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Employment in Agriculture and Food Trade

ASSESSING THE ROLE OF GVCS

Jared Greenville,

Kentaro Kawasaki,

Marie-Agnes Jouanjean



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EMPLOYMENT IN AGRICULTURE AND FOOD TRADE: ASSESSING THE ROLE OF GVCS

Jared Greenville, Kentaro Kawasaki,
and Marie-Agnès Jouanjean (OECD)

Agricultural sectors are increasingly integrated into international markets as global value chains (GVCs) expand. This integration is helping to drive value added growth in the sector, including the returns that flow to labour. This report explores the impact that trade and agro-food GVC participation has on labour returns and thereby employment not only within the agricultural sectors, but across other sectors of the economy. At the global level, trade and agro-food GVCs generated an average of between 20-26% of total agricultural workforce returns between 2004 and 2014, and labour returns were generated from both direct participation in trade and from indirect participation through other downstream sectors. This report finds that the impact on economy-wide labour returns is on average greater for countries specialising in direct exports of primary products as compared to those specialising in indirect agricultural exports. Evidence also shows that agricultural subsidies have a negative impact both on labour returns from primary sector exports and the returns generated indirectly from processing-sector exports.

Key words: Global value chains, multi-regional output, Agriculture, agricultural trade, GTAP

JEL codes: Q17, F60, F14

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Executive summary

There is increasing integration of the agricultural sector into international markets as trade continues to grow within global value chains (GVCs). This in turn is helping drive value added growth in the agricultural sector.

Value added creation impacts labour and employment. The domestic value added from the agricultural industry represents its returns to land, labour and capital. The return to labour represents the employment impact, and the transformation of agricultural products into food and in the use of inputs to produce agricultural exports suggest that the employment effects for the entire economy from agro-food GVC participation may be larger than initially expected.

At the global level, trade and GVC participation is a significant driver of labour returns to the agriculture sector. Trade and agro-food GVCs generated an average of between 20-26% of total agricultural workforce returns. Across countries, national agricultural workforces are variably reliant on GVC participation. At one extreme, New Zealand has close to 73% of its agricultural workforce value generated by trade in GVCs, compared with Japan at the other extreme with around 3%.

Similarly, employment reliance on trade and GVCs varies across different agricultural sectors. Trade and GVC reliance is greatest in the sectors of wool, oilseeds and plant-based fibres, which have 48%, 39% and 38% of sector employment respectively reliant on agro-food GVCs (global averages). These sectors are those which feed most into other production activities, both food, in the case of oilseeds, and manufacturing.

For major agricultural trading countries, both employment reliance and how labour returns are generated from trade and GVC participation varies considerably. Some countries are reliant on direct exports from their agricultural sectors – e.g. Chile – while in others, employment is generated through indirect channels where agricultural products are used in the production of processed products that get exported – e.g. Malaysia. Such differences in the way labour returns are generated are observed across all countries. The differences relate to both the nature of the products produced and the broader differences in value adding pathways adopted by different countries in taking advantage of agro-food GVCs.

Beyond the agriculture sector itself, trade and GVC participation creates employment in other sectors. In terms of exports, the employment spillovers appear to be greatest for sectors providing supporting services. Of the total returns to labour generated by agro-food exports, an average of 21% flows to the service sectors that support the production of primary and processed products. For food exports, this share is on average 26%, compared to 19% for agriculture. The share of the industrial sector is relatively small in both agriculture and food exports, on average around 6% (approximately equal for agriculture and food exports).

At the sector level, differences in channels of employment value creation from GVCs are apparent. These channels take the form of direct exports to GVCs to indirect links through other domestic industries. For the agriculture sector globally, the most important linkage to agro-food GVCs is the direct linkage, which represents over 9% of the total agricultural workforce value globally. The food sector is the second most important link to agro-food GVCs, generating 5% of total agricultural labour returns. In other words, around 5% of agricultural sector employment (in value terms) is created by links between agriculture and the domestic food processing sector, which then links to agro-food GVCs. Following food

sector linkages, 3% of agricultural employment on average (value terms) is generated by domestic linkages to exports by industrials sectors that are significant users of agricultural products – textiles, wood, leather and chemicals, rubber, and plastics. In total, 10% of the GVC-related agriculture jobs are reliant on domestic linkages (compared to total trade-related jobs at 19.1% of the agricultural workforce value).

The greater share of employment through indirect linkages, however, does not mean domestic processing is required to gain the most overall in terms of employment value creation. Contrasting countries based on their identified value adding pathway – those with greater overall agricultural domestic value added exported from agriculture directly versus those with a greater amount exported indirectly through other domestic processing sectors – reveals different results. In terms of total workforce effects for all sectors, the employment effect generated by participation in the primary pathway is higher or the same as the processing pathway depending on the metric used.

The results of this analysis have implications for overall employment or labour value creation from GVC participation. For countries where the agricultural sectors participate predominately in GVCs through exports of primary agricultural value added (participation in the "primary value adding pathway") total labour returns are greater – or at least equivalent –compared to those where agricultural value added is exported through downstream processing sectors (participation in the "processing value adding pathway"). In this way, countries are seen to add value to primary production within a GVC context and generate similar returns to labour to the overall economy (within and outside agriculture) to those created by moving down the value chain and exporting predominately processed agricultural products (as is seen for total domestic value added more broadly). However, as the sectoral composition of labour returns is different between the pathways, there could be differences in where jobs are created (or maintained). In the primary pathway, a much greater share of the total labour returns accrues to agriculture – as opposed to food. Furthermore, while the service sector labour returns are similar, as services are provided at different stages of production – primary *versus* processed – the location of these jobs may vary in accordance with the location of the food sector *versus* the agricultural sector activity.

On GVC engagement specifically, greater participation and market openness were found to promote labour returns for both skilled and unskilled workers. GVC engagement has positive impacts on labour returns from both direct exports from agriculture and those that occur indirectly through other sectors. The impact on the mix of directly driven labour returns from primary sector exports, and those from indirectly driven processing sector inputs is suggestive of a transformation impact from GVC participation. GVC participation appears to provide greater growth in indirectly driven labour returns through promoting processing sector exports. As part of this is the need for the processing food sector to be open to foreign inputs, barriers to agricultural trade may negate this positive transformation effect.

While this study found limited evidence on policy impacts, distorting agricultural subsidies – output and input related – were found to have a negative impact on labour returns from primary sector exports and those generated indirectly from processing sector exports. This suggests that subsidies have a longer run negative impact on the growth opportunities from trade by decreasing the competitiveness of the agriculture and food sectors.

1. Introduction

The agriculture and food sectors are becoming increasingly integrated into international markets (Greenville, Kawasaki and Jouanjean, 2019). This integration is occurring against a backdrop of changes in the way that agro-food trade is organised; namely, the development of agro-food global value chains (GVCs). Integration in GVCs is occurring on several fronts. For agriculture, there is an increase in the use of imported inputs in domestic production (termed backward linkages), along with a rising share of exported value added being used in value chains where the buying partner uses this as a base for their own exports or to serve their own final demand (forward linkages). Integration of other sectors, particularly the food sector, into GVCs is also increasing the demand for agricultural products. These factors are driving value added growth in the sector.

Value added growth (or creation more generally) has impacts on labour and employment. The domestic value added from an agricultural industry represents its returns to land, labour, and capital. The return to labour represents the employment impact. Trade and GVC participation through any of these channels can be responsible for value added creation and can thereby increase the return accruing to labour, either through creating more demand or through the effects over time of GVC participation on value added growth and its distribution across value added factors (as explored in Greenville, Kawasaki and Jouanjean, 2019).

Value adding in agriculture across countries has been found to take either a primary value adding pathway or a processing value adding pathway (Greenville, Jouanjean and Kawasaki, 2019), and thus the source of trade and GVC-related demand for agricultural products will also differ. For some countries, value added is primarily generated through direct exports of primary products (primary value adding pathway); for others, it occurs through indirect channels that flow through other domestic industries (primary value adding pathway). As such, the ways in which trade and GVCs will influence the returns to labour in an aggregate sense (along with possible future opportunities for growth) will differ. Furthermore, the transformation of agricultural products into food and the use of inputs to produce agricultural exports suggest that the employment effects for the entire economy from trade in agricultural products may be larger than initially expected.

This report explores the impact that agro-food GVC participation has on labour returns and employment within the agriculture and food sectors and across other sectors of the economy. Specifically, it explores the role that trade and GVC participation and domestic and trade policies have on labour creation over time. The impacts are explored through the returns to labour, measured as the total value of labour used in exports and production. The advantage of looking at labour returns is that it combines the effects of changes in employment numbers and changes in wages. Trade and GVC participation may enhance productivity in the sector, increasing the structural adjustment that is occurring. This will mean less but higher paid jobs – a net benefit – which would be represented by higher labour returns. In this way, higher returns to labour in the sector over time are likely to be representative of higher wages for a smaller number of workers – a closing of the gap between agricultural and non-agricultural workforce outcomes. Alternatively, the increased demand can lead to increased output and thus may increase employment numbers. Again, this will increase labour returns as employment numbers will have risen. Both these outcomes are beneficial for the agricultural sector, but may have differing impacts on rural communities. However, while a strength in focusing on benefits, it is also a constraint in that it does not allow the two aspects to be separately examined. That said, with a longer term trend of structural adjustment underway, reductions in employment numbers are likely

to be a beneficial outcome over time. In this way, focusing on employment numbers has serious policy shortcomings and in some ways, measuring employment returns, as done in this report, is a more policy relevant measure for agriculture.

This report explores the importance of GVCs, and trade more generally, to sector employment, and in particular to the employment effects for agriculture from participation in agro-food GVCs through the two pathways described above (see Greenville, Jouanjean and Kawasaki, 2019). Further, it seeks to set out differences in the total economy-wide labour returns (hereafter employment) generated by agricultural sector exports across countries participating through these pathways. In this way, the allied and downstream employment effects are explored.

Specifically, this report explores:

- The different channels of agricultural employment derived from agro-food GVCs across countries, along with those derived from servicing domestic final demand.
- Differences in agricultural sector linkages and employment from agro-food GVCs between countries specialised in different value adding pathways.
- The influence of policy and GVC participation on employment growth (labour returns) in the agriculture sector focusing on GVC participation metrics, trade policies, and domestic agricultural support policies.

To explore the employment effects, this report 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 ten-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 (2018). As for the other studies making use of the GTAP database as the source data, the caveats associated with the data used in the analysis need to be noted for this study. 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, Philippines, Costa Rica, Tunisia, New Zealand, the People's Republic of China (hereafter "China"), India, and the Ukraine (compared with version 9).

The advantage of using the GTAP database is that it reconciles data from different sources into a single consistent database. The disadvantage is that for several countries the underlying input-output tables are dated and there have been limited updates (Box 1). This means that 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. 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. These shortcomings cannot be overcome and adjustments cannot be made to the data. Given this, these caveats should be borne in mind when viewing the results.

The other limitation relates to the definition of production within the database. Each sector is assumed to produce one good and, as such, there is no way to differentiate the returns to labour associated with GVCs compared with production that goes to the domestic market

for final consumption; the goods produced and inputs used (domestic and foreign) are assumed to be identical. Similarly, no assessment can be made on the distribution of the returns realised, be they concentrated or diffuse across households of different income groups. Nevertheless, changes in the returns to labour point to possibilities for employment or wage growth (or both), and represent a benefit for some agricultural workers and, as such, merit investigation. The remaining areas represent areas of future work.

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 compiled to ensure that trade and domestic production data are consistent, and that world supply and demand balance.

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 (see GTAP, 2016b for full details). 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 made across years. Not all 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 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, in the absence of major new disruptive technologies, changes would be expected to be small.

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

Concepts of GVCs used in this study

GVCs are explored through the lens of trade in value added. As per other reports in this series, the approach adopted is to examine the flows of value added from agro-food sectors across countries through the various sector-to-sector and sector-to-final demand linkages that occur between countries. As such, this report does not analyse either individual value chains for specific products, nor the influences that the changes in contracting, decreases in transportation costs, or changes in consumer demand have had on the nature and extent of the linkages observed.

2. Why look at employment in agro-food GVCs?

GVCs in agro-food sectors have the potential to provide a source of employment or labour returns for producers across the world. If through participation sectors are able to grow domestic value added, this will flow through to the various factors of production that are used to produce the goods sold into these value chains. These flow-on effects can be through increased employment opportunities, higher returns to labour (wages), or both. Evidence from a broad range of sectors finds some support in these effects. Shepherd and Stone (2012), for example, show that internationalised firms tend to hire more workers and pay higher wages compared with those solely serving the domestic market. For agriculture, own sector GVC participation has been a positive influence on labour returns in that sector, generating growth in both total domestic value added and the share that accrues to labour (Greenville, Kawasaki and Jouanjean, 2019).

By contrast, movements in the location of production activities facilitated by GVCs may have negative effects on employment and labour returns in some countries. While outside of agriculture, papers by Autor et al. (2013; 2014; 2016) and Acemoglou et al. (2016) highlight how competitive pressures from China and the role of automation (which is likely to have occurred anyway) depressed aggregate manufacturing employment in the United States. Despite the effects on the manufacturing sector, however, total employment in the United States also grew due to increases in services jobs (Wright, 2014). Nevertheless, these jobs were often in different areas and required different skills sets from the jobs that were lost. For agriculture, while the potential for intensification and capital deepening can be high for some sectors in some countries, it will not be in others. Thus, some of the effects seen for other sectors of the economy may also occur in agriculture. Irrespective, trade can increase competition and induce productivity improvements that can hasten structural adjustment, reducing overall employment in the agriculture sector (a trend that has been occurring irrespective of trade). The net effects on total returns and employment in agriculture will be balanced by the possible growth impacts on production due to access to international markets.

Given the potential push and pull effects of GVCs on employment and labour returns, it is useful to draw out the various channels through which GVC participation can influence employment outcomes in the agriculture and food sectors. In doing so, it is also important to explore the effects on employment created outside the agriculture sector.

Beyond the direct links to employment, several past studies have pointed to other effects of GVC engagement and employment. Studies at the farm or individual value chain level have shown that GVC participation in agro-food activities has a number of spillovers in terms of productivity improvements, production growth, and livelihood improvement (Dedehouanou, Swinnen and Maertens, 2013; Colen, Maertens and Swinnen, 2012; Maertens and Swinnen, 2009; Jaffee and Masakure, 2005). In ASEAN, workers specialised in producing intermediates used by other countries in their exports (that is, forward GVC jobs) were found to have, on average, higher productivity than workers producing gross exports (Lopez Gonzalez, 2016).

