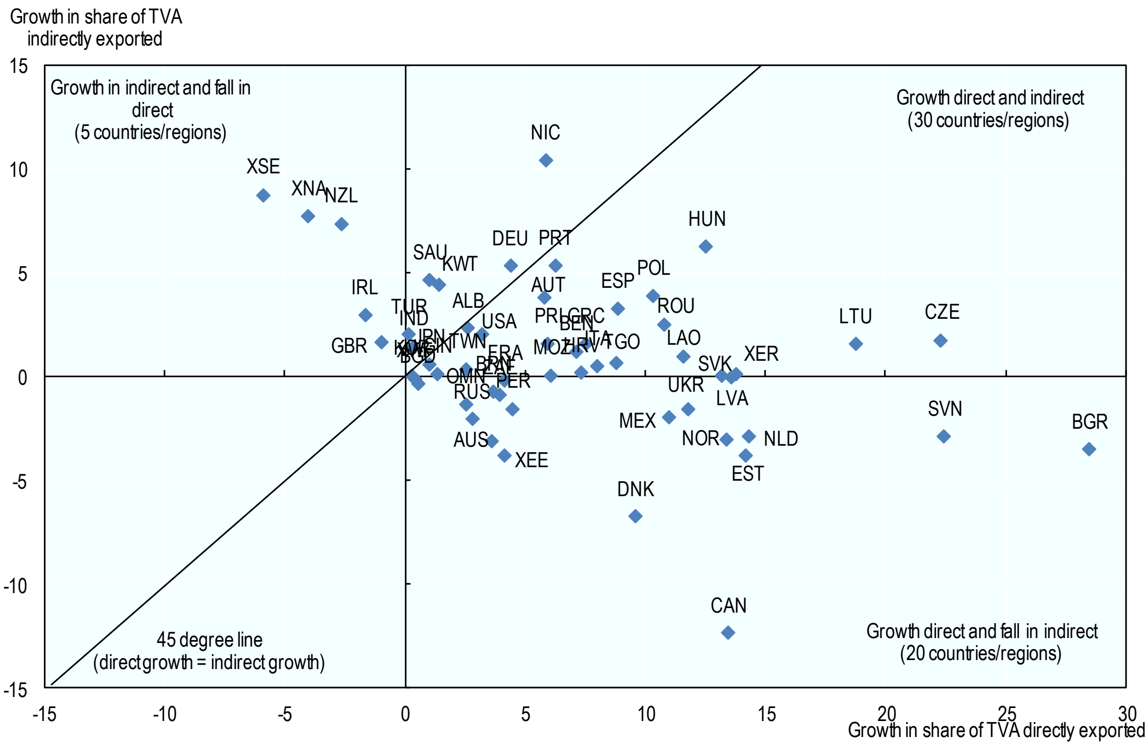
Is participation in trade growing through direct or indirect exports of agricultural value added?

35. The development of GVCs means that the processing of primary inputs into food, clothing or other goods can take place over a number of different countries. This is less possible for primary production as much is tied to geographic and climate conditions which are essentially non-tradeable inputs (or at least non-tradeable with current technologies). What this means for agriculture is that the opportunities for growing value added from exports of primary products are possibly greater in the GVC context where production of processing activities is being broken up across countries. In this sense, GVCs can enhance the opportunities of agricultural producers to tap into processing operations in foreign countries or to service foreign final demand. Thus the value creation from agriculture in any country may be less dependent on the development of downstream processing, or at the least, not having a comparative advantage in downstream processing may not have a negative impact on growth in agricultural or even total domestic value added from exports.

36. Exploring this hypothesis indicates that for the majority of countries between 2004 and 2014, much of the growth in value added exports took place through direct exports rather than indirect exports (Figure 5). Within the dataset examined, 55 of the 141 countries and regions saw an expansion in the share of total value added traded between 2004 and 2014 – simply put, these countries had a rising share of their total value added created by exports compared with selling to the domestic market. Of these, 44 of the 55 countries saw greater growth in the share of total domestic value added traded stemming from direct exports compared with that stemming from indirect exports. Thus, direct primary exports were the main driver of domestic value added growth in countries with deepening participation in GVCs.

Figure 5. Growth in the share of direct and indirect agricultural domestic value added exported

Growth in the share of total agricultural domestic value added exported directly and indirectly between 2004 and 2014 for countries with overall growth in share of total domestic value added traded



Note: Countries with growth in share of total agricultural domestic value added exported are those where the sum of direct and indirect shares of total value added traded is positive. Shares are calculated as the total agricultural sector domestic value added in direct and indirect exports divided by the total agricultural sector value added.
Source: Author estimates.

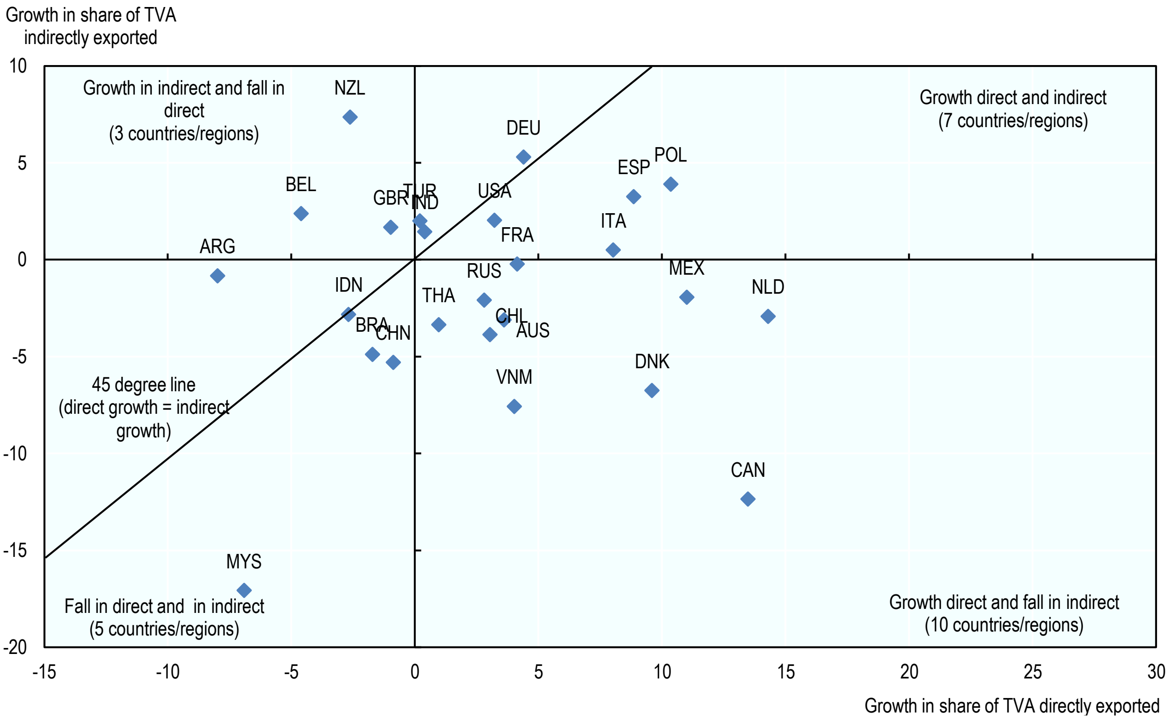
37. For the world's 25 largest agro-food exporters, the results also reveal a bias towards growth driven from primary exports (Figure 6). The unbundling of tasks within agro-food GVCs, and further opening of agricultural markets, is extending the reach of primary sectors as input suppliers into other countries' food systems.

38. There are a few notable exceptions within the group of major agro-food exporters whose agricultural sectors domestic value added growth from exports is being dominated by the indirect sales of agricultural domestic value added. These include some European countries – Belgium, the United Kingdom (GBR) and Germany – along with New Zealand, Turkey and India. For the European countries (along with Ireland depicted on Figure 5), all of which are European Union members, the Single Market's highly interconnected food system (Greenville, Kawasaki and Jouanjean, 2019a) has provided for greater specialisation opportunities and allowed processing sectors in these countries to be a driver of domestic agriculture sector growth. That is, for individual European Union members, access to inputs from across the European Union has provided growth opportunities for the competing domestic agricultural sectors. For India, the dominance of indirectly exported agricultural value added (Figure 6) is indicative of the significant potential for processing sector development. Both domestic market size and primary sector potential will potentially

provide opportunities for India's processing sector to be a driver of growth for its agricultural sector. However, current wholesale market policies and significant levels of trade restrictions on domestically produced and foreign sourced primary inputs (OECD/ICRIER, 2018), if continued, will work against this potential.

Figure 6. Growth in the share of direct and indirect agricultural domestic value added exported, world's top agro-food exporters

Growth in the share of total agricultural domestic value added exported directly and indirectly between 2004 and 2014, top 25 exporting countries



Note: Countries with growth in share of total agricultural domestic value added exported are those where the sum of direct and indirect shares of total value added traded is positive. Shares are calculated as the total agricultural sector domestic value added in direct and indirect exports divided by the total agricultural sector value added.
Source: Author estimates.

39. For New Zealand, the growth in its source of agricultural value added in exports is product specific. New Zealand's growth has been driven by the dairy sector – raw milk at the primary level. Raw milk requires processing for trade and so New Zealand's largest link to global markets and GVCs for its agricultural sector has relied on its processing sector. But as seen in both Figures 5 and 6, New Zealand is relatively alone in this. On the other side, Canada and the Netherlands have seen strong growth in primary sector exports, with agricultural sectors driving the increased integration in agro-food GVCs rather than their processing sectors.

