# Explaining the Employment Effect of Exports: Value-Added Content Matters

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**Abstract**

This paper estimates and decomposes the impact of export opportunities on countries' employment by using a global input-output analysis, focusing on the U.S., China, and Japan. The greater they export, the greater employment in the exporting countries. However, we first document that the number of jobs created per exports varies substantially across destination countries. We find that exports from sectors with higher domestic value-added contents such as natural resource, textile, and service sectors lead to a greater employment effect. As a result, cross-country differences in sectoral compositions of exports explain a large part of the variations in the employment effects across destination countries. Time series changes in the employment effect of exports come from changes in (1) the labor-to-output ratio, (2) input-output linkages, and (3) sectoral compositions in exports. Results suggest that the first channel worked to reduce the employment effect in all of the three countries we focused but the directions of the last two channels are different across the countries.

*Key Words*: Exports, Employment, Global Input-Output Table, Value-Added Content of Trade
*JEL codes*: E16, F14, F60, O19

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# 1 Introduction

Export opportunities to foreign countries create jobs in exporting countries. Previous literature finds a substantial employment creation effect of exports using an input-output analysis (e.g., Los, Timmer, and Vries, 2015, for the impact on China's employment; Feenstra and Sasahara, 2018, for U.S. employment; Feenstra and Sasahara, 2019 *forthcoming*, for employment in Asian countries). However, the employment effect per exports – roughly speaking, productivity of exports in creating employment – is not explored in the literature. We investigate if the size of employment generated by exports can be described by a one-to-one mapping from the size of exports. If so, we do not have to use an input-output analysis to find employment effects of exports and the total value of exports would be a sufficient statistic to know the employment effect of exports.

Results from the analysis show that the employment effect of exports is not just the size of exports and the employment effect per exports varies substantially across destination countries. Then we further examine why some countries create more jobs per exports than others do. Results suggests that exports from some sectors such as natural resources, textile, and services lead to a greater number of jobs than exports from other sectors. This is consistent with the recent literature on value added in trade, finding a substantial amount of intermediate good trade in manufacturing industries, making domestic value-added content of manufacturing exports smaller (e.g., Johnson and Noguera, 2012). Therefore, the employment effect per exports varies across destination countries primarily due to differences in sectoral composition of exports. Because countries sell disproportionally more services domestically, domestic final demand leads to more jobs for the same value of final demand.

Our analyses focus on three major countries in the world, the U.S., China, and Japan where these countries account for 41% of world GDP and 26% of world merchandise trade as of 2014 (World Bank, 2017) and they have large influences on the world economy. Therefore, it is critical to understand the employment effect of exports on these countries. Comparing these three countries, we find that employment effects of foreign final demand per million dollar exports on China are very different from those on the U.S. and Japan. For example, the employment effect of foreign final demand per exports on China, relative to the employment effect of China's final demand, is increasing over the period 2000-2014 because domestic value-added contents in China's exports are rising as shown in previous studies (e.g., Kee and Tang, 2016; Koopman, Z. Wang, and Wei, 2012). On the other hand, the employment effect of exports relative to that of domestic final demand is slightly declining in the U.S. and Japan.

We also find an interesting result that the three countries differ in sectors in which the employment creation effects are greater. For example, exports from the textile sector creates the greatest number of jobs in China while the service sector is the most important for the U.S. and Japan. This suggests that a country's development level has a close link with sectoral contributions in creating jobs. Forward and backward linkages with other countries also affect the employment effect of exports. We show that the impact of international production linkages on the employment effect of exports is complicated. Deeper backward linkages are particularly complicated as these sometimes lead to job replacement and sometimes boost exports due to an increase in the number of available intermediate inputs from abroad (see Feng, Li, and Swenson, 2016, for the case in China; Harrison and McMillan, 2011 and Wright, 2016, for the case in the U.S.).[1]

Regarding time-series variations in the employment effect of exports, it declined by 30%, 60%, and 5% in the U.S., China, and Japan, respectively, during the period 2000-2014. Time-series changes in the employment effect of exports per exports are decomposed to changes in (1) the labor-to-gross output ratio, (2) the sectoral composition in exports, and (3) input-output linkages. Results suggest that a decrease in the labor-to-gross output ratio — i.e., an increase in labor productivity — is the biggest reason why the employment effect of exports declined in the U.S. and China. If a country becomes more productive and one unit of labor produces a greater amount of output, then it means that a one unit increase in exports requires a fewer number of labor. We also find that changes in sectoral composition of exports worked to reduce the employment effect of exports in the U.S. and China. Changes in input-output linkages slightly reduced the employment effect of exports in the U.S. while it increased the employment effect of exports in China. We find small time-series variations in the employment effect of exports in Japan during the same period.