3. Channels of employment in agro-food GVCs

Data on trade in value added, both within the domestic economy and across borders, provides a means to explore the impacts of trade on the generation of returns to labour in agriculture – in short hand, the impacts of trade and GVC participation on employment.[1] Using the labour share of sector total value added, the returns to labour that result from trade within GVCs can be determined (Box 2).

There are various ways to measure the trade impacts of GVCs and how agriculture sectors participate in them. Agriculture sectors participate in GVCs through buying foreign inputs, but also through selling intermediates to foreign producers and final goods to foreign consumers. For this report, the employment effects examined concentrate on the agriculture sector and explore the food sector where relevant. As such, the effects are derived from selling intermediates to foreign producers or final goods to foreign consumers (directly or indirectly). The various channels through which GVC participation can influence employment include:

- *Directly driven employment*: Labour returns to agriculture that are attributable to direct exports of primary products from agriculture sectors. This is based on exports of own domestic value added either as intermediates or as final goods.
- *Indirectly driven employment*: Labour returns to agriculture sectors that are attributable to agriculture returns from exports from other domestic downstream processing or using sectors that use agricultural inputs in the production of their exports.
- *Embodied employment*: Labour returns that accrue to sectors outside agriculture where domestic value added from these sectors is embodied in agriculture and food exports from the use of domestic intermediates. That is, the embodied labour returns to the food, services and industrials sectors.[2]

In general, the mix of employment effects between those which are directly or indirectly driven should be governed by relative comparative advantages along different parts of the value chain. It is not possible to make such differentiation with the data used in this report. However, it should be possible to see changes on average and to differentiate the effect according to country specific characteristics. It is worthwhile to explore whether, on average, the differences in the total employment effects between those that might be created between countries that predominately experience directly driven employment *versus* those that might be created indirectly by driven employment just as was done for total value added returns (see Greenville, Jouanjean and Kawasaki, 2019).

[1] The ICIO table used in this report, as with other ICIO tables, assumes that the same aggregate production technology is applied to produce goods that are exported and those which service the domestic market. In this way, the labour content of both exported and domestic good is the same. Similarly, the use of non-sector inputs (other sector linkages) and foreign inputs (buying from GVCs) is also the same.

[2] Embodied employment is calculated by exploring the attributable labour returns to different sectors of the economy based on value added contributions to exports. For each sector, its labour share of value added is applied to its value added contribution to determine the labour component in exports. This is then analysed in terms of shares of total labour returns in exports, sector workforce labour returns, or shares of total economy labour returns.

At a country level, it is worth contrasting employment generation in trade and GVCs to that generated through serving domestic final demand. The employment channels for agriculture derived from trade may differ in some countries to that derived from servicing domestic final demand.

Directly and indirectly driven employment by country

Trade within GVCs can directly generate employment when sectors directly participate in GVCs through exports of primary products. For example, sectors may sell intermediate inputs, e.g. wheat, to overseas millers who turn that wheat into flour which is either re-exported as flour or transformed further in food sectors for export or for final local demand. Similarly, sectors may service foreign final demand directly, be it apples going straight to a foreign final consumer or processed apple juice from a food sector being sent to foreign final demand. This section describes the current mix of directly and indirectly driven employment in agriculture across countries and sectors.

The returns from this trade within GVCs are used to pay the value added factors that contributed to the product's creation. In the examples just above, for agriculture it is the wheat farmer who exported to a foreign miller, the apple grower who sent apples to a foreign consumer, and the juice maker who sold juice across borders. The factors employed in these industries directly to make these products represent the direct impacts from trade.

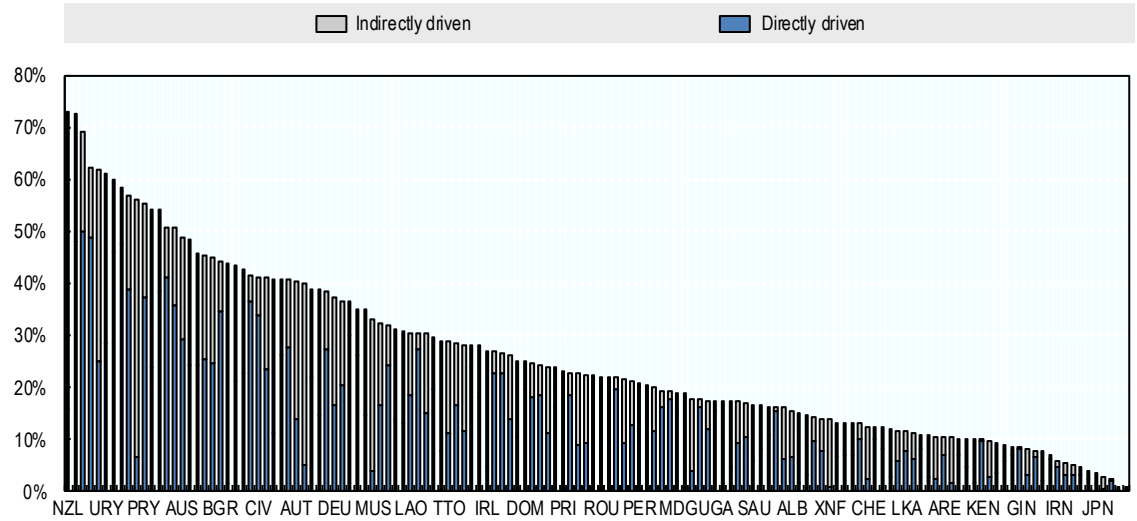
There is a wider range of indirect linkages, however. For the apple grower, they may also sell apples to a local juice factory which exports. Thus for the apple grower, there will be the direct link from selling apples to foreign consumers and the indirect link created through the local juice maker selling juice to foreign consumers. Other agricultural sectors may feed into sectors such as textiles or pharmaceuticals that in turn produce goods traded within GVCs.

Tracing value added through these linkages provides a means to examine the source of trade and GVC-related employment. At the global level, on average, close to 26% of total agricultural workforce returns is derived from trade and GVC engagement.[3] Across countries, there is significant variation: New Zealand is at one extreme with close to 73% of its agricultural workforce (in value terms) reliant on domestic value added created by trade and GVCs (Figure 1) and Japan at the other with only 3%.

[3] Computed on a simple average basis. When weighted by sector size, global average GVC related employment represented around 19% of total agricultural workforce returns, with a roughly even split between direct and indirect sources.

Figure 1. Employment in agriculture generated from trade and GVC participation, 2014

% of total agricultural employment directly and indirectly driven by exports to GVCs



Note: Directly driven represents employment from exports from the agriculture sector of primary products, indirectly driven represents agricultural labour returns and thus employment embodied in non-agricultural sector exports that use agricultural domestic value added.
Source: Author estimates.

Box 2. Calculating shares of total value added is not so straightforward

Value added represents the returns to the use of "value added factors"; that is, the returns to land, labour and capital. For agriculture, it captures the returns to producers in the primary production sectors (GTAP sectors 1 to 14 in Annex A). Sector value added also includes some policy transfers. A sector's total value added equals the sum of the returns to the value added factors, plus taxes paid (value created by the sector that does not flow as income to the value adding factors), less subsidies received (returns provided to the sector that are not generated by the value adding factors directly).

In theory, the labour share in trade in value added can be determined based on labour's share in total sector value added. However, this becomes complicated in the presence of subsidies. Subsidies received by a sector will flow through to the factors of production, often disproportionally accruing to fixed factors (OECD, 2016). They also flow through to labour, and as such, the observed value of labour returns in a sector may be greater than would otherwise be the case. To the extent that this occurs, it implies that some of the labour employed (or return to labour in the form of wages) is market driven, while some is paid from the subsidies received. If subsidies are high enough, it can create a situation where the returns to labour in a sector exceed the total value added that is generated by that sector. Thus, if subsidies are present, the labour share of total value added can overstate the market driven (or in this case GVC and trade driven) employment effects. The calculation of shares of labour in trade is adjusted to address this issue. As subsidies change the observed value of labour, the labour share of trade in value added is calculated as the returns to labour divided by the sum of the returns to value adding factors plus taxes and *plus* subsidies.

This approach does not perfectly account for the subsidy effect on labour as some of the total subsidies received will flow to the other factors of production. However, as the breakdown of all subsidies to each of the value adding factors is unknown, it provides a more accurate measure than expressing the total industry labour as a share of total sector value added. In the case where no subsidies exist, this change makes no difference. Furthermore, various combinations of subsidy inclusions were examined by differentiating input and output related subsidies. These changes did not materially influence the results obtained for this report.

Beyond the overall levels of employment reliant on trade and GVCs, there is significant variation across countries in the shares that are directly and indirectly related (Figure 2). GVC participation by agricultural sectors across the world varies in its form, with some agricultural sectors reliant on other domestic processing sectors as the pathway to GVC participation, whereas others participate through direct exports of primary products.[4] On average, around 15 percentage points of the 26% of total workforce returns is derived from direct GVC participation by agricultural sectors themselves. This varies across countries. In New Zealand, for example, due to significant exports of dairy products, much of the agricultural sector's employment from GVCs is generated indirectly through exports from its domestic processing sector. In contrast, in Chile, the agricultural sector (fruits) participates more directly in GVCs and employment is generated predominantly through exports of primary agricultural products.

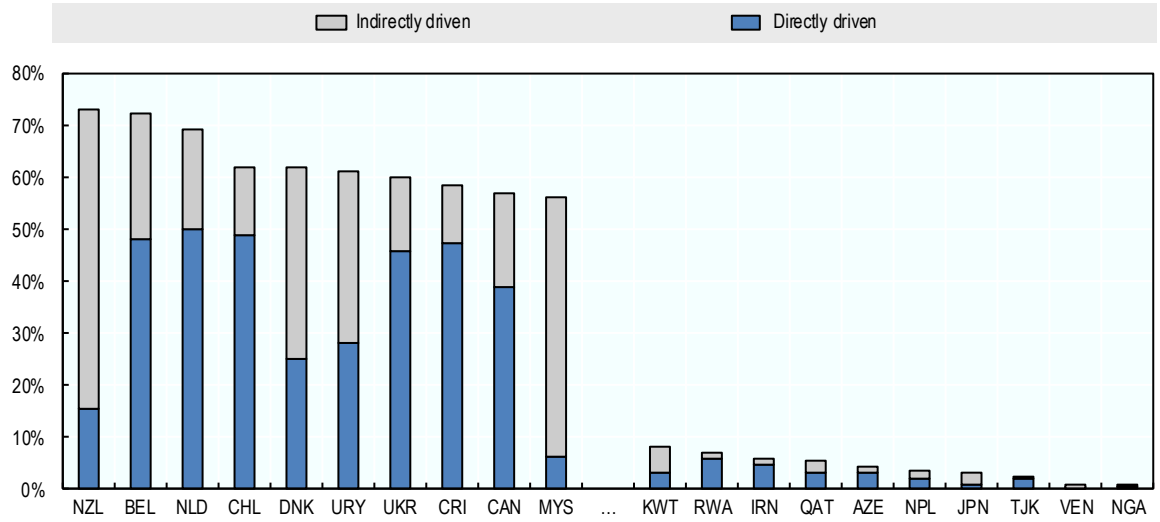
The variation in shares in the employment generated from trade and GVC participation is observed for the world's largest agro-food exporters (Figure 3). For some countries, the agricultural sectors are heavily reliant on trade within GVCs which represents the main source of labour returns and employment for agriculture. For others, despite significant levels of trade in world markets, employment in the sectors is less reliant on trade in GVCs. Of those sectors having less reliance, this can be due to large domestic markets, e.g. China and the United States. For other countries, such as India and Indonesia, it is a combination of domestic market size and domestic policy. For Indonesia, there is a large labour force participation in the domestic rice sector – which is heavily protected – meaning that while GVC participation generates significant oilseed sector employment, it does not contribute in the same way to overall agricultural sector employment. In India, distortions in domestic wholesale market regulations, and the costs involved in accessing both domestic and international markets, have likely limited the sector's participation in GVCs and thus, despite its potential, limited the labour returns generated (OECD/ICRIER, 2018).

Agricultural sectors in major trading countries also show variation in direct and indirect employment. Not all agricultural sectors in these countries rely on downstream sectors to access GVCs and generate employment (see below for details). For this group, New Zealand, Malaysia and Thailand have the greatest shares from indirect participation. These linkages are generated largely due to the nature of the products produced – milk, palm oil and rice. All these products are generally processed before being traded on international markets due to product specific characteristics.

[4] There is a continuum for agriculture sectors across the globe in relative reliance on direct exports or primary agricultural products and those which rely on transformed processed products as the means in which agricultural value added is exported. Broadly grouped, countries who have the majority of value added, in this case labour value added, exported within exports of primary products have been termed to be in the 'primary pathway', with those with the majority of agricultural labour value added exported embodied in processed products in the "processed pathway".

Figure 2. Employment in agriculture generated from GVC participation, top and bottom 10 countries reliant on trade for agricultural employment in 2014

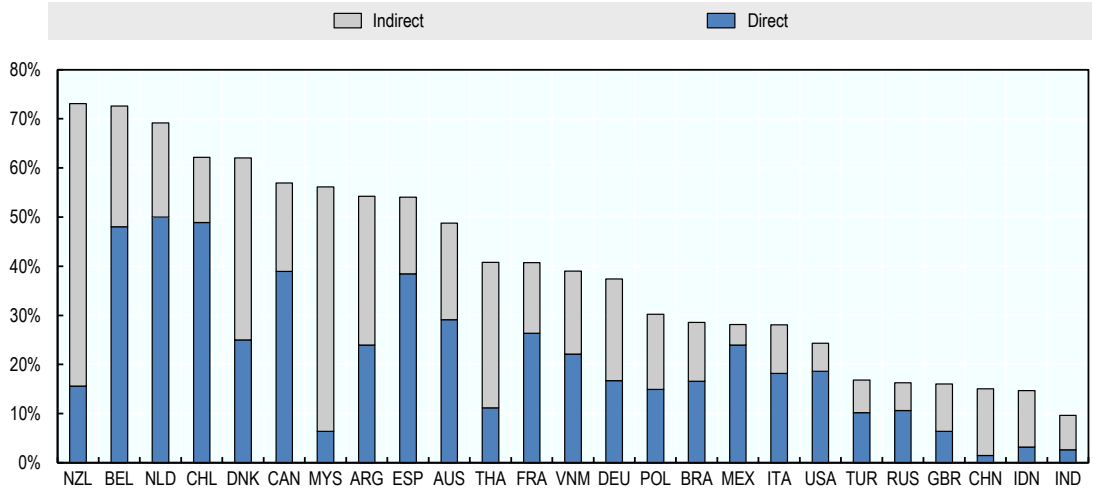
% of total agricultural employment from directly and indirectly driven exports to GVCs



Note: Directly driven represents employment from exports into GVCs from the agriculture sector of primary products, indirectly driven represents agricultural labour returns and thus employment embodied in non-agricultural sector exports that use agricultural domestic value added.
Source: Author estimates.

