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The Labor Content of Exports Database

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Abstract

This paper develops a novel methodology to measure the quantity of jobs and value of wages embodied in exports for a large number of countries and sectors for intermittent years between 1995 and 2011. The resulting Labor Content of Exports database allows the examination of the direct contribution of labor to exports as well as the indirect contribution via other sectors of the economy for skilled and unskilled labor. The analysis of the new data sets documents several new findings. First, the global share of labor value added in exports has been declining globally since 1995, but it has increased in low-income countries. Second, in line with the standard Heckscher-Ohlin trade model, the composition of labor directly contained in exports is skewed toward skilled labor in high-income countries relative to developing countries. However, that is not the case for the indirect labor content of exports. Third, manufacturing exports are a key source of labor demand in other sectors, especially in middle- and low-income countries. And the majority of the indirect demand for labor spurred by exports is in services sectors, whose workers are the largest beneficiaries of exporting activities globally. Fourth, differences in the labor value added in exports share across developing countries appears to be driven more by differences in the composition of exports rather than in sector labor intensities. Finally, average wages typically increase rapidly enough with the process of economic development to more than compensate the loss in jobs per unit of exports. The paper also includes the necessary information to build the Labor Content of Exports database from the original raw data, including stata do-files and matlab files, as well as descriptions of the variables in the data set.

This paper is a product of the Trade and Competitiveness Global Practice Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at mcali@worldbank.org.

The Labor Content of Exports Database[1]

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1. Introduction

Trade – and exports in particular – play a crucial role in supporting jobs and increasing labor earnings, consistent with the fact that 90% of jobs in the developing world are associated with private sector activities (World Bank, 2012). This role of exports is particularly important as jobs and labor earnings are key drivers of poverty reduction and increased shared prosperity in many developing countries (Azevedo et al., 2013). Indeed export growth played a significant role in the dramatic reduction in poverty rates in East Asian countries in recent decades.[2]

Despite this, systematic data on the contribution of exports to employment and labor earnings across countries and sectors is not readily available, particularly for developing countries. How much labor income is supported by automotive exports in South Africa? How much of that is via linkages to sectors providing inputs for automotive? How many domestic jobs does $1 million of processed food exports support in Brazil? Is that higher than in comparator countries? Answers to such questions are typically not readily available. Yet this information matters. First, such information would provide some reference to the relative importance of exports for employment and wages in specific countries and sectors. Second, it would shed light on the extent to which the interconnections between sectors matter for jobs and wages supported by exports. However for the majority of governments in developing countries today, it is difficult to know how many jobs and what size of earnings their countries' exports support domestically, let alone the contribution of individual export sectors.

This paper helps fill this gap by computing the domestic value of labor (i.e. total wages) and the number of jobs contained in exports for a large sample of developed and developing countries and sectors for intermittent years between 1995 and 2011.[3] The resulting Labor Content of Exports (LACEX) database, consisting of two data sets on the labor value added and the jobs content of exports, decomposes the contribution of jobs and wages to exports separately through their direct and indirect components (including both forward and backward linkages), and by skilled and unskilled labor. Doing so illustrates the broader, economy-wide relationship between trade and labor market outcomes. With the LACEX database in hand, the paper then presents stylized facts of how the labor and jobs content of exports have changed over time, and potential drivers of this change by comparing across sectors and countries based on income level and region.

The paper is related to some recent efforts to quantify the labor and jobs content of exports across countries. Timmer et al. (2013) provide an estimation of the number of jobs directly and indirectly related to manufacturing output (rather than exports) using the World Input-Output Database (WIOD). Their focus is almost exclusively on high income countries, and the EU27 countries in particular. Using similar methods and the same data, Jiang and Milberg (2013) estimate the (direct and indirect) labor content of exports for a panel of mainly high income countries at the aggregate level. Stone et al. (2011) compute the factor content of trade, including also skilled and unskilled labor for OECD countries as well as for some emerging countries. Their factor content does not distinguish between domestic and foreign.

Other studies investigate the impact of exports on the number of jobs within countries. The US Department of Commerce (2010) has begun to quantify the number of jobs that exports support in the American economy both directly and indirectly. Kucera et al. (2012) investigate the impact of the recent crisis through exports on employment in India and South Africa by computing the employment content of sectoral exports, including also employment via household expenditure due to export-related earnings.

[2] For example, the boom in Vietnamese exports to the United States following the US–Vietnam Bilateral Trade Agreement of 2001 led to a large reduction in poverty (McCaig, 2011).
[3] In the remainder of the paper we refer interchangeably to total wages, total labor value added, total compensation to employees, and total labor contained in exports.

This paper expands on this literature by combining data on several cross sections of global input-output (IO) tables, social accounting matrices and exports to construct the labor content of exports, and employment data to construct the jobs content of exports. The first three types of data come from the Global Trade Analysis Project (GTAP), which covers a wide range of countries, including many developing countries. The employment data come from the International Labor Office (ILO) statistics. The combination of these data allows for a wider coverage of developing countries and sectors than previous studies. The labor content of exports data for 2011 cover 57 sectors and 120 countries, 74 of which are developing and comprise over 90% of all developing countries' population (see Appendix 1 for the sector coverage and Appendix 2 for the country coverage). The sectoral and country coverage is more limited for the jobs content of exports due to the restrictions imposed by employment data availability. The data in this case comprise 73 countries in 2001 but only 66 in 2011 and are available for 11 sectors. The resulting database splits the labor content into skilled and unskilled, as well as into the wages paid and jobs used directly for the production of exports or indirectly via the production of inputs for export production. We also use gross output in place of exports to construct the labor and jobs content of domestic production. (See Appendix 3 for the steps needed to reconstruct the LACEX database from GTAP and Appendix 4 for the list of variables in the LACEX database.[4])

The resulting LACEX database is a valuable tool to describe the extent to which exports support jobs and wages in an economy, in specific sectors and over time. On the other hand such data are not meant to be used for policy analysis, for example to assess the possible labor market effects of a policy promoting specific sectors' exports. The data are a representation of equilibrium outcomes, where firms have made input choices, given technology, output prices, labor market institutions as well as other relevant policies, and input prices. Because of that, the data are ill suited to predict the effect of a policy that changed this equilibrium in one way or another.

The analysis using the new LACEX data sets documents a number of new findings. First, the global share of labor value added embodied in gross exports (LVAX share or the labor intensity of exports) has been declining since 1995, when the total value of wages was $46 for each $100 of gross exports while in 2011 the value was $40. This decline is driven by a drop in high income countries as the LVAX share has remained flat in middle income countries, and has increased in low income countries. Overall the number of jobs supported by gross exports (JobX) has declined more rapidly than the labor value added in exports, a result consistent with labor saving technological changes across countries. It has also declined more rapidly in middle income than in high income countries. This decline notwithstanding, our data suggest that exports supported over 20% of total employment for the sample of 66 countries with data available in 2011.

Second, the labor value added directly contained in exports has declined over the past two decades. This result is not a reflection of changes in the share of labor value added in output (LVAD), which in fact has remained stable over the period. This difference between the direct LVAX share and direct LVAD share is thus mainly due to the different changes in the composition of exports versus output. The direct LVAX share has declined in high income and to some extent in middle income countries and has been flat in low income countries. On the other hand the indirect LVAX share has remained flat through the period, slightly declining in high income and increasing in developing countries. This is consistent with two opposite trends over the past two decades: first, countries have overall become more integrated in GVCs, where an increasing share of foreign value added (including labor) is embodied within countries' exports via imported inputs, which would reduce the indirect labor value added in exports; second, coordinating these inputs requires more intensive use of (mainly domestic) services, which would increase the indirect content of domestic labor. We find a decline in the total value added share in exports, while the total labor share in exported value added increased. In contrast, we find declines in both the direct labor share in exported

[4] The LACEX data sets can be accessed at: http://data.worldbank.org/data-catalog/lacex.

value added and the direct value added share in exports. This suggests that the share of indirect labor value added in total exported value added has increased.

Third, in line with the standard Hecksher-Ohlin trade model, the composition of labor directly contained in exports is skewed towards skilled labor in high income countries relative to developing countries. However that is not the case for the indirect labor content of exports, where the skill composition is similar across income groups. This suggests that sectors providing domestic inputs to exports are less subject to the comparative advantage rule than the export sectors themselves. Thus skilled labor in developing countries appears to be relatively more important for the inputs to the exports than for the exports themselves.

Fourth, much of the indirect demand for labor spurred by exports is in services. Overall, the labor value added in services contained in exports (directly and indirectly) is larger than the entire value of gross services exports. This is consistent with total services value added (Francois et al., 2013). The ratio of the former to the latter has increased rapidly in developing countries over the past two decades, consistent with the increase in indirect labor demand from exports in developing countries. This confirms the increasing importance of services as enablers of export competitiveness in developing countries.

Fifth, manufacturing exports are a key source of labor demand in other sectors, especially in middle- and low-income countries. Each US$1 of manufacturing export supports a higher level of wages and more jobs in sectors providing domestic inputs to manufacturing than in the manufacturing sector itself. This pattern is particularly important in developing countries, where the labor intensity of manufacturing exports has increased markedly between 1995 and 2011 (the opposite trend for high income countries). This finding not only underscores the importance of the manufacturing sector's backward linkages to support jobs and wages in developing countries, but it also highlights the relevance of skills in other sectors for the development of manufacturing exports. Chinese machinery and equipment exports are a case in point. These dramatically increased the demand for labor particularly in domestic input-providing sectors. As a result, the share of domestic wages per $100 of machinery exports almost doubled from $23 in 1995 to almost $40 in 2011.

Sixth, differences in the LVAX share across developing countries appear to be driven more by differences in the composition of exports rather than in sectoral labor intensities. Indeed the Middle East and Northern Africa (MENA) region has the lowest LVAX share, a result consistent with the dominance of capital intensive extractive exports with little linkages with the domestic economies. On the other hand, the labor intensity among developing countries is highest in East Asia and the Pacific (EAP), consistent with its export sector dominated by labor intensive manufacturing and - particularly in China - increasing linkages with the domestic economy. The share of direct labor value added in exports is highest in South Asia, a reflection of the large share of exports – particularly in India – concentrated in relatively skill intensive services sectors that exhibit a high direct labor content and few backward linkages.

Seventh, unlike the levels of the LVAX share, the change in the LVAX share between 2004 and 2011 was mainly driven by changes in sectoral labor intensities rather than by changes in the sectoral composition of exports. In particular, the sectoral labor intensity of developing countries' exports generally increased – mostly the result of the increase in labor demand in input providing sectors. In most cases this effect prevailed over the compositional shift towards less labor intensive industries, which is consistent with the increase in minerals' commodity prices during most of the period.

Eighth, the job intensity of exports is inversely related with a country's income per capita, while the opposite is true for the wage intensity of exports; as countries develop economically, the labor value added share in their exports increases and the jobs share decreases. These contrasting results suggest that average wages increase rapidly enough with the process of economic development to more than compensate the loss in jobs per unit of exports.

The remainder of this paper is organized as follows. The second section discusses the methodology and data used to measure and labor and jobs content of exports to construct the LACEX database. The third section discusses how the labor content of exports has evolved globally, and the fourth section turns attention to the jobs content. These developments are explored across income groups and regions, sectors, as well as at the country level. The concluding remarks are in the fifth section of the paper.

2. Data and methodology

We compute the labor value added and jobs content of exports on the basis of a panel of global IO and other aggregate data from the Global Trade Analysis Project (GTAP). GTAP represents a massive combined effort of international institutions and universities. Over time, the data set has grown to include more countries and more sectors. The latest version, GTAP 9, has data on 129 countries/regions and 57 sectors (Narayanan et al., 2012). Table A1 in Appendix 1 provides the description of the 57 GTAP sectors.

Why GTAP

Although recent years have seen the emergence of different databases of global IO tables, we believe the GTAP data offer a balance between quality and country coverage, making it more suitable than other alternatives for our purposes. There are at least three other databases that could be used to compute the labor contained in exports: the World Input-Output Database (WIOD), the OECD-WTO Trade in Value Added (TiVA) Database and the UNCTAD-Eora Database. These data differ in their coverage of countries, sectors, and years as well as in overall accuracy.[5] WIOD and TiVA include a limited number of developing countries, although they account for most of world trade in value added, which is generated by high income countries. Because they comprise only high income or large middle income countries, these databases tend to have great levels of accuracy. On the other hand, the Eora database has the widest country coverage, with 187 countries in total, but only 25 sectors. However, the data at this stage do not ensure consistency in terms of aggregation and reconciliation of trade flows. This can generate problems of imbalances in the data, which can be particularly relevant for smaller developing countries.[6]

GTAP data strike a balance between the accuracy of the data (including a rigorous submission process for national IO tables), the global consistency of the national account and trade data across countries, and the relatively wide coverage of developing countries. GTAP uses various data sources and estimates missing data. The GTAP IO data also include social accounting matrices that cover additional countries where no official IO tables are available. While the global coverage is smaller than Eora (120 versus 187 countries), the countries covered in the GTAP data account for over 90% of developing countries' population.[7] In addition, GTAP disaggregates the factors of production into skilled and unskilled labor.

There are also certain drawbacks in using GTAP to compute such data, which should be acknowledged upfront. The quality of the data critically hinges on the underlying IO tables and social accounting matrices that each country produces autonomously. While GTAP researchers check and validate these data before using it, their quality cannot be fully observed. That can be a problem especially for certain sectors in specific countries. A second problem relates to the frequency of the data. As the production of GTAP data is complex (it needs global consistency and requires multiple data inputs and iterations), its frequency is not regular and the data suffer from non-negligible time lags. For example, the latest data currently available are from 2011. For these reasons, in the future it will be important to reconcile GTAP with the

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[5] See Tukker and Dietzenbacher (2013) for a review comparing the various databases.

[6] The Eora developers explain that "for some sectors imbalance remains. Generally this imbalance is small, e.g. <5% for bigger economies, but can be up to 20% (IIRC) in the worst case sectors, e.g. manufactured goods from Mongolia, or similar sectors where we have poor or conflicting input data" (http://worldmrio.com/EoraFAQ.pdf).

[7] In the longer term, as the database matures, and assuming it shows a pattern of regular updating, one may consider moving partially or fully to Eora for updating of the database developed herein.

various existing data, such as TiVA and Eora, from which the labor value added in exports can be extracted, and which can help increase the frequency of the data and improve their quality.

Computing the labor value added content of exports

We work with multiple versions of the GTAP database, benchmarked to 1995, 1997, 2001, 2004, 2007 and 2011. To maintain backward compatibility, we start with the 1995 structure of sectors, and carry this forward in aggregation of more recent iterations of the database. To do so, we aggregate the 57 GTAP sectors into 24 sectors, which also allows ease of exposition of the results. (Table A2 in Appendix 1 provides the concordance between the 24 and 57 sectors.) We also generate the data with the 57 sectors from 1997 onwards. Our database excludes the regional aggregates in GTAP, resulting in 31 countries in 1995 expanding to 120 countries in 2011.

The IO tables in the GTAP data set allow one to exploit a form of social-accounting data – a variation on the social accounting matrix (SAM) where incomes are shown in the rows of the SAM while expenditures are shown in the columns (Hertel, 2013 and McDougall, 2001). The structure of the data provides a comprehensive and consistent record of national income accounting relationships between different sectors of an economy. It is based on a fundamental, general equilibrium principle of economics – every income (receipt) has a corresponding expenditure (outlay). The strength of this framework is that it provides a comprehensive record of the interrelationships of an economy, including intermediate and final demand linkages. For our purposes, it offers the advantage of linking consumption and external trade patterns explicitly to the inter-industry structure of intermediate demand. This allows for a fuller analysis than is possible when working strictly with IO tables.

We also make one adjustment to the data to ensure compatibility of the skilled-unskilled labor split over the years. All the versions of the GTAP data up to 2007 use only two types of labor – skilled and unskilled – while the latest version for 2011 (GTAP 9) classifies labor into five groups of occupational categories, such as officials and managers and service/shop workers (see Table A6 in Appendix 3). We checked that these categories cannot be reconciled with previous versions (see Figure A1 in Appendix 3), and instead exploit the fact that in previous versions of the data set the ratio of skilled-unskilled labor value added is constant over time for a specific country-sector pair.[8] Thus we apply the same skilled-unskilled labor value added ratio for each of these pairs to the 2011 data.

Since the GTAP database tracks interrelationships of an economy both for intermediate use and final demand (including exports), this complex structure of the database allows us to obtain the total value added content of final output and exports, including the compensation of employees' component. This includes both the direct and indirect value added, based on the linkages of each sector with all other sectors in the economy. We can obtain both forward and backward linkages, where forward linkages count the value added of a given sector that goes into other sectors, while backward linkages count all the value added from other sectors that go into a given sector. Thus we can also account specifically for the direct value added attributable to labor, indirect value added (via backward or forward linkages), and total value added (the summation of direct and indirect value added via backward or forward linkages). We can further distinguish between the labor contributions from skilled and unskilled workers. Finally, we repeat the exercise for total final output as well as final output that is exported. This is explained in what follows more formally.

In order to obtain these labor value added measures, we first need to calculate intermediate multiplier matrixes that will be then used to multiply exports and final outputs. We begin by denoting a representation of intermediate and final demands as follows:

[8] Results of this comparison are available upon request.

$$Y = Z — AZ \quad (1)$$

In equation (1), the term Y denotes a final demand vector, Z denotes a gross output vector, and A denotes a matrix of intermediate use coefficients, which can be calculated using data from IO tables. Equation (1) therefore defines final output with respect to intermediate input requirements.

The first matrix that is calculated is the widely used Leontief inverse matrix, also known as the multiplier matrix M. With some manipulation we arrive at the Leontief inverse matrix:

$$Z = (I - A)^{-1}Y = MY \quad (2)$$

The multiplier matrix M measures the inputs contained in a unit of final output. This M matrix contains both direct and indirect inputs. In particular, if we assign the sector indexes i,j to the M matrix, then a representative element of the M matrix, M_{ij}, gives the direct and indirect inputs (and thus receipts) of sector i linked to each unit (for example each dollar) of sector j receipts in the data. This implies real production activities measured by value of output. For our purposes, it provides a means to trace through these income flows, the flow of gross activity (and eventually labor value added) from intermediate to final goods and services, ostensibly across borders as well as sectors. Because linkages will vary by industry, each industry will be characterized by different multipliers.

Next, we need to calculate a diagonal matrix that measures the labor value added (compensation of employees) share of total gross output, which can be calculated using data from SAMs. To focus on labor value added, rather than gross activity, we note first that in terms of gross output values Z, some share of this involves labor value added within each sector. We define $\hat{B}$ as the diagonal matrix indexed over i,j with diagonal elements equal to the compensation of employees' shares of output Z. These shares can be split between types of workers (e.g. skilled/unskilled).

We then use M and $\hat{B}$ to provide a breakdown of the flow of labor value added across activities in the form of the matrix V:

$$V = \hat{B}M \quad (3)$$

Similar to the Leontief inverse matrix itself, the V matrix identifies the inputs of labor value added in each sector related to a unit of final demand.