This paper contributes to a growing body of literature on the employment effect of international trade, focusing on a positive employment creation effect of exports (e.g., Los, Timmer, and Vries, 2015, for China; Vianna, 2016, for Latin American countries; Feenstra, Ma, and Xu, 2017, Feenstra and Sasahara, 2018, Liang, 2018, and Magyari, 2017, for the U.S.; Feenstra and Sasahara, 2019 *forthcoming*, and Kiyota, 2016, for Asian countries). Among these studies, this paper is particularly related with Los, Timmer, and Vries (2015), Feenstra and Sasahara (2019), Feenstra and Sasahara (2018), and Kiyota (2016) because we also use an input-output analysis and quantifies the employment effect of foreign final demand.[2] We go beyond the literature by highlighting the fact that the employment effect per exports varies substantially across destination countries and by explaining the reasons why they differ.

Echoing recent studies investigating implications of value-added contents of trade under expanding Global Value Chains (hereafter GVCs), we aim to understand how value-added con-

[1] Feng, Li, and Swenson (2016) show that an increase in imported inputs increased exports from China because imported inputs have higher quality and led to a positive spillover. Harrison and McMillan (2011) analyze the data from the U.S. between 1982 and 1999 and find that offshoring to low-wage countries reduced U.S. manufacturing employment. They also find that offshoring increased employment for firms doing very different tasks between home and abroad. Wright (2016) examines a direct displacement effect of offshoring, which works to reduce domestic employment, and a positive productivity effect, which increases employment. By taking these two effects into account, he finds that offshoring to China increased overall employment by 2.6% during 2001-2007 following China's accession to the WTO.

[2] This approach focuses on the demand-side of the labor market only and does not allow general equilibrium feed backs from the supply-side of the labor market. See, for example, Caliendo, Dvorkin, and Parro (2015) for a general equilibrium analysis of the impact of trade on labor markets.

tents affect the employment effect of exports. Expanding GVCs have a significant implication on various economic indicators (see Feenstra, 1998; Baldwin, 2012), especially in East Asia (see Ando and Kimura, 2005; Ando and Kimura, 2014; Kimura and Obashi, 2016; Obashi and Kimura, 2017).[3] Previous studies show that GVCs and value-added contents of trade have implications on trade imbalances (Johnson and Noguera, 2012), U.S. employment in import-competing sectors (Shen and Silva, 2018; Shen, Silva, and H. Wang, 2018), business cycle synchronization (Duval et al., 2016), exchange rates (Bems and Johnson, 2017), trade policies (Blanchard, Bowen, and Johnson, 2017), Heckscher-Ohlin trade patterns (Ito, Rotunno, and Vézina, 2017), and geographical distribution of 'good' jobs and 'bad' jobs (Baldwin, Ito, and Sato, 2014).

This paper considers an implication of GVCs from a different angle. We investigate whether GVCs and value-added contents of trade affect the employment creation effect of exports from a country. This paper is inspired by Feenstra (2017), proposing an idea that value-added contents of trade are considered as the 'second generation' measure of offshoring and suggesting its implication on labor markets. In terms of focus, the paper is the most closely related with Ito (2018), examining the effect of expanding GVCs on *overall* employment. Our focus is similar but it differs from Ito (2018) because we focus on how deepening GVCs affect the employment creation effect of exports *per value of exports*.

The rest of the paper is organized as follows. The next section estimates the employment effect of exports and discusses results. Section 3 finds domestic value-added contents in exports and consider how these are associated with the employment effect of exports. Section 4 provides a decomposition exercise in order to understand why the employment effect of exports has changed over time. Section 5 concludes. Details on data and results from some additional analyses are summarized in Appendix.

# 2 Estimating the Employment Effect of Final Demand

## 2.1 The Method

This section presents the technique we use in order to estimate the employment effect of final good exports – or final demand in general. We use an input-output approach where it has a long history since Leontief (1936) and the method is also employed by Los, Timmer, and Vries (2015) and Feenstra and Sasahara (2018) to quantify the employment effect of exports. The data come from the WIOD, the 2016 release (Timmer, Dietzenbacher, et al., 2015; Timmer et al., 2016). It has $C = 44$ economies including the rest of the world as one economy and each

[3] Ando and Kimura (2005) document development of international production and distribution networks in East Asia using the data from 1996-2000. Obashi and Kimura (2017) show deepening and widening of the production networks in the same region by looking at the number of exported products, destination countries, and product-destination pairs. Ando and Kimura (2014) highlight the link between East Asia and North America through machinery trade. Kimura and Obashi (2016) provide a summary of its implications and related research.

of them consists of $N = 56$ sectors. Input-output analyses are conducted using this WIOD input-output table with $C = 44$ and $N = 56$. However, for the sake of simplicity, this section assumes that there are only two countries – country 1 and country 2, denoted with superscripts 1 and 2, respectively – and each of them has two sectors – the manufacturing and service sectors, denoted with superscripts $M$ and $S$, respectively. As a result, $C = 2$ and $N = 2$. This simplifies matrix notations. Although we have a simplified $2 \times 2$ case here, the same logic applies to a general case with an arbitrary number of countries and sectors. The input-output table is available annually from 2000 to 2014 so we introduce time subscript $t = 2000, 2001, ..., 2014$.