Figure 3. Employment in agriculture generated from GVC participation top 25 agro-food exporters, 2014

% of total agricultural employment from direct and indirect exports to GVCs



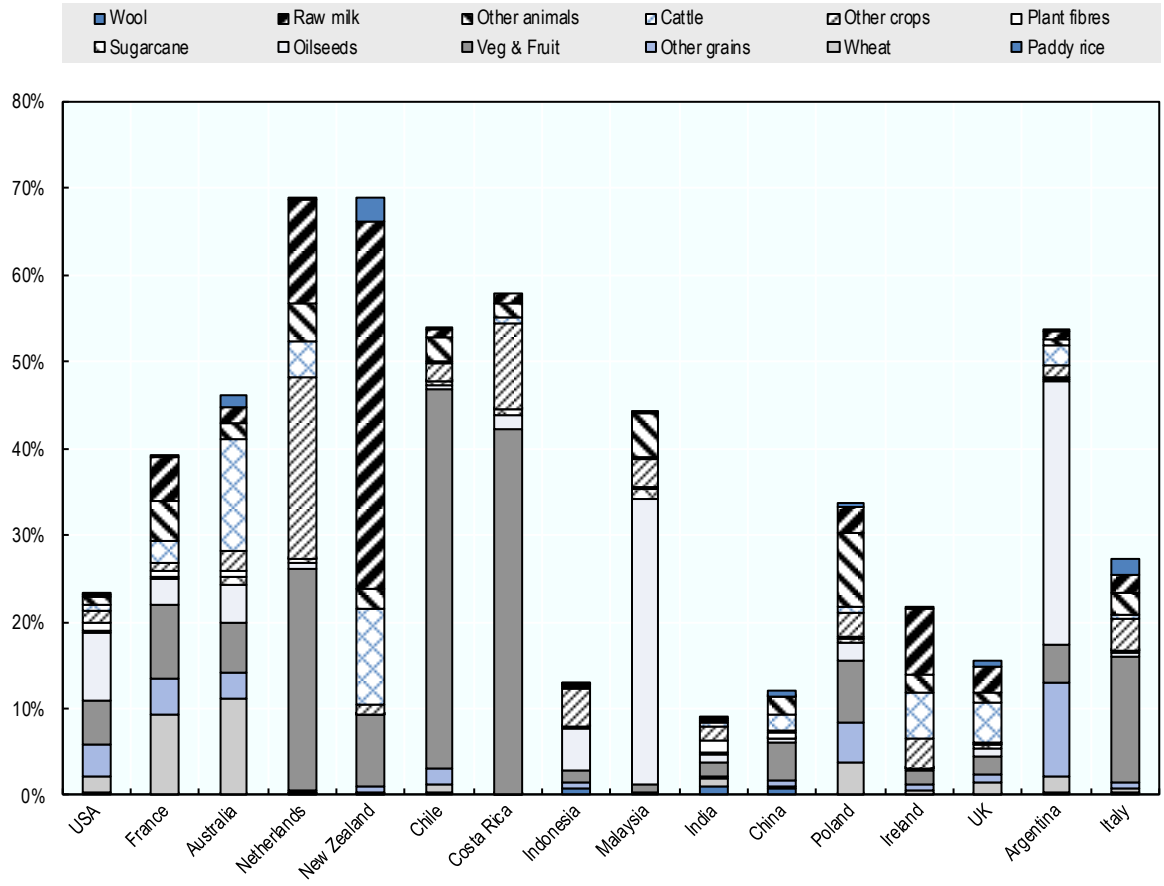
Note: Directly driven represents employment from exports into GVCs from the agriculture sector of primary products, indirectly driven represents agricultural labour returns and thus employment embodied in non-agricultural sector exports that use agricultural domestic value added.
Source: Author estimates.

Within country sector differences

The sector profile of employment from trade and GVC participation across countries varies (Figure 4). For some, employment from GVC engagement is driven by one or two main sectors, such as oilseeds for Malaysia and fruits and vegetables for Chile and Costa Rica. For other countries, GVC participation is more widespread, with a greater number of sectors benefiting from GVC related employment, such as France, Australia, Poland, and Ireland.

Figure 4. Employment in agriculture generated from GVC participation by sector, selected countries 2014

% of total agricultural employment from directly and indirectly driven exports to GVCs by sector



Note: Directly driven represents employment from exports into GVCs from the agriculture sector of primary products, indirectly driven represents agricultural labour returns and thus employment embodied in non-agricultural sector exports that use agricultural domestic value added. Countries chosen to depict variation across different sectors and countries.
Source: Author estimates.

Differences and similarities between GVC based employment effects compared with employment associated with serving domestic final demand

Not all employment in agriculture or agro-food sectors relates to participation in GVCs. While for some countries this represents the vast majority of its participation, for others it represents only a small share of sector employment (Figure 1). Furthermore, countries that

generate employment from direct exports may not sell directly to domestic final consumers. Or the effects may be the contrary: countries that produce competitive intermediates may fuel a competitive domestic processing sector that serves domestic final demand. As such, countries may not follow the same employment-generating path domestically as they do when participating in GVCs. Irrespective of this, agro-food production serving domestic demand is underpinned by the same foreign inputs as those that go into the production of exports – backward participation is the same.[5] As such, GVC participation may also influence domestic linkages.

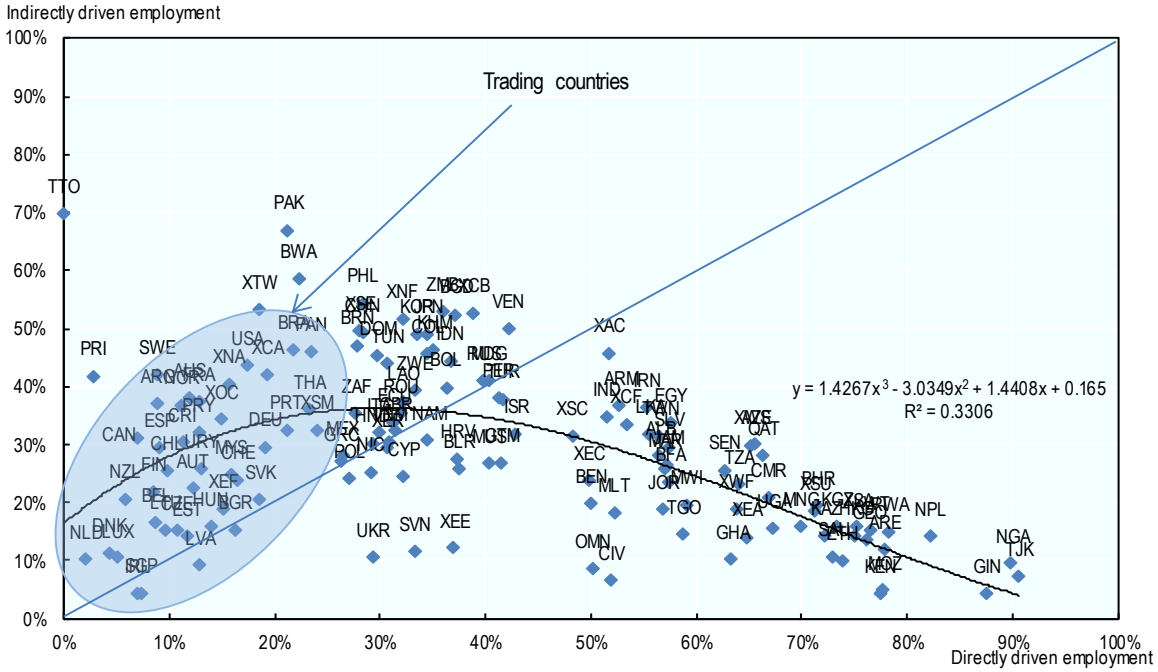
Across countries, an inverted U-shaped pattern is observed in employment directly and indirectly driven by domestic final demand (Figure 5). Countries that trade heavily have a large share of total employment (labour returns) driven by trade and thus sit to the left of Figure 5. For these countries, there is a bias towards indirectly driven employment from serving domestic final demand; that is, through domestic processing sectors (they are above the 45-degree line on Figure 5). In other words, it appears that for these countries, which participate in GVCs in varied ways, the domestic value chains are overall more indirectly oriented, with final demand buying from downstream sectors instead of directly from agriculture itself. This may suggest that participating in GVCs through exports of primary products does not limit the development of domestic downstream processing activities, just that these may be domestically instead of internationally focused (that said, trade protections are not considered and may bias the result; see next section).

Countries with little participation in, and employment derived from, trade and GVCs (in either direct or indirect ways) sit to the right of Figure 5. These countries have direct agricultural production links to domestic final demand. For these countries, there are little indirect linkages for the sector with relatively simple domestic value chains. In other words, countries without domestic downstream processing sectors do not participate in trade or GVCs. For some countries, this lack of development of domestic downstream processing sectors, or the development of modern value chains that require the adoption of product standards and certain levels of production coordination, may limit opportunities to participate in GVCs and thus prevent these countries from benefiting from GVCs. For other countries, it may be due to relatively small agricultural sectors and a domestic population that is reliant on food imports.

[5] This result is due to a lack of differentiation within sectors between different groups of producers. Each sector is assumed to produce one output. To differentiate between foreign and domestic suppliers, each sector in each country would need to be split into two with the specific links between imports and domestic industries specified. Such splitting requires significant amounts of data on production systems which are not available.

Figure 5. Domestic value chain employment channels, 2014

% of total agricultural employment from directly and indirectly serving final domestic demand



Note: Directly driven represents employment from exports into GVCs from the agriculture sector of primary products, indirectly driven represents agricultural labour returns and thus employment embodied in non-agricultural sector exports that use agricultural domestic value added.
Source: Author estimates.

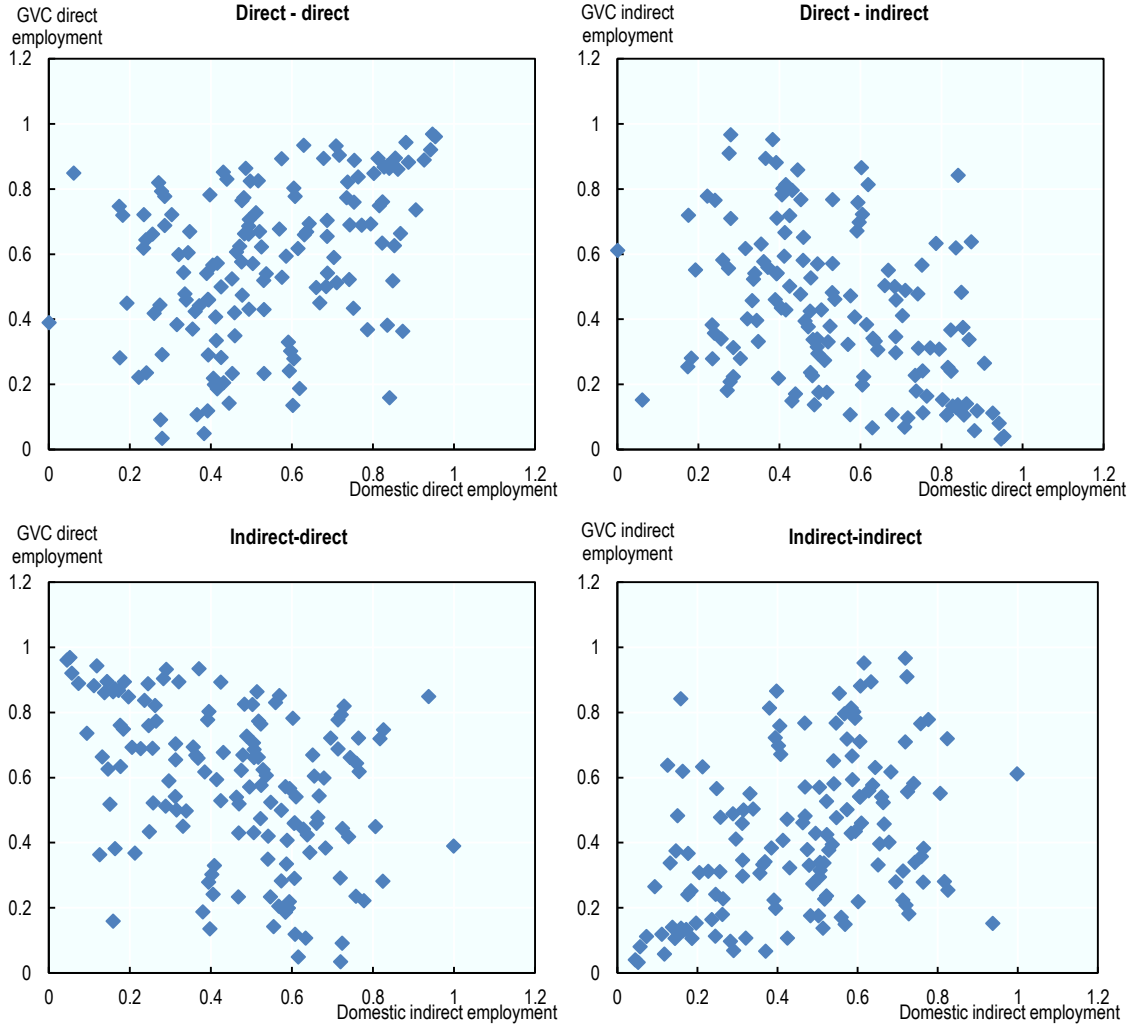
Comparing the employment drivers from agro-food GVCs to those from value chains that serve domestic demand reveals little correlation between the two. Looking at the direct and indirect shares of employment generated from GVCs and domestic demand[6] suggests that patterns of employment generation in GVC are not necessarily followed at the domestic level (Figure 6). In particular, countries with a high share of employment created through direct GVC participation do not always have a high share driven by direct sales to domestic final consumers (Direct-direct on Figure 6). There does appear to be a bias in that direction, potentially driven through product characteristics or more fundamentally the structure of the economies and agricultural production systems of those countries. Despite this, there does appear to be more of a correlation between indirect employment within GVCs and the presence of domestic-processing based value chains for domestic consumers (Indirect-indirect on Figure 6). In other words, a domestic processing sector supplying domestically may underpin the ability to participate indirectly in agro-food GVCs – as it occurs through this sector. The question remains: what conditions on that food or processing sector will help drive indirect exports of agricultural value added? This is explored briefly in Section 7.