Using the V matrix as a multiplier for exports and final outputs, one can obtain the total labor value added of exports and final outputs, respectively. If we multiply V by the diagonal matrix $\hat{Y}$ whose non-zero elements are the vector of final demand, the matrix yields a breakdown of economy-wide labor value added (both direct and indirect) (the primary component of Gross National Product on a source basis). Similarly, if we multiply V by the diagonal matrix $\hat{X}$ whose non-zero elements are the national export vector, we can recover the labor value added content of exports X (both direct and indirect).

$$G = V\hat{Y} \quad (4)$$

$$H = V\hat{X} \quad (5)$$

The G matrix and the H matrix thus give us the set of linkages, both direct and indirect, between value added across sectors for total domestic demand and export demand, respectively.

Computing the jobs content of exports

We are also interested in the jobs content of exports. In order to compute that one would ideally need to split the compensation of employees between the number of jobs and the average wage. However this split

is not available in the underlying national account data used in GTAP. The next best thing was to use sectoral employment data that matches the GTAP data.

The United Nations Industrial Development Organization (UNIDO) provides such employment data at a relatively high level of disaggregation (4-digit ISIC sector) for a large number of countries and years but the data are only available for the industrial sector. Therefore we resort to the ILO statistics, which compile sectoral employment data for various countries and years. However the country and sectoral coverage is considerably more limited than that of GTAP, which reduces the number of countries and sectors for which the jobs content of exports is available. In particular, the prevailing aggregation of sectors in the ILO statistics consists of 11 sectors (see Table A3 in Appendix 1), which we match with the original GTAP sectors.

We replace the diagonal matrix of the compensation of employees in total output $\hat{B}$ with the equivalent matrix of employment in output $\hat{E}$, which is obtained by the number of employees per total output Z. By replacing $\hat{B}$ with $\hat{E}$ in equation (3) we can compute the J matrix $J = \hat{E}M$ and then derive the counterparts of the G and H matrixes in terms of jobs contained in output and exports. Appendix 3 lists the steps needed to reconstruct the LACEX database from GTAP and Appendix 4 for the list of variables in the labor value added and jobs content of exports data sets.

One drawback of this approach is that the employment data are not always consistent with the compensation of employees data used to compute the labor content of exports. The original source of the former is typically national labor force surveys. These are often not easily reconcilable with national account data, which are the source of compensation of employees data. This discrepancy is particularly acute at the sectoral level also due to the different sectoral classifications of the two sources of data, ultimately making the labor and jobs content of exports data not strictly comparable at the sectoral level.[9] However, this method allows both the labor and jobs content of exports to be consistent with the national account and labor force survey data, respectively.

3. Global patterns of wages in exports

3.1. Global patterns of labor value added across income groups and regions

We start by discussing global patterns of total wages linked to exports, followed by some cross-country comparisons.[10] We examine the labor content of exports both in terms of their direct and indirect value added.[11] The labor content of exports is measured as nominal values in US$ (denoted LVAX), and as a share of gross exports (LVAX share), which is a measure of the labor intensity of a country's or sector's exports. We also use our measures of the labor content of domestic output (denoted LVAD).

Error! Reference source not found. shows that the global share of total labor value added in the value of gross exports (LVAX share) has been in constant decline since 1995. In 1995, the total (direct plus indirect) value of wages was \$46 for each \$100 of gross exports and in 2011 the value was \$40.[12] The direct value

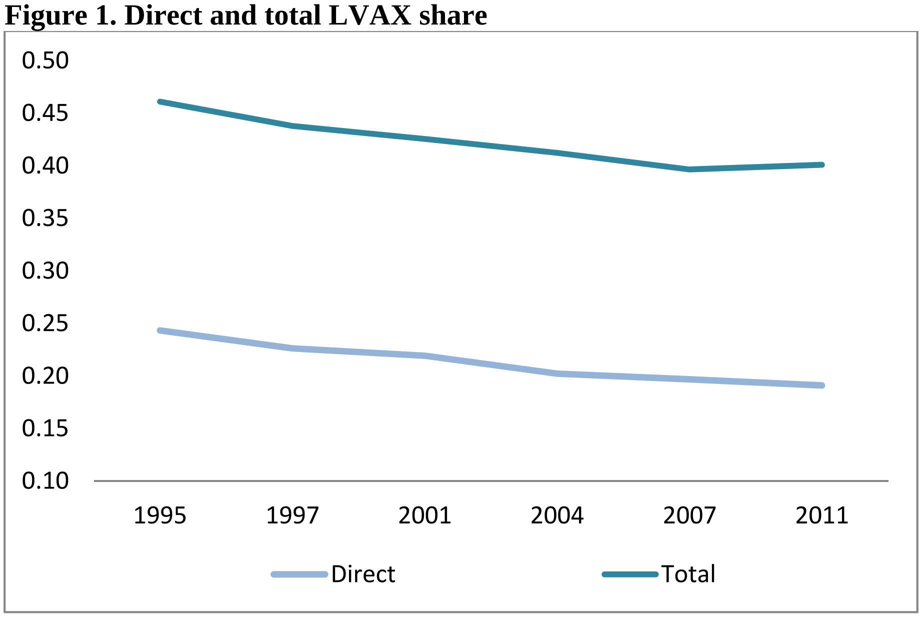
[9] To check this we compute the sectoral average wage for laborers by dividing the total compensation of employees by the total number of employees. For several country-sector pairs this computation generates unreasonably high or low average wage values.
[10] We do not provide global trends for jobs given the limited availability of the data for several countries.
[11] Where indirect value added can take into account either the indirect contribution via backward or forward linkages to exports, we focus on the backward linkages in this report unless otherwise noted. Total value added accounts for both the direct and indirect value added. At the country level, the indirect value added is the same when considering either the forward or backward linkages.
[12] According to the TiVA Database, the trade-weighted average share of foreign value added in gross exports across all countries in the world in 2011 is 25%. Combined with our estimates, this suggests the domestic capital value added share of gross exports is 35%.

added of labor is roughly half of the total value added of labor in exports and has declined more steeply than the indirect value added, going from $24 for each $100 of gross exports in 1995 to $19 in 2011. This drop in fact explains almost entirely the drop in LVAX share with the indirect share constant. These results are based on the export-weighted average LVAX share at the country level of a balanced sample of 31 mainly large economies for which we have data throughout the period (equivalent to the global sum of LVAX in global exports). The decline would be steeper if we included all countries in the database (results not shown here), implying that the composition of the sample changed to include more countries with relatively lower LVAX shares.

The decrease in the share of direct labor value added in gross exports is consistent with labor saving technological changes across countries, with a substitution away from labor to capital for domestic export production. Conversely the flat trend in the indirect labor content of exports is also consistent with two opposite trends: on the one hand, over the past two decades countries have become more integrated in global value chains (GVCs), where an increasing share of foreign value added (including labor) is embodied within countries' exports via imported inputs. On the other hand, coordinating these inputs requires more intensive use of (mainly domestic) services, including financial services, transport and logistics, and other business services. The automotive sector in middle-income countries illustrates these concomitant trends well (Farole, 2016).

Within this long-term declining trend, the data also show a slight increase in the total LVAX share between 2007 and 2011. This is consistent with other findings that countries' domestic value added contained in exports across all factors including labor has tended to decrease over time, but increased during the 2008-09 global crisis (Stehrer et al., 2012). Notably, however, the direct LVAX share continued to decline even between 2007 and 2011, implying that indirect labor value added became relatively more important to the labor content contained in countries' gross exports during the crisis period.

Figure 1. Direct and total LVAX share

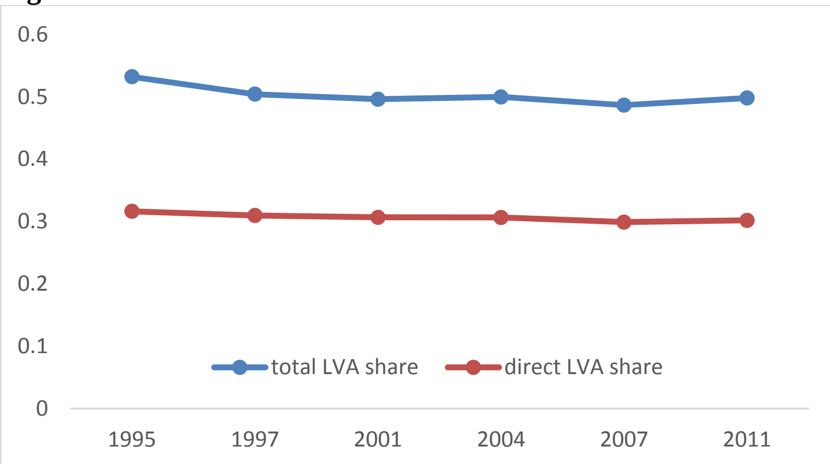


Note: Based on export-weighted data for 31 countries that are present in the database every year since 1995, including: China, India, Sri Lanka, Vietnam, Argentina, Brazil, Chile, Colombia, Indonesia, the Republic of Korea, Morocco, Mexico, Malaysia, Philippines, Thailand, Turkey, Uruguay, República Bolivariana de Venezuela, Australia, Canada, Denmark, Finland, Germany, Hong Kong SAR, China, Japan, New Zealand, Singapore, Sweden, Taiwan, China, UK and USA.

The decline in the share of labor value added in exports in Figure 1 does not reflect a general decline in the share of labor value added in output. Figure 2 shows that the global share of labor value added in the value

of gross output (LVA share) has remained fairly constant since 1995, for both the direct and total LVA share. This finding suggests that the determinants of labor shares in exports may be divorced somewhat from those in output, potentially due to different changes in the composition of exports and output.

Figure 2. Direct and total LVA share



Note: Based on export-weighted data for 31 countries that are present in the database every year since 1995, including: China, India, Sri Lanka, Vietnam, Argentina, Brazil, Chile, Colombia, Indonesia, the Republic of Korea, Morocco, Mexico, Malaysia, Philippines, Thailand, Turkey, Uruguay, República Bolivariana de Venezuela, Australia, Canada, Denmark, Finland, Germany, Hong Kong SAR, China, Japan, New Zealand, Singapore, Sweden, Taiwan, China, UK and USA.

In Figure 3 and Figure 4 we split the world into three income groups to understand the drivers of these aggregate trends.[13] In order to gauge the evolution of our indicators over time we draw trend lines using data only for the 31 countries that are present in the database over the whole period 1995-2011, and group countries according to their 1995 income classification. The group of high-income countries is the only group that experienced a considerable and steady decline in both the direct and total LVAX share, and drives the observed declining trend at the global level. In the middle-income group both the direct and the total LVAX share remained rather stable. In the low-income group the total LVAX share increased, notably between 2007 and 2011, despite the direct LVAX share remaining stable. This suggests the indirect linkages have become relatively more important for exports in the low-income group, a result in line with the increasing importance of backward linkages in exports from China (Kee and Tang, forthcoming), the largest country in that group.

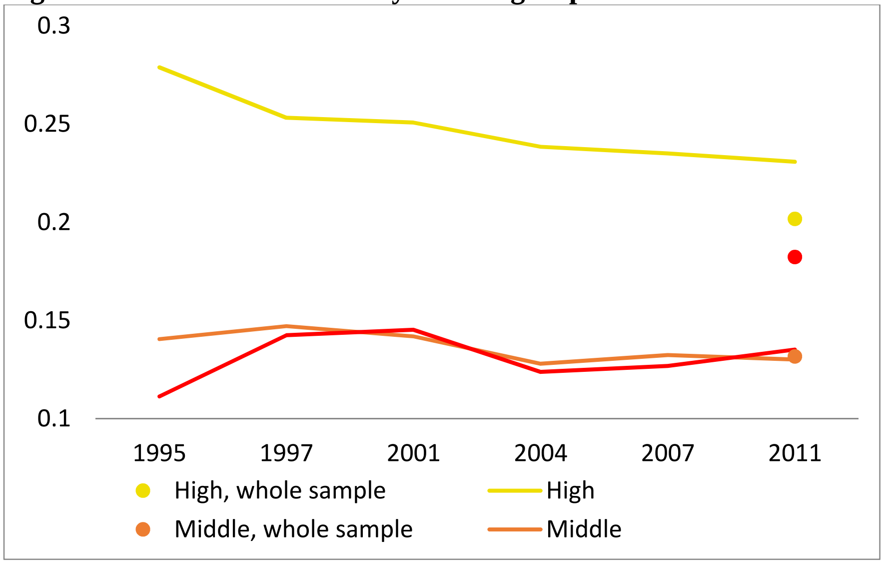
For a more accurate comparison of how the direct and total labor value added in exports varies across level of economic development, we use data for the full sample of countries in the database. Because country coverage has increased over the years, to avoid making erroneous comparisons over time we use data only for 2011 represented as dots, and group countries according to their 2011 income classification. In high-income countries the direct labor value added accounts for the greatest share of gross export values (20%). The low-income group has a similar share (18%) while it is the lowest in the middle-income group (13%). This pattern is broadly consistent with the relative export specialization of high-income countries in skilled labor intensive services and of low-income countries in unskilled labor intensive agriculture. On the other

[13] Income group is defined according to the World Bank country group classification, found at https://datahelpdesk.worldbank.org/knowledgebase/articles/378834-how-does-the-world-bank-classify-countries. A country is low income in 1995 if its 1993 GNI per capita, atlas method (current US$) is $765 or less, middle income if greater than $765 and $9,385 or less, and high income if greater than $9,385. A country is low income in 2011 if its 2009 GNI per capita, atlas method (current US$) is $1,005 or less, middle income if greater than $1,005 and $12,275 or less, and high income if greater than $12,275.

hand middle-income countries' exports tend to concentrate more in less labor intensive extractive and manufacturing sectors. As shows below, however, middle-income countries have a relatively low direct labor intensity of exports even for the same sectors.

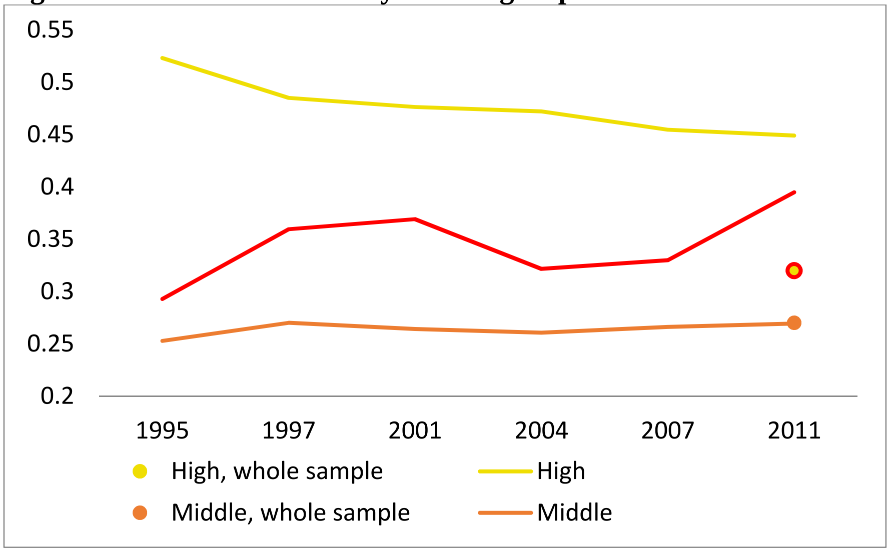
In terms of the total LVAX share, the high- and low-income groups are again similar (38% and 36%, respectively) and the middle-income group is at a lower level (32%). Other literature has found that emerging economies tend to export relatively more capital and import labor in value terms, with the opposite pattern for advanced economies (Stehrer et al., 2012). This also suggests that while the three income groups differ in the direct LVAX share, the indirect share via the backward linkages is similar between all groups (between 18% and 19%). Comparing the ratios of direct-to-total LVAX shares shows that the indirect linkages are relatively more important for exporting labor value added in middle-income countries than in low- or high-income countries.

Figure 3. Direct LVAX share by income group



Note: Income group is held constant for the time series and is defined according to the World Bank country group 1995 classification. In the subsample of countries present in the database since 1995, low-income countries are represented by China, India, Sri Lanka and Vietnam; middle-income countries by Argentina, Brazil, Chile, Colombia, Indonesia, the Republic of Korea, Morocco, Mexico, Malaysia, Philippines, Thailand, Turkey, Uruguay and República Bolivariana de Venezuela; high-income countries by Australia, Canada, Denmark, Finland, Germany, Hong Kong SAR, China, Japan, New Zealand, Singapore, Sweden, Taiwan, China, UK and USA. Income group for the point comparison is defined according to the World Bank country group 2011 classification.

Figure 4. Total LVAX share by income group



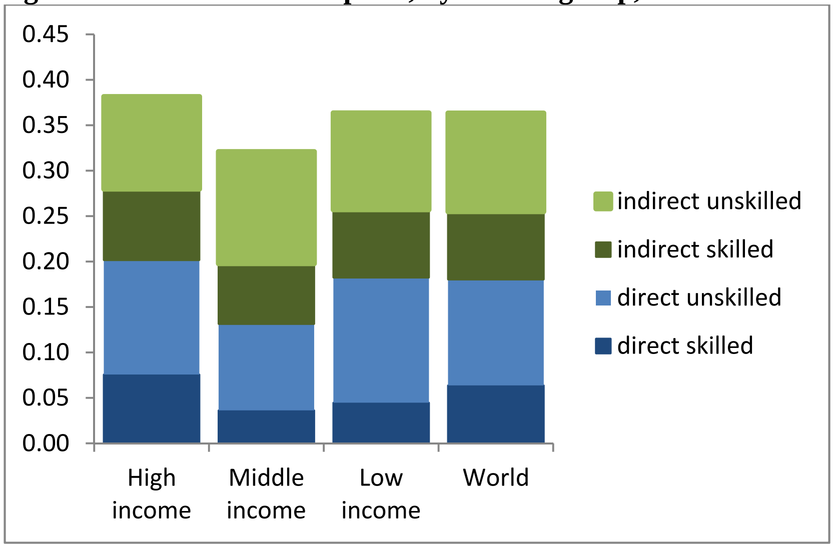
Note: Income group is held constant for the time series and is defined according to the World Bank country group 1995 classification. In the subsample of countries present in the database since 1995, low-income countries are represented by China, India, Sri Lanka and Vietnam; middle-income countries by Argentina, Brazil, Chile, Colombia, Indonesia, the Republic of Korea, Morocco, Mexico, Malaysia, Philippines, Thailand, Turkey, Uruguay and República Bolivariana de Venezuela; high-income countries by Australia, Canada, Denmark, Finland, Germany, Hong Kong SAR, China, Japan, New Zealand, Singapore, Sweden, Taiwan, China, UK and USA. Income group for the point comparison is defined according to the World Bank country group 2011 classification.