40. Taking a broader approach and looking at growth in value added exported directly and indirectly alone (independent of sector growth levels)[4] reveals similar results. In real terms,[5] 95 of the 141 countries and regions experienced growth in the value of their exports (Table 1). A total of 86 had stronger growth in direct agricultural domestic value added exports, with 55 experiencing stronger indirect agricultural domestic value added trade growth. However, of these, 72% of those with stronger direct domestic value added growth also had growth in overall domestic value added agricultural exports (total), while only 60% of those with indirect trade driven domestic value added growth saw growth in total agricultural domestic value added exports. Furthermore, the overall growth in real domestic value added by countries with a more direct exports was greater – of those with positive growth 66% in real terms versus 55%.[6]

Table 1. Average real growth in direct and indirect agricultural domestic value added exports

Real growth between 2004 and 2014

	All countries		Countries with overall positive trade growth	
	No.	Average growth %	No.	Average growth %
Direct export domestic value added greater	86	42%	62	66%
Indirect export domestic value added greater	55	21%	33	55%
Those with overall growth in domestic value added exported	95	62%	95	62%

Note: Growth in real values explored. Real values are calculated through deflating nominal values by the food price index published by the IMF.
Source: Author calculations.

4. Are there differences in the contribution to total domestic value added from exports between 'value adding' pathways?

41. The section above explores evidence to looking at the ways in which agricultural value added is exported and the ways in which these sectors engage in GVCs and international markets. As seen, there is a range of different intensities in exports of agricultural value added as primary or within processed products. With observations of different intensities in the way that agricultural value added is traded, this section explores whether these differences can be grouped into two 'value adding pathways' – one with value added to the primary product through direct exports from agricultural sectors (GTAP sectors 1-14), the other with agricultural products having value added by downstream

[4] This measure avoids comparing only countries which have increased the export share of their total sector size and captures a wider set of countries where exports to GVCs may have grown more slowly than total sector growth.

[5] Deflated by the food price index published by the IMF.

[6] As a test on these results, a simple fixed effects regression model was explored relating the changes in shares of agricultural value added directly exported to total sector value added growth. Fixed effects were set at the country and year level. The results depicted a positive relationship between increasing shares of direct value added exported and total sector growth. As causation is unknown, the results are not presented in detail here, however, it provides some evidence of a positive correlation between sector growth and increasing shares of agricultural value added directly exported, supporting the findings in Table 1.

sectors. These two pathways are termed the 'primary pathway' and the 'processing pathway'.

42. Evidence on trade in value added above shows that possibilities exist to export and create and grow agriculture value through both direct and indirect exports, and so possibly in specialising in either pathways. However, the observations on trade and growth in trade do not in and of themselves provide insights into one of the main arguments behind policy makers' push for downstream value added – the view that the processing pathway would provide greater overall economic returns as it would capture a greater share of the total value of food ultimately consumed.

43. Providing insights into this question is difficult. The arguments presented in this paper suggest that there are volume, share (of final value), export value (price) and value added contributed from other domestic industry considerations at play. That is, the total domestic value added return from exports will rest on all these factors with some trade-offs between them. Because of this, playing to a country's comparative advantage is critical.

44. The different pathways offer, in theory, potentially similar opportunities to grow total domestic value added from exports. In the processing pathway, the opportunities are apparent. Processed products attract higher prices due to the greater amounts of value addition that occur in transforming a primary product into one closer to that which gets consumed by the final consumer. If that is done within the country producing the primary agricultural products, then at least in theory, total domestic value added from exports could grow by moving into downstream sectors. In reality, it depends on how well this is done – how competitive the downstream sector is.

45. For the primary pathway, opportunities for value addition also exist. Primary agricultural exports also include value added from a range of other sectors. As discussed above, there are considerable shares of value addition from services and industrial sectors in the export value of agricultural products. These supporting services thus also create domestic value added and, in the same way as food processing, can increase total domestic value creation.[7] If GVCs are opening up possibilities to access foreign processing under certain conditions (certain 'quality' requirements on the primary product), then countries without internationally competitive food processing sectors may be able to leverage similar gains to those which do – they do not have to complete the entire production process themselves.

46. To shed light on these pathways, countries need to be grouped somehow and the differences between the groups assessed. As highlighted above, for this report, the two 'value adding pathways' are defined at the country level. The grouping of countries to these pathways is such that those with the majority of exports of domestic agricultural value added as primary good are in the primary pathway. The others, majority as indirect exports of agricultural value added, are defined as being in the processing pathway. In this way, it depicts the broad specialisation of a country's agriculture sector. It also means that while countries in both pathways export both primary and processed products, it is rather that the

[7] In both instances value is created outside the agricultural sector – in the support sectors or in the food sector. This will have an influence on where economic activity takes place and the growth of returns across value chain participants. The influence on agriculture sector returns is for both unclear and dependant on a range of other factors including market structure. That said, increasing service share in exports has been found to have a positive impact on agriculture (and food) sector value added growth – that is returns to producers themselves (Greenville, Kawasaki and Jouanjean, 2019a).

relative mix is focused on one more than the other. While this choice is arbitrary around the 50% mark, taking weighted averages of results is needed to obtain representative estimates for within each group should provide a more robust measure of total effects. In effect, the weighted averages move the focal point of comparison away from the 50 percentile to the average point within the groups.

47. Testing the differences or similarities in the total domestic value added contribution from countries in the different pathways is also difficult. For example, the total size of the agricultural sector, its relative size in the economy, the volume of trade and differences in the level of development between countries in the same pathway will all influence outcomes for total aggregate domestic value added creation from exports and when comparing average results may bias estimates and cloud the findings.

48. There are also issues around 'cut-offs' – that is, the level of agricultural sector input use that makes a sector reliant on domestic agriculture, meaning the associated value added of that sector in its own exports is considered an indirect contribution. For example, decisions need to be made whether to include value added from the food sector versus value added from the chemicals and plastics sector – both of which use agricultural inputs. For this study, it has been assumed that all non-agricultural value added in exports from the food sectors is considered as an indirect benefit that accrues to countries from exports of agricultural value added. Furthermore, the domestic agriculture inputs into other non-food sector exports is included (such as pharmaceuticals and textiles), but, the own and other sector inputs into these non-food sector exports are not included. This is due to the relatively small share of agricultural inputs in the production of these sectors' exports.[8]

49. Ultimately, analysis rests on trying to compare aggregate domestic value added creation from exports in a relative manner. In other words, there is a need to place each total export value amount in context to measure aggregate returns – simple cross country comparisons on their own are not enough to shed light on this question. In this paper, the total returns from exports in either pathway expressed relative to total agriculture domestic value added is explored. This estimate is akin to a multiplier – it shows how much $1 of agriculture value added creates domestic value added returns from exports, both within agriculture and outside.

50. To try and account for issues around the total size of the agriculture and food sectors, the relative importance of these sectors in the economy and the amount of trade that occurs, various weights are applied to the pathway averages to build up a picture around the total benefits on offer across the two pathways. These are computed so as to see if one pathway generated higher domestic returns, on average, than the other pathway. The averages explored include:

- *Simple average*: equal weights applied and the simple cross country averages presented. This does not account for any differences in agro-food sector size or export size, but rather treats each country in each pathway equally.
- *Total size of agricultural domestic value added weighted average:* this expresses the results on a basis that is more representative of the average agriculture sector in each pathway.

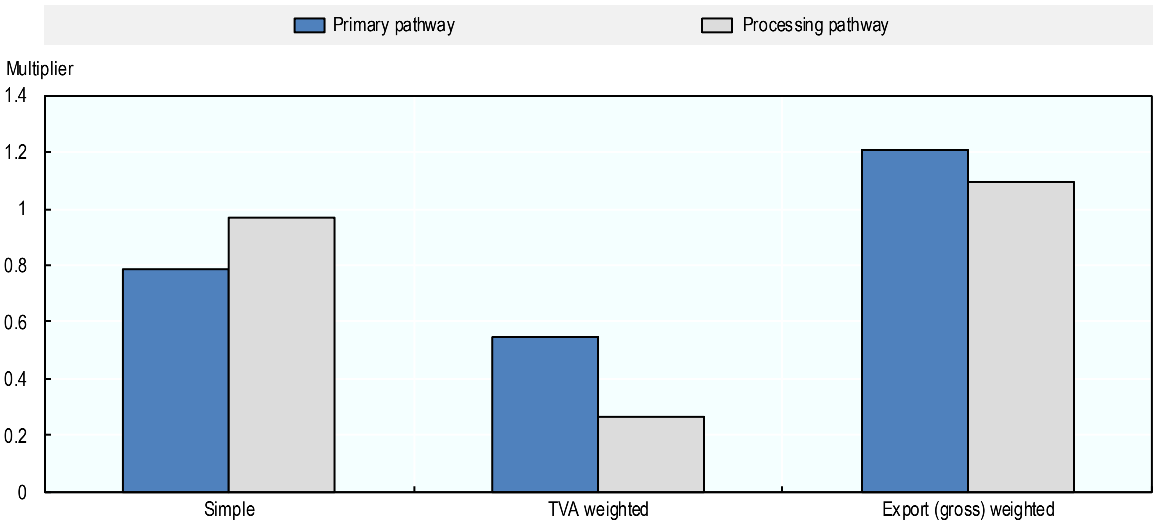
[8] In essence, with small shares it is assumed that these sectors could more easily source internationally for the required intermediate inputs.

- *Total export (trade) weighted average*: this places a higher weighting on those who export more, so presents the indicator on a basis that is more representative of the average exporting agro-food sector in each pathway.

51. Comparisons suggest that the benefits on offer for countries from either pathway are comparable (Figure 7).[9] That is, there is evidence to support that countries on average can capture similar gains in domestic value added from value adding through downstream sectors to value adding to the primary product and direct exporting. For the multiplier, the weighted (by total agriculture value added) estimate makes most intuitive sense when viewing from the point of view of leveraging the most from the agricultural sector (maximising the total domestic return from that production). That is, it better depicts the returns from the average $1 of agriculture value produced in each pathway. This estimate suggests that in terms of total returns that accrue from agricultural production, the multiplier is on average, in 2014, greater in the direct pathway than that from the indirect pathway. This result is seen in all years for which data are available.

Figure 7. Overall pathway contributions to domestic value added, 2014

Global average agriculture total value added multiplier in primary and processing pathways



Note: The primary and processing pathways are identified at the country level based on the total amounts of value added exported as primary versus food products. The multiplier represents the total domestic value added generated in exports on average in the pathways across countries.
Source: Author estimates.