[6] As the sum of domestic and GVC is equal to 1, the shares have been re-expressed so that each market share sums to 1. That is, shares for GVC direct is the GVC direct share in total GVC related employment, and shares for domestic direct is the share of domestic direct share in total domestic related employment.

Overall, the relationship between domestic value chains and GVCs warrants further investigation. While it is beyond the scope of this report, further work could explore the role and characteristics of domestic value chain participation as determinants of GVC participation. There is also a question relating to the growth in domestic processing and the influence this has on participation through primary or processed exports. The data presented here suggest, *prima facie*, that domestic processing sectors may underpin both types of participation.

Figure 6. Relationships between GVC and domestic direct and indirect driven employment, 2014

Share of agricultural workforce employment created through direct and indirect sales to GVCs or domestic consumers



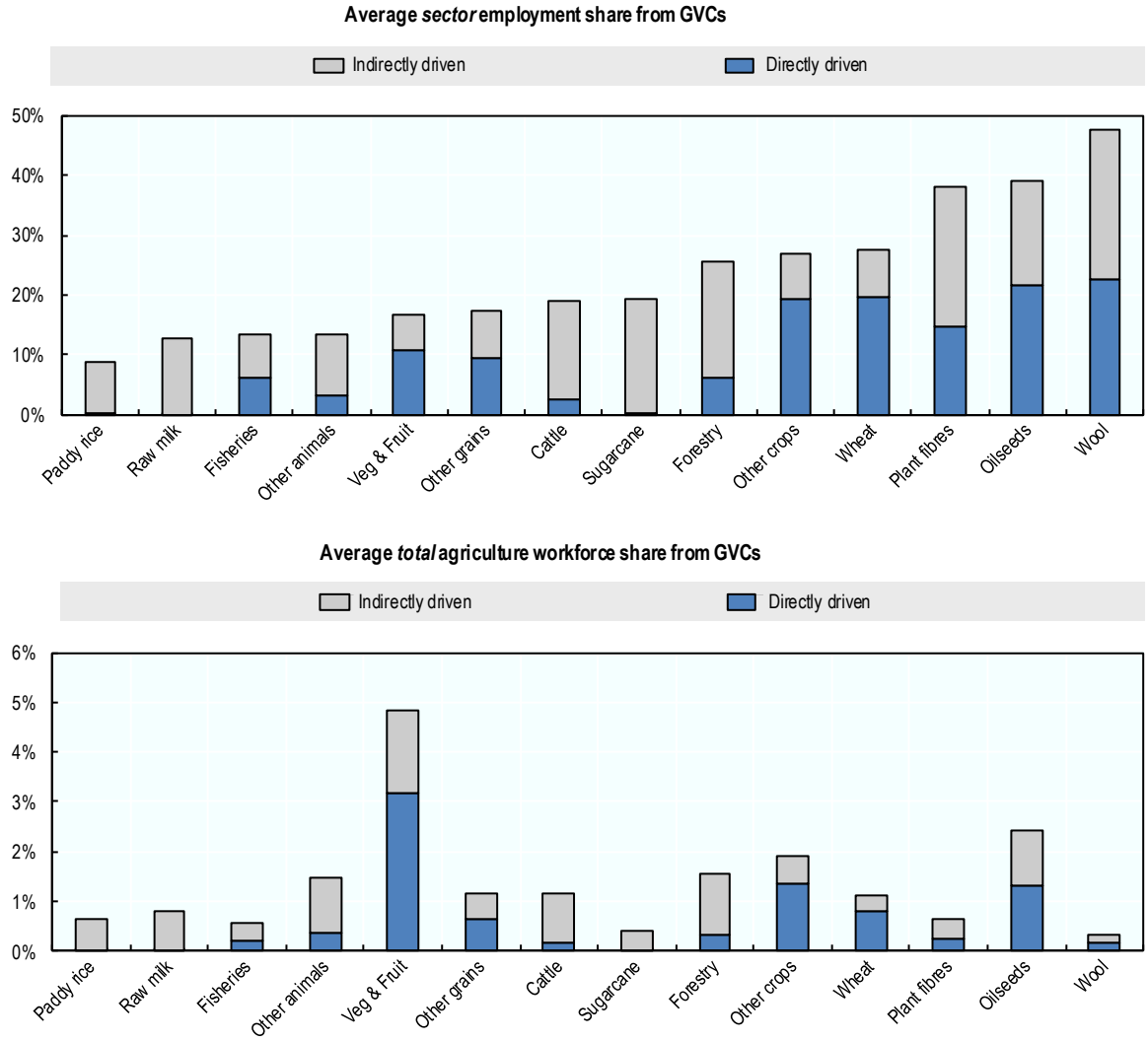
Note: Directly driven represents employment from exports into GVCs from the agriculture sector of primary products, indirectly driven represents agricultural labour returns and thus employment embodied in non-agricultural sector exports that use agricultural domestic value added.
Source: Author estimates.

Direct and indirect employment by sector

The ways in which individual sectors participate in GVCs differs, and thus so does the way and extent to which GVCs influence employment across these sectors. Differences across sectors are driven by the type of product, production characteristics (labour usage), and the relative size of the sector. Globally, wool, oilseeds and plant-based fibres have workforces that are the most reliant on GVCs – around 40% of sector employment, on average, is driven by GVC participation (Figure 7, top panel). These three sectors are those which produce products that more often feed into manufacturing or other activities (including other agricultural activities for oilseeds in the form of feed).

Figure 7. Global average sector employment reliance on agro-food GVCs, 2014

Weighted average sector employment shares % and weighted average agriculture total employment shares %



Note: Directly driven represents employment from exports into GVCs from the agriculture sector of primary products, indirectly driven represents agricultural labour returns and thus employment embodied in non-agricultural sector exports that use agricultural domestic value added. Figures presented represented total sector weighted averages across the 141 countries and regions examined.
Source: Author estimates.

However, the sectors that are most reliant on GVCs are not always those for which GVC participation contributes the most to *total* agricultural employment (Figure 7, bottom panel). Differences in labour use intensity across sectors will mean that the share of total agricultural jobs reliant on trade may come from sectors which are not overly trade reliant from a share of individual sector workforce. In other words, sectors heavily participating in trade and GVCs might not be the ones exporting the most important labour value added from the agriculture sector. For example, the share of the workforce that is export reliant in the vegetables and fruits (and nuts) sector is the fifth smallest across the 14 agricultural sectors examined. However, it is the largest contributor to total export-reliant employment when viewed as a share of the total agricultural workforce. The exception to this is the oilseeds sector, where GVC participation is important for the sector and in terms of its contribution for total agricultural employment. In contrast, for wool and plant-based fibres this is much less the case. When viewed in terms of the impact on total agricultural employment, vegetables, fruits (and nuts), and other crops are the sectors through which GVC participation generates the highest and third highest contribution to overall agriculture sector employment.

Paddy rice, despite its importance globally as a staple crop, is not well linked into GVCs, nor does participation in them drive employment outcomes for the sector. It has the lowest share of sector workforce related to trade and GVC participation and this participation contributes the least to overall agricultural employment – after considering all direct and indirect linkages across the economy. These observed outcomes are likely influenced by the significant government intervention in this sector and the high levels of protection (Greenville, 2018; Greenville and Kawasaki, 2018).

Embodied employment in agro-food GVCs

Agro-food exports contain more than just the domestic value added created by the agro-food sectors. Beyond foreign inputs, domestic value added is sourced from other domestic sectors beyond agriculture – that is, from the industrials and services sectors. As such, the employment generated by agro-food exports extends beyond the sectors (Figure 8).

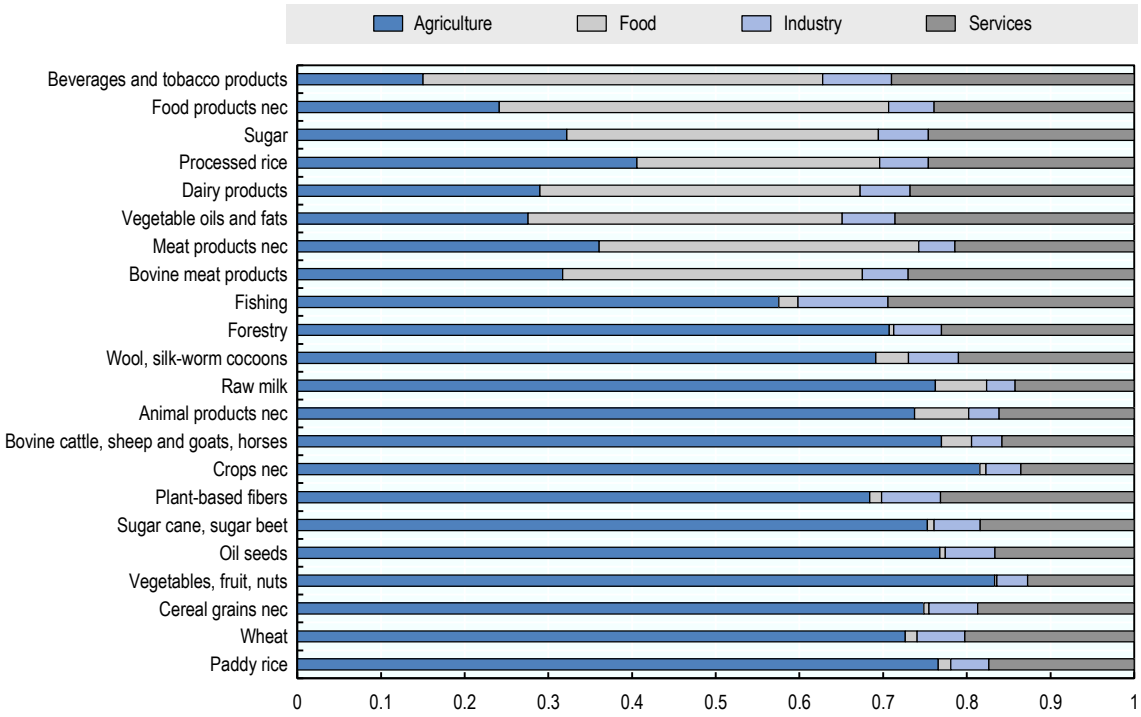
The breakdown in the employment share of gross agro-food exports shows the services content in agro-food exports. Of the total returns to labour generated by agro-food exports, an average of 21% flows to the service sectors that support the production of primary and processed products.[7] For food exports, this share is on average (simple average across countries) greater at 26%, compared to 19% for agricultural.

Beyond services, employment effects from agro-food GVC participation are concentrated in the agriculture and food sectors themselves. The industrials sector share of total employment (labour value) is relatively small in both agriculture and food sector exports, on average around 6% (approximately equal in both agriculture and food exports). Thus, the employment spillovers from participation in agro-food GVCs appear to be greatest for supporting services sectors. Overall, similar trends are seen for both high income and low and middle income countries. The main differences are that for low and middle income countries, higher agriculture sector shares of employment are higher in agriculture and food exports, and service and food sectors shares are lower.

[7] See Greenville, Jouanjean and Kawasaki (2019) for details on the types of services used.

Figure 8. Average shares of total employment generated by agro-food exports, 2014

Shares across broad source sector groupings



Note: Shares represent the share of total labour returns in exports distributed across the domestic supplying sectors.
Source: Author estimates.

4. Employment numbers in agriculture related to agro-food GVC participation: Experimental estimates

The above analysis has focused on the share of labour returns that are attributable to different forms of engagement in trade and GVCs. Labour returns provides a means to explore the potential returns to those employed in the sector, but levels and changes in them depict both wages and employment numbers. While such information is useful, at times policy makers prefer to focus on employment numbers.

The task of estimating employment numbers is difficult. For each sector, while total labour returns are known, obtaining employment numbers requires information on either country-sector-occupation-specific employment – say the number of unskilled workers in Australia's paddy rice sector – or country-sector-occupation-specific wages. To get coverage over the entire database, this would require this information for 141 different countries and regions for four different periods. To date, such information is not readily available.

Despite this, experimental estimates can be obtained based around the notion of "average jobs". It is much easier to obtain information on labour force numbers and unemployment levels, and therefore possible to create a database of country-level employment at least at the skilled and unskilled levels. Using labour returns paid to skilled and unskilled workers, an average skilled-based wage for each country can be calculated and the number of "average jobs" employed in each sector can be obtained. Differences in the relative use of

skilled versus unskilled labour by each sector thus provides some sectoral variation within the dataset. However, as each sector has a differing distribution of workers – ranging from skill level to full versus part time employment – the actual number employed will differ from that which is estimated. Furthermore, the analysis assumes an economy-wide skilled and unskilled wage with no sectoral-based variation (although average sectoral wages will differ based on relative use of skilled and unskilled workers). Nevertheless, changes in "average jobs" provide information akin to expressing employment along the lines of full-time equivalents. For this reason, some changes in average jobs due to trade and GVC engagement are presented here.

In this section, three sources of employment are examined:

- Employment from final domestic demand: total agricultural employment created by selling products to domestic consumers.
- Employment from exports of intermediates: total agricultural employment created from the export of intermediate products, either as intermediate primary or processed that embody agricultural value added.
- Employment from exports of final products (to foreign final demand): total agricultural employment created from the export of final products, either final primary products (such as fruits, for example), or final processed products.