Figure 5 shows the breakdown of the total labor value added share in exports for each income group in 2011. It illustrates differences in the importance of domestic sourcing as opposed to the direct labor value added in export industries, as well as differences in the skill composition of each component.[14] The group of high-income countries has the highest share of labor value added in exports, driven entirely by a relatively large share of direct high-skilled labor value added; this component is smaller by half in the middle- and low-income groups, which on the other hand have the highest component of unskilled labor directly contained in exports. This relationship is a direct implication of the Heckscher-Ohlin theorem, whereby a country will export goods that use its abundant factors intensively. This is also consistent with other literature that finds skills are a necessary factor for countries to increase domestic value addition in their exports (Miroudot and Squicciarini, 2015 and Farole, 2016).

On the other hand that does not apply to the indirect labor content of exports, where the skill composition is similar across income groups, with the skilled labor share around 7% and the unskilled labor share around 11% of gross exports. This suggests that sectors providing domestic inputs to exports are less subject to the comparative advantage rule than the export sectors themselves. Thus skilled labor in developing countries appears to be relatively more important for the inputs to the exports than for the exports themselves.

[14] The blue parts of the bars represent the direct content and the green parts the indirect content of wages (i.e. the domestic wages paid to those sectors providing inputs for the exports). The darker parts of the bars represent wages paid to skilled workers while the lighter parts represent unskilled workers.

Figure 5. LVAX share in exports, by income group, in 2011



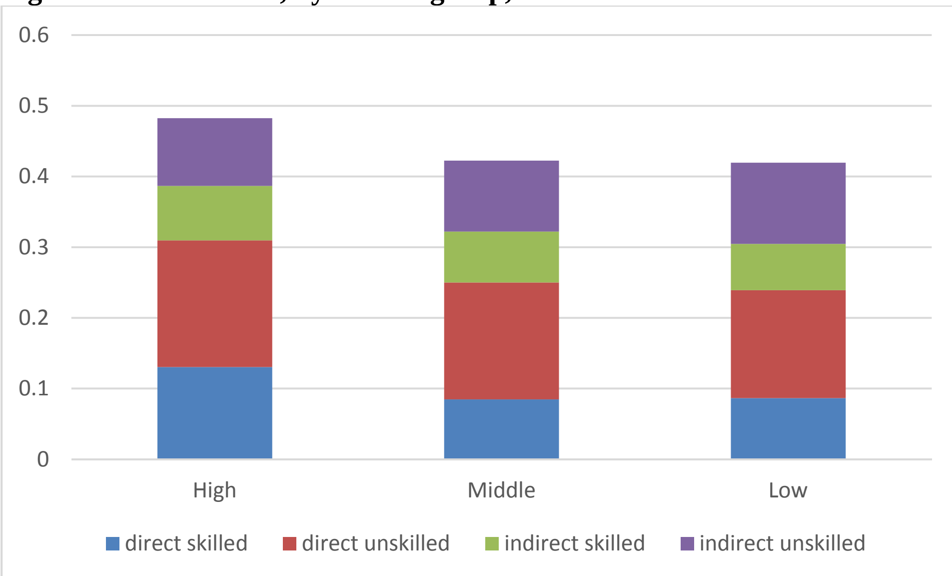
Note: Income group is defined according to the World Bank country group 2011 classification.

The export-weighted world average LVAX share suggests that unskilled labor is more important than skilled labor for either direct or indirect export production, and that unskilled labor is more important for direct exports than indirect exports. These findings are consistent across all income levels, though to a varying degree:

- In the high-income group the *skilled* direct and indirect components are the same while the *unskilled* share is higher for the direct value added than for the indirect value added. This suggests that unskilled workers are relatively more important in the export industries than in the industries that supply them with intermediate inputs.
- In the middle-income group the direct *skilled* and *unskilled* labor share is smaller than the indirect one. Nevertheless the proportion of unskilled to skilled is higher in the indirect part of the labor value added in exports than in the direct part. Thus unskilled labor is slightly more important in direct export industries than in the rest of the economy that supplies them.
- The direct and indirect shares of the *skilled* labor value added are the same in low-income countries as they are in the middle-income group. However, the *unskilled* direct component is larger than the unskilled indirect component. Therefore, the higher proportion of unskilled labor in export industries compared to their suppliers is much more pronounced than in the middle-income group.

These differences in LVAX shares across income countries do not necessarily extend to domestic production. The share of labor value added in domestic output, as for exports, continues to be the highest in high-income countries. However, unlike for exports, the labor value added share of domestic output is equal in middle- and low-income countries, with similarities in the skilled vs. unskilled and direct vs. indirect splits (Figure 6). As such, we argue that understanding these differences in the LVAX shares across countries is informative about how exports support labor in countries.

Figure 6. LVAD share, by income group, in 2011



3.2. Global patterns of labor value added across sectors and industries

One natural follow up question is to what extent the LVAX shares are driven by the composition of the export basket towards more or less labor intensive sectors. In Figure 7 we start investigating this by breaking down the global share of total labor value added in exports by sector. We construct the indicators at the disaggregated level before aggregating into four macro sectors – manufacturing, services, agriculture and extractives (meaning that manufacturing inputs into other manufacturing sectors are still captured as indirect linkages) – and taking the trade-weighted average across the balanced sample of 31 countries.[15] The top panel of Figure 7 considers backward linkages, and the bottom panel forward linkages. The left-hand side figures consider all countries, and the right hand side figures only developing countries (based on 2011 income classification). The bars indicate the export-weighted labor value added of exports (LVAX), and the dots the export-weighted labor value added share in gross exports (LVAX share). The highest share of labor value added in gross exports is in the services sector, followed by agriculture and manufacturing exports, if considering either forward or backward linkages. This shows that services exports are more labor intensive than other sectors' exports – in large part due to the direct labor value added in the sector, given that services tend to create weak backward linkages with the rest of the economy. At the other end of the spectrum with the lowest LVAX share are extractives, reflecting both a low direct labor intensity and generally little backward linkages in economies.

Once considering forward linkages, services are substantially more labor intensive than other sectors' exports – for high income and developing countries alike. In 2011 the labor value added from domestic services sectors going into other sectors' exports was greater than the value of services gross exports for the world as well as for developing countries. This confirms that the largest beneficiaries of exports' domestic backward linkages are typically the services sectors. While this is consistent with total value added related to forward linkages of services exports in general (Francois et al., 2013), the result is even more evident in this context as labor is the main factor of production for services. The role of services as

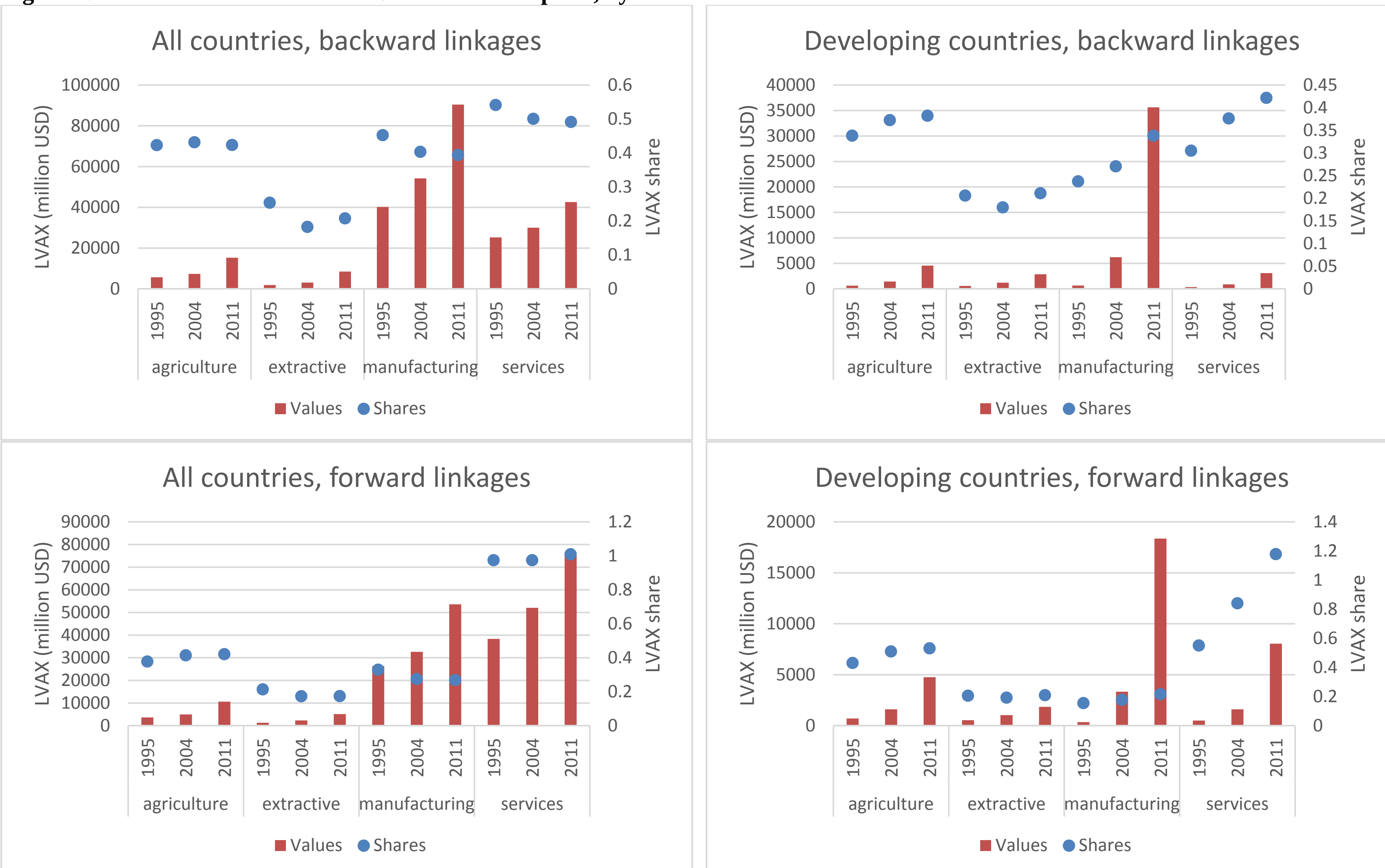
[15] Agriculture includes primary agriculture, forestry and fisheries; extraction includes energy extraction and minerals nec; and services includes electricity, gas and water, construction, trade and transport services, other private services, public administration, defense, health and education, and dwellings.

key input providers for other exports is more dominant in high income than developing countries, where the services sector lags behind manufacturing in terms of wages paid to produce exports.

Again the extractive sector instead uses the least amount of domestic labor to produce $1 of gross exports, consistent with the high capital intensity of mining activities. Interestingly, the low LVAX share for manufacturing (on the basis of forward linkages) suggests that not much labor in manufacturing sectors is used to produce domestic inputs for other export sectors, particularly in developing countries.

On average, the nominal value of wages supported by exports has been increasing between 1995 and 2004 across all sectors. The increase is most notable for developing countries in the manufacturing sector, when considering either forward or backward linkages. China is largely driving this trend, where the average developing countries' LVAX increased 54-fold between 1995 and 2011 including China, and 7-fold excluding China (also aided by China's large export weight).

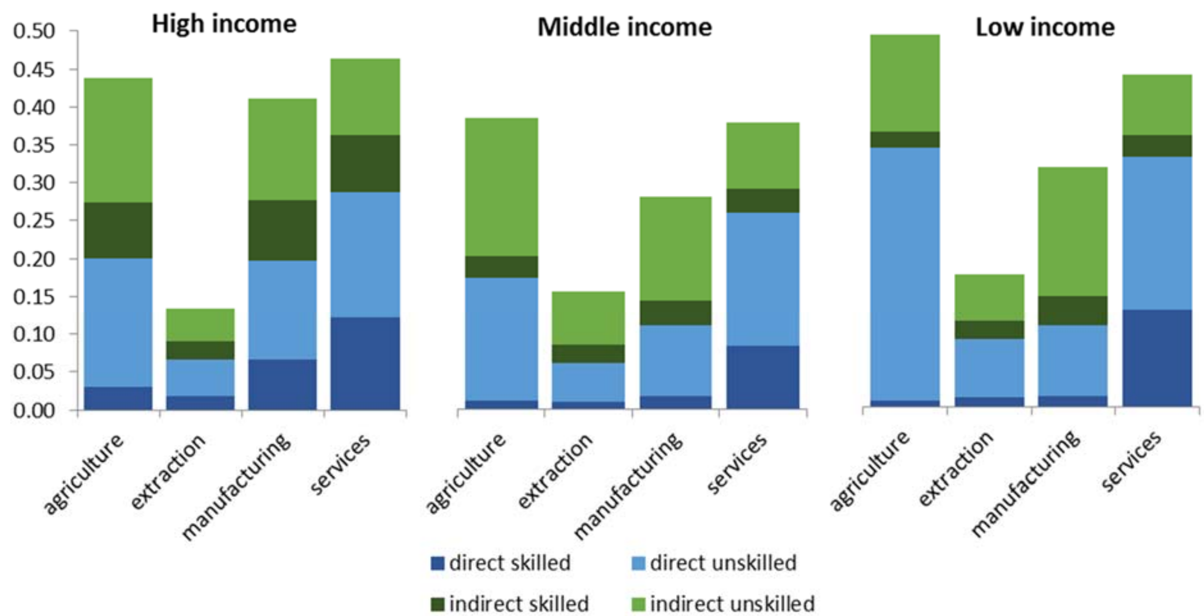
Figure 7. The evolution of the total LVAX share in exports, by sector



Note: Based on export-weighted data for 31 countries that are present in the database every year since 1995. Income group is defined according to the World Bank country group 2011 classification. High-income countries are represented by Australia, Canada, Denmark, Finland, Germany, Hong Kong SAR, China, Japan, the Republic of Korea, New Zealand, Singapore, Sweden, Taiwan, China, United Kingdom, and United States.

Considering the backward linkages and all 31 countries in the balanced sample, there has been a steady decline in the labor value added share embodied in exports of manufacturing and services – suggesting exports of these products have become less labor intensive since 1995. In agriculture the share has remained stable. Once excluding high-income countries from the sample, however, manufacturing and services exports have become more labor intensive, as have agricultural exports. Thus the decline in the global LVAX share in Figure 1 is driven by a declining labor intensity of manufacturing and services exports in high-income countries. The high labor intensity of services is, at least in part, also driven by high-income countries. Manufacturing exports continue to be less labor intensive than services exports once removing high income countries, but agriculture exports are now as labor intensive as services exports in developing countries. However, the labor intensity of agriculture exports is higher in high-income countries than developing countries as a whole.

Figure 8. LVAX share in exports, by sector and income group, in 2011



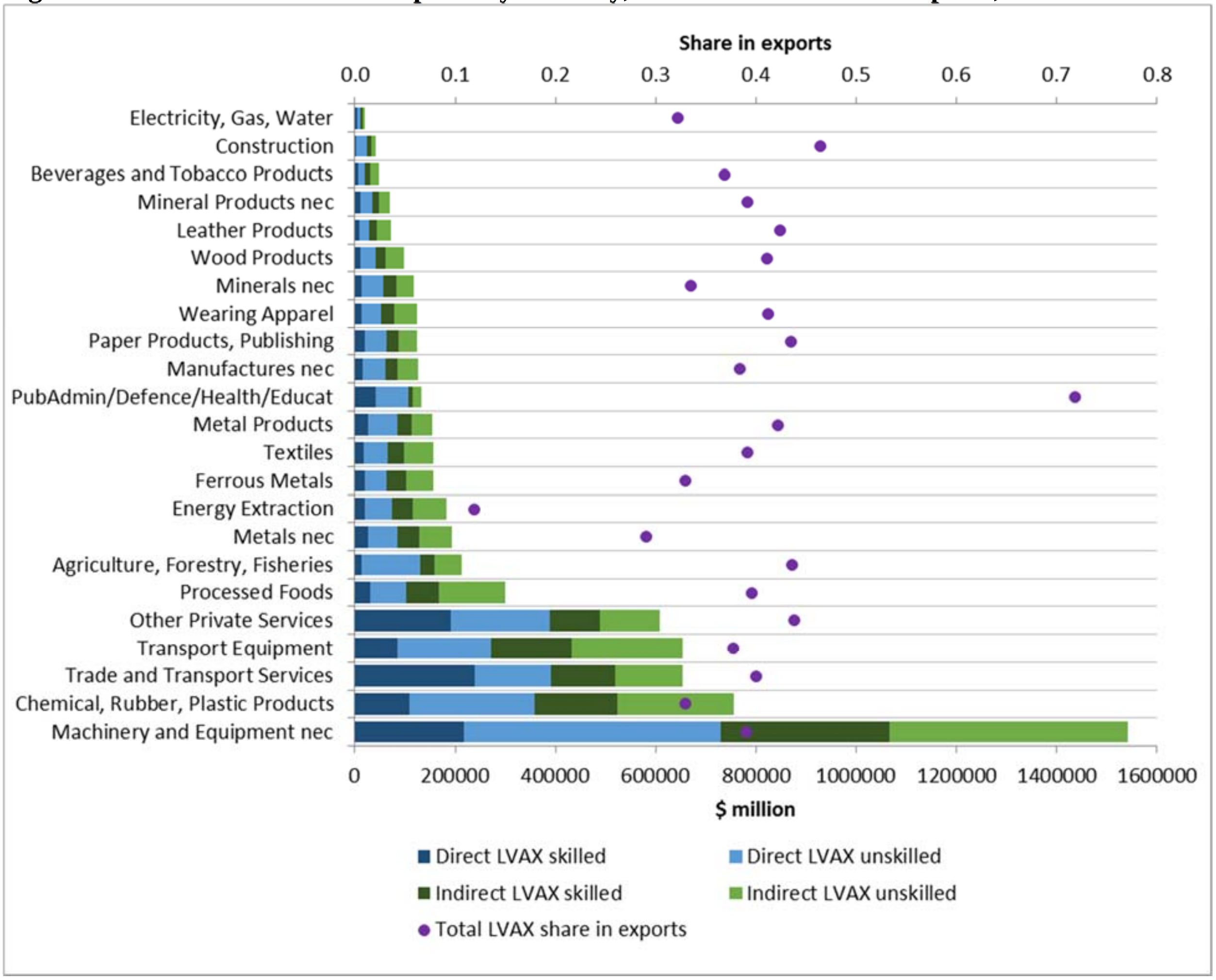
Note: Income groups are defined according to the World Bank country group 2011 classification.

Figure 8 is constructed the same as Figure 7, but presents the differences in labor intensities of the sectors across the three income groups, as well as their direct/indirect and skilled/unskilled split. In terms of the total LVAX share, agricultural exports in low income economies are the most labor intensive, largely explained by unskilled labor employed directly within the exporting sector (the direct LVAX share). Services exports are the most labor intensive for high-income countries, and rely in particular on skilled labor employed directly within the sector. Manufacturing exports in high income countries are more labor intensive than in other countries' groups, in both skilled and unskilled labor. In addition, wages paid to workers in high-income countries to directly produce manufacturing exports are more important than wages paid indirectly. This result does not extend to middle- and low-income economies where indirect wages are a larger share of exports than direct wages. Agricultural exports in high income countries also rely relatively more on skilled labor – both directly and indirectly – than agricultural exports in middle and low income countries.