52. The average results support the notion that equivalent total domestic returns are on offer from the primary value adding pathway to that of the processing value added pathway. However, it is also useful to look across the distribution of returns to see if the arbitrary grouping at the 50% mark makes a differences to the results obtained. The multiplier results for all countries in this study are shown on Figure 8, with the mark between the two groups

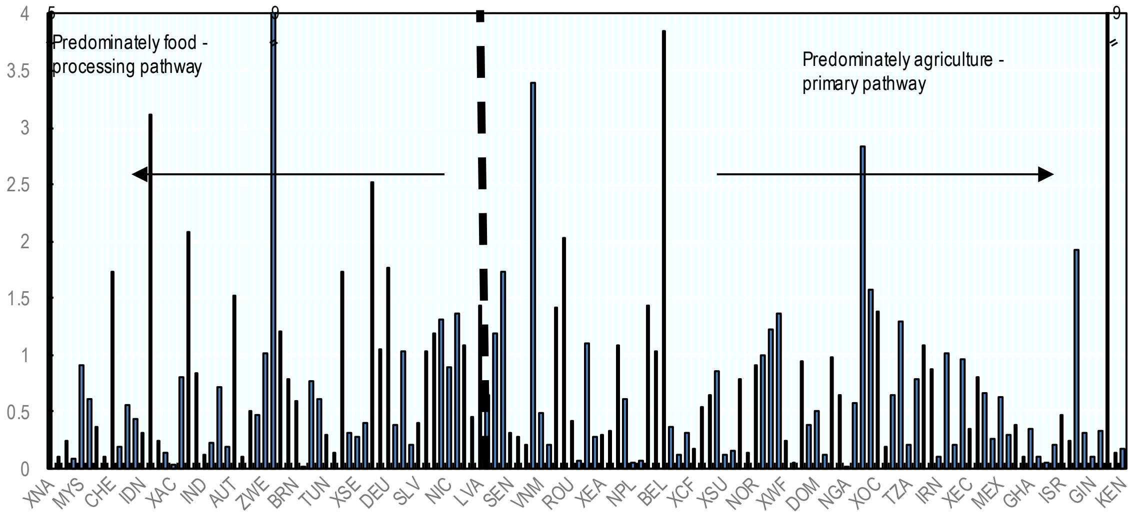
[9] An alternative formulation was explored including GTAP sectors 27 (textiles), 29 (leather) and 30 (lumber) in the same manner as the food sector. Thus, own value added created by these sectors is assumed to be a return that is related to agricultural production. This inclusion did not change the average results depicted, showing the pathway returns were robust to this change. For this paper, the narrower focus has been maintained.

(at 50% of exports of agricultural value added) depicted by the vertical dashed line. As can be seen, there is variation in both groups – with some outliers in terms of high multipliers seen on both sides of the cut off.

53. Looking in more detail within these groups, estimates suggest that the average result obtained is robust. That is, taking different points along the distribution of countries along the predominately direct primary exporting to predominately processed agricultural value added exporting shows that the total returns are similar (Figure 9). Three additional cut offs are explored moving closer to the extremes – where primary value added exports account for more than 85% of total value added exports (and the opposite for processed value added), at the 75% cut off and at the 65% cut off. For each of these the comparisons between the two pathways are very similar to the overall average, suggesting that along the continuum, the result holds.

Figure 8. Multiplier estimates for all countries

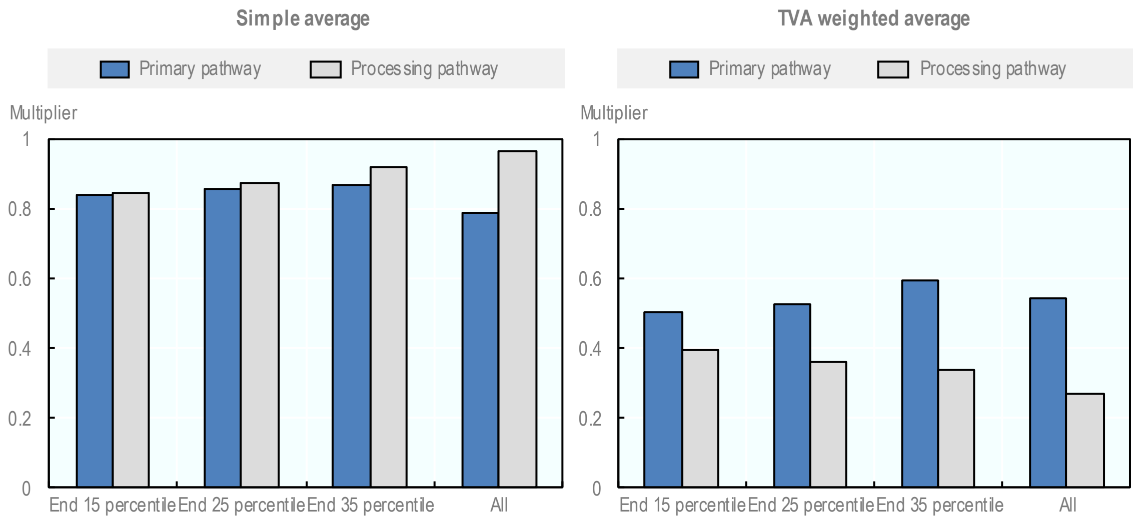
Agriculture total value added multiplier



Note: The primary and processing pathways are identified at the country level based on the total amounts of value added exported as primary versus food products. The multiplier represents the total domestic value added generated in exports on average in the pathways across countries.
Source: Author estimates.

Figure 9. Multiplier estimates for different pathway cut-offs

Average agriculture total value added multiplier



Note: The primary and processing pathways are identified at the country level based on the total amounts of value added exported as primary versus food products. The multiplier represents the total domestic value added generated in exports on average in the pathways across countries.
Source: Author estimates.

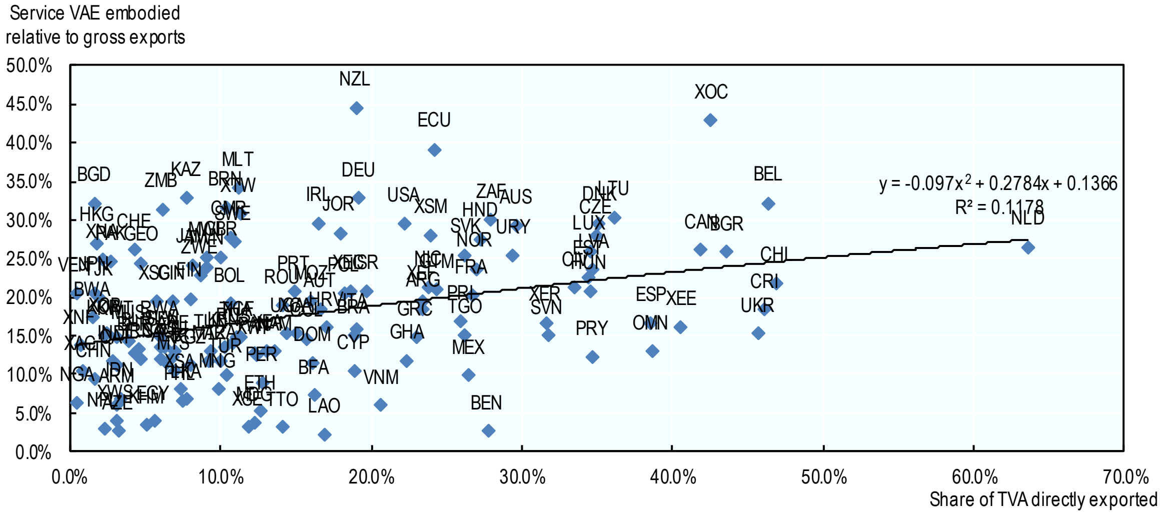
5. What differentiates the value adding pathways? The role played by services

54. With two possible value adding pathways which deliver similar levels of total economic returns from agriculture, understanding the differences between them can provide insights for policy makers. For example, in the context of developing countries, it suggests that there are alternative pathways for sector transformation and development possible with access to efficient support sectors. This section explores the factors that differentiate the two pathways – that is, it explores the characteristics of the sectors that participate through direct exports from agricultural sectors compared with those that participated in the indirect pathway.

55. Looking at the characteristics of countries with a high share of total value added exported directly exported as primary products shows a weak but positive correlation with services (measured as the service value added content of agriculture exports relative to gross export value). Services represent a wide range of sectors from construction activities to business services (which include a number of agricultural consultants and contractors) to transport and trade services. Countries with a higher share of domestic value added created through direct exports of primary products also have relatively higher share service sector input use to support those exports (Figure 10). Despite this, there is a lot of noise and a clear link between service use and direct exports is not readily discernible through correlations and is explored in more detail in Section 6.

Figure 10. Services value in agricultural exports and direct exports of agriculture domestic value added

Relative use of services in exports and share of total domestic value added directly exported



Note: Relative service value added measured as the service value added content of agriculture exports relative to gross export value.
Source: Author estimates.

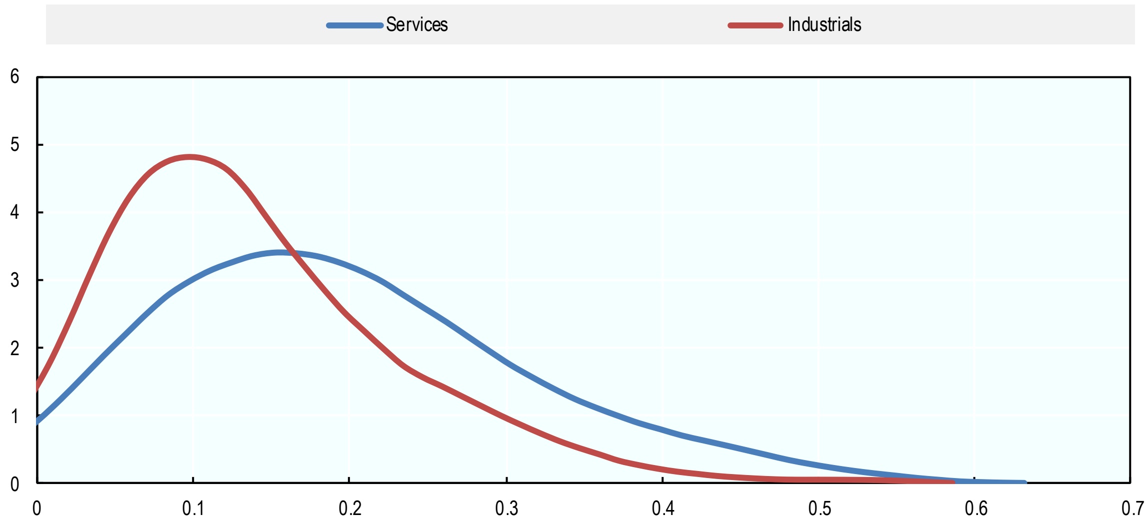
What services are used in the production of agro-food exports?