Changes in total "average" employment in agriculture: Trade and domestic reliant

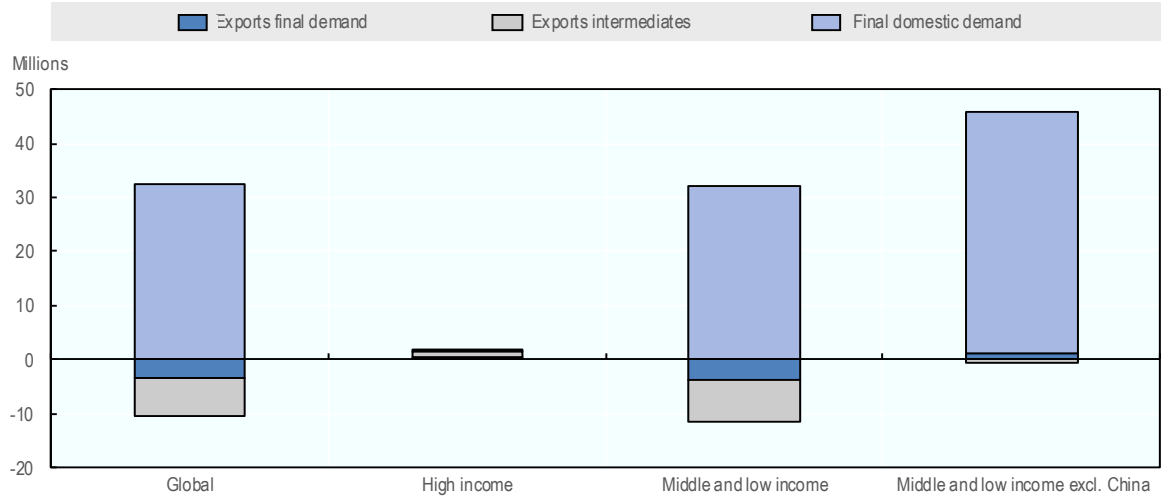
Overtime, broad trends of productivity improvements in agriculture and a rising total population with higher average incomes will create both push and pull factors on employment within agriculture. The productivity "push" will create labour shedding in the sector as fewer workers are required to produce any given level of output. On the other hand, rising populations and incomes will increase demand for agricultural output and thus potentially create more jobs within the sector. The balance will depend on the relative intensity of the effects and whether demand shifts with higher income are towards more labour intensive sectors.

Looking globally, some interesting patterns emerge in terms of total "average" employment that is trade (and GVC) and domestic demand reliant. At the global scale, the number of jobs associated with agricultural trade has fallen, predominately due to falling jobs in middle and low income countries offset by an increase in jobs in high income countries (Figure 9).

For middle- and low-income countries the figure is significant influenced by China. China's shift towards a significant importer of food to feed its growing population has created a fall in export related jobs, and when China is excluded from the group, the findings are reversed. Indeed, the increase in trade related jobs in low and middle income countries excluding China is approximately the same as the increase seen for high income countries. Excluding the period of rising prices and looking at changes between 2007 and 2014, the results are starker (Figure 10). Middle- and low-income countries (excluding China) added more trade-related jobs than in high-income countries, suggesting that much of the supply response to higher food prices came from middle- and low-income countries. Furthermore, the strongest turnaround growth in jobs was associated with trade in intermediates, which initially fell between 2004 and 2007 and then rose with the increased engagement in GVCs.

Figure 9. Global changes in trade and domestic related jobs

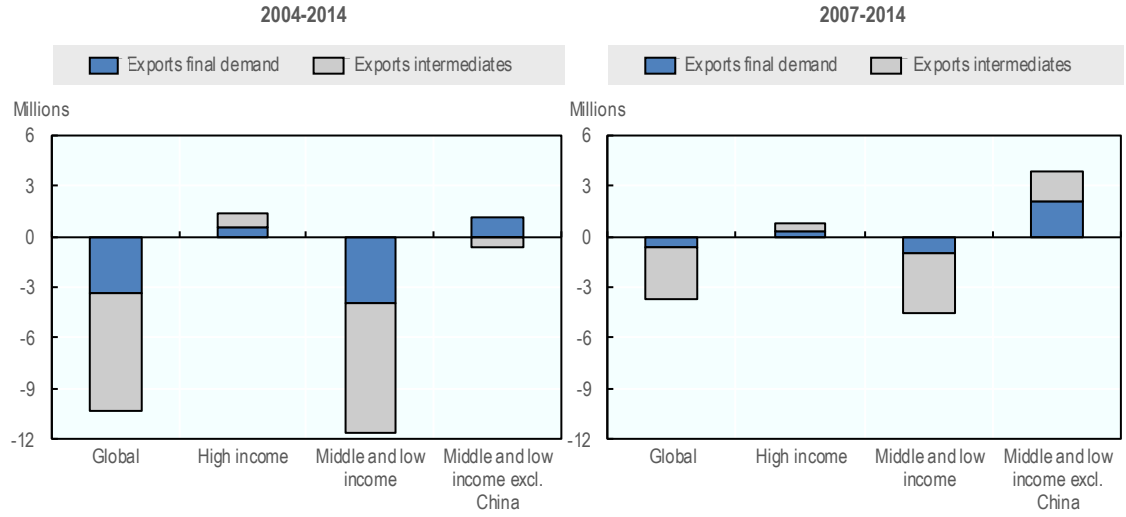
Number of "average" workers, millions



Note: Average workers refers to the number of workers derived by apply the average economy wide wage for skilled and unskilled workers to skilled and unskilled labour returns across each agricultural sector. Differences in part-time work, under employment, and potential industry specific (non-occupational) wage differences across sectors cannot be taken into account and thus total actual is likely to differ from the estimates depicted.
Source: Author estimates.

Figure 10. Changes in trade related jobs across country groups

Number of 'average' workers, millions



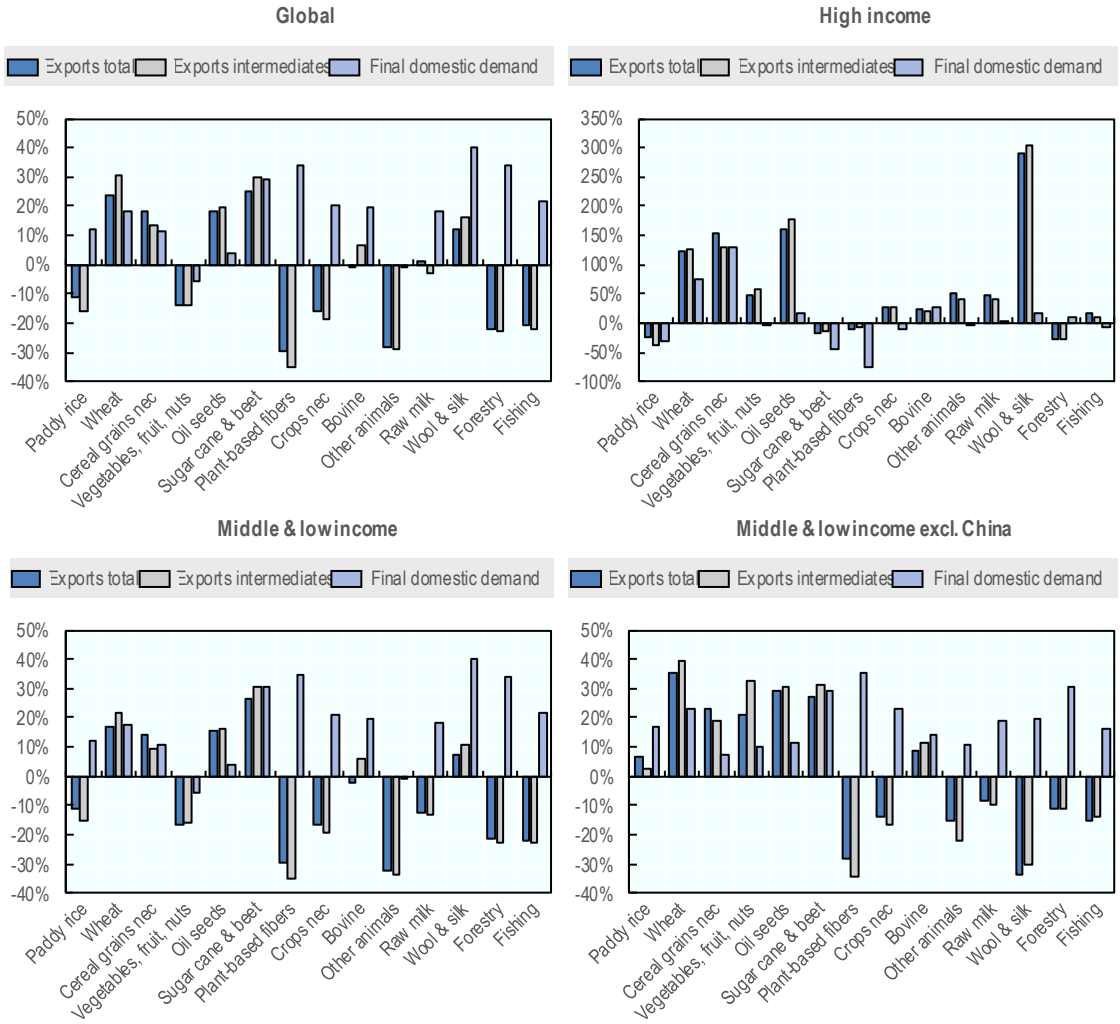
Note: Average workers refers to the number of workers derived by apply the average economy wide wage for skilled and unskilled workers to skilled and unskilled labour returns across each agricultural sector. Differences in part-time work, under employment, and potential industry specific (non-occupational) wage differences across sectors cannot be taken into account and thus total actual is likely to differ from the estimates depicted.
Source: Author estimates.

Sectoral differences are significant

The changes seen in the number of jobs associated with trade and final demand differ across sectors (Figure 11). Globally, wheat, other cereal grains, oilseeds, sugar, and wool and silk have all increased the number of jobs that are associated with trade and GVCs between 2004-14. The mix though of sectors with growth in trade related jobs differs between high income and low and middle income countries. Excluding China, a number of plant-based groups (including staples) and bovine meat saw increases in trade-related jobs amongst middle- and low-income countries. For high-income countries, increases were more widespread across sectors with the exclusion of paddy rice, sugar, and plant-based fibres (which saw an overall retraction globally in trade-related jobs).

Figure 11. Changes in trade and domestic related jobs by sector

Number of "average" workers, % change 2004 to 2014



Note: Average workers refers to the number of workers derived by apply the average economy wide wage for skilled and unskilled workers to skilled and unskilled labour returns across each agricultural sector. Differences in part-time work, under employment, and potential industry specific (non-occupational) wage differences across sectors cannot be taken into account and thus total actual is likely to differ from the estimates depicted.
Source: Author estimates.

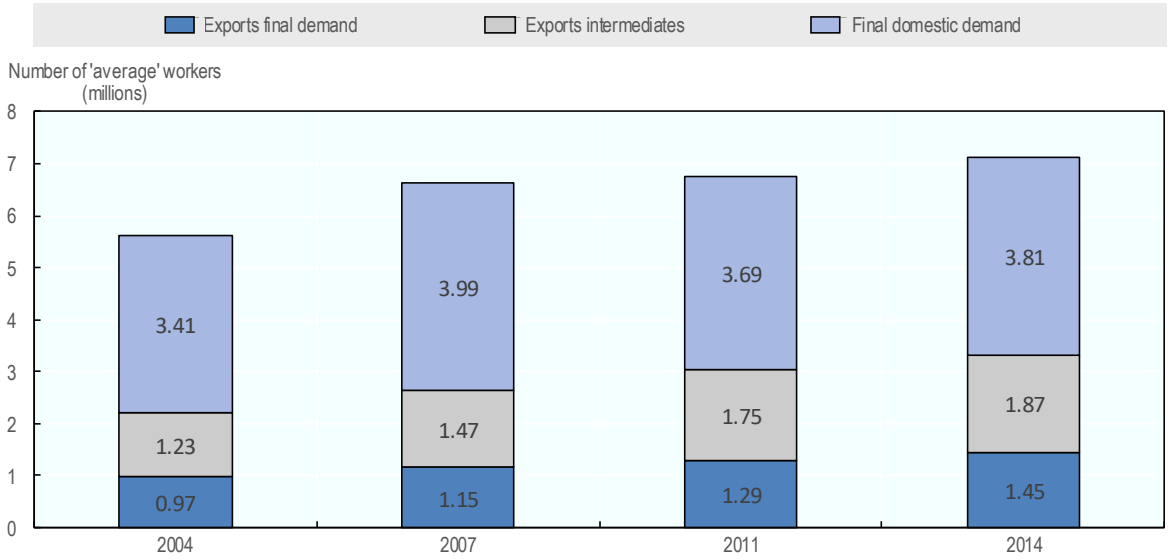
Trade and GVC participation as a means to counter labour shedding pressures of structural adjustment

For several high-income countries, the labour demand of agricultural sectors has fallen over time due to rising levels of productivity. With smaller population growth, and relatively saturated domestic demand (due to sufficiently high incomes), this means that over time it is expected that the demand for labour to feed domestic demand will fall over time. With the price rises that occurred in 2007-08, employment levels increased within the sector. However, real prices have since continued to fall, meaning past trends are likely to reappear.

Total employment in agriculture amongst high-income major trading countries has increased between 2004 and 2014 (Figure 12).[8] An estimated 5.6 million "average workers" were employed in the agricultural sectors in the 14 high income major trading countries in 2004, a figure that rose to 7.1 million in 2014. This increase occurred despite the continued productivity increases seen over the period.

Figure 12. Total agricultural employment in high income major trading countries

Number of "average" workers, millions



Note: Average workers refers to the number of workers derived by apply the average economy wide wage for skilled and unskilled workers to skilled and unskilled labour returns across each agricultural sector. Differences in part-time work, under employment, and potential industry specific (non-occupational) wage differences across sectors cannot be taken into account and thus total actual is likely to differ from the estimates depicted.
Source: Author estimates.