In Figure 9 we provide a more detailed breakdown of the total labor value added share in gross exports across 24 sectors (identified through the dots), constructed by taking the simple average across all countries in 2011 for each sector. The figure also shows for each sector the total nominal labor value added in exports in US$1 by summing across all countries in the world (identified through the bars). Among all export

sectors *machinery and equipment nec* is by far the largest source of total nominal wages generated by exports across all countries in the sample. In 2011 this sector's exports generated an estimated $1.5 trillion in wages through direct and indirect demand. This leading position reflects the fact that this sector has the largest value of exports across all sectors, while it does not reflect a particularly high labor intensity.

Figure 9. Labor value added in exports by industry, absolute and share in exports, 2011



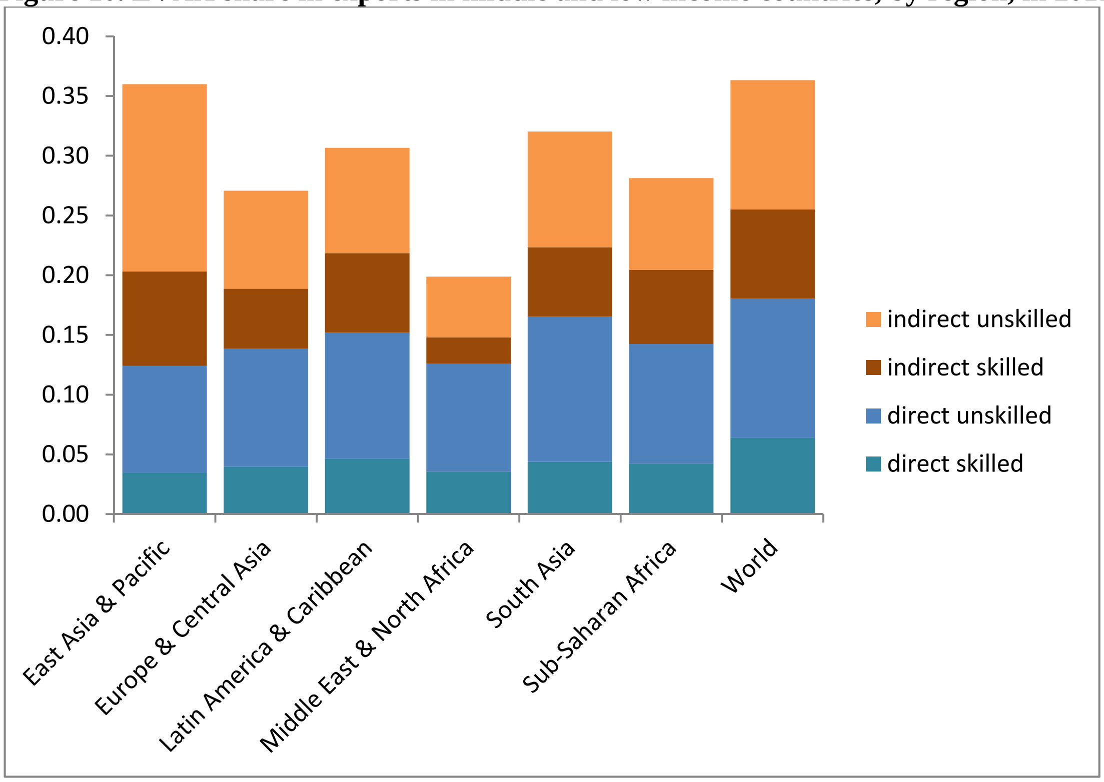
Mainly owing to their relatively high direct labor content, services exports appear to be a key source of labor demand worldwide, and one which is often underestimated by policy makers. *Trade and transport services* and *other private services* (mainly comprising business services) also play a key role as a source of labor demand from exports. For example trade and transport services support a higher overall labor value added than merchandise sectors as *processed food* and *transport equipment*, which are often identified as key export sectors to promote in developing countries. On the other hand these merchandise sectors tend to be particularly important for labor in the other sectors of the economy. The indirect labor content embodied in inputs is more important than the wages paid directly in the export production. The opposite holds for services, which is in line with their usually upstream position in the supply chain and a high labor intensity.

In most industries the share of wages in gross export values is between 30% and 45%. *Ferrous metals*, *metals nec*, and *minerals nec*, as well as *electricity*, *gas and water*, are at the lower bound while *construction* and *other private services* are at the upper bound. There are two outliers – *public services* with the share

above 70% and *energy extraction* with the share close to only 10%. By and large these shares confirm the importance of labor as a key factor in the direct production of services and agriculture and fisheries. The overall labor intensity of manufacturing exports tends to be slightly lower but the importance of labor value added from other sectors is generally higher.

The labor content of exports shows substantial heterogeneity across developing countries' region as shown in Figure 10, which reports the export-weighted LVAX share in middle and low income economies by region in 2011. The share of total labor value added in exports was on average the lowest in MENA countries and the highest in EAP, on par with the world average though still below high-income economies. The result for EAP is entirely explained by the large share of indirect labor, which comprises around two third of the labor value in EAP exports, while the direct LVAX share in EAP exports is the lowest across all regions. Export sectors in the EAP region are relatively well connected with the rest of the economy, a result almost entirely explained by China. As the next section will clarify part of this effect is compositional: for example the specialization of MENA countries and of Europe and Central Asian (ECA) countries in capital intensive extractive sectors is less conducive to developing backward linkages than that of EAP countries in manufacturing exports. The labor intensity of exports – both through its direct and indirect components – is low in Sub-Saharan Africa (SSA) relative to most other regions. Coupled with the relatively low value of SSA exports, this result confirms that exports still support only a limited amount of domestic wages in the region.

Figure 10. LVAX share in exports in middle and low income countries, by region, in 2011



Note: Income group is defined according to the World Bank country group 2011 classification.

3.3. Patterns of labor value added across countries

While these general patterns are interesting, they mask a large heterogeneity among countries. Table 1 starts unveiling that heterogeneity by presenting measures of labor value added at the country level for the 15 countries in the sample with the highest and the 15 countries with the lowest total labor value added in exports (in nominal US$, shown in the first column). Columns two and three show the amount of labor

value added directly in the exporting industries by skilled and unskilled labor. The US is the country in the sample with the highest value of wages supported by exports at just over $1 trillion, roughly split between wages paid directly to produce the exports and wages paid by industries providing inputs to exports. Most of these wages paid to skilled workers are in input providing sectors (column 4), while the opposite is true for unskilled workers (column 5). In the US on average $100 of gross exports support $58 in wages (column 6), the highest labor intensity in the sample. However the labor value added in exports accounts for only 10% of domestic labor value in the US (column 7), one of the lowest shares in the sample. That is mainly the reflection of the relatively low values of exports relative to the economy.

China is the country with the second highest nominal LVAX with $795 billion of wages stemming from exports, around 21% of the domestic labor value added. Every $100 of gross exports support $42 in wages in China, more than two-thirds of which are from domestic backward linkages. This is the highest share of indirect LVAX in the sample and explains the increase in labor intensity of Chinese exports since 1995. Kee and Tang (forthcoming) show that the impressive domestic vertical integration of Chinese exports is explained mainly by the intermediate-input industry becoming more competitive and thus allowing for the replacement of imported inputs.

These backward linkages are also an important source of LVAX in countries such as Japan and Brazil. In other countries the importance differs across the skill groups. For example, in the U.S., Japan and Taiwan, China, backward linkages are relatively important for the skilled LVAX while the direct contribution of the exporting industry is more important for the unskilled LVAX. This suggests that exporting industries in these economies rely heavily on domestic skill-intensive services.

A majority of the top 15 countries have relatively high labor intensities of exports (which also tend to be high income economies). The bottom 15 are more heterogeneous, ranging from a high intensity in agricultural exporters, such as Benin ($46 paid in wages for every $100 of exports) or Malawi ($41), to a very low intensity in oil exporters, such as Brunei ($5) or Guinea ($13). The importance of exports as a source of labor demand varies in both groups. Exports play a negligible role in Nepal (responsible for 5% of domestic labor value added) and Brazil (8%) while they are very important in Togo (41%) and Taiwan, China (45%).

Table 1. Labor value added in exports (LVAX), 2011, $ million, ratio and share of gross exports

Rank	Country	LVAX	LVAX breakdown				LVAX share in exports	Share of LVAX in LVAD	Income group
			Direct		Ratio direct/indirect				
			skilled	*unskiled*	*skilled*	*unskilled*			
1	United States	1,000,205	109,347	380,793	0.68	1.09	0.58	0.10	HOECD
2	China	795,419	69,004	177,323	0.39	0.48	0.42	0.21	LM
3	Germany	667,647	163,843	228,359	1.25	1.59	0.43	0.35	HOECD
4	Japan	451,779	65,360	114,491	0.49	0.83	0.49	0.15	HOECD
5	United Kingdom	276,966	55,780	113,022	1.47	1.61	0.43	0.21	HOECD
6	France	270,351	58,713	70,809	0.91	0.93	0.38	0.20	HOECD
7	Italy	210,013	47,246	53,385	0.83	1.02	0.36	0.23	HOECD
8	Canada	168,277	32,726	53,155	0.92	1.13	0.38	0.17	HOECD
9	Korea, Rep.	155,684	43,822	30,716	0.88	0.98	0.27	0.32	HOECD
10	Spain	149,242	36,254	48,885	1.21	1.43	0.39	0.19	HOECD
11	Switzerland	144,794	38,428	45,765	1.23	1.56	0.44	0.33	HOECD
12	Netherlands	120,826	25,528	41,351	1.18	1.28	0.31	0.29	HOECD
13	Taiwan, China	117,504	19,743	39,104	0.61	1.50	0.32	0.45	H
14	Brazil	109,097	13,178	32,262	0.50	0.87	0.41	0.08	UM
15	Australia	105,658	14,094	30,419	0.57	0.84	0.44	0.14	HOECD
…									
106	Madagascar	921	187	303	1.10	1.17	0.34	0.18	L
107	Senegal	855	194	308	1.28	1.54	0.24	0.18	LM
108	Malawi	758	103	320	0.95	1.41	0.41	0.27	L
109	Burkina Faso	754	38	440	0.80	1.93	0.24	0.20	L
110	Togo	716	72	434	0.90	3.31	0.40	0.41	L
111	Zimbabwe	674	139	244	0.99	1.62	0.26	0.17	L
112	Lao PDR	616	60	267	0.80	1.25	0.21	0.20	L
113	Armenia	599	150	223	2.13	1.42	0.32	0.15	LM
114	Kyrgyzstan	516	72	222	1.34	1.31	0.19	0.24	L
115	Benin	503	65	313	3.38	2.98	0.46	0.16	L
116	Mongolia	500	91	217	1.04	2.08	0.15	0.17	LM
117	Nepal	416	101	151	1.24	1.81	0.31	0.05	L
118	Brunei	403	123	165	2.32	2.62	0.05	0.10	H
119	Rwanda	390	96	164	1.41	2.69	0.39	0.11	L
120	Guinea	215	16	126	0.50	2.91	0.13	0.16	L

Note: Income group is defined according to the World Bank country group 2011 classification. H-OECD = high income OECD country; H = other high income country; UM = upper middle income country; LM = lower middle income country; L = low income country.

In Table 2 we investigate to what extent LVAX mirrors the stages of economic development. To do so we regress direct (columns 1) and total LVAX share in exports (columns 2) on the log of each country's GDP per capita measured at PPP current dollars. We find no systematic relationship between level of development and labor intensity of exports. However, once we include country and year fixed effects, a positive and significant correlation is unveiled for both direct and total LVAX share in exports (columns 3 and 4). As countries develop economically, their exports become more labor intensive. As there is no pretense of identifying any causality here, the relationship could also be expressed the other way around:

as a country's exports become more labor intensive, the country's rate of economic development increases. A 1% increase in a country's GDP per capita is associated with approximately a 0.3% increase in the direct labor value added of exports as a share of exports and 0.1% increase in the total labor value added of exports as a share of exports. The smaller increase in the total as compared to the direct suggests that the direct becomes relatively more important along the development process, confirming the results in Figure 5. This positive relation is driven entirely by the more than proportionate increase in average wages in the process of economic development, which more than compensate the loss in jobs per unit of exports that we document in Section 4 below.

Table 2. Labor value added in exports (LVAX)

	(1)	(2)	(3)	(4)
	ln(direct LVAX share)	ln(total LVAX share)	ln(direct LVAX share)	ln(total LVAX share)
ln(GDP per capita)	**-0.007**	**-0.011**	**0.266*** **	**0.135** **
	(0.013)	(0.013)	(0.091)	(0.061)
Constant	-1.689	-1.022	-4.833	-2.832
	(0.179)	(0.167)	(1.114)	(0.721)
Year dummies	Yes	Yes	Yes	Yes
Country dummies	No	No	Yes	Yes
R^2	0.019	0.032	0.855	0.919
n	470	470	470	470

Note: * indicates significance at the 10% level; ** indicates significance at the 5% level; *** indicates significance at the 1% level. Robust standard errors in parentheses.

Table 1 suggests a large heterogeneity across countries in both the LVAX share in exports and the LVAX share in domestic labor value added. These two shares comprise the two key dimensions of the contribution of exports to a country's labor value added: intensity (US$1 of wages per US$1 of exports) and importance (share of domestic labor paid for by exports). Figure 11 uses these two dimensions to classify countries: the labor intensity of exports (y-axis) and the total domestic labor value added that is generated by exports (x-axis). Black lines indicate the median values for each indicator. Countries that are located on the right of the vertical line have a high share of labor value added that ends up being exported. Countries that are in the upper part of the figure have relatively high labor intensive exports.

The figure confirms the wide dispersion along both dimensions. Countries like Romania and Germany in the upper-right quadrant score high in both dimensions: their exports generate relatively high labor demand and at the same time are also a key source of demand for domestic labor. At the other end of the spectrum countries like Nigeria and República Bolivariana de Venezuela are in the diametrically opposite situation (not surprisingly two oil exporting countries). Countries like Brazil, Ethiopia and Ghana have relatively high labor intensity of exports but their exports explain a small share of domestic labor value added. Finally, in small and medium export oriented EAP economies like Vietnam, Thailand, Malaysia and Singapore, exports are responsible for a large share of the domestic wages but their labor intensity is below the median (a reflection of the relatively low backward linkages in these economies).

Overall, there appears to be no relationship between the labor intensity of exports and the total domestic labor value added that is generated by exports; countries whose exports are an important source of labor demand are no more likely to export products that are labor-intensive.

Figure 11. Total LVAX share and share of LVAX in total domestic labor value added, 2011

Note: Income group is defined according to the World Bank country group 2011 classification.

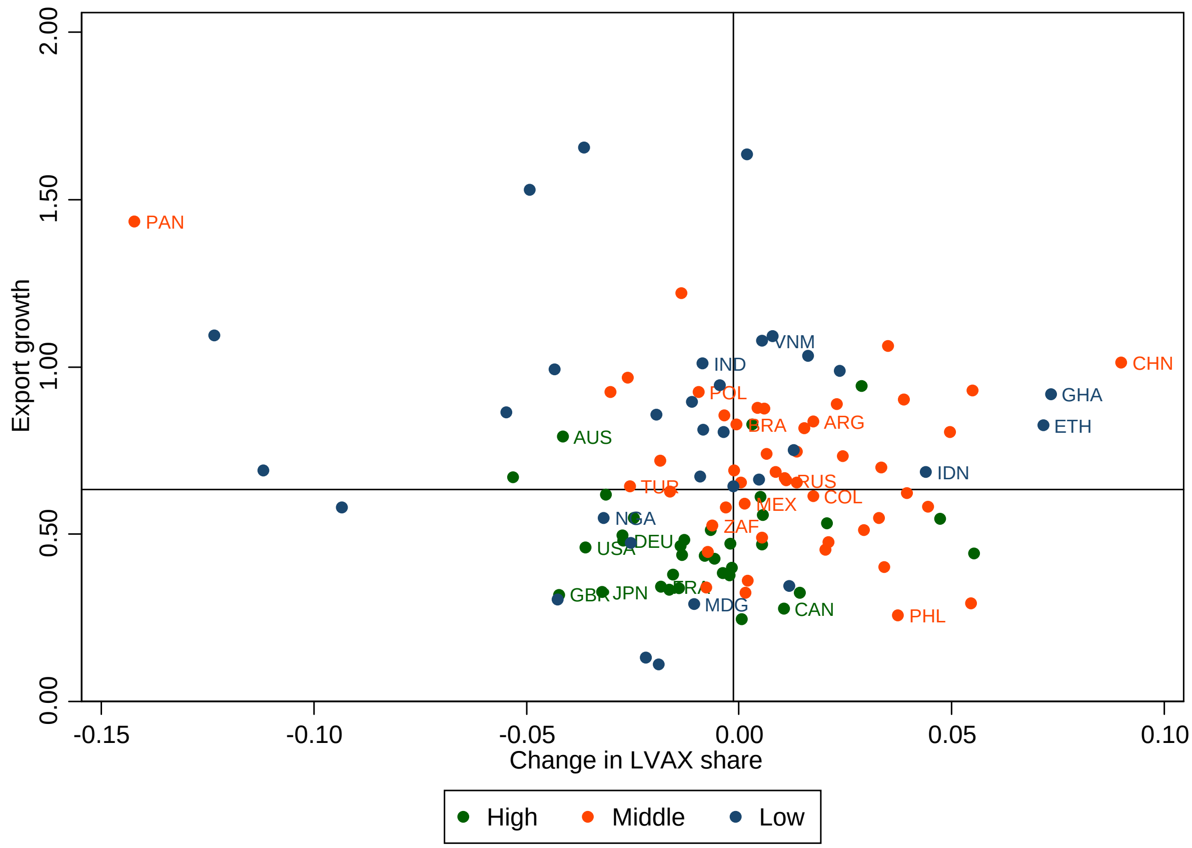
The LVAX share in exports can also be interpreted as the inverse measure of wage productivity of exports, i.e. how much export value is generated per unit of wages. From this perspective an increase in LVAX in a country may be associated with a reduction in export competitiveness and thus in exports. In order to check this hypothesis Figure 12 shows the relationship between the growth in a country's exports and the change in the LVAX share between 2004 and 2011.[16] The horizontal and vertical lines divide the plot into below- and above- median values of each variable. The figure suggests no statistically significant relation for the whole sample of countries, or when split by income group, thus refuting the hypothesis that increases in labor intensity of exports are not systematically associated with reduction in export competitiveness.[17] China is the extreme example of that, as it has been able to achieve positive export growth and the highest increase in the LVAX share.

While all countries in our sample experienced export growth, the LVAX share declined in half of them (meaning that a country's exported labor value added did not grow as quickly as gross exports). Most of the high-income OECD countries are concentrated in the lower-left quadrant, i.e. they experienced a below median export growth and a decline in the labor intensity of their exports – consistent with Figure 4. The upper-right quadrant, on the other hand, groups almost exclusively middle- and low-income countries,

[16] These two years were selected so as to maximize the number of countries in the sample and to encompass a reasonable period to observe relevant changes.
[17] If excluding Panama and China, there is no statistically significant negative correlation for middle income countries. The correlation for high and low income countries is slightly positive and not statistically significant.

however middle-income countries show much more varied performance. These countries, such as Ghana, Ethiopia and the aforementioned China, saw an above-median growth in exports and a positive change in their LVAX share.