56. Despite the weak correlation between services value added in gross exports and direct or indirect trade of agricultural products, there is considerable variation in the use of services value added across sectors and countries. This variation suggests that it may be an important factor in explaining different exporting patterns across countries. At the country level, the average use of services value added in 2014 (and in earlier years) was greater than that of industrial inputs.[10] However, as seen by the width of the distribution, there is more variability in service use across countries – depicted by a wider distribution (less uniform) – than that seen for industrials (Figure 11). The wider variation suggests much less consistency in service addition to production, possibly influencing the value adding pathway that is taken.

[10] Where average service shares are mentioned in this section, these represent total domestic value added weighted averages.

Figure 11. Distributions of service value added in agro-food exports across countries, 2014

Distribution of the ratio of service and industrial value added in total sector domestic value added across countries



Note: 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 calculations.

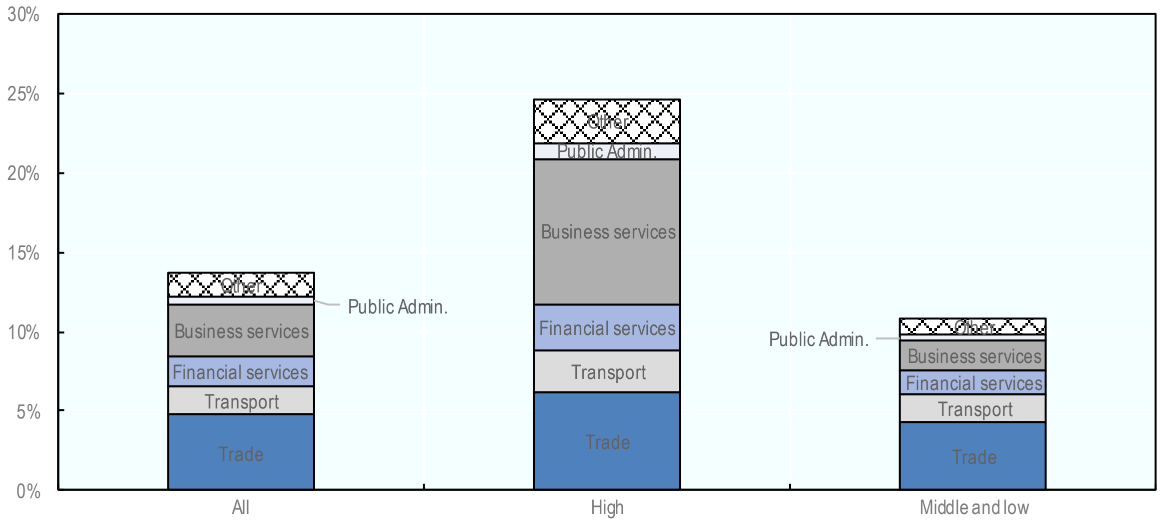
57. The major service inputs into agro-food exports are shown in Figure 12, expressed relative to gross export value. Globally, there are four major service supplying sectors that provide inputs into agricultural production and therefore exports. These include trade, transport, financial and business services. These four sectors accounted for over 86% of service provision to the world's agricultural exports in 2014 – a figure that has remained stable over time.

58. Most of these services are provided by the domestic market. In 2014, on average, 80% of the services provided to agriculture and 73% to food were sourced from the domestic market. These figures show the importance of the domestic services market as a supplier to agro-food production, including its international competitiveness.[11]

[11] A note of caution is warranted. Services trade is hard to measure and the true extent of domestic versus foreign service input is subject to error – particularly in developing countries. Part of this is due to difficulties in measuring Mode 3 services trade within national accounts.

Figure 12. Major service inputs into agro-food exports by broad country groupings, 2014

Global weighted averages expressed as a share of total industry domestic value added



Note: Other refers to construction, communication; insurance; recreation and other services; and dwellings. Estimates weighted by industry total value added.
Source: Author estimates.

Differences between developed and developing countries in service use

59. High income countries[12] make use of a significantly greater amount of services in producing both agricultural and food exports and in production more generally than middle and low income countries (Figure 11). The average share of services value added in gross exports is 11% in low and middle income countries compared to 25% in high income countries. But despite the differences between the groups, the composition of service inputs is relatively similar, suggesting that agricultural sectors globally have a similar service input bundle in production and in exports.[13]

60. However, despite the similarities, three exceptions exist. Looking at the relative importance of different service industries shows that low and middle income countries make use of trade services[14] with greater relative intensity than high income countries – 40% of total service value added in agricultural exports compared to 26%. On the other side, high income countries make much greater use of business services – a group that includes contractors to farms and so represents a number of ancillary rural services from agronomists to leasing of agricultural machinery to computing services. In high income countries this is the largest sector supplying services to agriculture. Third, the sector

[12] High income countries are those defined by the World Bank (2018, see https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups) and represent those classified as High Income in 2014.

[13] Part of the lack of differentiation is due to the broad nature of the services sector within the GTAP database.

[14] Trade services include all retail sales; wholesale trade and commission trade; hotels and restaurants; repairs of motor vehicles and personal and household goods; and retail sale of automotive fuel.

that contains veterinary services (which are classified under health and in the Public administration, defence, education and health sector) also supplies a slightly higher share of services in high income countries.

61. In terms of foreign or domestic sourcing, across countries at varying levels of income there appears to be little difference for agricultural sectors in the share of services imported – on average, around 20%. However, for the food sector there is some variation. In high income countries, the share of imported foreign inputs in exports relative to sector total value added is higher. Foreign service supplies account for on average 30% of total service inputs compared to just over 20% in low and middle income countries.

Transport services and agro-food GVCs

62. The use of transport sector value added in exports for all countries is significant, but it is not the largest service sector. While the underlying database used for the analysis has limited differentiation, the majority of transport services provided come from the 'transport nec' sector – which includes land based transport services. These include services from road, rail and auxiliary transport activities.

63. The relative importance of land based transport was similar across high-income and low and middle income countries, accounting for between 9% and 13% of total service value added in agricultural exports for the country groups respectively. Land based transport relies more heavily on internal domestic settings – such as road and rail quality – but also relies on policy settings that provide for competition which, in some cases, may be natural monopoly industries (if network infrastructure and service provision is intertwined) or otherwise constrained by regulatory limitations (for example, truck queueing systems).

Differences in service use across the pathways

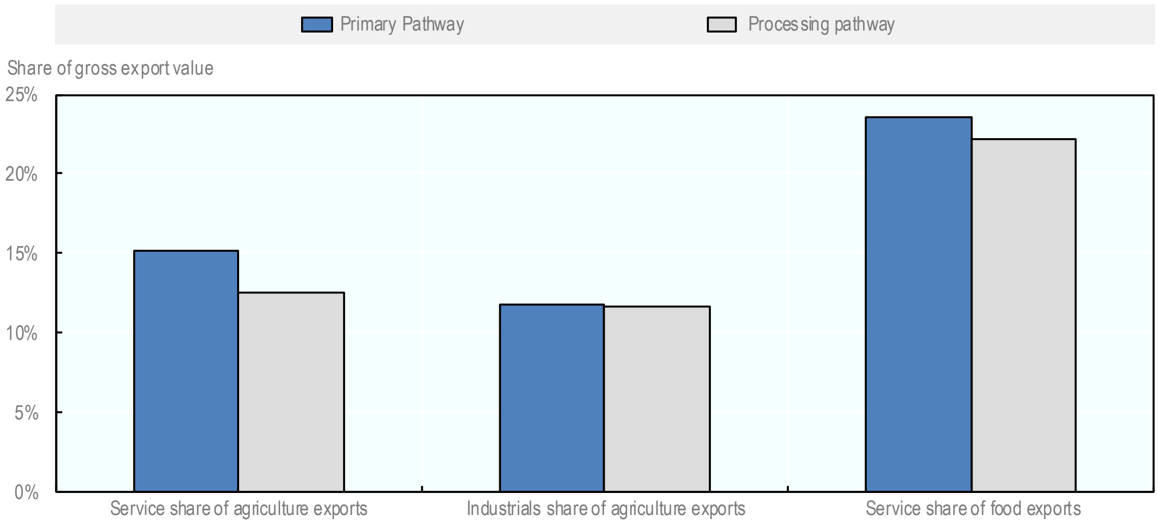
64. Differences in service addition between the pathways can point to the importance of services in influencing the value adding pathway taken (Figure 13). Agricultural sectors in countries which participate in the primary pathway use a higher relative proportion of service value to produce their exports. That is, the services content in exports is higher in countries which export predominately through the processing pathway – 15% of gross exports versus 12%. An while total exports of primary products are higher for countries in the primary pathway, as per the grouping, primary exports from countries in the processing pathway remain significant. Gross agricultural exports from countries in the primary pathway in 2014 were close to USD 406 billion, while those in the processing pathway amounted to USD 118 billion – shares of 77% and 23% respectively.