The increase in employment has followed differing trends and has been driven by different sources of growth (Figures 13 and 14). As seen above, total employment rose across all sources between 2004 and 2014; however, the source of growth has since differed. For these countries, there has been a net fall in agricultural jobs post-2007 associated with

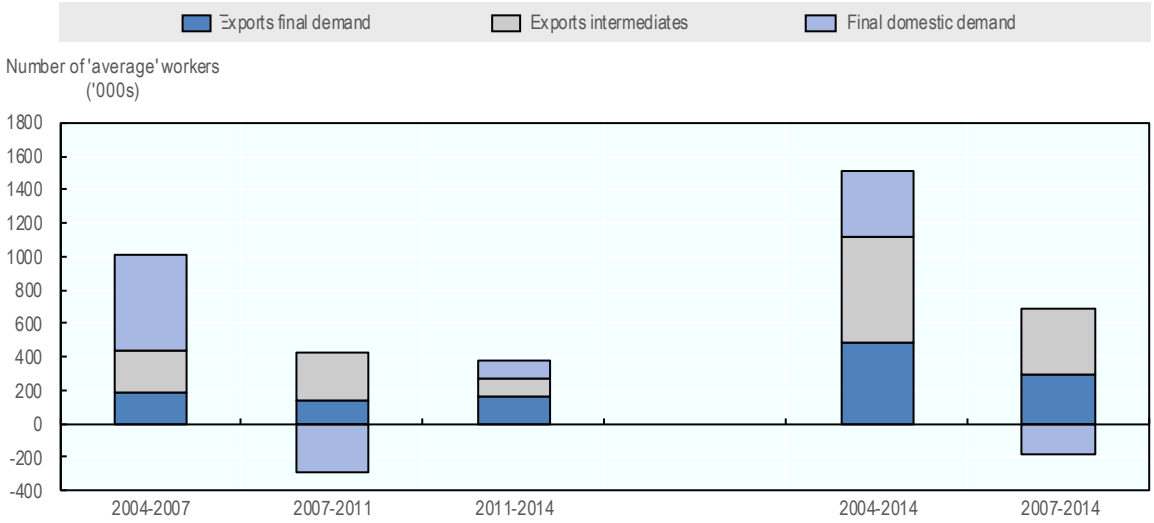
[8] Major high income trading countries include Australia, Belgium, Canada, Chile, Germany, Denmark, Spain, France, the United Kingdom, Italy, the Netherlands, New Zealand, Poland, and the United States.

domestic final demand; that is, the agricultural sector requires fewer jobs to service its own domestic demand. However, increases have been seen in total employment over this period due to increases in trade-related employment. The number of average workers associated with the production of intermediate products – ones that go into foreign processing sectors – rose most strongly between 2007 and 2014. This, combined with the increase in employment associated with exports of final goods destined for foreign final demand, has offset the falls related to domestic final demand. In other words, trade jobs have been the driving job creator in agricultural sectors in high income major trading countries, which has helped to offset the effects on rural communities of longer term structural adjustment pressures created through continued productivity improvements in the sector.

Across the high income countries examined, the counter effects of trade on labour shedding associated with selling to domestic final demand is particularly strong in Australia, Spain, France, and Poland (Figure 14). For all but France, the growth in trade jobs was greater than the reduction in jobs associated with serving the domestic market, and having a net positive impact on the total number of jobs in the sector. In Australia, for example, the average number of jobs associated with selling to domestic final demand fell by around 27 000 between 2007 and 2014; trade-related jobs, however, increased by around 39 000, predominately from trade in intermediate inputs.

Figure 13. Changes in total employment in high income major trading countries

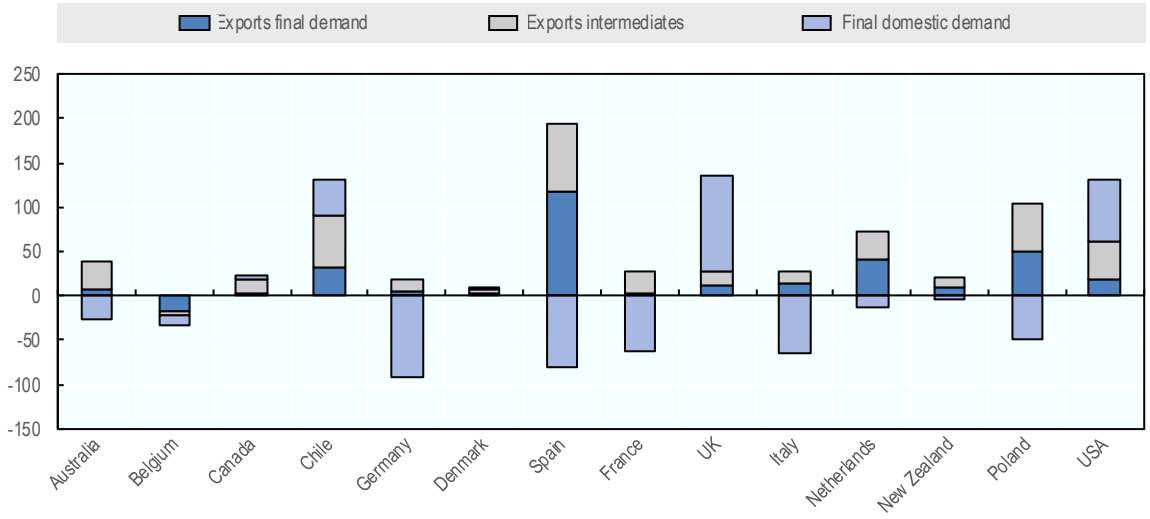
Number of "average" workers, thousands



Note: Average workers refers to the number of workers derived by apply the average economy wide wage for skilled and unskilled workers to skilled and unskilled labour returns across each agricultural sector. Differences in part-time work, under employment, and potential industry specific (non-occupational) wage differences across sectors cannot be taken into account and thus total actual is likely to differ from the estimates depicted.
Source: Author estimates.

Figure 14. Changes in employment associated with trade and final demand, 2007-14

Number of "average" workers, thousands



Note: Average workers refers to the number of workers derived by apply the average economy wide wage for skilled and unskilled workers to skilled and unskilled labour returns across each agricultural sector. Differences in part-time work, under employment, and potential industry specific (non-occupational) wage differences across sectors cannot be taken into account and thus total actual is likely to differ from the estimates depicted.
Source: Author estimates.

5. GVC Employment related sector linkages for agriculture

Agriculture and agro-food sectors generally have different linkages to trade and GVCs. In this section, the direct and indirect linkages at the sector level are explored in detail, highlighting the key domestic sector-to-sector linkages that generate employment from trade and GVC participation.

Employment links through own and other agro-food sectors to trade and GVCs

At the sector level, differences exist in the direct and indirect domestic links to agro-food GVCs. These links represent the flows of value added generated in agriculture or agro-food in total to GVCs. They may be direct from agriculture – the agriculture sector directly exports to GVCs – or indirect through other agriculture – such as soybeans used to feed cattle which are then exported. They may be indirect through non-agricultural sectors – the soybeans used to feed cattle that may be slaughtered domestically before being exported as meat products into GVCs. For the soybeans sector, these two possibilities create two indirect links – one through the meat sector, and one through the livestock.

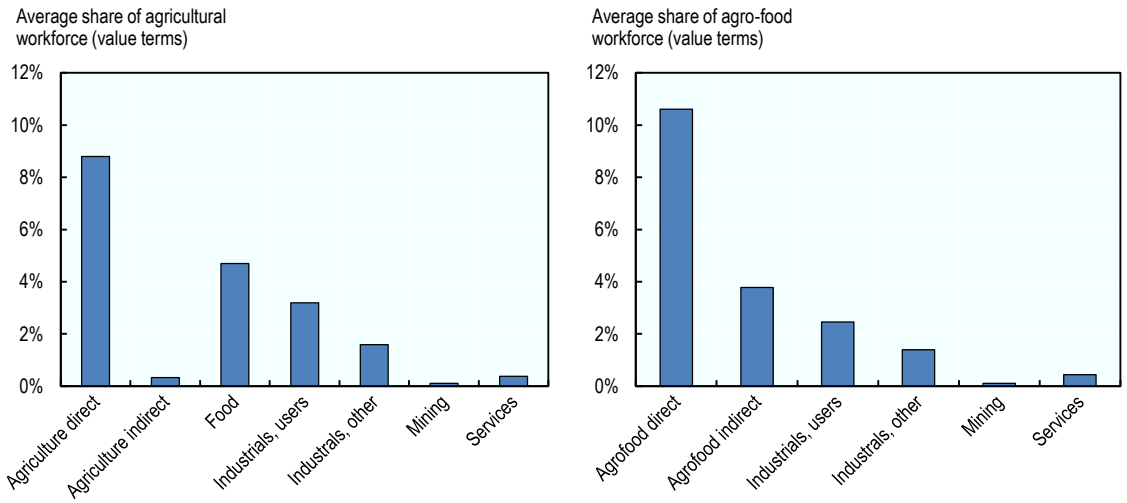
For the agriculture sector globally, the most important linkage to agro-food GVCs is the direct linkage (Figure 15, right panel), which generates over 9% of total agricultural workforce value globally. The food sector provides the second most important link to agro-food GVCs, generating 5% of total agricultural labour returns. In other words, around 5% of agricultural sector employment (in value terms) is created by links between agriculture and a domestic food processing sector which then links into agro-food GVCs. Following that, on average, 3% of agricultural employment (value terms) is generated by domestic linkages to exporting industrials sectors that are major users of agricultural inputs: textiles, wood, leather and chemicals, rubber, and plastics (depicted as "Industrials, users" in

Figure 15). In total, 10% of the GVC-related agriculture jobs are reliant on domestic linkages (compared to total trade related jobs at 19.1% of agricultural workforce value).

The results are similar for agro-food sectors in aggregate, (Figure 15, left panel). In this case, shares represent the total agro-food workforce value generated from GVC participation, 18.8% on average across the globe in 2014. Direct exporting from agro-food sectors (so direct exports from agriculture and food of their own domestic value added) are the most important link to agro-food GVCs. These have a number of indirect links within the agro-food sectors, which indicate that domestic linkages between agro-food sectors to other agro-food sectors that then export to GVCs are an important source of employment creation. These direct and within agro-food linkages generate 14% of total agro-food employment (in value terms) globally.

Figure 15. Domestic links to agro-food GVC participation by broad grouping, agriculture and agro-food 2014

Global domestic sector linkages to agro-food GVCs, weighted average path contribution to total agricultural employment (% of labour returns to agriculture)



Note: Averages are total country level agriculture and agro-food sector value added weighted averages. "Industrials, users" represent manufacturing industries with a heavy reliance on agriculture and include textiles; wearing apparel; leather products; wood products; paper products and publishing; and chemicals, rubber and plastics products.
Source: Author estimates.

Figure 16. Domestic sector-sector linkages for agriculture to agro-food GVCs, heatmap 2014

Global domestic sector linkages, weighted average path contribution to total agricultural employment
(% of labour returns to agriculture)



Note: Averages are total sector value added weighted averages. "Industrials, users" represent manufacturing industries with a heavy reliance on agriculture and include textiles; wearing apparel; leather products; wood products; paper products and publishing; and chemicals, rubber and plastics products.
Source: Author estimates.

Not all sectors are the same and the total agriculture result may not hold for individual agro-food sectors. Figure 16 depicts the linkages at the sector level – expressed as global averages (weighted by country agriculture sector domestic value added). The sectors that represent the columns are the source agriculture sectors – those supplying. The sectors represented by the rows show the exporting sector. The level of shading highlights the importance of the link in generating agricultural employment (expressed as a percentage total of agricultural employment).

Figure 16 shows the importance of direct linkages to agro-food GVCs in generating employment for most agricultural sectors. Paddy rice, sugar cane and beet, and raw milk, do not link directly into agro-food GVCs due primarily to the nature of the product – perishable and thus expensive to trade in its raw form. For these sectors, indirect linkages dominate, primarily through the food sector. The oilseeds sector has important direct and indirect linkages, largely driven by the diverse nature of production within this aggregated sector.

Outside agro-food sector links, there are some smaller but sector-specific relevant links directly to domestic manufacturing. These are seen between the textiles and wearing apparel sectors, and plant-based fibres; between leather products and livestock and animals sectors; and between wood and paper products and forestry.

6. Employment differences across value adding pathways

The evidence above, and drawing on (Greenville, Jouanjean and Kawasaki, 2019) in relation to total value added returns, shows that employment is generated in GVC participation directly through primary exports or indirectly through processed product exports. Countries operate along a continuum or relative shares in employment that is generated by each of these channels (Figure 1). However, it is of interest to policy makers to assess whether countries that have more of what is traditionally termed "value adding" activities also create higher employment returns, or whether those with more exports of primary products do so.

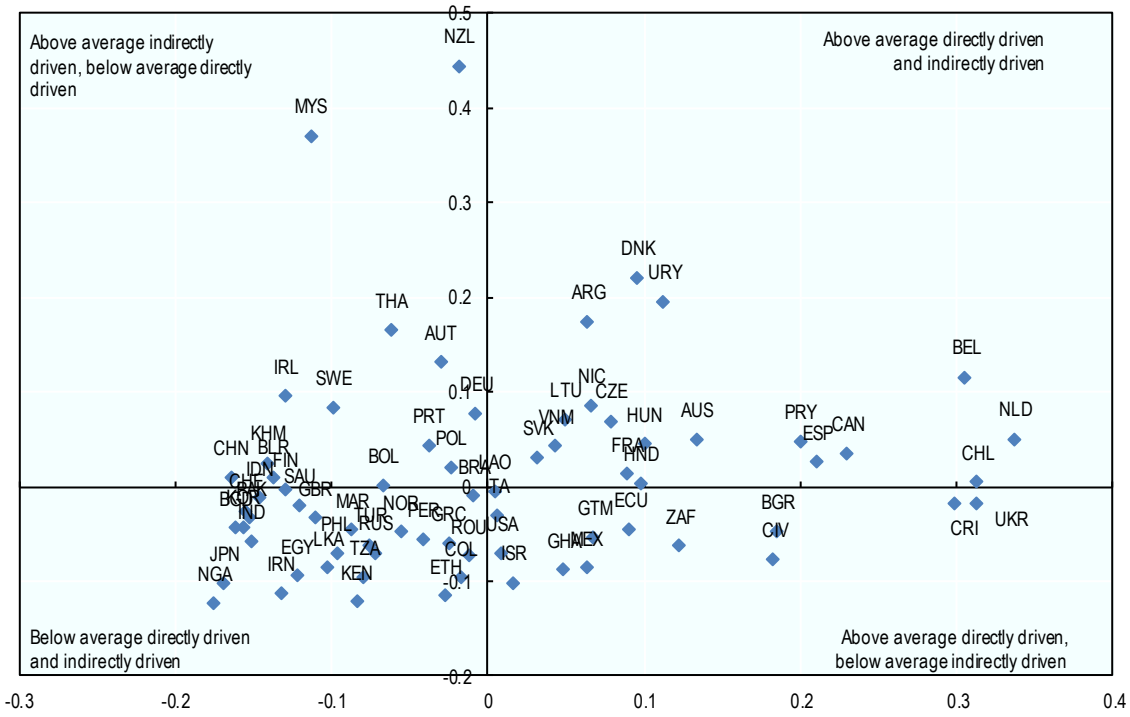
To test this proposition, countries need to be grouped and the differences between the groups assessed. For this report, two "value adding pathways" are defined at the country level. The first is where a country predominately exports primary products and has most of its GVC related agricultural employment driven by direct exports from primary sectors. This pathway is termed the primary pathway. The second is where agricultural employment (labour returns) are predominately driven indirectly through exports of processed products. This pathway is termed the processing pathway. In this way, it depicts the broad specialisation of a country's agriculture sector, and means that while countries in both pathways export primary and processed products, it is the relative mix that is focused on one more than the other. While this choice is arbitrary around the 50% mark, taking weighted averages to obtain representative estimates for within each group should provide a more robust measure of total effects. The weighted averages move the focal point of comparison away from the 50 percentile to the average point within the groups.