Figure 12. Export growth and the change in the LVAX share between 2004 and 2011, in log changes



Note: Income group is defined according to the World Bank country group 2011 classification.

So far we have not distinguished between the main sources of change in the LVAX share: the actual change in the labor value added in sectoral exports of the exporting country and the change in the composition of exports across industries. In order to disentangle these two components for each country, we decompose the change in the labor value added share in exports as follows. First, define L_i as total labor value added in exports (in US$) in sector i and LS_i its ratio to gross exports ($LS_i=L_i/X_i$) with X as gross exports. The LS for the entire economy is:

$$LS_{TOT} = \frac{\sum_{i=1}^{N} L_i}{\sum_{i=1}^{N} X_i} = \sum_{j=1}^{N} \left[\frac{L_j}{\sum_{i=1}^{N} X_i} \right]$$

If we multiply the term in parenthesis by Xj/Xj, then we can re-write that as: $\sum_{j=1}^{N} \left[LS_j \frac{X_j}{\sum_{i=1}^{N} X_i} \right]$. Then the difference between time 0 and 1 is defined as:

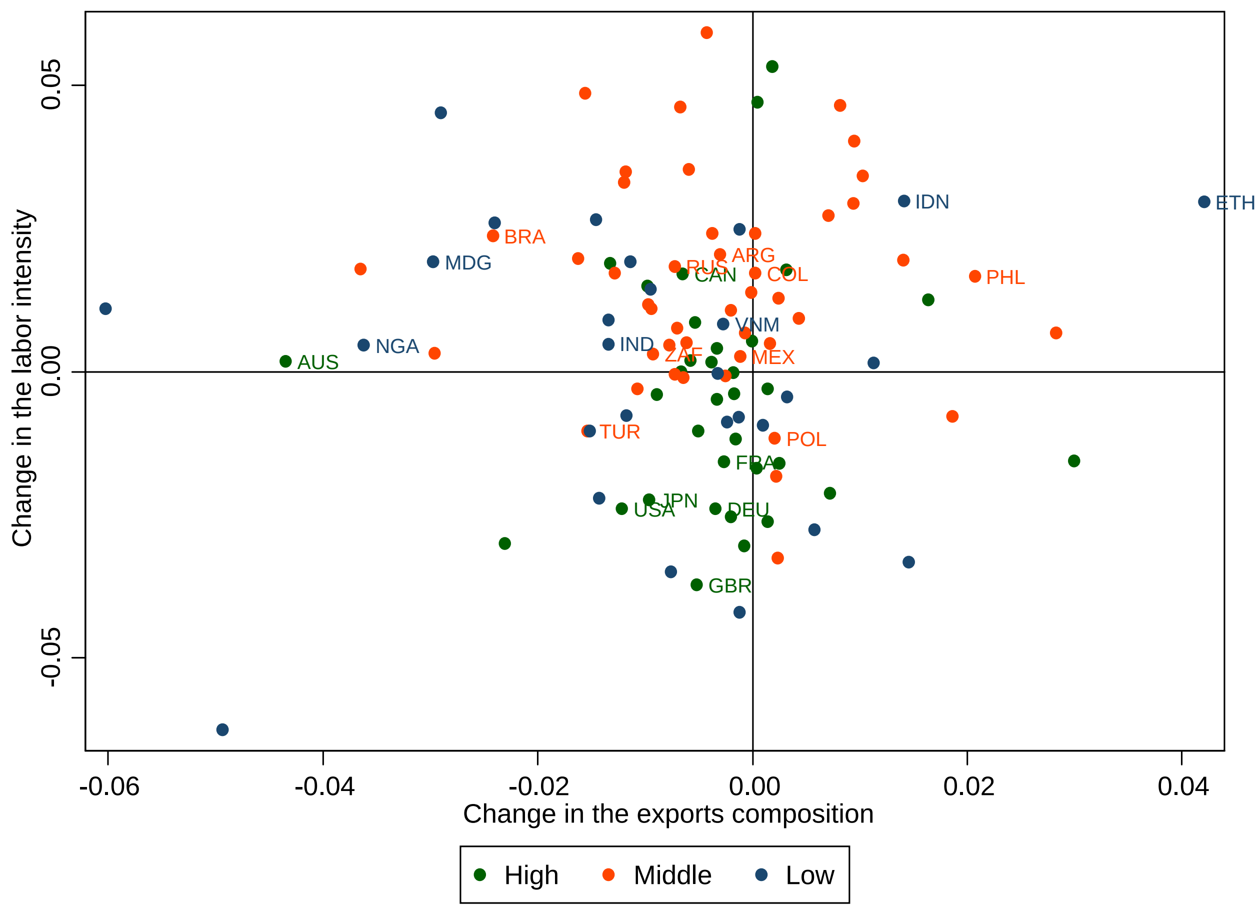
$$\sum_{j=1}^{N} \left[LS_{1j} \frac{X_{1j}}{X_1} \right] - \sum_{j=1}^{N} \left[LS_{0j} \frac{X_{0j}}{X_0} \right] = \left[\sum_{j=1}^{N} \left[LS_{1j} \frac{X_{1j}}{X_1} \right] - \sum_{j=1}^{N} \left[LS_{0j} \frac{X_{1j}}{X_1} \right] \right] + \left[\sum_{j=1}^{N} \left[LS_{0j} \frac{X_{1j}}{X_1} \right] - \sum_{j=1}^{N} \left[LS_{0j} \frac{X_{0j}}{X_0} \right] \right]$$

The first term is the labor intensity effect, the second term is the export composition effect.

Figure 13 plots each of these two components at the country level. The changes in the labor intensity of the exporting industry when the export composition is kept constant is on the vertical axis and the change in the export composition when the labor intensity of the exporting industries is kept constant is on the horizontal axis. The black horizontal and vertical lines divide the plot into negative and positive quadrants. For most countries the change in the LVAX share is explained more by the labor intensity than by the export composition component – or that the LVAX share is changing less because of compositional shifts in the export basket towards more/less labor intensity sectors, but more because the labor intensity of exports within sectors is changing. Furthermore, the majority of low and middle income countries lie in the left quadrants, suggesting a shift in the export composition towards less labor intensive industries. This is consistent with the commodity boom during the 2004-11 period. At the same time the labor intensity of individual export sectors increased for the majority of low and middle income countries. Most of the high-income OECD countries, on the other hand, had small negative changes in the export composition, and negative changes in the labor intensity of exporting industries (meaning they simultaneously shifted towards less labor intensity sectors, which were also experiencing declines in their labor intensity).

The trade-weighted aggregated effect across countries of each of these components is negative, suggesting that the decline in the global LVAX share was driven by declines in both the labor intensity of a sector's exports, and a shift towards less labor-intensive export sectors. However, the component for the change in export composition was stronger. Only high-income countries saw declines on both of these margins, however. Taking the trade-weighted average, for low-income and middle income countries, the change in the export composition component continued to be negative, while the change in the export intensity component was instead positive.

Figure 13. Decomposition of the change in the LVAX share between 2004 and 2011



Note: Income group is defined according to the World Bank country group 2011 classification.

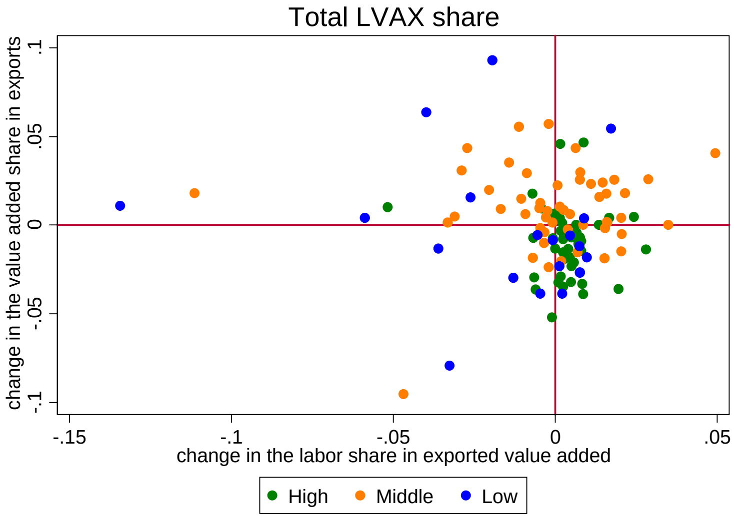
Changes in the LVAX share can also be decomposed into two different margins: changes in the labor share in exported value added (denoted LVAX/VAX), and changes in the value added share in exports (denoted VAX/X). The decomposition can be expressed as

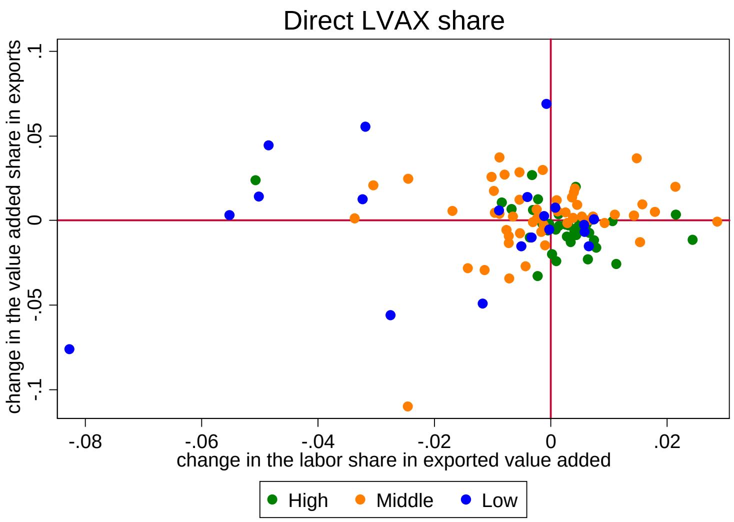
$$\Delta LS = LS_1 - LS_0 = \frac{LVAX_1}{VAX_1}\frac{VAX_1}{X_1} - \frac{LVAX_0}{VAX_0}\frac{VAX_0}{X_0}$$
$$= \left[\frac{LVAX_1}{VAX_1}\frac{VAX_1}{X_1} - \frac{LVAX_0}{VAX_0}\frac{VAX_1}{X_1}\right] + \left[\frac{LVAX_0}{VAX_0}\frac{VAX_1}{X_1} - \frac{LVAX_0}{VAX_0}\frac{VAX_0}{X_0}\right]$$

The first term captures the change in the labor share in exported value added, and the second term the change in the value added share in exports. Both the total and direct LVAX shares can be decomposed along these margins.

The top panel of Figure 14 plots the change in the labor share in exported value added on the x-axis against the change in the value added share in exports on the y-axis between 2004 and 2011 (to maximize the number of observations) for the total LVAX share, and the bottom panel for the direct LVAX share. There exists no relationship between the two margins for the total LVAX share, while there exists a highly significant negative relationship for the direct LVAX share for high-income countries.

Figure 14. Decomposition of the change in the LVAX share between 1997 and 2011





Using a longer time horizon by calculating export-weighted changes in these margins between 1997 and 2011 for the balanced sample of 31 countries, we find that the decline in the total LVAX share is driven by a decline in the total value added share in exports, while the total labor share in exported value added increased. In contrast, the decline in the direct LVAX share is driven by declines in both the labor share in exported value added and the value added share in exports. This suggests that it is the increase in the share of indirect labor value added in total exported value added that explains the rise in the labor share in exported value added.

4. Global patterns of jobs in exports

In this section we turn to the number of jobs that enter export production either directly or indirectly through input sourcing. The jobs content of exports is measured as the number of jobs (denoted JobX), and as a share of gross exports (JobX share), which is a measure of the job intensity of a country's or sector's exports. We also use measures of the job content of domestic production (denoted JobD) for comparisons.

Table 3 presents the number of jobs directly used in export production, the total number of jobs used in export production, and the (direct and total) job intensity of exports. The top panel includes only the subsample of countries that are present every year since 1997, which more accurately captures the evolution of the indicators than the bottom panel, which includes the whole sample (with varying number of countries over the years). Until 2007 both the direct and the total jobs contained in exports were increasing while between 2007 and 2011 both decreased. The job intensity of exports, on the other hand, has been steadily decreasing since 2001. This is different than what we saw for the labor intensity of exports, which has been decreasing since 1995 but experienced a slight increase between 2007 and 2011 (Figure 1). Notably, the change in the job intensity was much more pronounced than the change in the absolute number of jobs – meaning that the number of jobs fell relatively more than any shifts in export values. Again, this is consistent with a transition to labor-saving technologies in production.

Table 3. Total number of jobs in exports (JobX) and the job intensity of exports

	1997	2001	2004	2007	2011
Balanced sample - 32 countries					
JobX in thousands					
Direct	31,092	38,962	39,850	40,662	39,386
Total	66,187	87,825	88,311	89,265	83,553
Jobs per $1 mil. of exports					
Direct	11	13	9	6	5
Total	24	29	19	13	11
Whole sample					
Jobs per $1 mil. of exports					
Direct	14	17	11	7	6
Total	31	38	27	16	14
No. of countries	36	48	73	65	66

Note: Based on export-weighted data for 32 countries that are present in the database every year since 1997, including: Australia, Austria, Belgium, Bulgaria, Canada, Switzerland, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, Greece, Bosnia and Herzegovina, Hungary, Ireland, Italy, Korea, Rep., Lithuania, Luxembourg, Latvia, Mexico, Netherlands, New Zealand, Philippines, Poland, Portugal, Romania, the Russian Federation, the Slovak Republic, Slovenia, and Sweden.

Table 4 presents various indicators of the job content of exports but for the 15 richest and 15 poorest individual countries in our database in 2011 based on GDP per capita.[18] While the first two columns show the number of jobs aggregated across all sectors directly and indirectly embodied in exports (in thousands), the third column shows the ratio of the two and thus the relative importance of direct employment compared to the employment generated by backward linkages. The fifth and sixth columns show the total number of jobs per $1 million of gross exports and the share in the economy-wide employment (JobD), respectively. Thus these two columns allow comparisons across countries in terms of the job intensity of exports and how important exports were for generating jobs in total employment.

The data suggest that in 2011 the jobs supported (directly or indirectly) by the exports amounted to 160.7 million for the 66 countries in the sample, or 20.6% of total employment in these countries. The importance of exports as a source of employment does not vary systematically with level of income. Within the high-

[18] The countries in the table are sorted based on the level of development measured by GDP per capita in 2011, starting with the most developed countries in our database.

income group, it ranges between 12% of total employment in Australia and 49% in Ireland. Within the low- and low-middle-income it ranges from 8% in Ethiopia and 39% in Thailand.

In general countries with lower GDP per capita (and consequently lower wages) tend to have a greater job intensity of exports. For example, while the Philippines had about 105.5 total jobs embodied in $1 million worth of exports in 2011, Belgium had only about 3.4 jobs embodied in the same value of exports. This is in line with standard trade theory, which predicts that exports of countries where labor is relatively cheaper would be more labor intensive, in line with comparative advantage.

There is substantial dispersion in the ratio of direct to indirect jobs embodied in exports across countries. For some countries, it is close to or above one, and thus direct employment plays a relatively more important role in supporting exports. For some countries the ratio is as low as 0.5, which means that compared to the jobs generated in the export industries, twice as many jobs are generated through domestic sourcing of intermediate inputs by the export industries. All of the high-income countries have direct-to-indirect ratios close to or above 1, with the exception of Poland, Italy and the Republic of Korea. A simple regression analysis across countries reveals a negative and mildly significant relation between this ratio and per capita GDP controlling for country size and geographic remoteness, [19] two natural determinants of the extent to which exports may use domestically produced inputs.[20] This suggests that backward linkages for exports are still relatively more important in richer economies.

[19] Results are not reported here and are available from the authors upon request. In particular the analysis regresses the ratio on a constant, the log of per capita GDP in 2005 PPP terms, the log of the population and the log of market potential measure as a proxy for the country's remoteness. GDP and population are taken from the World Development Indicators, while the market potential measures are taken from CEPII database and are computed using the Redding and Venables (2004) or the Head and Meyer (2004) method.

[20] For example, Luxembourg has a very high ratio because a small economy that is integrated into Europe will naturally buy its imports from overseas. Among other explanations, Australia has a fairly low ratio because it is geographically remote and production must use more upstream inputs that are locally sourced.

Table 4. Jobs embodied in exports in 2011, in thousands

Rank	Country	Income group	Jobs in exports: Direct	Jobs in exports: Indirect	Jobs in exports: Ratio direct/ indirect	Total jobs in $1 million of exports	Share of JobX in JobD
1	Australia	H-OECD	638.83	675.21	0.95	5.49	0.12
2	Austria	H-OECD	750.76	539.83	1.39	6.12	0.31
3	Belgium	H-OECD	824.26	579.37	1.42	3.42	0.31
4	Canada	H-OECD	1388.68	1452.60	0.96	6.37	0.16
5	Croatia	H-OECD	244.2	256.75	0.95	21.52	0.34
6	Czech Republic	H-OECD	877.92	867.80	1.01	11.14	0.36
7	Denmark	H-OECD	516.11	336.88	1.53	5.50	0.32
8	Estonia	H-OECD	141.45	86.78	1.63	13.09	0.37
9	Finland	H-OECD	296.19	256.04	1.16	5.99	0.22
10	France	H-OECD	2359.8	2105.64	1.12	6.32	0.17
11	Germany	H-OECD	5560.64	5340.57	1.04	6.90	0.27
12	Greece	H-OECD	477.14	270.48	1.76	11.52	0.18
13	Hungary	H-OECD	882.94	637.98	1.38	13.49	0.40
14	Ireland	H-OECD	447.62	451.30	0.99	3.83	0.49
15	Israel	H-OECD	340.92	266.49	1.28	7.34	0.20
…							
52	Uruguay	UM	177.1	141.15	1.25	28.48	0.19
53	Venezuela, RB	UM	323.46	498.17	0.65	14.80	0.07
54	Armenia	LM	109.45	98.33	1.11	112.54	0.18
55	Ecuador	LM	581.51	679.81	0.86	64.19	0.20
56	Egypt, Arab Rep.	LM	1709.06	858.36	1.99	52.04	0.11
57	Guatemala	LM	939.09	615.17	1.53	118.65	0.29
58	Moldova	LM	150.92	136.69	1.10	103.49	0.25
59	Mongolia	LM	111.95	75.54	1.48	57.95	0.18
60	Morocco	LM	861.89	1140.37	0.76	66.84	0.19
61	Paraguay	LM	431.82	285.45	1.51	91.74	0.24
62	Philippines	LM	2758.88	4281.16	0.64	105.45	0.19
63	Thailand	LM	5105.1	10420.23	0.49	63.93	0.39
64	Ukraine	LM	2030.03	4128.07	0.49	77.22	0.30
65	Ethiopia	L	247.72	181.22	1.37	109.97	0.08
66	Zimbabwe	L	1489.62	434.30	3.43	735.12	0.35

Note: Income group is defined according to the World Bank country group 2011 classification. H-OECD = high income OECD country; H = other high income country; UM = upper middle income country; LM = lower middle income country; L = low income country.