65. While service use is higher in primary exports, it is worth contrasting service addition to food exports. The food provides a proxy for all processed products, and thereby provides a way to explore differences focussing on the processing pathway (recalling that exports of processed products occur from countries in both pathways). It may be the case that countries in the processing pathway have higher service shares in food exports, potentially suggesting a services link through the food sectors as a driver of increased processing activity. However, service addition to food exports from countries in both pathways is similar, with a slightly higher share for those in the primary export pathway (Figure 13). This results suggests that services provided to downstream sectors may play less of a role in driving growth of agricultural value added through domestic processing sectors.

66. In relation to industrial inputs to agricultural exports, the share of value added in exports from countries in the primary or processed pathways are the same. This is representative of the tighter distribution on industrial inputs across the globe.

Figure 13. Service and industrial shares of export value by value adding pathway, 2014

Weighted average service value added shares of total value added

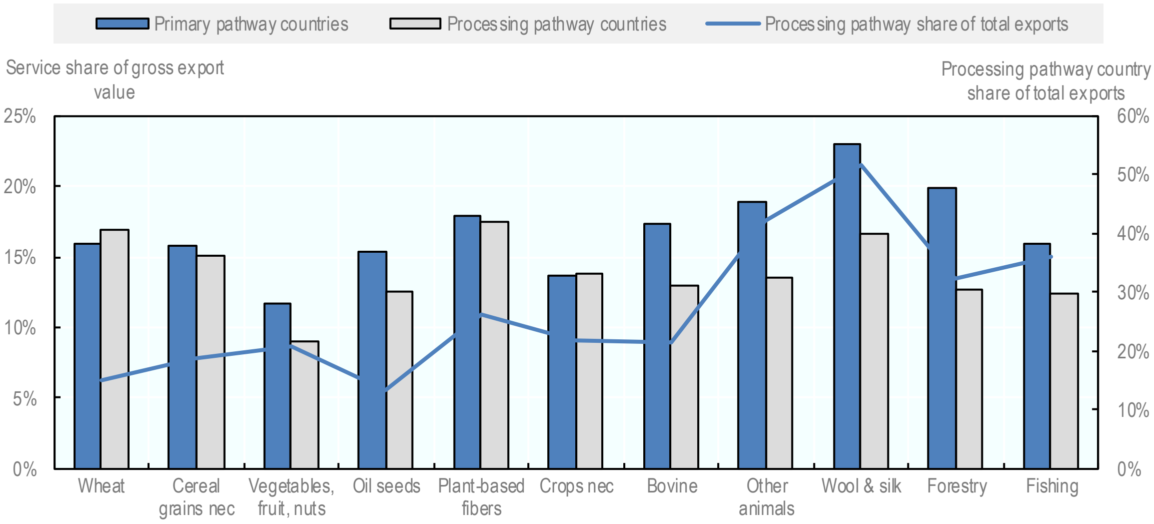


Note: The primary and processing pathways are identified at the country level based on the total amounts of agricultural value added exported directly from agricultural sectors (GTAP sectors 1-14) as primary exports versus the amount of agricultural value added exported indirectly through other domestic sectors (GTAP sectors 15-57). Averages are weighted by total agricultural value added.
Source: Author calculations.

67. Across agricultural sectors, the greater use of services by countries in the primary value adding pathway is apparent for most commodities (Figure 14). In most sectors (paddy rice, raw milk and sugarcane and beet excluded due to the nature of the product), service addition is higher if exported by countries in the primary pathway. This does not occur for all commodities, with wheat, and crops nec being the exceptions. As depicted, the majority of exports of these commodities come from countries in the primary pathway, with countries in the processing pathway accounting for between 13% (oilseeds) and 51% (wool and silk) of primary exports across sectors.

Figure 14. Relative use of services in different agricultural sectors by value adding pathway, 2014

Global weighted averages expressed as a share of gross sector export value



Note: The primary and processing pathways are identified at the country level based on the total amounts of agricultural value added exported directly from agricultural sectors (GTAP sectors 1-14) as primary exports versus the amount of agricultural value added exported indirectly through other domestic sectors (GTAP sectors 15-57). Averages are weighted by total agricultural value added.
Source: Author estimates.

Differences in services inputs in agricultural exports

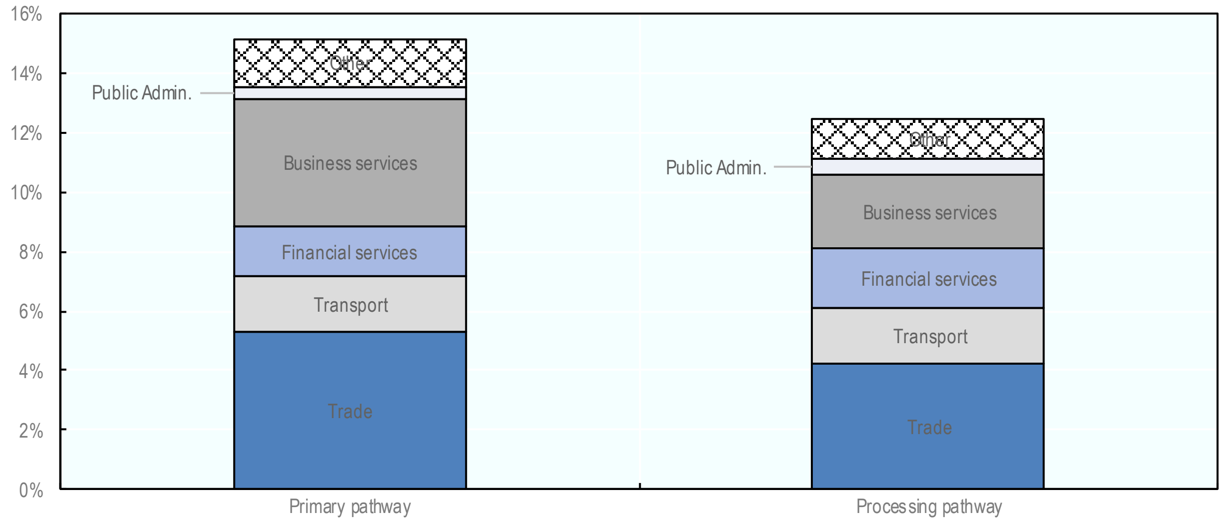
68. Breaking down service use in agricultural exports by service sector across the two pathways indicates that while the relative use of services across service sectors for the two pathways is fairly similar, the aggregate amounts used in each pathway varies– by around 3 percentage points (Figure 15). Across the service sector inputs, the largest difference is observed in business services and trade sector inputs. These account from almost all the differences observed, with the share of transport services the same. Business services is potentially an import sector creating differences in the primary product as it includes a number of on farm services along with research and development.

69. The question that arises is why additional service inputs are being used by countries who export agricultural products more directly – that is in as primary products. Given that countries in the processed pathway still export significant amounts of primary products, it is not a matter of just residual or small supplies of exports that may account for the difference.

70. One possible explanation may be to do with the composition of countries within each pathway. High income countries, that have a more developed service sector, and will thus add more services sector inputs to exports than low and middle income countries. If there are more high income countries in the primary pathway, this would bias the result. However, further splitting countries into levels of development and pathways reveals that while high income countries do apply more services overall, differences still exist in service use across high income countries between the pathways, and similarly so for middle and low income countries – but the gaps have narrowed.

Figure 15. Service addition to agricultural exports by service sector by value adding pathway, 2014

Weighted average service value added shares of gross agricultural exports



Note: The primary and processing pathways are identified at the country level based on the total amounts of agricultural value added exported directly from agricultural sectors (GTAP sectors 1-14) as primary exports versus the amount of agricultural value added exported indirectly through other domestic sectors (GTAP sectors 15-57). Averages are weighted by total agricultural value added.
Source: Author estimates.

71. An alternative explanation is based on the nature of the goods that feed into agro-food GVCs, either as final goods or as intermediate inputs. Accessing foreign consumers or foreign production processes directly often requires products to have additional characteristics. Such characteristics include, for example, quality assurance related aspects like traceability; being of particular size and condition, such as for fruits and vegetables; or production following certified processes (such as for coffee or tea). These in essence can be termed quality attributes – they alter the attributes of the underlying product despite it still being a primary good. Coffee is still coffee, for example, whether it is produced in a certified manner or not. The certified product is essentially one of different quality to the uncertified product. However, quality is not generated by simply applying own sector factors of production better. Instead, it often requires additional inputs, with many of these related to service sectors. For example, these include inputs from R&D activities, from farm consultants and processes for traceability and their certification – all part of business services – and from high quality trade, logistics and transport services.

72. If quality is comprised of, and relies upon provision of, services, then additional service use may drive participation in GVCs through exports of primary products and help grow the value that is generated over time from this pathway. The relationships between service use and the value adding pathways provides some evidence in support of this, but does not correct for other factors. These issues are explored in the following section.

Differences in services inputs in food exports

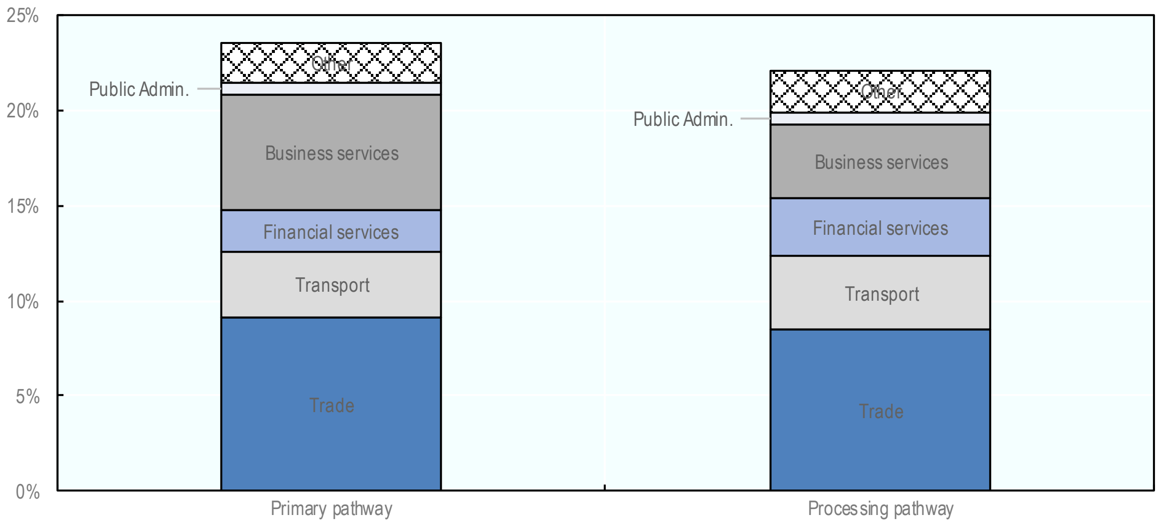
73. While service addition at the primary production level is important, the different pathways may also be dependent on set up of the downstream sectors, and in particular the food sector. Availability of additional services or complex production within domestic

processing may create a 'natural pull' for primary sector production, thus creating more domestic value added from trade and GVCs through exports from downstream sectors, creating the conditions for countries to be in the processing value adding pathway.