Countries are relatively spread out with respect to how they compare to the average global shares of agricultural employment from either directly or indirectly driven trade and GVC-related employment (Figure 17). Several large agricultural producing countries have above world average shares of employment from both sources (top right quadrant), driven by the export orientation of the sectors overall. Within this group, many have a greater reliance on directly driven employment due to high levels of exports of primary products. There are

relatively few countries with a clear specialisation in the indirectly driven employment – those which have above average indirectly driven employment and below average directly driven employment. Outliers in this group are New Zealand (due to dairy) and Malaysia (due to palm oil) as both products require processing prior to trade.

Figure 17. Shares of total workforce value from direct and indirect sources relative to world averages, 2014

Differences from averages for countries with agriculture sector total value added over USD 1 billion in 2014



Note: Directly driven represents employment from exports into GVCs from the agriculture sector of primary products, indirectly driven represents agricultural labour returns and thus employment embodied in non-agricultural sector exports that use agricultural domestic value added. Differences calculated at the country level where country results are compared with the global simple average for those with agricultural sectors that generate over USD1 billion in total value added (71 of the 141 countries and regions examined).
Source: Author estimates.

Testing the differences or similarities in the total employment contribution for countries in the different pathways is 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. Thus, when comparing average results, estimates may be biased so as to obscure the findings.

There are judgements to be made around "cut-offs". What level of agricultural sector input use makes a sector reliant on domestic agriculture and therefore makes the associated domestic value added from that sector in own exports part of the processing contribution for agriculture? For this study, all non-agricultural value added in exports from the food sectors is considered an indirect benefit that accrues to countries in the processing pathway (that is, food sector domestic 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 given the relatively small share of agricultural inputs into the production of these sectors' exports.[9]

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 of employment contribution from GVCs to build up a picture around the total benefits on offer across the two pathways. The averages 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 agriculture domestic value added weighted average*: This expresses the results on a basis that is more representative of the average agricultural sector in each pathway.[10]
- *Total export (trade) weighted average*: This expresses the results with a higher weighting towards those who export, so presents the indicator on a basis that is more representative of the average exporting agro-food sector in each pathway.

Comparisons of the results suggest that the employment effects on offer for countries across the two pathways are at least similar, if not greater, for those specialised in the primary pathway (Figure 18). On a simple and total value added weighted average basis, the employment (total workforce shares) generated by participation in agro-food GVCs is greater for countries specialised in the primary pathway.

Interestingly, there are smaller differences in the total employment value generated in the services and industrial sectors outside of agriculture and food across the pathways. In particular, there is no difference for industrials across all the measures highlighting the relatively similar usage of industrial sector inputs in agro-food (Greenville, Kawasaki and Beaujeu, 2017). For services, on both a simple and trade weighted basis there is little difference, but a 0.2% point difference on a total value added weighting basis. Thus, while the types of employment may differ – service inputs to the food sector versus those to the agriculture sector – the aggregate effects at the country level on these support sectors are similar.

The main differences exist in the shares generated from the agriculture or food sectors. As expected, agricultural employment value (as a share of total employment) for all measures is greater for countries specialised in the primary pathway. For those specialised in the

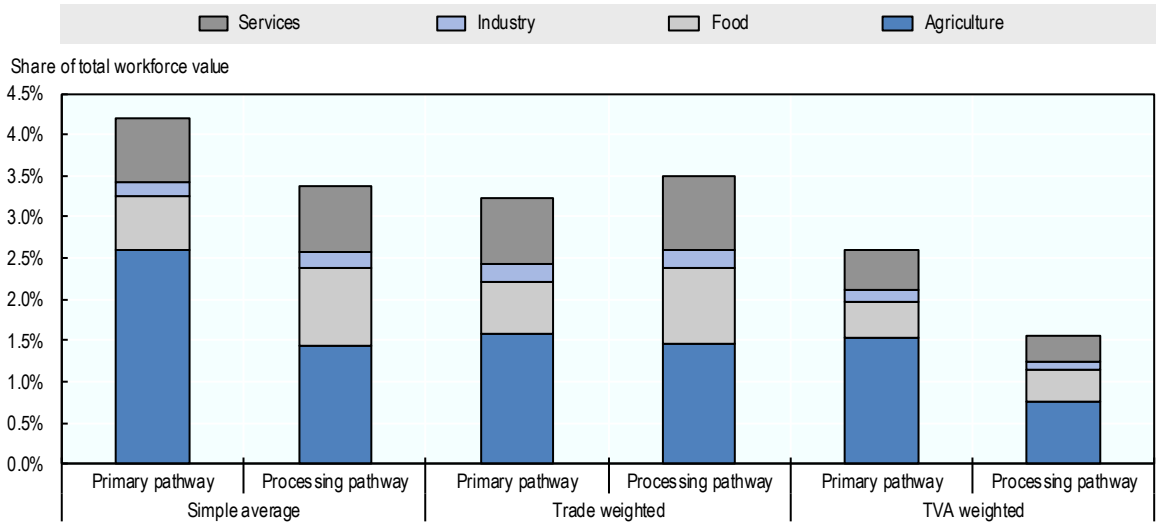
[9] In essence, with small shares it is assumed that these sectors could more easily source internationally for the required intermediate inputs. Other combinations were also assessed including the own sector value added and associated value added for the textiles and wood sectors. Including these sectors did not alter the results seen, however, the narrower definition has been maintained for this paper.

[10] Weighting data changes the way the data are viewed depending on the variable that is used to do the weighting. When using a total value added weighting, the observations from larger sectors are given more weight or count for more in calculating the average; thus, this average provides the average return for the average unit of agricultural output produced globally. This compares to the average a country using the simple average which shows the result for the average country, or that calculated from the trade weighted averages which show the result for the average trade agricultural product.

processing pathway, food sector employment from participation in agro-food GVCs contributes more to total economy employment, but only based on a simple and trade weighted basis (as expected).

Figure 18. Total workforce value created by GVC participation across the agricultural value adding pathways, 2014

Averages shares of total workforce value across countries identified as participating in the primary or processing pathway



Note: The primary and processing pathways are identified at the country. Those with the majority of agricultural domestic value added (and this labour returns) exported as primary products are defined to be in the primary pathway. Those with the majority of agricultural domestic value added (and thus labour returns) exported indirectly through domestic downstream processing sectors are defined to be in the processing pathway.
Source: Author estimates.

The key differences in the employment effects between the agriculture and food sectors in the pathways highlights the importance of comparative advantage. Exporting in the primary pathway, if no comparative advantage exists in food processing, can deliver similar economy wide employment effects by promoting greater employment in the agriculture sector itself. In other words, moving down the value chain may not be a value adding strategy for all countries; what matters is not the place in the value chain per se, but the extent to which the country is competitive in the activities in which it is engaged. GVCs intensify the importance of comparative advantage and provide a greater range of avenues in which countries can create niche comparative advantage, but they do not change the need for that comparative advantage.

7. Influences on employment in agro-food GVCs

There are various types of employment and employment linkages for agriculture created by agro-food GVCs. Greenville, Kawasaki and Jouanjean (2019) has shown that backward GVC participation contributes to growth in total domestic value added, adds in domestic value in exports and increases labour returns by reducing the returns to intermediates (via access to more productive and lower cost inputs). In view of these findings, this section explores the influence that different forms of GVC participation have on labour values generated through exports of primary products and exports of processed products. It will

take a closer look at the influence of policy settings on the shares of employment across channels and the growth in the returns to labour observed. In particular, two aspects of employment growth are explored:

- *Growth in labour returns for skilled and unskilled workers*: The role that backward and forward participation in both food and agriculture sectors, trade policy (tariffs) and domestic support (measured as subsidies to the sector) on the share of returns to labour and growth of returns to labour is explored. This analysis is completed at the country-sector level and covers 22 primary and processing sectors.
- *Growth and share of labour returns from primary versus processed products*: The role of GVC participation (forward and backward), tariffs and agricultural subsidies in influencing the share and growth of employment in agriculture generated from exports of primary and processed products is explored. This analysis is completed at the country-sector level and covers 14 primary sectors.

Full details of the results are provided in Annex C.

Growth in labour returns for skilled and unskilled workers

The analysis suggests that GVC participation is an important driver of growth in labour returns for both skilled and unskilled workers (Figure 19). In essence, greater participation in GVCs was found to promote total sector labour returns. The use of foreign value added in exports – backward participation – was positively related to growth in labour returns and increased the share of labour returns in total value added. The other measures of GVC engagement shown – share of value added in foreign final demand and diversity in imported input use – increased labour returns but did not influence the share of labour in total value added with the exception for diversity in imported inputs and unskilled labour. This suggests some substitution occurs between intermediate inputs and labour, yet the net result is still higher labour returns.

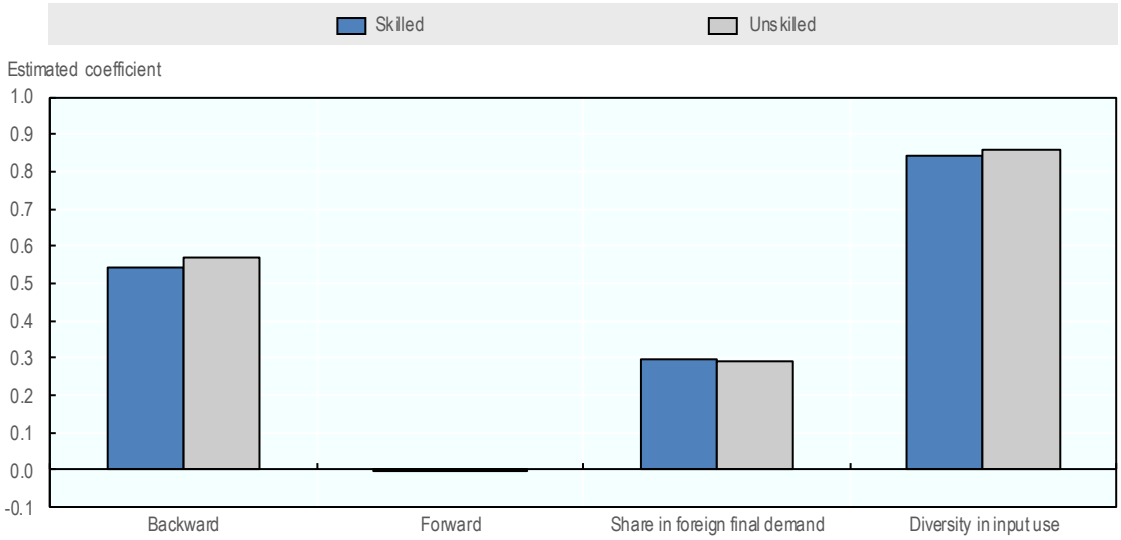
Forward participation, an indicator of participation in ongoing GVCs, was found to have a small negative effect on growth in labour returns, but less than the positive impact due to higher shares of domestic value added in foreign final demand. Thus, while there is a net positive impact, labour returns growth appears to be less strong in value chains with greater forward linkages than in others (possibly due to the associated product mix differences and labour intensities).

Overall, the results suggest that both market openness and GVC participation have the potential to grow labour returns over time, suggesting that GVC participation has a longer term impact on improving farmer returns beyond the immediate increase in market opportunities that might be created – akin to greater market access.

Limited effects were found for policy variables when examining skilled and unskilled labour returns separately. Increases in subsidies were found to have a small and negative impact on the share of labour returns in total input costs, suggesting that subsidies create a shift in value added away from labour – possibly to the use of intermediate inputs or the fixed factors of production such as land. Trade policy variables proved to be inconclusive in this analysis. However, evidence from Greenville et al. (2019) on the role of trade and domestic support policies on domestic value added returns using a different method point to the negative impact these policies can have on producers. Furthermore, the impacts of trade and domestic support policies are more likely to influence exports rather than total returns (see below).

Figure 19. GVC participation and growth in in the level of labour returns by skill category

Estimated coefficients of the effect on growth in the level of labour returns



Source: Author estimates.