Figure 15 and Figure 16 plot the total number of jobs embodied in exports, split between direct and indirect jobs based on backward and forward linkages, respectively. The job content of exports is broken down by industry in 2011 (services, manufacturing, agriculture, and mining and energy extraction) aggregated across all countries in the database. It also presents the indicators at a more disaggregated level for eight services sectors. Our sample covers 66 countries in 2011, with total employment of 778.6 million, of which

73.8 million jobs are directly used to produce exports and 86.9 million are embodied in exports indirectly. The dots in the figures show the total number of jobs per $1 million of gross exports. These are measured domestically within countries then aggregated across all countries in the database.

Worldwide, manufacturing exports are by far the most important source of jobs embodied in exports, both directly and in total when considering backward linkages. It is followed by services, most notably transport and communication services, then agriculture. Direct manufacturing jobs are more important than direct services or agriculture jobs. The indirect component (or the backward linkages) is especially important for manufacturing, which means that the majority of jobs are embodied in the intermediate inputs that are used for the export of manufacturing production.

The ratio of the direct and indirect job content reflects the relative importance of the direct employment compared to the employment generated by backward linkages. Agriculture and most services sectors have ratios above 1, meaning they rely more on direct than indirect jobs to produce their exports. Put another way, these sectors support relatively fewer jobs by sourcing intermediate inputs for exports compared to the number of jobs their exports generate directly. Manufacturing, on the other hand, uses twice as many jobs indirectly through input sourcing compared to its direct jobs content.

Considering backward linkages, exports of the agriculture sector are substantially more job-intensive than manufacturing and services, with close to 60 total jobs created per $1 million of gross exports. In manufacturing it is 13 jobs and services 15 jobs, though there is significant dispersion across services sectors. In real estate, renting, and financial services, for example, less than 10 jobs are supported by $1 million of gross exports, compared to 58 jobs in other commercial services.

Services are instead the most important supplier of jobs embodied in exports if considering forward linkages, driven by the indirect component, followed by manufacturing. Forward linkages present the number of the sector's jobs used in total exports of all other sectors, showing the importance of a sector as a supplier of jobs embodied in exports. For example in trade, sales and accommodation, relatively little jobs are in export production; the majority of jobs are embodied in exports through supplies of these services to exporting industries. Nevertheless, the distribution of the sources of jobs that are ultimately embodied in exports is much less skewed when considering forward linkages.

By comparing the indirect jobs considering forward versus backward linkages we can gauge the position of the sector in the supply chain. Services have much more jobs in exports embodied through forward linkages (sourced in services and used anywhere) than they use through backward linkages (sourced anywhere and used in services). This means that they are upstream in the supply chain, being a supplier of embodied jobs to other sectors during the production process, rather than a user of embodied jobs from other sectors (with the exception of transport services). The opposite holds for manufacturing, which is a much larger source of demand for jobs than it is a supplier of jobs embodied in exports.

Despite strong forward linkages with export activities, services jobs are supported less by exports than other sectors of the economy. The share in total domestic employment in the sector illustrates how important exports are as a source of jobs in each sector (if considering forward linkages for exports and for domestic production), or the importance of economy-wide exports as a source of jobs in the sector. Seventy-four percent of jobs supplied by mining and energy and 46% of jobs supplied by manufacturing are ultimately embodied in exports while it is only 13% in services.

Figure 15: Jobs embodied in exports based on backward linkages in 2011

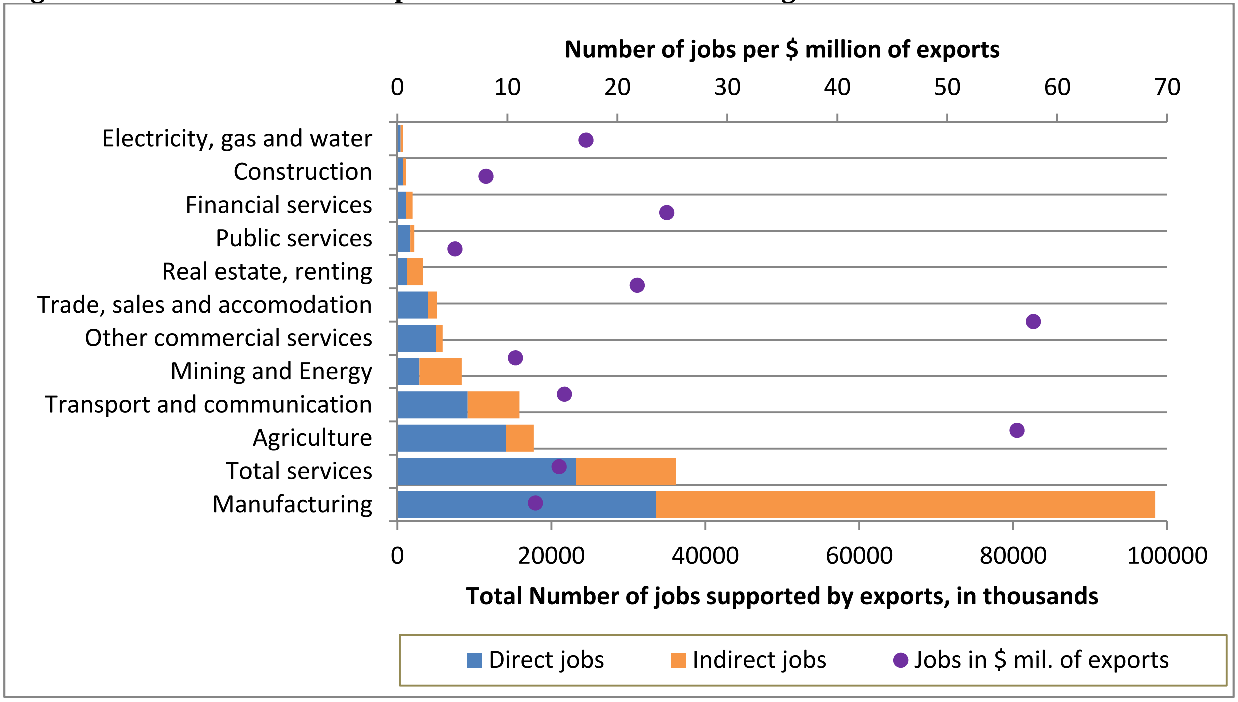
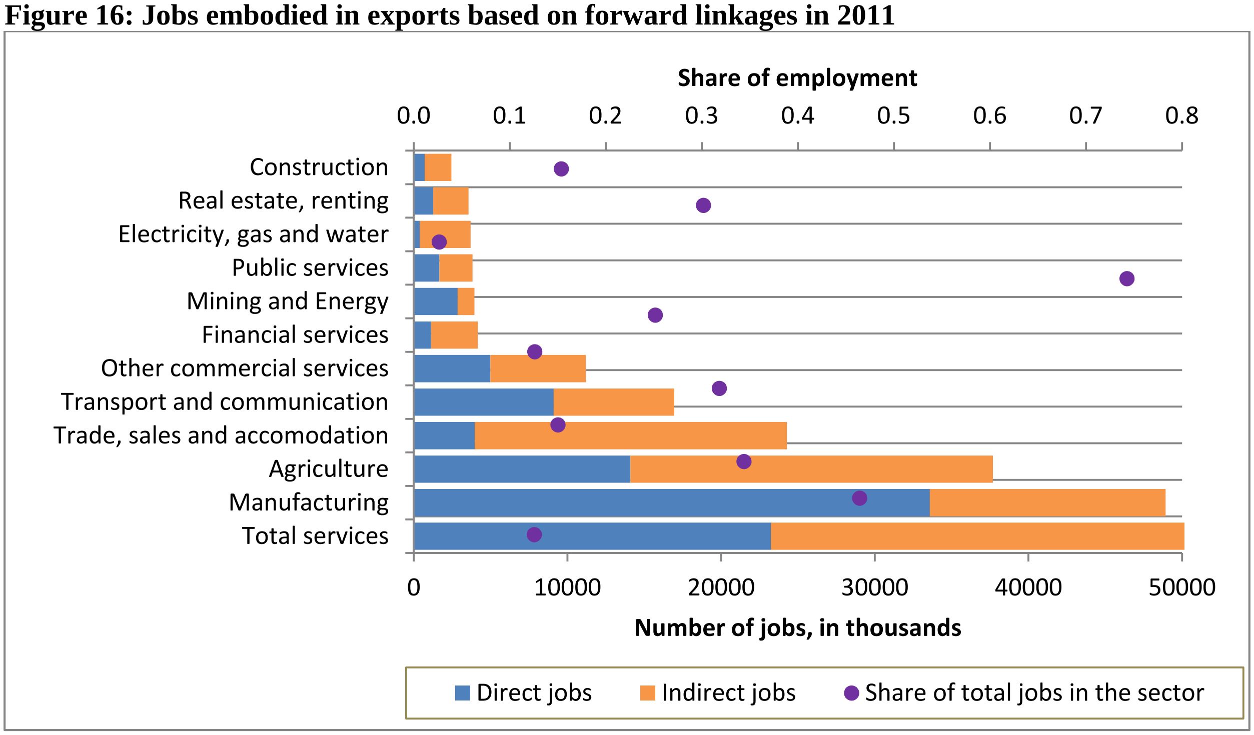


Figure 16: Jobs embodied in exports based on forward linkages in 2011



In Table 5 we further investigate the link between the level of development of a country and the job intensity of a country's exports, similar to what we did for the LVAX share. The dependent variable in the first column is the log of the number of jobs used directly in exports per $1 million of gross exports (direct JobX share). The dependent variable in the second column is the log of the total number of jobs embodied in exports per $1 million of gross exports (total JobX share). The results indicate a negative and statistically significant correlation between the level of development measured by GDP per capita and the job intensity

of exports, regardless of whether we use country and year fixed effects (columns 3 and 4) or not (columns 1 and 2). Developed countries on average have lower job intensity of exports – in line with comparative advantages and with a cursory look what **Error! Reference source not found.** Table 5 suggests. However, this between-country effect is smaller than the within-country effect, which is captured in columns (3) and (4). A 1% increase in a country's GDP per capita is associated with an approximately 1.44% decrease in the direct number of jobs per $1 million of gross exports and 1.64% decrease in the total number of jobs per $1 million of gross exports. Thus, as countries develop, the job intensity of their exports declines, the opposite result to the LVAX share above.

Table 5. Number of jobs in $1 million of gross exports (JobX share)

	(1)	(2)	(3)	(4)
	ln(direct JobX share)	ln(total JobX share)	ln(direct JobX share)	ln(total JobX share)
ln(GDP per capita)	**-1.283*** **	**-1.371*** **	**-1.444*** **	**-1.644*** **
	(0.058)	(0.062)	(0.235)	(0.189)
Constant	8.123	9.683	9.659	12.236
	(0.576)	(0.614)	(1.985)	(1.548)
Year dummies	Yes	Yes	Yes	Yes
Country dummies	No	No	Yes	Yes
R^2	0.861	0.884	0.975	0.982
n	281	281	281	281

Note: * indicates significance at the 10% level; ** indicates significance at the 5% level; *** indicates significance at the 1% level. Robust standard errors in parentheses.

5. Conclusions

Jobs and labor earnings can be a potential driver of poverty reduction and increased prosperity in developing countries. A channel through which exports can have an impact on poverty is by supporting jobs and increasing earnings for those employed.

In this paper we developed a methodology to measure wage content embodied in exports across countries and sectors. To create this database, we combined different releases of the GTAP database from 1995 to 2011. Although recent years have seen the emergence of different databases of global IO tables, we believe the GTAP data offer a balance between quality and country coverage, making it more suitable than other alternatives for our purposes. The resulting data set includes national IO linkages through trade for a maximum of 120 countries and 57 sectors in 2011. We also use data from the ILO to construct the jobs content of exports, resulting in 66 countries and 11 sectors in 2011. The data sets offer a unique opportunity to examine the value added linkages between different sectors for both skilled and unskilled labor and jobs. We analyze not only the direct contribution of labor to value added contained in a given county's exports but also the indirect contribution of labor through exports via other sectors of the economy.

In this paper we discuss some global patterns of labor value added, followed by cross-country comparisons both for wages and jobs. We also examine the wage and labor content of exports both in terms of direct and indirect value added. We show that the share of labor costs in the total value of exports has been somewhat declining over time both for skilled and unskilled workers, with the share of total wages declining somewhat more for unskilled than for skilled workers. A similar trend can be observed when looking at only the direct value added of jobs, without taking into account the linkages between sectors in the economy. Moreover, we showed that countries with lower GDP per capita (and consequently lower wages) have more labor embodied in their exports. This is also supported by the results of a simple OLS regression showing the correlation between the level of development and jobs embodied in exports. The results indicate that a 1% increase in GDP per capita is associated with an approximately 1.3% decrease in the number of jobs as a share of exports. This finding is also in line with standard trade theory predicting

that for countries where labor is relatively cheaper, exports would be more labor intensive given these countries' comparative advantage being in more labor intensive products.

The agenda for further research is rich, starting from the need to explore the causal determinants of the patterns identified in the data. This paper has not gone further than basic correlations. More systematic analyses of the determinants of the labor value added and jobs in exports - possibly trying to exploit shocks exogenous to countries – would be welcome. Going forward it will also be important to reconcile the various existing data, such as GTAP, TiVA and Eora, from which the labor value added in exports can be extracted. This would allow filling the existing data gap (for example this data set has still only 60% of the country coverage) as well as improving the quality of the data.

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Appendix 1. Sectoral coverage of the LACEX database

Table A1. Description of 57 sectors in GTAP

GTAP code	GTAP description
pdr	Paddy Rice: rice, husked and unhusked
wht	Wheat: wheat and meslin
gro	Other Grains: maize (corn), barley, rye, oats, other cereals
v_f	Veg & Fruit: vegetables, fruitvegetables, fruit and nuts, potatoes, cassava, truffles,
osd	Oil Seeds: oil seeds and oleaginous fruit; soy beans, copra
c_b	Cane & Beet: sugar cane and sugar beet
pfb	Plant Fibres: cotton, flax, hemp, sisal and other raw vegetable materials used in textiles
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
ctl	Cattle: cattle, sheep, goats, horses, asses, mules, and hinnies; and semen thereof
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
rmk	Raw milk
wol	Wool: wool, silk, and other raw animal materials used in textile
frs	Forestry: forestry, logging and related service activities
fsh	Fishing: hunting, trapping and game propagation including related service activities, fishing, fish farms; service activities incidental to fishing
coa	Coal: mining and agglomeration of hard coal, lignite and peat
oil	Oil: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
gas	Gas: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
omn	Other Mining: mining of metal ores, uranium, gems. other mining and quarrying
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.
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
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.
mil	Milk: dairy products
pcr	Processed Rice: rice, semi- or wholly milled
sgr	Sugar

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.
b_t	Beverages and Tobacco products
tex	Textiles: textiles and man-made fibres
wap	Wearing Apparel: Clothing, dressing and dyeing of fur
lea	Leather: tanning and dressing of leather; luggage, handbags, saddlery, harness and footwear
lum	Lumber: wood and products of wood and cork, except furniture; articles of straw and plaiting materials
ppp	Paper & Paper Products: includes publishing, printing and reproduction of recorded media
p_c	Petroleum & Coke: coke oven products, refined petroleum products, processing of nuclear fuel
crp	Chemical Rubber Products: basic chemicals, other chemical products, rubber and plastics products
nmm	Non-Metallic Minerals: cement, plaster, lime, gravel, concrete
i_s	Iron & Steel: basic production and casting
nfm	Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
fmp	Fabricated Metal Products: Sheet metal products, but not machinery and equipment
mvh	Motor Motor vehicles and parts: cars, lorries, trailers and semi-trailers
otn	Other Transport Equipment: Manufacture of other transport equipment
ele	Electronic Equipment: office, accounting and computing machinery, radio, television and communication equipment and apparatus
ome	Other Machinery & Equipment: electrical machinery and apparatus n.e.c., medical, precision and optical instruments, watches and clocks
omf	Other Manufacturing: includes recycling
ely	Electricity: production, collection and distribution
gdt	Gas Distribution: distribution of gaseous fuels through mains; steam and hot water supply
wtr	Water: collection, purification and distribution
cns	Construction: building houses factories offices and roads
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
otp	Other Transport: road, rail ; pipelines, auxiliary transport activities; travel agencies
wtp	Water transport
atp	Air transport
cmn	Communications: post and telecommunications
ofi	Other Financial Intermediation: includes auxiliary activities but not insurance and pension funding (see next)
isr	Insurance: includes pension funding, except compulsory social security
obs	Other Business Services: real estate, renting and business activities
ros	Recreation & Other Services: recreational, cultural and sporting activities, other service activities; private households with employed persons (servants)
osg	Other Services (Government): public administration and defense; compulsory social security, education, health and social work, sewage and refuse disposal, sanitation and similar activities, activities of membership organizations n.e.c., extra-territorial organizations and bodies
dwe	Dwellings: ownership of dwellings (imputed rents of houses occupied by owners)

Source: GTAP

Table A2. Concordance between 57 sectors in GTAP and 24 sectors in the labor value added content of exports data set

LACEX code	LACEX description (24 sectors)	GTAP codes (57 sectors)
aff	Agr, Forestry, Fisheries	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, frs, fsh
pfd	Processed Foods	cmt, omt, vol, mil, pcr, sgr, ofd
egy	Energy Extraction	coa, oil, gas, p_c
omn	Minerals nec	omn
b_t	Beverages and Tobacco Products	b_t
tex	Textiles	tex
wap	Wearing Apparel	wap
lea	Leather Products	lea
lum	Wood Products	lum
ppp	Paper Products, Publishing	ppp
crp	Chemical, Rubber, Plastic Products	crp
nmm	Mineral Products nec	nmm
i_s	Ferrous Metals	i_s
nfm	Metals nec	nfm
fmp	Metal Products	fmp
trn	Transport Equipment	mvh, otn
mac	Machinery and Equipment nec	ele, ome
omf	Manufactures nec	omf
egw	Electricity, Gas, Water	ely, gdt, wtr
cns	Construction	cns
t_t	Trade and Transport Services	trd, otp, wtp, atp
ops	Other Private Services	cmn, ofi, isr, obs, ros
osg	PubAdmin/Defence/Health/Educat	osg
dwe	Dwellings	dwe

Table A3. The 11 sectors in ILO and jobs content of exports data set

LACEX code	ILO/LACEX description (11 sectors)
agr	Agriculture
meg	Mining and Energy
mfc	Manufacturing
egw	Electricity, gas and water
cns	Construction
tsa	Trade, sales and accomodation
tco	Transport and communication
fin	Financial services
rer	Real estate, renting
ops	Other commercial services
osg	Public services