74. Looking at service shares of gross food exports (GTAP sectors 19-26) for countries in either pathway, however, does not reveal significant differences. Both the levels and the types of services used in food exports of countries in either value adding pathway are similar (Figure 16). Similarly, virtually no difference in value added shares of gross food exports from industrials sectors exists between the two pathways – industrials represented 12.7% and 13.4% of food export value for countries in the primary and processing pathway respectively. Thus, in producing exports (and serving the domestic market by extension) the food sectors in countries whose agricultural sectors generate larger amounts of domestic value added from direct trade do not appear to be different, at least in terms of production processes, to those which rely on agricultural export value added being generated through food and downstream sector exports.

Figure 16. Service addition to food exports by service sector by value adding pathway, 2014

Weighted average service value added shares of gross food export value



Note: The primary and processing pathways are identified at the country level based on the total amounts of agricultural value added exported directly from agricultural sectors (GTAP sectors 1-14) as primary exports versus the amount of agricultural value added exported indirectly through other domestic sectors (GTAP sectors 15-57). Averages are weighted by total agricultural value added.
Source: Author estimates.

6. How does GVC participation and services impact agriculture value added growth across the value adding pathways

75. As examined above, agricultural value added generated from trade can come from direct exports of primary products or through the embodied value added within processed products. Agricultural producers vary in the mix of the value added created from these two sources, however, the difference does not appear to negatively impact the total domestic returns that can be generated from exports related to agriculture. This suggests that countries do not need to move into downstream activities to increase the total trade-related value from agriculture – exporting more primary products may in fact yield as good or

greater total economic returns. This finding suggests that countries can seek to explore value adding activities in primary exports, and thus countries have two value adding pathways for the agriculture sector.

76. It is useful, therefore, to look at the factors that may influence the growth of agricultural value added in trade in either pathway. One aspect identified is the possible role played by service sector inputs into primary sector exports. Indeed, in a general setting, past OECD work (Greenville, Kawasaki and Jouanjean, 2019a) has shown that an increasing service share of exports contributes to growth in domestic value added. In this section, the role played by GVC participation, service sector inputs and some trade policy measures on the growth of value added directly exported by agricultural sectors (GTAP sectors 1-14) and the agriculture value added that is exported by other sectors (GTAP sectors 15-57) is explored. The influence of these factors on the share of value added exported in either way is also examined to gain an indication as to what factors may influence a country following the primary pathway and what may influence it following the processing pathway. Specifically, the analysis is centred on:

- *Growth in agricultural value added directly exported in primary exports and indirectly exported in processed products*: the role of own sector and food sector GVC participation (backward and forward participation, along with the share of value added in foreign final demand); tariffs; agricultural subsidies; and service share of exports are explored.[15]
- *Changes in the share of agricultural value added directly exported in primary exports and indirectly exported in processed products*: using the factors above, the influence on changes in the shares of value added exported is explored. In doing so, whether these factors have a disproportionate effect on either types of exports can be explored and thus whether these factors help underpin the observed value adding pathway that countries participate in.

77. Detailed results for the regressions are set out in Annex C.

Growth in direct and indirect exports of agricultural value added

78. Analysis of the growth in agricultural value added created through direct exports of primary products and indirect exports of agricultural value added embodied within processed products reveals a mix of influences. Forms of GVCs participation and the use of services are found to be important to varying degrees across countries at differing levels of development. In terms of trade policy specific impacts, however, the analysis sheds little light. Despite this, other studies using differing approaches have explored the role of trade policies on domestic value added growth through exports, showing the negative impact that tariffs and non-tariff barriers have on levels of agricultural domestic value added in exports (Greenville et al., 2018).

79. The key GVC related influences on the creation of value added through primary sector direct or processed sector indirect exports of agricultural value added relate to the share of value added that ends in foreign final demand, GVC participation by the food sector, openness in imported input markets and the use of services in agricultural exports (Table 2). For GVCs links by the food sector, the forward link to foreign markets by the agricultural sector (value added in foreign final demand), and openness in imported input

[15] The role played by services trade restrictions, as measured by the Services Trade Restrictiveness Index, could not be examined due to the short time period for which data are available.

markets for agriculture, were found to support the growth in agricultural value added exported indirectly. All these variables increased growth in exports of indirect value added (with the exception of value added in foreign final demand for low income countries). The result provide some support to the possible transformation potential for the agricultural sector from the use of foreign inputs in the production of exports – in both agriculture and food sectors. For middle income countries, access to foreign intermediate inputs for the food sector was important for growth of indirectly exported value added, suggesting that restrictions on imports of agricultural inputs (the largest supplying sector to the food industry), and other attempts by policy makers to increase local content, may be counterproductive.

Table 2. Influences on indirect exports of agricultural value added

Direction of effect from estimated coefficients

	All	Low income countries	Middle income countries	High income countries
Value added in foreign final demand	Positive	Negative	Positive	Positive
Backward food	n.s.	n.s.	Positive	n.s.
Forward food	n.s.	Positive	Positive	n.s.
Openness in imported inputs	Positive	n.s.	n.s.	n.s.

Note: See Annex C for full details. n.s. is not significant at least at a 10% level of significance.
Source: Author estimates.

80. For direct exports of agricultural value added, the impact of the share of value added in foreign final demand was the opposite to that seen for indirect exports – suggesting it creates a bias towards the processing pathway (discussed more below). Similarly, food sector forward engagement for high income countries reduced growth in primary exports. Despite these effects, for middle income countries, those with higher service sector shares of export value saw greater growth in primary exports – providing some evidence of the service sector underpinnings of growth of primary exports and participation in the primary value adding pathway.

81. In terms of policy impacts, increases in agricultural subsidies were found to have a negative impact on the growth of value added indirectly exported, and no impact on direct exports of primary sector value added. In other words, it suggests that subsidies decrease the competitiveness of the agriculture sector as a value added supplier for downstream sectors, reducing the potential for growth in exports of transformed agricultural goods.

Influences on the share of agricultural value added directly and indirectly exported

82. To gain more insight into the effects of GVC participation and services on which value adding pathway countries may take, the share of agricultural value added directly and indirectly exported was explored. This analysis confirmed the results seen above for the share of value added in foreign final demand: countries with a higher share grew indirect exports of agricultural value added faster and thus increased the share of total exports of value as indirect (Table 3). Increasing exports in this way would shift countries into the processing pathway, suggesting GVC participation is a driver of transformation in the use of agricultural value added. Similarly, the other measures of GVC participation by

downstream sectors (food) and openness in input markets for agriculture also generally promoted growth towards the processing pathway.

Table 3. Influences on shares of value added indirectly exported

Direction of effect from estimated coefficient

	All	Low income countries	Middle income countries	High income countries
Value added in foreign final demand	Positive	Positive	Positive	Positive
Backward food	n.s.	Negative	n.s.	n.s.
Forward food	Positive	n.s.	Positive	Positive
Openness in imported inputs	Positive	n.s.	n.s.	Positive
Services share of exports	n.s.	Negative	Negative	n.s.
Forward agriculture	Negative	Negative	n.s.	n.s.
Agricultural subsidies	n.s.	Negative	Negative	n.s.

Note: See Annex C for full details. n.s. is not significant at least at a 10% level of significance. Low income country: average (2004-14) GDP per capita is < USD 5 000. Middle income country: average (2004-14) GDP per capita is [USD 5 000 – USD 20 000]. High income country: average (2004-14) GDP per capita is > USD 20 000.
Source: Author estimates.

83. On the other hand, GVC participation by agricultural sectors – particularly forward participation – and service sector inputs into agricultural exports promoted growth in the share of direct primary exports. This suggests that services are playing a role in supporting countries participation in the primary value adding pathway.

84. In terms of policy impacts, a negative relationship was seen for distorting agricultural subsidies.[16] The use of subsidies reduced the share of agricultural value added indirectly exported, and combined with results above, suggest these measures will not grow value adding opportunities in the sector and can limit the possible growth in downstream sectors. In other words, agricultural subsidies are likely to negatively impact the ability for countries to move into the processing value adding pathway.

7. Conclusions and policy implications

85. Across agricultural exporters worldwide, differences in the specialisation between agricultural value added exported as direct primary exports and that which is embodied in transformed products is evident. In line with increasing trade in GVCs and potentially greater possibilities for direct agricultural sector participation, for a number of countries the main driver of export related value added has been through direct exports of primary products from the agricultural sector itself. Out of all agricultural value added exporters, directly exported agricultural value added growth grew faster between 2004 and 2014 than that seen for indirectly exported value added. This growth was seen for a number of major agricultural traders and for developed and developing countries alike – a total of 86 of 141 countries and regions had stronger growth in direct domestic value added exports.

86. With differing forms of trade and engagement in GVCs, and the potential growth opportunities that exist with direct exports of primary products, this paper has sought to

[16] Includes subsidies provided to producers and not those provided to the sector as a whole as part of government provision of services or as public goods.

explore whether total returns to the economy from agriculture are different if trade and GVC engagement occurs directly through primary products or indirectly through processed products. Evidence of the total returns from exports – total domestic value added related to the export of agricultural value added – suggests that countries can gain just as much when exporting value added directly compared to that which is generated when exports occur indirectly through domestic processing sectors. That is, countries that specialise towards primary exports of agricultural products do just as well as countries that export their agricultural products primarily through processed products. In this paper, these two specialisations have been termed value adding pathways – one a primary product pathway, the other a processing pathway.