Growth and share of labour returns from primary versus processed exports

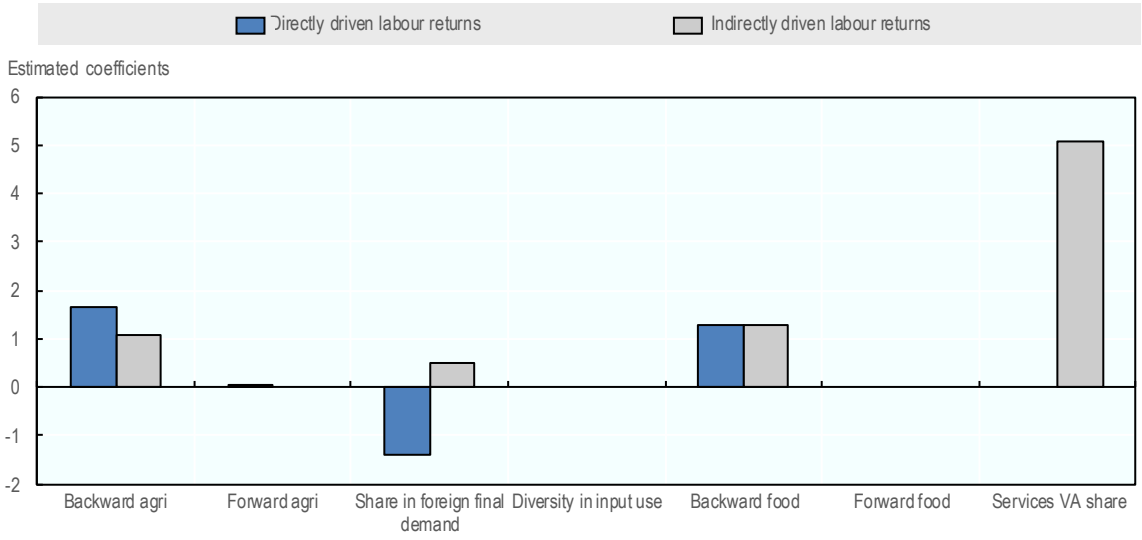
GVC participation was found to have a similar impact on growth in labour returns from both directly driven and indirectly driven exports (Figure 20). As with labour returns for skilled and unskilled workers, returns grew with the greater use of foreign value added in the agriculture and food sectors – that is, backward participation. However, while backward participation increased labour return growth for both, it also created a shift towards greater indirectly driven labour return (Annex C) – suggesting a transformation path may occur from the use of foreign factors (increases the potential for downstream activities).

Looking at the forward engagement variables – both forward participation and the share of value added in foreign final demand – shows a bias in the effects towards growth in indirectly driven labour returns. While forward participation of the agriculture sector was positively related to the directly driven returns growth, it was offset by the effects estimated for the share of value added in foreign final demand. As with the backward participation effects, there is evidence to suggest some transformation arising from GVC participation.

The use of services was found to have an impact on the growth of labour returns across agricultural sectors. Sectors with a higher use of services, measured as services share of total value added, experienced stronger growth labour returns that were indirectly driven versus directly driven. However, the estimated coefficient was positive for both, so less indicative of an offsetting impact. This translated to a higher share of labour returns from indirectly driven exports over time. Despite this, service shares have been shown to have a stronger impact on total agricultural domestic value added growth from primary exports (Greenville, Jouanjean and Kawasaki, 2019), suggesting that they may influence the value added input bundle used to produce primary exports, but not for those which flow through to domestic processing.

Figure 20. GVC participation and growth in the level of directly and indirectly driven labour returns

Estimated coefficients of the effect on growth in the level of labour returns



Source: Author estimates.

The growth of labour returns – either through direct exports of primary products or through indirect exports of processed products – was found to be negatively influenced by the use of distorting agricultural subsidies (input and output combined).[11] Increases in subsidies were found to have a negative impact on labour return growth between 2004 and 2014, suggesting these measures have an underlying negative impact on sector competitiveness and thus producer returns in the longer run. Furthermore, they are not seen to benefit one form of labour return over another, conferring no long run benefits to indirect-using sectors. As with the preceding analysis, limited findings were obtained on policy variables of interest.

8. Conclusions and policy implications

The integration of global food markets and the possibility for value added creation from participation in them has flow-on effects on labour and employment. The results from the analysis in this paper indicate that employment associated with trade in agro-food GVCs is significant. At the global level, trade in GVCs was responsible for between 20-26% of total agricultural workforce returns (depending on the measure used) in 2014. Across countries, several agricultural workforces are reliant on GVC participation. At one end, New Zealand has close to 73% of its agricultural workforce value generated by trade in GVCs, compared with Japan with around 3%.

Across agriculture, not all sector employment is equally reliant on trade in GVCs. Sectoral employment is greatest in the wool, oilseeds, and plant based fibres sectors which have 48%, 39% and 38% of sector employment respectively that is reliant on agro-food GVCs

[11] Distorting agricultural subsidies represent those provided directly to producers and do not include government service or public good provision to the sector as a whole.

(global averages). These sectors are those which feed most into other production activities – both food in the case of oilseeds, and manufacturing.

Beyond the agriculture sector, GVC participation by agriculture and food sectors creates employment in other sectors. In terms of exports, the employment spillovers from participation in agro-food GVCs appear to be greatest for supporting services sectors. Of the total returns to labour generated by agro-food exports, an average of 21% flows to the service sectors that support the production of primary and processed products. For food exports, this share is on average greater at 26%, compared to 19% for agricultural. The share of the industrial sector is relatively small in both agriculture and food sector exports – on average around 6% (approximately equal for agriculture and food exports).

Differences in the way that labour returns are created from trade and GVC participation are apparent. Sectors can create labour returns through direct exports of primary products, or labour returns can be generated from the use of agricultural value added in other sector exports – such as exports from the food sector. For the agriculture sector globally, the most important of the linkages to agro-food GVCs is the direct linkage. This link generates over 9% of total agricultural workforce value globally. The food sector provides the next most important link to agro-food GVCs, generating 5% of total agricultural labour returns. In other words, around 5% of agricultural sector employment (in value terms) is created by links between agriculture and its domestic food-processing sector which then links into agro-food GVCs. Following food sector linkages, on average, 3% of agricultural employment (value terms) is generated by domestic linkages to exporting industrials sectors that are major users of agricultural inputs – textiles, wood, leather and chemicals, rubber and plastics. In total, 10% of the GVC related agriculture jobs are reliant on domestic linkages (compared with 19.1% overall).

However, the greater share of employment through indirect linkages does not mean domestic processing is required to gain the most overall in terms of employment value creation from GVC participation. Contrasting countries based on whether the majority of returns are from direct exports of primary products (primary pathway) versus exports of processed products (processing pathway) reveal that the total employment impacts are similar. In terms of total workforce effects from all sectors, the employment effect generated by participation in agro-food GVCs for countries specialised in the primary pathway is higher or the same as for those specialised in the processing pathway depending on the metric used.

The results from this analysis have implications for overall employment or labour value creation from GVC participation.

- At the country level, specialising in exports of primary sector products as the key input into GVCs (the "primary adding pathway") has the potential to generate greater or at least as much returns to labour value compared to the employment effects from specialising in exports of processed products as the link to GVCs (the "processing value adding pathway").
- Countries can add value to primary production within a GVC context and generate returns to labour overall similar to those generated from moving down the value chain (as seen for total domestic value added more broadly). Policies that use market and trade distorting measures to "push" GVC participation towards processing sectors may therefore reduce the total benefits possible from agro-food GVCs.

- As the sectoral composition of labour returns is different between primary and processing pathways, there could be differences in the where jobs are created (or maintained). In the primary pathway, a much greater share of the total labour returns accrues to agriculture, as opposed to food. Furthermore, while the service sector labour returns are similar for the primary and processing pathways, as services are provided at differing stages of production – to agriculture versus food – the location of these jobs may vary in accordance with the location of food sector versus agricultural sector activity.
- For both pathways, the importance of other domestic sectors as conduits and supports for agricultural employment is apparent. Furthermore, for either pathway, there appears to be a link between more indirect value chains serving domestic final demand and GVC employment (and value added) returns. Thus, employment and value creation from agro-food GVCs has clear domestic sector underpinnings.

On GVC engagement specifically, greater participation and market openness were found to promote labour returns for both skilled and unskilled workers. GVC engagement has positive impacts on labour returns from both direct exports from agriculture and those that occur indirectly through other sectors. The impacts on the mix of directly driven labour returns from primary sector exports, and those from indirectly driven processing sector inputs, suggest a transformation impact from GVC participation. GVC participation appears to provide greater growth in indirectly driven labour returns by promoting processing sector exports. As part of this is the need for the processing food sector to be open to foreign inputs, barriers to agricultural trade may negate this positive transformation effect.

While this study found limited evidence on policy impacts, agricultural subsidies – both output and input related – were found to have a negative impact on labour returns from primary sector exports and returns generated indirectly from processing sector exports. This suggests that subsidies have a longer run negative impact on growth opportunities from trade by reducing the competitiveness of the agriculture and food sectors.

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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	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	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

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).

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 (less than USD 10 million) are dropped from the regressions.

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 for model variables

Variable name	Mean	Std. Dev.	Min	Max	Description
Dependent variables					
Unskilled labour share	0.156	0.126	0.001	0.685	The share of value added by unskilled labour in total gross input
Skilled labour share	0.038	0.048	0.000	0.608	The share of value added by skilled labour in total gross input
Labour return from direct export	0.159	0.202	0.000	0.980	The share of labour return from direct export in total labour return (export and domestic sales)
Labour return from indirect export	0.106	0.112	7E-06	0.651	The share of labour return from indirect export in total labour return (export and domestic sales)
Regressors					
Backward	0.206	0.126	0.001	0.726	Backward indicator
Forward	0.945	2.946	0.000	29.11	Forward indicator
Tariffs faced	7.069	15.295	0.000	250.0	Average tariff faced (weighted by export value. %)
SPS faced	1.471	7.090	0.000	128.0	# of SPS faced
TBT faced	0.689	4.933	0.000	100.0	# of TBT faced
Tariffs charged	9.949	26.536	0.000	485.9	Average tariff charged (weighted by import value. %)
SPS charged	1.561	10.416	0.000	225.0	# of SPS charged
TBT charged	0.502	6.016	0.000	184.0	# of TBT charged
DVA in foreign demand	0.307	0.249	0.001	0.996	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	0.113	0.067	0.000	0.405	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	0.014	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	0.043	0.084	0.000	0.638	Subsidy received (for output, input, and production factors) divided by gross output value.
Backward of food sectors	0.241	0.108	0.016	0.670	Backward indicator of food sectors (weighted by agricultural sector's value-added used by each food sector)
Forward of food sectors	0.144	0.529	0.001	9.559	Forward indicator of food sectors (weighted by agricultural sector's value-added used by each food sector)

Table A C.2. Detailed results from labour growth and share in total input model

	Unskilled labour	Skilled labour	Unskilled labour	Skilled labour
	(log. difference)		(share. difference)	
Backward	0.542	0.570	0.034	0.012
	[4.35]***	[4.50]***	[4.35]***	[3.33]***
Forward	-0.002199	-0.002115	0.000065	0.000009
	[-2.05]**	[-2.00]**	[1.33]	[0.75]
Tariffs faced	0.000120	0.000178	0.000005	0.000005
	[0.42]	[0.63]	[0.65]	[1.32]
SPS faced	-0.000035	-0.000023	0.000015	-0.000006
	[-0.03]	[-0.02]	[0.48]	[-0.33]
TBT faced	0.000984	0.000966	-0.000004	-0.000010
	[1.82]*	[1.80]*	[-0.36]	[-1.18]
Subsidy per output	-0.002310	-0.001935	-0.000408	-0.000081
(log. difference)	[-0.69]	[-0.57]	[-2.62]***	[-1.93]*
DVA in foreign demand	0.298	0.292	0.001844	0.000333
(difference)	[5.32]***	[5.37]***	[1.01]	[0.53]
Service share	-0.109	-0.016	-0.079	-0.044
(difference)	[-0.13]	[-0.02]	[-2.20]**	[-1.07]
Imported inputs concentration	-0.842	-0.859	-0.041	-0.008
(difference)	[-2.56]**	[-2.56]**	[-2.82]***	[-1.53]
Tariffs charged	-0.000190	-0.000177	0.000002	-0.000002
(difference)	[-1.55]	[-1.43]	[0.45]	[-0.77]
SPS charged	0.000106	0.000109	0.000001	0.000000
(difference)	[0.87]	[0.89]	[0.14]	[0.29]
TBT charged	-0.000100	-0.000103	0.000001	-0.000002
(difference)	[-0.73]	[-0.74]	[0.14]	[-1.20]
Observations	2248	2248	2248	2248
R-squared	0.607	0.606	0.517	0.654

Note: The sample covers all agricultural and food processing sectors (sectors 1-14 and 19-26 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 input cost (payments for intermediates, land, labour, capital, and natural resources). *10%, **5% and ***1% level of significance.

Table A C.3. Detailed results from growth in labour returns through directly and indirectly driven exports model

	Direct export	Indirect export	Direct export	Indirect export
	(log. difference)		(share. difference)	
Backward	1.640	1.060	0.143	0.105
	[1.72]*	[3.14]***	[1.58]	[2.42]**
Forward	0.03152	-0.00243	0.00027	-0.00021
	[3.63]***	[-0.98]	[0.86]	[-0.96]
Tariffs faced	0.00076	0.00002	0.00006	0.00002
	[0.65]	[0.07]	[0.81]	[0.55]
SPS faced	0.00147	0.00010	-0.00026	0.00003
	[0.39]	[0.05]	[-0.82]	[0.25]
TBT faced	0.00474	0.00034	0.00039	-0.00006
	[2.70]***	[0.41]	[2.57]**	[-0.98]
Subsidy per output	-0.01601	-0.01849	-0.00321	-0.00181
(log. difference)	[-3.27]***	[-4.66]***	[-4.24]***	[-5.07]***
DVA in foreign demand	-1.39	0.49	-0.29	0.04
	[-7.55]***	[4.60]***	[-12.53]***	[3.59]***
Service share	2.92	5.09	0.33	0.29
	[0.98]	[3.51]***	[1.02]	[2.46]**
Imported inputs concentration	-1.00	0.41	0.02	0.35
(difference)	[-0.63]	[0.60]	[0.13]	[2.35]**
Tariffs charged	0.00026	-0.00024	0.00005	0.00000
(difference)	[0.51]	[-1.01]	[1.18]	[0.22]
SPS charged	0.00203	0.00007	0.00004	-0.00001
(difference)	[2.24]**	[0.33]	[1.03]	[-1.51]
TBT charged	-0.00055	-0.00009	0.00009	0.00001
(difference)	[-0.39]	[-0.61]	[0.66]	[0.37]
Backward of food sectors	1.270	1.270	-0.034	0.115
	[1.72]*	[3.71]***	[-0.55]	[2.98]***
Forward of food sectors	-0.072	0.226	-0.038	0.022
	[-0.13]	[1.32]	[-0.96]	[1.88]*
Observations	1516	1516	1516	1516
R-squared	0.403	0.545	0.566	0.423

Note: The sample covers all agricultural sectors (sectors 1-14 of GTAP classification). Food sectors represent GTAP sectors 19-26. 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 labour return (returns from export and domestic sales). *10%, **5% and ***1% level of significance.