Appendix 2. Country coverage of the LACEX database

Table A4. Country coverage of the labor value added content of exports data set

Country	Country code	1995	1997	2001	2004	2007	2011
Albania	ALB		•	•	•	•	•
Argentina	ARG	•	•	•	•	•	•
Armenia	ARM				•	•	•
Australia	AUS	•	•	•	•	•	•
Austria	AUT		•	•	•	•	•
Azerbaijan	AZE				•	•	•
Bangladesh	BGD		•	•	•	•	•
Belarus	BLR				•	•	•
Belgium	BEL		•	•	•	•	•
Benin	BEN				•	•	•
Bolivia	BOL			•	•	•	•
Bosnia and Herzegovina	BHR				•	•	•
Botswana	BWA		•	•	•	•	•
Brazil	BRA	•	•	•	•	•	•
Brunei	BRN						•
Bulgaria	BGR		•	•	•	•	•
Burkina Faso	BFA				•	•	•
Cambodia	KHM				•	•	•
Cameroon	CMR				•	•	•
Canada	CAN	•	•	•	•	•	•
Chile	CHL	•	•	•	•	•	•
China	CHN	•	•	•	•	•	•
Colombia	COL	•	•	•	•	•	•
Costa Rica	CRI				•	•	•
Côte d'Ivoire	CIV				•	•	•
Croatia	HRV		•	•	•	•	•
Cyprus	CYP		•	•	•	•	•
Czech Republic	CZE		•	•	•	•	•
Denmark	DNK	•	•	•	•	•	•
Dominican Republic	DOM						•
Ecuador	ECU			•	•	•	•
Egypt, Arab Rep.	EGY				•	•	•
El Salvador	SLV				•	•	•
Estonia	EST		•	•	•	•	•
Ethiopia	ETH				•	•	•
Finland	FIN	•	•	•	•	•	•
France	FRA		•	•	•	•	•
Georgia	GEO				•	•	•
Germany	DEU	•	•	•	•	•	•
Ghana	GHA				•	•	•
Greece	GRC		•	•	•	•	•
Guatemala	GTM				•	•	•
Guinea	GIN				•	•	•
Honduras	HND				•	•	•
Hong Kong SAR, China	HKG	•	•	•	•	•	•
Hungry	HUN		•	•	•	•	•
India	IND	•	•	•	•	•	•
Indonesia	IDN	•	•	•	•	•	•
Iran, Islamic Rep.	IRN			•	•	•	•
Ireland	IRL		•	•	•	•	•
Israel	ISR				•	•	•

Italy	ITA		•	•	•	•	•
Jamaica	JAM						•
Japan	JPN	•	•	•	•	•	•
Jordan	JOR						•
Kazakhstan	KAZ				•	•	•
Kenya	KEN				•	•	•
Korea, Rep.	KOR	•	•	•	•	•	•
Kuwait	KWT				•	•	•
Kyrgyzstan	KGZ				•	•	•
Lao PDR	LAO				•	•	•
Latvia	LVA		•	•	•	•	•
Lithuania	LTU		•	•	•	•	•
Luxemburg	LUX		•	•	•	•	•
Madagascar	MDG			•	•	•	•
Malawi	MWI		•	•	•	•	•
Malaysia	MYS	•	•	•	•	•	•
Malta	MLT		•	•	•	•	•
Mauritius	MUS			•	•	•	•
Mexico	MEX	•	•	•	•	•	•
Mongolia	MNG				•	•	•
Morocco	MAR	•	•	•	•	•	•
Mozambique	MOZ		•	•	•	•	•
Namibia	NAM				•	•	•
Nepal	NPL				•	•	•
Netherlands	NLD		•	•	•	•	•
New Zealand	NZL	•	•	•	•	•	•
Nicaragua	NIC				•	•	•
Nigeria	NGA			•	•	•	•
Norway	NOR				•	•	•
Oman	OMN				•	•	•
Pakistan	PAK			•	•	•	•
Panama	PAN				•	•	•
Paraguay	PRY				•	•	•
Peru	PER		•	•	•	•	•
Philippines	PHL	•	•	•	•	•	•
Poland	POL		•	•	•	•	•
Portugal	PRT		•	•	•	•	•
Puerto Rico	PRI						•
Qatar	QAT				•	•	•
Romania	ROU		•	•	•	•	•
Rwanda	RWA				•	•	•
Russian Federation	RUS		•	•	•	•	•
Saudi Arabia	SAU				•	•	•
Senegal	SEN				•	•	•
Singapore	SGP	•	•	•	•	•	•
Slovak Republic	SVK		•	•	•	•	•
Slovenia	SVN		•	•	•	•	•
South Africa	ZAF			•	•	•	•
Spain	ESP		•	•	•	•	•
Sri Lanka	LKA	•	•	•	•	•	•
Sweden	SWE	•	•	•	•	•	•
Switzerland	CHE		•	•	•	•	•
Taiwan, China	TWN	•	•	•	•	•	•
Tanzania	TZA		•	•	•	•	•
Thailand	THA	•	•	•	•	•	•
Togo	TGO				•	•	•

Trinidad and Tobago	TTO						•
Tunisia	TUN			•	•	•	•
Turkey	TUR	•	•	•	•	•	•
Uganda	UGA		•	•	•	•	•
Ukraine	UKR				•	•	•
United Arab Emirates	ARE				•	•	•
United Kingdom	GBR	•	•	•	•	•	•
United States	USA	•	•	•	•	•	•
Uruguay	URY	•	•	•	•	•	•
Venezuela, RB	VEN	•	•	•	•	•	•
Vietnam	VNM	•	•	•	•	•	•
Zambia	ZMB		•	•	•	•	•
Zimbabwe	ZWE		•	•	•	•	•

Table A5. Country coverage of the jobs content of exports data set

Country	Country code	1997	2001	2004	2007	2011
Albania	ALB	•	•	•		
Argentina	ARG	•	•	•		•
Armenia	ARM			•	•	•
Australia	AUS	•	•	•	•	•
Austria	AUT	•	•	•	•	•
Azerbaijan	AZE			•	•	•
Belarus	BLR					•
Belgium	BEL	•	•	•	•	•
Bolivia	BOL			•	•	
Botswana	BWA		•			
Brazil	BRA			•	•	•
Bulgaria	BGR	•	•	•	•	•
Cambodia	KHM			•		
Canada	CAN	•	•	•	•	•
Chile	CHL					•
China	CHN			•		
Colombia	COL			•		•
Costa Rica	CRI			•	•	
Croatia	HRV	•	•	•	•	•
Cyprus	CYP		•	•	•	•
Czech Republic	CZE	•	•	•	•	•
Denmark	DNK	•	•	•	•	•
Ecuador	ECU		•	•		•
Egypt, Arab Rep.	EGY			•	•	•
El Salvador	SLV			•	•	
Estonia	EST	•	•	•	•	•
Ethiopia	ETH			•		•
Finland	FIN	•	•	•	•	•
France	FRA		•	•	•	•
Georgia	GEO			•	•	
Germany	DEU	•	•	•	•	•
Greece	GRC	•	•	•	•	•
Guatemala	GTM					•
Hong Kong SAR, China	HKG					•
Hungary	HUN	•	•	•	•	•
Indonesia	IDN		•	•	•	
Iran, Islamic Rep.	IRN				•	
Ireland	IRL	•	•	•	•	•
Israel	ISR			•	•	•

Italy	ITA	•	•	•	•	•
Japan	JPN			•	•	
Kazakhstan	KAZ			•	•	
Korea, Rep.	KOR	•	•	•	•	•
Kyrgyzstan	KGZ			•	•	
Latvia	LVA	•	•	•	•	•
Lithuania	LTU	•	•	•	•	•
Luxembourg	LU•	•	•	•	•	•
Moldova	MDA			•	•	•
Malaysia	MYS		•	•	•	•
Malta	MLT		•	•	•	•
Mauritius	MUS		•	•	•	•
Mexico	ME•	•	•	•	•	•
Mongolia	MNG			•	•	•
Morocco	MAR					•
Namibia	NAM			•		
Netherlands	NLD	•	•	•	•	•
New Zealand	NZL	•	•	•	•	•
Nicaragua	NIC			•		
Nigeria	NGA				•	
Norway	NOR			•	•	•
Panama	PAN			•	•	•
Paraguay	PRY					•
Peru	PER	•	•	•	•	
Philippines	PHL	•	•	•	•	•
Poland	POL	•	•	•	•	•
Portugal	PRT	•	•	•	•	•
Qatar	QAT			•	•	•
Romania	ROU	•	•	•	•	•
Russian Federation	RUS	•	•	•	•	•
Saudi Arabia	SAU				•	
Singapore	SGP		•	•	•	•
Slovak Republic	SVK	•	•	•	•	•
Slovenia	SVN	•	•	•	•	•
South Africa	ZAF			•		•
Spain	ESP	•	•	•	•	•
Sweden	SWE	•	•	•	•	•
Switzerland	CHE	•	•	•	•	•
Taiwan, China	TWN		•	•	•	
Thailand	THA			•	•	•
Turkey	TUR		•	•	•	•
Ukraine	UKR					•
United Kingdom	GBR		•	•	•	•
United States	USA			•	•	
Uruguay	URY					•
Venezuela, RB	VEN					•
Vietnam	VNM	•	•	•		
Zimbabwe	ZWE					•

Appendix 3. Recreating the LACEX database

3.1 LACEX from GTAP tables

Open GTAP and select the level of aggregation for countries and sectors, then create the aggregated database. This database will be used to extract the underlying matrices that feed into Stata. GTAP 9 is used to extract data for 2011; GTAP 8 for 2007 and 2004; GTAP 6.5 for 2001; and GTAP 5 for 1997.

Once the aggregated database is saved, open the files with Viewhar.exe, which can be found in the folder where GTAP is installed (usually in C:\GAggXXX).

The arrays and matrices that need to be extracted and saved as .csv filse are:

- **Gross Exports** (X vector): Calculated as VALEXPORTS + VST on (t_t) (found in BaseView.har). Open each and from the menu select Export -> Save Screen as CSV file
- **Gross Output** (Z vector): Calculated from NVFA (found in BaseView.har). Open and from the menu select File -> Save as -> Select "Selected header ..." and "Database text file" -> Select "Comma"
- **Share of Value Added by Factors** (b vector): Compensation of factors over gross output. Calculated from NVFA using the Stata .do file (see Box A1 below)
- **Leontief Matrix** (A matrix): Calculated from NVFA (1 domestic), where each value of the column should be divided by the column total in NVFA (sum dir) using the Stata .do file (below)
- **Final Sales** (Y vector): Calculate (using Matlab, Stata's matrix functions, or Excel's array functions) as Y=Z-A*Z (see Box A2 below)

Box A1. Stata .do file

```
////////////////////////////////////////////////////////////////////////////////
//Construct Exports
////////////////////////////////////////////////////////////////////////////////
foreach yyy of numlist 1997 2001 2004 2007 2011{
*EXPORTS
        insheet using "24 Sectors\Raw Data\Export_`yyy'.csv", clear
        //drop variables that should not be in there (i.e. Total)
        drop if valexports=="Total"
        split valexports, p(" ")
        rename valexports2 sector
        drop valexports* total
        foreach var of varlist *{
                rename `var' _`var'
        }
        rename _sector sector

        reshape long _, i(sector) j(iso3) string
        rename _ net_exp
        //drop codes that are not for countries (e.g. v81)
        bys iso3: egen chk=total(net_exp)
        drop if chk==0
        drop chk
        save exp_tmp_`yyy', replace

*TRANSPORT COSTS
        insheet using "24 Sectors\Raw Data\VST_`yyy'.csv", clear
        drop if vst=="Total"
        split vst, p(" ")
        rename vst2 sector
```

```
        drop vst* total
        foreach var of varlist *{
                rename `var' _`var'
        }
        rename _sector sector

        reshape long _, i(sector) j(iso3) string
        rename _ cost_exp
        //drop codes that are not for countries (e.g. v81)
        bys iso3: egen chk=total(cost_exp)
        drop if chk==0
        drop chk
        merge 1:1 sector iso3 using exp_tmp_`yyy'
        drop _merge
        replace cost_exp=0 if cost_exp==.
        replace net_exp=0 if net_exp==.

*EXPORTS=NET+Trans.Costs
        gen exports=cost_exp+net_exp
        drop cost_exp net_exp
        gen year=`yyy'
        sort iso3 sector year
        save exp_tmp_`yyy', replace
}

clear all
foreach yyy of numlist 1997 2001 2004 2007 2011{
        append using exp_tmp_`yyy'
        erase exp_tmp_`yyy'.dta
}
replace sector="coa" if sector=="col"
replace sector="frs" if sector=="for"

order iso3 sector year
sort iso3 year sector
save exports_4_LACEX, replace


////////////////////////////////////////////////////////////////////////////////
//Get the betas, gross output and Leontief matrices
////////////////////////////////////////////////////////////////////////////////
foreach yyy of numlist 1997 2001 2004 2007{

        insheet using "24 Sectors\Raw Data\NVFA_`yyy'.csv", clear
        drop in 1/2
        rename (v1 v2 v3 v4 v5 v6) (row column iso3 dom_imp tax_val value)
        destring value, replace

        reshape wide value, i(row iso3 dom_imp tax_val) j(column) string
        drop valueCGDS
        gen b_sk=.
        gen b_usk=.
        gen gross_output=.
        gen row_tmp="a_"+row
*Betas and Gross Output
        foreach var of varlist value*{
```

```
			replace `var'=0 if `var'==.
			local j="a_"+substr("`var'", 6,.)
			rename `var' `j'

		//Gross Output
			bys iso3: egen total_`j'=total(`j')
		//Betas
			gen tmp1=`j' if row=="SkLab"
			bys iso3: egen tmp2=total(tmp1)
			replace b_sk=tmp2/total_`j' if row_tmp=="`j'"
			drop tmp1 tmp2

			gen tmp1=`j' if row=="UnSkLab"
			bys iso3: egen tmp2=total(tmp1)
			replace b_usk=tmp2/total_`j' if row_tmp=="`j'"
			drop tmp1 tmp2

			replace gross_output=total_`j' if row_tmp=="`j'"
		}
		drop row_tmp
		drop if row=="UnSkLab" | row=="SkLab" | row=="NatRes" | row=="Land" ///
		| row=="Capital" | row=="NatlRes"

		keep if dom_imp=="domestic"

		//Getting data I need to construct the Leontief matrix
		collapse (sum)  a_* (mean) total_* b_* gross_output, by(iso3 row)

*Leontief
		foreach var of varlist a_*{
			replace `var'=`var'/total_`var'
			drop total_`var'
		}

		rename row sector
		gen year=`yyy'
		order iso3 sector year
		sort iso3 sector year
		save nvfa_tmp_`yyy', replace
}

clear all
foreach yyy of numlist 1997 2001 2004 2007{
		append using nvfa_tmp_`yyy'
		erase nvfa_tmp_`yyy'.dta
}

sort iso3 year sector

//Adjust for sectoral names changing in GTAP
replace sector="coa" if sector=="col"
replace sector="frs" if sector=="for"

replace a_coa=a_col if a_coa==.
replace a_frs=a_for if a_frs==.
drop a_col a_for
```

```
order a_*, alphabetic last
sort iso3 year sector

save leo_4_LACEX, replace


////////////////////////////////////////////////////////////////////////////////
//Get the betas, gross output and Leontief matrices FOR 2011. It has a different split
//////////////////////////////////////////////////////////////////////////////////
//Getting the split between skilled and unskilled from 2007
        use leo_4_LACEX, clear
        keep if year==2007
        keep iso3 sector b_*
        gen sum_b=b_sk+b_usk
        gen ratio_sk=b_sk/sum_b
        gen ratio_usk=b_usk/sum_b
        drop b_* sum_b
        save ratios_4_2011, replace

//Getting the data for 2011
        insheet using "24 Sectors\Raw Data\NVFA_2011.csv", clear
        drop in 1/2
        rename (v1 v2 v3 v4 v5 v6) (row column iso3 dom_imp tax_val value)
        destring value, replace
        tab row
        replace row="Labor" if row=="ag_othlowsk" | row=="clerks" | row=="off_mgr_pros" ///
        | row=="service_shop" | row=="tech_aspros"
        tab row
        collapse (sum) value, by( row column iso3 dom_imp tax_val)
        reshape wide value, i(row iso3 dom_imp tax_val) j(column) string
        drop valueCGDS
        gen b_labor=.
        gen gross_output=.
        gen row_tmp="a_"+row

*Betas and Gross Output
        foreach var of varlist value*{
                replace `var'=0 if `var'==.
                local j="a_"+substr("`var'", 6,.)
                rename `var' `j'

        //Gross Output
                bys iso3: egen total_`j'=total(`j')
        //Betas
                gen tmp1=`j' if row=="Labor"
                bys iso3: egen tmp2=total(tmp1)
                replace b_labor=tmp2/total_`j' if row_tmp=="`j'"
                drop tmp1 tmp2

                replace gross_output=total_`j' if row_tmp=="`j'"
        }
        drop row_tmp
        drop if row=="Labor" | row=="NatRes" | row=="Land" ///
        | row=="Capital" | row=="NatlRes"
```

```
            keep if dom_imp=="domestic"

//Getting data I need to construct the Leontief matrix
            collapse (sum)  a_* (mean) total_* b_* gross_output, by(iso3 row)

            *Leontief
            foreach var of varlist a_*{
                        replace `var'=`var'/total_`var'
                        drop total_`var'
            }

            rename row sector
            gen year=2011
//Merging with the Ratios
            merge 1:1 iso3 sector using ratios_4_2011
//Missing for some countries that did not exist in GTAP 8
            tab iso3 if _merge!=3
            drop if _merge!=3

            gen b_sk= b_labor*ratio_sk
            gen b_usk= b_labor*ratio_usk
            drop _merge b_labor ratio_sk ratio_usk
            order iso3 sector year
            sort iso3 sector year
            erase ratios_4_2011.dta
            //Append to the other years
            append using leo_4_LACEX
            sort iso3 year sector

merge 1:1 iso3 sector year using exports_4_LACEX
//Missing for countries that did not exist in GTAP 8
drop if _merge!=3
sort iso3 year sector
drop _merge
gen id=_n
order a_*, alphabetic last
save LACEX_before_Matlab, replace


////////////////////////////////////////////////////////////////////////////////
//Prepare data for MATLAB
////////////////////////////////////////////////////////////////////////////////
//Stata 12
//outsheet  a_* export gross_output b_* using "4_matlab2_`yyy'.csv", nonames comma replace

//Stata 13
export delimited a_* export gross_output b_* id year using 4_matlab.csv, ///
replace


**********************
/////RUN MATLAB
********************************************************************************
********************************************************************************
********************************************************************************
```

```
//Put the data together
//////////////////////////////////////
foreach file in G_final H_final{
	insheet using `file'.txt, clear

	rename (v115 v116) (id year)
	erase `file'.txt
	save `file', replace
}

use H_final, clear

merge 1:1 id year using LACEX_before_Matlab
drop _merge

global i=1
foreach var of varlist a_*{
	rename v$i h_`var'_sk
	global i=$i+1
}

foreach var of varlist a_*{
	rename v$i h_`var'_usk
	global i=$i+1
}
order iso3 sector year
save tmp, replace

//G Matrix
use G_final, clear

merge 1:1 id year using tmp
drop _merge

global i=1
foreach var of varlist a_*{
	rename v$i g_`var'_sk
	global i=$i+1
}

foreach var of varlist a_*{
	rename v$i g_`var'_usk
	global i=$i+1
}


///////////
//Some cleaning
foreach var of varlist g_a_*{
	local i=substr("`var'", 4, .)
	rename `var' g`i'
}
foreach var of varlist h_a_*{
	local i=substr("`var'", 4, .)
	rename `var' h`i'
}
```

```
drop a_*
order g_*_sk h_*_sk , alphabetic last
order g_*_usk h_*_usk , alphabetic last
drop id

merge m:1 sector using sector_names
drop _merge

order iso3 sector* year
sort iso3 year sector


foreach file in tmp.dta exports_4_LACEX.dta 4_matlab.csv G_final.dta H_final.dta LACEX_before_Matlab.dta leo_4_LACEX.dta{
        erase "`file'"
}

//merge m:1 iso3 using country_names
//browse if _merge==2
saveold LACEX_57sect, replace
```