87. The existence of similar total economic returns from exporting for countries in either of the two pathways suggests that a relevant alternative value adding pathway – beyond moving into downstream processing – exists. For policy makers, it suggests that developing downstream sectors is not a necessary pre-condition to grow exports of agricultural value added and increase the total economic return from agricultural exporting activities. Instead, helping sectors, agriculture and food alike, to better take advantage of their competitive edge will yield greater returns. This may be through allowing greater imports of foreign agricultural value added, or through enhancing exports of primary unprocessed agricultural products.

88. But the question remains as to what allows countries to better take advantage of their competitive edge, and in particular, what may allow countries to exploit the returns on offer from exports of primary agriculture? Contrasting agricultural exports across the two pathways reveals that the service sector share of export value is a key factor that differentiates the pathways. And while the relative use of services from different service sectors is fairly similar, the aggregate shares used in agricultural exports across the two pathways vary – by close to 2.7 percentage points. This difference is significant – with higher service shares in exports helping grow agricultural exports for middle income countries between 2004 and 2014.

89. The majority of this difference is due to differences in the use of business services – a grouping of services that includes digital services, agri-business and on farm services, along with research and development. These services are enabling agricultural sectors to access foreign supply chains and thus consumers, and although often viewed as additional costs to access markets, are actually value adding activities akin to what a food or downstream processing sector delivers.

90. For the processing pathway, GVC engagement by both the agriculture sector and the food sector is an important factor underpinning its growth and may also create transformation opportunities. Greater GVC engagement along with greater openness to imported inputs is linked to both growth in agricultural value added indirectly exported as part of processed products, and creates a shift in the share of total agricultural value exported in this fashion. In other words, it helps create a push towards the processing pathway. Openness includes backward participation by food sectors and thus being open to import agricultural sector products. As part of this, distorting agricultural subsidies were found to have a harmful effect on growth of agricultural value added indirectly exported. Such policies reduce agricultural sector competitiveness and can thus harm downstream sectors over time. They also do not boost primary sector exports of value added.

91. The findings on the value adding pathways have implications for policy makers:

- The results provide evidence to support the notion that total economic gains from agricultural-related exports (as measured by domestic value added) to an economy may be equivalent between moving into downstream processing sectors or specialising in participation through primary commodities. Thus in thinking of policies for agricultural sector development, or leveraging the most from agricultural production, moving into downstream processing is not the only or best option for a number of countries.
- Moving into downstream processing sectors needs to be based around comparative advantages. Policy moves to direct agricultural production into domestic processing activities may reduce growth for the sector and limit the overall economy wide contribution to the economy from agricultural production.
- Services sector input into agricultural exports help differentiate the pathways and are driving aspect of growing agricultural value added in the primary export pathway for middle income countries. Thus, for the agricultural sector to gain the most from this pathway access to competitive service inputs are critical. In other words, the enabling environment to support agricultural production is likely to be a key determinant of the economy wide gains from agricultural production.

92. The findings also suggest scope for further work to untangle some more of the driving factors behind value added growth in either pathway. Both pathways are underpinned by domestic sectors and domestic value chains – either as downstream buyers of agricultural value added or as suppliers of inputs into agricultural production. The nature of these linkages through the domestic downstream and upstream support sectors warrants further investigation – including the role played by domestic policy settings and investments in connectivity infrastructure and agricultural research and development. Such analysis can thus better define policy recommendations that can allow countries to maximise the returns from trade and GVC participation, regardless of the pathway taken. Further work could also be done to breakdown the service sectors into less aggregate sectors, in particular the sectors related to transport, communications and business services, to explore the role played by these sectors and the impacts of regulatory aspects related to them. Similarly, the influence of standards – private and public – on value creation and pathway participation could be explored.

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Annex A. GTAP sector list

Table A A.1. GTAP sector list

Number	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	Veg & Fruit: vegetables, fruit vegetables, fruit and nuts, potatoes, cassava, truffles
5	osd	Oil Seeds: oil seeds and oleaginous fruit; soy beans, copra
6	c_b	Cane & Beet: sugar cane and sugar beet
7	pfb	Plant 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	Cattle: 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, whether or not refined or coloured
11	rmk	Raw milk
12	wol	Wool: 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	Cattle 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: 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; degras and other residues resulting from the treatment of fatty substances or animal or vegetable waxes.
22	mil	Milk: dairy products
23	pcr	Processed Rice: rice, semi- or wholly milled
24	sgr	Sugar
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, food products n.e.c.

26	b_t	Beverages and Tobacco products
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: 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 (see next)
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 defence; 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)

Annex B. GTAP region list

Table A B.1. GTAP regions

No.	Region	No.	Region	No.	Region
1	Australia	48	Rest of Central America	95	Armenia
2	New Zealand	49	Dominican Republic	96	Azerbaijan
3	Rest of Oceania	50	Jamaica	97	Georgia
4	China	51	Puerto Rico	98	Bahrain
5	Hong Kong	52	Trinidad and Tobago	99	Iran Islamic Republic of
6	Japan	53	Caribbean	100	Israel
7	Korea Republic of	54	Austria	101	Jordan
8	Mongolia	55	Belgium	102	Kuwait
9	Taiwan	56	Cyprus[1,2]	103	Oman
10	Rest of East Asia	57	Czech Republic	104	Qatar
11	Brunei Darussalam	58	Denmark	105	Saudi Arabia
12	Cambodia	59	Estonia	106	Turkey
13	Indonesia	60	Finland	107	United Arab Emirates
14	Lao PDR	61	France	108	Rest of Western Asia
15	Malaysia	62	Germany	109	Egypt
16	Philippines	63	Greece	110	Morocco
17	Singapore	64	Hungary	111	Tunisia
18	Thailand	65	Ireland	112	Rest of North Africa
19	Viet Nam	66	Italy	113	Benin
20	Rest of Southeast Asia	67	Latvia	114	Burkina Faso
21	Bangladesh	68	Lithuania	115	Cameroon
22	India	69	Luxembourg	116	Cote d'Ivoire
23	Nepal	70	Malta	117	Ghana
24	Pakistan	71	Netherlands	118	Guinea
25	Sri Lanka	72	Poland	119	Nigeria
26	Rest of South Asia	73	Portugal	120	Senegal
27	Canada	74	Slovakia	121	Togo
28	United States of America	75	Slovenia	122	Rest of Western Africa
29	Mexico	76	Spain	123	Central Africa
30	Rest of North America	77	Sweden	124	South Central Africa
31	Argentina	78	United Kingdom	125	Ethiopia
32	Bolivia	79	Switzerland	126	Kenya
33	Brazil	80	Norway	127	Madagascar
34	Chile	81	Rest of EFTA	128	Malawi
35	Colombia	82	Albania	129	Mauritius
36	Ecuador	83	Bulgaria	130	Mozambique
37	Paraguay	84	Belarus	131	Rwanda
38	Peru	85	Croatia	132	Tanzania United Republic of
39	Uruguay	86	Romania	133	Uganda
40	Venezuela	87	Russian Federation	134	Zambia
41	Rest of South America	88	Ukraine	135	Zimbabwe
42	Costa Rica	89	Rest of Eastern Europe	136	Rest of Eastern Africa

43	Guatemala	90	Rest of Europe	137	Botswana
44	Honduras	91	Kazakhstan	138	Namibia
45	Nicaragua	92	Kyrgyzstan	139	South Africa
46	Panama	93	Tajikistan	140	Rest of South African Customs Union
47	El Salvador	94	Rest of Former Soviet Union	141	Rest of the World

Notes: 1. Note by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue." 2. Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Annex C. Detailed results

93. The regression analysis used in this study is based on the estimation of the following equation:

$$\Delta y_{cst} = \boldsymbol{\alpha}\mathbf{X}_{cs,t-1} + \boldsymbol{\beta}\Delta\mathbf{Z}_{cst} + \theta_{cs} + \eta_{ct} + u_{cst} \quad \text{(A1)}$$

where the indices c, s, and t represent country, sector, and year and α and β are parameters to be estimated. The symbol Δ denotes the difference (per year) from the previous period (for example, $\Delta y_{cst} \equiv y_{cst} - y_{cs,t-1}$). **X** and **Z** are vectors of regressors. Some regressors (**X**) are measured as initial value at period *t*-1 to avoid endogeneity concern caused by reverse causality, while others (**Z**) are measured as difference when reverse causality is less likely to be the case. The model includes two fixed effects: θ controls for country-sector specific unobservable factors (e.g. product characteristics) and η for country-year specific unobservables (e.g. weather, macroeconomic shocks, and food prices).

94. Parameters are estimated by the fixed effect estimator using panel dataset for 2004, 2007, 2011, and 2014. The dataset covers 14 agricultural sectors (GTAP sectors 1 through 14) and 8 processing sectors (GTAP sectors 19 through 26) for 141 countries and regions. To avoid unrealistic changes in dependent variables, observations with small value added exported (less than USD 10 million) are dropped from the regressions.

95. The following tables show summary statistics (measured as level, not in differences) and full regression results. If dependent variable is transformed in logarithm, the difference from the previous period approximates growth rate.