Box A2. Matlab .m file

```
clear all
num_sectors=57

[~, ~, raw] = xlsread('4_matlab.csv','4_matlab');
data = cell2mat(raw(2:end,:));

%num_countries actually refers to the product of number of countries and years
num_countries=size(data, 1)/num_sectors

YY=zeros(num_countries*num_sectors,1);

G_sk_keep=zeros(num_countries*num_sectors,num_sectors);
G_usk_keep=zeros(num_countries*num_sectors,num_sectors);

H_sk_keep=zeros(num_countries*num_sectors,num_sectors);
H_usk_keep=zeros(num_countries*num_sectors,num_sectors);

for i=1:num_countries
X=diag(data(num_sectors*(i-1)+1:num_sectors*i,58));
Z=data(num_sectors*(i-1)+1:num_sectors*i,59);

A=data(num_sectors*(i-1)+1:num_sectors*i,1:57);

Y=diag(Z-A*Z);
b_sk=diag(data(num_sectors*(i-1)+1:num_sectors*i,60));
b_usk=diag(data(num_sectors*(i-1)+1:num_sectors*i,61));


M=inv(eye(num_sectors)-A);

G_sk=b_sk*M*Y;
G_usk=b_usk*M*Y;
```

```
H_sk=b_sk*M*X;
H_usk=b_usk*M*X;


YY(num_sectors*(i-1)+1:num_sectors*i,:)=diag(Y);

H_sk_keep(num_sectors*(i-1)+1:num_sectors*i,:)=H_sk;
H_usk_keep(num_sectors*(i-1)+1:num_sectors*i,:)=H_usk;

G_sk_keep(num_sectors*(i-1)+1:num_sectors*i,:)=G_sk;
G_usk_keep(num_sectors*(i-1)+1:num_sectors*i,:)=G_usk;

end

H_final=[H_sk_keep, H_usk_keep, data(:,62), data(:,63)];
G_final=[G_sk_keep, G_usk_keep, data(:,62), data(:,63)];

dlmwrite('H_final.txt',H_final,'\t')
dlmwrite('G_final.txt',G_final,'\t')
dlmwrite('Y_final.txt',YY,'\t')
```

3.2 Reconciling the skill split of labor between GTAP 9 and the preceding versions

It seems there is no one-to-one match between the occupational categories of GTAP 9 and 8. We defined skilled labor as the sum of the compensation of "Officials and Mangers" and "Technicians" (Table A6).

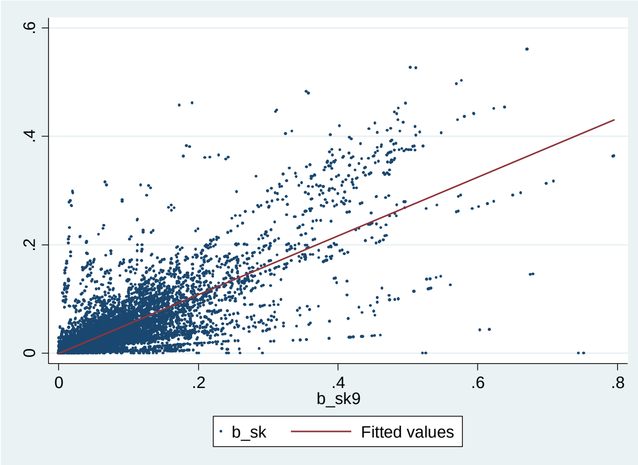
Table A6. Occupational categories of labor in GTAP 9

ISCO-88 Major Group	Abbreviated Name used in GTAP	Short name used in Paper	Description
1,2	off_mgr_pros	Officials and Mangers	legislators, senior officials and managers (Major Groups 1), and professionals (Major Group 2)
3	tech_aspros	Technicians	technicians and associate professionals
4	Clerks	Clerks	Clerks
5	service_shop	Service/Shop workers	service workers and shop and market sales workers
6,7,8,9	ag_othlowsk	Agricultural and Unskilled	skilled agricultural and fishery workers (Major Group 6), craft and related trade workers (Major Group 7), plant and machine operators and assemblers (Major Group 8), and elementary occupations (Major Group 9)

Source: GTAP 9

The y axis of Figure A1 measures the share of skilled labor in value added for each country-sector pair in GTAP 8; the x axis measures the share of "Officials and Mangers" and "Technicians" in value added for the same country-sector pairs in GTAP 9. The weak correlation between these two shares contrast with the constancy of the production function by sector-country over time, which we check by comparing the ratio of skilled to unskilled labor between the 2004 and the 2007 data in GTAP 8 (results available upon request), thus suggesting that there is no way of perfectly reconciling the different categories of labor in 2007 vis-à-vis 2011.

Figure A1. Share of skilled Labor VA in GTAP 8 over GTAP 9



Source: Authors' elaboration on GTAP 8 and 9.

Checking the correlation sector-by-sector, we find that the low correlation is not driven by specific sectors. However, when we aggregate skilled and unskilled labor value added, the correlation between the two data sets is 99.88%. This suggests that the underlying statistics constructed from the National Accounts are the same.

To test whether the share of Skilled/Unskilled Labor Value Added is constant over time, we use comparisons between 2007 and 2004 from GTAP 8. We first calculated the ratio of the betas (share of skilled/unskilled LVA in gross output) and calculated the difference between 2007 and 2004. The mean difference is 0.0002962 with a standard deviation of 0.0122919. Since only less than 1% of the observations have changed between 2007 and 2004, we decided to split the 2011 labor value added (GTAP 9), using the proportions from 2007, in order to make 2011 comparable to previous years.

Appendix 4. Definitions of variables in the LACEX database

The purpose of this appendix is to serve as a reference of all the variables and files used in the database on embodied labor value added in exports, which is accompanied by a second database containing data on total jobs contained in exports. Total wages correspond to labor value added, so we will use both terms interchangeably. Sectors we denote with indices i and j, countries with r and endowments with k.

4.1 List of variables in the labor value added content of exports data set

G_matrix:
This group of variables contains the total labor value added flows in final sales between sectors. They span a matrix with the 24 sectors as rows and columns. The matrix exists for skilled and unskilled labor. Take the row "pfd" in the G_matrix_sk for Australia in 2011, for example. Following this row the cells contain the direct and indirect skilled labor va/wages sold from the processed foods sector to the other sectors of the Australian economy. Taking the sum of the whole row thus gives the total skilled labor va/wages of the processed food sector in Australia in 2011 based on forward linkages for the processed food sector. The column g_pfd_sk denotes the direct and indirect skilled labor va/wages bought by the Australian processed food sector from the other sectors of the economy in 2011. The column sum thus gives the total labor va/wages contained in the Australian processed foods sector in 2011 based on backward linkages. For each country G matrix is calculated as a diagonal matrix of (skilled/unskilled) labor va/wages share of output ($\hat{B}$) times the multiplier matrix (M). This is then multiplied with a vector of total final sales ($\hat{Y}$):

$$G_{ij}^{r} = \widehat{B_{ij}^{r}} M_{ij}^{r} \widehat{Y_{ij}^{r}}$$

H_matrix:
This group of variables contains the total labor value added flows in exports between sectors. They span a matrix with the 24 sectors as rows and columns. The matrix exists for skilled and unskilled labor. Take the row "pfd" in the H_matrix_sk for Australia in 2011, for example. Following this row the cells contain the direct and indirect skilled labor va/wages embodied in exports sold from the processed foods sector to the other sectors of the Australian economy. Taking the sum of the whole row thus gives the total skilled labor va/wages embodied in exports of the processed food sector in Australia in 2011 based on forward linkages. The column g_pfd_sk denotes the direct and indirect skilled labor va/wages bought by the Australian processed food sector for its exports from the other sectors of the economy in 2011. The column sum thus gives the total labor va/wages embodied in the exports in the Australian processed foods sector in 2011 based on backward linkages. For each country H matrix is calculated as a diagonal matrix of (skilled/unskilled) labor va/wages share of output ($\hat{B}$) times the multiplier matrix (M). This is then multiplied with a vector of gross exports ($\hat{X}$):

$$H_{ij}^{r} = \widehat{B_{ij}^{r}} M_{ij}^{r} \widehat{X_{ij}^{r}}$$

direct_lva_x:
This variable is the direct (skilled/unskilled) labor va/wages contained in exports in absolute dollar values. It is calculated as (skilled/unskilled) labor va/wages share of output multiplied by the gross value of exports:

$$direct\_lva\_x_{i}^{r} = b_{i}^{r} * gxwd_{i}^{r}$$

where dlvax is direct labor va in exports; b is labor va share of output; gxwd is gross export values at world prices.

dom_lva_shr:
This variable contains the (skilled/unskilled) labor va/wages share of output per sector. Basically it corresponds to vector b_{i}^{r} and the diagonal of matrix B_{ij}^{r} as defined above.

dlvaX_shr:
This variable relates the direct (skilled/unskilled) labor va/wages contained in exports to the direct va (meaning not just labor, but also capital, land and natural resources) contained in the exports of an economy:

$$dlvaX\_shr_i^r = \frac{dlvax_{i,(un-)skilled}^r}{\sum_{i,k} dlvax_{ik}^r}$$

It gives the labor intensity of a sector in exports if exports are valued at direct exported value added instead of gross values.

tlvaX_shr_fwd:
This variable relates the total (direct + indirect), (skilled/unskilled) labor va/wages contained in exports to the total va (meaning not just labor, but also capital, land and natural resources) contained in the exports of an economy based on forward linkages:

$$tlvaX\_shr\_fwd_i^r = \frac{tlvax\_fwd_{i,(un-)skilled}^r}{\sum_{i,k} tlvax\_fwd_{ik}^r}$$

It gives the labor intensity of a sector in exports if exports are valued at total exported value added instead of gross values.

tlvaX_shr_bwd:
This variable relates the total (direct + indirect), (skilled/unskilled) labor va/wages contained in exports to the total va (meaning not just labor, but also capital, land and natural resources) contained in the exports of an economy based on backward linkages:

$$tlvaX\_shr\_bwd_i^r = \frac{tlvax\_bwd_{i,(un-)skilled}^r}{\sum_{i,k} tlvax\_bwd_{ik}^r}$$

It gives the labor intensity of a sector in exports if exports are valued at total exported value added instead of gross values.

RCAstandard:
This variable is a standard revealed comparative advantage index. It measures the relative (dis-)advantage a country has in certain sectors compared to global trade flows:

$$RCA_i^r = \frac{\left(\frac{gxwd_i^r}{\sum_i gxwd_i^r}\right)}{\left(\frac{\sum_r gxwd_i^r}{\sum_{ir} gxwd_i^r}\right)}$$

See also Table 10 of Francois et al. (2013).

relintfwd:
We called this the revealed intensity index for embodied total labor va/wages based on forward linkages. It is calculated similar to the RCA index, but instead of gross value of exports it uses on embodied labor va/wages based on forward linkages. It measures the relative (dis-)advantage skilled or unskilled labor in a country has in certain sectors compared to global trade flows if trade is valued in total embodied va instead of gross values:

$$relintfwd_i^r = \frac{\left(\frac{tlvax\_fwd_{i,(un-)skilled}^r}{\sum_i tlvax\_fwd_{i,(un-)skilled}^r}\right)}{\left(\frac{\sum_{rk} tlvax\_fwd_{ik}^r}{\sum_{irk} tlvax\_fwd_{ik}^r}\right)}$$

relintbwd:
We called this the revealed intensity index for embodied total labor va/wages based on backward linkages. It is calculated similar to the RCA index, but instead of gross value of exports it uses on embodied labor va/wages based on backward linkages. It measures the relative (dis-)advantage skilled or unskilled labor in a country has in certain sectors compared to global trade flows if trade is valued in total embodied va instead of gross values:

$$relintbwd_i^r = \frac{\left(\frac{tlvax\_bwd_{i,(un-)skilled}^r}{\sum_i tlvax\_bwd_{i,(un-)skilled}^r}\right)}{\left(\frac{\sum_{rk} tlvax\_bwd_{ik}^r}{\sum_{irk} tlvax\_bwd_{ik}^r}\right)}$$

4.2 List of variables in the jobs content of exports data set

GMatrix:
This group of variables contains the job flows in final sales between sectors. They span a matrix with the 24 sectors as rows and columns. Take the row "pfd" in the G_matrix_sk for Australia in 2011, for example. Following this row the cells contain the direct and indirect jobs sold from the processed foods sector to the other sectors of the Australian economy. Taking the sum of the whole row thus gives the total jobs embodied in final sales of the processed food sector in Australia in 2011 based on forward linkages for the processed food sector. The column g_pfd_sk denotes the direct and indirect jobs bought by the Australian processed food sector from the other sectors of the economy in 2011. The column sum thus gives the total jobs contained in final sales in the Australian processed foods sector in 2011 based on backward linkages. For each country G matrix is calculated as a diagonal matrix of jobs numbers divided by total endowment costs of output ($\hat{J}$) times the multiplier matrix (M). This is then multiplied with a vector of total final sales ($\hat{Y}$):

$$G_{ij}^r = \widehat{J_{ij}^r} M_{ij}^r \widehat{Y_{ij}^r}$$

HMatrix:
This group of variables contains the total job flows in exports between sectors. They span a matrix with the 24 sectors as rows and columns. Take the row "pfd" in the G_matrix_sk for Australia in 2011, for example. Following this row the cells contain the direct and indirect jobs sold from the processed foods sector to the other sectors of the Australian economy. Taking the sum of the whole row thus gives the total jobs embodied in exports of the processed food sector in Australia in 2011 based on forward linkages for the processed food sector. The column g_pfd_sk denotes the direct and indirect jobs bought by the Australian processed food sector from the other sectors of the economy in 2011. The column sum thus gives the total jobs contained in exports in the Australian processed foods sector in 2011 based on backward linkages. For each country G matrix is calculated as a diagonal matrix of jobs numbers divided total endowment costs of output ($\hat{J}$) times the multiplier matrix (M). This is then multiplied with a vector of total final sales ($\hat{Y}$):

$$G_{ij}^r = \widehat{J_{ij}^r} M_{ij}^r \widehat{X_{ij}^r}$$

dom_job_shr:

This variable contains the job number per output for each sector. Basically it corresponds to vector j_i^r and the diagonal of matrix J_{ij}^r as defined above.

GXshr:
This variable contains the shares of the exports of a sector relative to total exports of a country denoted in gross values:

$$GXshr_i^r = \frac{gxwd_i^r}{\sum_i gxwd_i^r}.$$

djobs_x:
This variable is the direct job number contained in exports. It is calculated as job number per output multiplied by the gross value of exports:

$$djobsx_i^r = j_i^r * gxwd_i^r$$

where djobsx is direct jobs in exports; j is jobs per unit of output; gxwd is gross export values at world prices.

av_wage:
This variable is average wage per sector for each country. It is calculated as total labor va/wages in a sector divided by total number of jobs in that sector:

$$av\_wage_i^r = \frac{labor\_va_i^r}{jobs\_ilo_i^r}$$

where jobs_ilo is the number of jobs per sector provided by ILO data. The variable is given as yearly wage in USD per worker.

djobsx_shr:
Basically this variable relates the direct job numbers contained in exports to the direct job numbers contained in the exports of all the sectors of an economy:

$$djobsx\_shr_i^r = \frac{djobsx_i^r}{\sum_{i,k} djobsx_{ik}^r}$$

It gives the labor intensity of a sector in exports if exports are valued at job numbers.

tjobsx_shr_fwd:
This variable relates the total (direct + indirect) jobs contained in exports of a sector to the total jobs an economy is exporting based on forward linkages:

$$tjobsx\_shr\_fwd_i^r = \frac{tjobsx\_fwd_i^r}{\sum_i tjobsx\_fwd_i^r}$$

It gives the labor intensity of a sector in exports if exports are valued as exported jobs instead of gross values.

tjobsx_shr_bwd:
This variable relates the total (direct + indirect) jobs contained in exports of a sector to the total jobs an economy is exporting based on backward linkages:

$$tjobsx\_shr\_fwd_i^r = \frac{tjobsx\_bwd_i^r}{\sum_i tjobsx\_bwd_i^r}$$

It gives the labor intensity of a sector in exports if exports are valued as exported jobs instead of gross values.

RCAstandard:
This variable is a standard revealed comparative advantage index. It measures the relative (dis-)advantage a country has in certain sectors compared to global trade flows:

$$RCA_i^r = \frac{\left(\frac{gxwd_i^r}{\sum_i gxwd_i^r}\right)}{\left(\frac{\sum_r gxwd_i^r}{\sum_{ir} gxwd_i^r}\right)}$$

See also Table 10 of Francois et al. (2013).

relintfwd:
We called this the revealed intensity index for embodied jobs based on forward linkages. It is calculated similar to the RCA index, but instead of gross value of exports it uses on embodied jobs based on forward linkages in the nominator. It measures the relative (dis-)advantage jobs in a country have in certain sectors compared to global trade flows.

$$relint\_fwd_i^r = \frac{\left(\frac{tjobsx\_fwd_{i,(un-)skilled}^r}{\sum_i tjobsx\_fwd_{i,(un-)skilled}^r}\right)}{\left(\frac{\sum_r gxwd_i^r}{\sum_{ir} gxwd_i^r}\right)}$$

relintbwd:
We called this the revealed intensity index for embodied jobs based on backward linkages. It is calculated similar to the RCA index, but instead of gross value of exports it uses on embodied jobs based on backward linkages in the nominator. It measures the relative (dis-)advantage jobs in a country have in certain sectors compared to global trade flows.

$$relint\_fwd_i^r = \frac{\left(\frac{tjobsx\_bwd_{i,(un-)skilled}^r}{\sum_i tjobsx\_bwd_{i,(un-)skilled}^r}\right)}{\left(\frac{\sum_r gxwd_i^r}{\sum_{ir} gxwd_i^r}\right)}$$