Table A C.1. Summary statistics

Variable name	Mean	Std. Dev.	Min	Max	Description
Dependent variables					
Directly export agricultural value added (level and share)	0.595	0.291	0.007	1.000	The level (log difference) and share of agricultural value added exported directly
Indirectly export agricultural value added (level and share)	0.405	0.291	0.000	0.993	The level (log difference) and share of agricultural value added exported indirectly
Regressors					
Backward	0.177	0.114	0.005	0.675	Backward indicator
Forward	0.517	1.384	0.021	25.896	Forward indicator
Tariffs faced	6.151	14.530	0.000	250.0	Average tariff faced (weighted by export value. %)
SPS faced	2.429	9.633	0.000	128.0	# of SPS faced
TBT faced	1.036	6.087	0.000	92.0	# of TBT faced
Tariffs charged	5.816	12.021	0.000	111.9	Average tariff charged (weighted by import value. %)
SPS charged	2.330	14.369	0.000	225.0	# of SPS charged
TBT charged	0.643	7.263	0.000	184.0	# of TBT charged
DVA in foreign demand	0.392	0.259	0.001	0.986	This represents the destination of the value added generated in the sector - that is the domestic or foreign markets. It shows the share which is ultimately consumed by foreign consumers.
Service share	0.111	0.068	0.003	0.349	This represents the source of value added in the output of the sector that ultimately originated from service sectors (GTAP sectors 51-57)
Imported inputs concentration	0.015	0.013	0.003	0.161	Herfindahl index, measured as the sum of squared share of imported value added used for the output (calculated at source country * source sector level), where a higher value indicates higher concentration.
Subsidy	0.083	0.246	0.000	5.080	Subsidy received (for output, input, and production factors) divided by gross output value.
Backward of food sectors	0.242	0.107	0.051	0.631	Backward indicator of food sectors (weighted by agricultural sector's value-added used by each food sector)
Forward of food sectors	0.100	0.357	0.003	7.320	Forward indicator of food sectors (weighted by agricultural sector's value-added used by each food sector)

Table A C.2. Detailed results for level of agriculture value added exported equation

	Direct channel (log. difference)				Indirect channel (log. difference)			
	All	Low income	Middle income	High income	All	Low income	Middle income	High income
Backward	0.564	14.000	-0.585	-1.370	0.394	1.240	-0.164	0.354
	[0.64]	[1.66]	[-0.87]	[-0.88]	[1.12]	[1.34]	[-0.38]	[0.35]
Forward	0.008	0.020	0.037	0.024	-0.006	0.000	-0.045	-0.042
	[0.51]	[1.45]	[0.32]	[0.56]	[-1.59]	[-0.05]	[-1.45]	[-1.51]
Tariffs faced	-0.00021	-0.00058	-0.00111	0.00203	-0.00007	0.00010	0.00054	-0.00071
	[-0.37]	[-0.70]	[-0.95]	[1.33]	[-0.25]	[0.30]	[0.52]	[-0.65]
SPS faced	0.00289	0.00971	-0.00639	0.00045	0.00091	-0.00033	-0.00127	0.00336
	[0.89]	[1.08]	[-1.46]	[0.10]	[0.45]	[-0.17]	[-0.63]	[0.75]
TBT faced	0.00332	-0.07742	0.00109	0.00312	0.00087	-0.00177	-0.00029	0.00075
	[2.29]**	[-1.33]	[0.33]	[2.02]**	[1.10]	[-0.25]	[-0.13]	[0.63]
DVA in foreign demand	-1.040	-1.690	-1.060	-1.070	0.659	-0.388	0.546	0.919
	[-5.94]***	[-2.23]**	[-3.59]***	[-4.68]***	[6.46]***	[-1.78]*	[4.65]***	[5.52]***
Backward of food sectors	-0.022	3.550	1.380	-1.960	0.997	-1.080	2.010	-0.393
	[-0.02]	[1.31]	[1.51]	[-0.86]	[1.42]	[-1.66]	[2.47]**	[-0.21]
Forward of food sectors	-1.190	0.357	-0.981	-1.700	0.264	1.160	2.070	-0.016
	[-1.53]	[0.14]	[-0.68]	[-2.05]**	[0.83]	[2.27]**	[1.84]*	[-0.05]
Service share	-0.152	6.120	6.520	-0.640	-1.990	-2.800	1.880	-2.510
	[-0.07]	[0.21]	[1.86]*	[-0.26]	[-0.79]	[-0.62]	[0.67]	[-0.90]
Subsidy per output	-0.0008	0.0474	-0.0011	-0.0037	-0.0056	-0.0212	-0.0183	-0.0012
(log. difference)	[-0.17]	[0.46]	[-0.11]	[-0.78]	[-1.21]	[-1.35]	[-2.32]**	[-0.25]
Imported inputs concentration	2.210	11.000	-1.250	6.400	-0.802	0.118	-1.670	-7.890
(difference)	[2.09]**	[1.39]	[-0.59]	[1.16]	[-2.71]***	[0.07]	[-1.19]	[-1.60]
Tariffs charged	-0.00102	-0.00303	-0.00074	-0.00001	-0.00013	-0.00046	0.00060	-0.00027
(difference)	[-1.06]	[-1.10]	[-0.92]	[-0.00]	[-0.30]	[-0.77]	[1.07]	[-0.18]
SPS charged	0.00084	-0.00127	-0.00070	0.00093	0.00001	-0.00078	0.00008	0.00000
(difference)	[1.08]	[-0.81]	[-0.48]	[0.99]	[0.03]	[-1.32]	[0.09]	[-0.01]
TBT charged	-0.00028	0.00209	-0.00526	-0.00122	0.00025	0.00109	-0.00113	0.00066
(difference)	[-0.16]	[0.50]	[-1.13]	[-0.76]	[0.61]	[1.62]	[-1.11]	[0.89]
Observations	1148	207	361	527	1148	207	361	527
R-squared	0.443	0.484	0.526	0.502	0.464	0.775	0.621	0.381

Note: The sample covers all agricultural sectors (sectors 1-14 of GTAP classification). All specifications include country-sector level fixed effects, country-year level fixed effects, and constant term. No weight is used..

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Table A C.3. Detailed results for level of agriculture value added exported equation

	Direct channel (share. difference)				Indirect channel (share. difference)			
	All	Low income	Middle income	High income	All	Low income	Middle income	High income
Backward	-0.013	0.802	-0.130	-0.183	0.013	-0.802	0.130	0.183
	[-0.11]	[1.18]	[-0.88]	[-0.77]	[0.11]	[-1.18]	[0.88]	[0.77]
Forward	0.002	0.003	0.009	0.012	-0.002	-0.003	-0.009	-0.012
	[1.72]*	[2.03]**	[0.36]	[1.27]	[-1.72]*	[-2.03]**	[-0.36]	[-1.27]
Tariffs faced	-0.00003	-0.00015	-0.00023	0.00033	0.00003	0.00015	0.00023	-0.00033
	[-0.28]	[-1.30]	[-0.81]	[0.81]	[0.28]	[1.30]	[0.81]	[-0.81]
SPS faced	0.00007	-0.00003	-0.00063	0.00003	- 0.00007	0.00003	0.00063	-0.00003
	[0.15]	[-0.04]	[-1.18]	[0.03]	[-0.15]	[0.04]	[1.18]	[-0.03]
TBT faced	0.00022	-0.01035	0.00031	0.00015	- 0.00022	0.01035	-0.00031	-0.00015
	[0.74]	[-2.70]***	[0.41]	[0.44]	[-0.74]	[2.70]***	[-0.41]	[-0.44]
DVA in foreign demand	-0.246	-0.150	-0.247	-0.260	0.246	0.150	0.247	0.260
	[-7.70]***	[-1.67]*	[-4.08]***	[-6.73]***	[7.70]***	[1.67]*	[4.08]***	[6.73]***
Backward of food sectors	-0.024	0.584	0.143	-0.043	0.024	-0.584	-0.143	0.043
	[-0.15]	[1.92]*	[0.56]	[-0.13]	[0.15]	[-1.92]*	[-0.56]	[0.13]
Forward of food sectors	-0.238	-0.023	-0.456	-0.237	0.238	0.023	0.456	0.237
	[-3.30]***	[-0.09]	[-1.28]	[-2.48]**	[3.30]***	[0.09]	[1.28]	[2.48]**
Service share	0.352	5.510	1.370	0.187	-0.352	-5.510	-1.370	-0.187
	[1.42]	[1.93]*	[1.82]*	[0.57]	[-1.42]	[-1.93]*	[-1.82]*	[-0.57]
Subsidy per output	0.0008	0.0196	0.0037	-0.0008	-0.0008	-0.0196	-0.0037	0.0008
(log. difference)	[0.93]	[1.83]*	[2.15]**	[-0.94]	[-0.93]	[-1.83]*	[-2.15]**	[0.94]
Imported inputs concentration	0.421	0.719	0.040	1.820	-0.421	-0.719	-0.040	-1.820
(difference)	[5.14]***	[0.92]	[0.11]	[1.84]*	[- 5.14]***	[-0.92]	[-0.11]	[-1.84]*
Tariffs charged	-0.00027	-0.00029	-0.00023	-0.00054	0.00027	0.00029	0.00023	0.00054
(difference)	[-1.71]*	[-1.14]	[-1.70]*	[-1.03]	[1.71]*	[1.14]	[1.70]*	[1.03]
SPS charged	0.00012	-0.00021	-0.00026	0.00016	- 0.00012	0.00021	0.00026	-0.00016
(difference)	[0.76]	[-1.31]	[-0.75]	[0.87]	[-0.76]	[1.31]	[0.75]	[-0.87]
TBT charged	-0.00025	0.00007	-0.00098	-0.00006	0.00025	-0.00007	0.00098	0.00006
(difference)	[-0.85]	[0.19]	[-1.07]	[-0.20]	[0.85]	[-0.19]	[1.07]	[0.20]
Observations	1148	207	361	527	1148	207	361	527
R-squared	0.471	0.593	0.489	0.504	0.471	0.593	0.489	0.504

Note: The sample covers all agricultural sectors (sectors 1-14 of GTAP classification). All specifications include country-sector level fixed effects, country-year level fixed effects, and constant term. No weight is used. Share is relative to total value added exports (value-added exported directly and indirectly). Low income country: average (2004-14) GDP per capita is < USD 5 000. Middle income country: average (2004-14) GDP per capita is [USD 5 000 – 20 000]. High income country: average (2004-14) GDP per capita is > USD 20 000. Observation where agricultural value exports < 10 million excluded. * 10%, ** 5% and *** 1% level of significance.