Table 1 shows a simplified two country and two sector input-output table. The $4 \times 4$ symmetric matrix in the left side of the table describes intermediate good flows. For example, $m_t^{(1,M),(2,S)}$ measures the value of intermediate good flows from the manufacturing sector of country 1 to the service sector of country 2. The last two columns indicated by $d$'s describe final good flows. For example, $d^{(1,M),2}$ denotes the value of final goods produced in the manufacturing sector and purchased by country 2. Using these, we find input-output coefficients:

$$\underbrace{\mathbf{A}_t}_{(C\times N)\times(C\times N)} = \begin{bmatrix} a_t^{(1,M),(1,M)} & a_t^{(1,M),(1,S)} & a_t^{(1,M),(2,M)} & a_t^{(1,M),(2,S)} \\ a_t^{(1,S),(1,M)} & a_t^{(1,S),(1,S)} & a_t^{(1,S),(2,M)} & a_t^{(1,S),(2,S)} \\ a_t^{(2,M),(1,M)} & a_t^{(2,M),(1,S)} & a_t^{(2,M),(2,M)} & a_t^{(2,M),(2,S)} \\ a_t^{(2,S),(1,M)} & a_t^{(2,S),(1,S)} & a_t^{(2,S),(2,M)} & a_t^{(2,S),(2,S)} \end{bmatrix},$$

where

$$a^{(i,s),(j,r)} = m^{(i,s),(j,r)}/y^{j,r},$$

with gross production in sector $r$ of country $j$, $y_t^{j,r} = \sum_{s\in\{M,S\}} \sum_{i=1}^{C} m_t^{(j,r),(i,s)} + \sum_{i=1}^{C} d_t^{(j,r),i}$.

Table 1: Simplified Two Country × Two Sector Input-Output Table

| | Country 1 | | Country 2 | | Country 1 | Country 2 |
|---|---|---|---|---|---|---|
| | Manuf. | Services | Manuf. | Services | Final | Final |
| Country 1, Manufacturing | $m_t^{(1,M),(1,M)}$ | $m_t^{(1,M),(1,S)}$ | $m_t^{(1,M),(2,M)}$ | $m_t^{(1,M),(2,S)}$ | $d_t^{(1,M),1}$ | $d_t^{(1,M),2}$ |
| Country 1, Services | $m_t^{(1,S),(1,M)}$ | $m_t^{(1,S),(1,S)}$ | $m_t^{(1,S),(2,M)}$ | $m_t^{(1,S),(2,S)}$ | $d_t^{(1,S),1}$ | $d_t^{(1,S),2}$ |
| Country 2, Manufacturing | $m_t^{(2,M),(1,M)}$ | $m_t^{(2,M),(1,S)}$ | $m_t^{(2,M),(2,M)}$ | $m_t^{(2,M),(2,S)}$ | $d_t^{(2,M),1}$ | $d_t^{(2,M),2}$ |
| Country 2, Services | $m_t^{(2,S),(1,M)}$ | $m_t^{(2,S),(1,S)}$ | $m_t^{(2,S),(2,M)}$ | $m_t^{(2,S),(2,S)}$ | $d_t^{(2,S),1}$ | $d_t^{(2,S),2}$ |

Suppose country 1 is home and country 2 is a foreign country. We are interested in the effect of final demand from country 2 to country 1 on country 1's employment. The employment effect of the final demand is estimated as[4]

$$\mathbf{L}_t^{(1,All),2} \equiv \mathbf{\Lambda}_t(\mathbf{I}-\mathbf{A}_t)^{-1}\mathbf{D}_t - \mathbf{\Lambda}_t(\mathbf{I}-\mathbf{A}_t)^{-1}\mathbf{D}_t^{*(1,All),2}, \tag{1}$$

where

$$\underbrace{\mathbf{D}_t}_{(C\times N)\times 1} \equiv \begin{bmatrix} d_t^{(1,M),1}+d_t^{(1,M),2} \\ d_t^{(1,S),1}+d_t^{(1,S),2} \\ d_t^{(2,M),1}+d_t^{(2,M),2} \\ d_t^{(2,S),1}+d_t^{(2,S),2} \end{bmatrix} \quad \text{and} \quad \underbrace{\mathbf{D}_t^{*(1,All),2}}_{(C\times N)\times 1} \equiv \begin{bmatrix} d_t^{(1,M),1}+0 \\ d_t^{(1,S),1}+0 \\ d_t^{(2,M),1}+d_t^{(2,M),2} \\ d_t^{(2,S),1}+d_t^{(2,S),2} \end{bmatrix},$$

and $\mathbf{\Lambda}_t$ is a $(C\times N)\times(C\times N)$ matrix with the labor-to-gross production ratio in diagonal entries and zeros in off-diagonal entries. $\mathbf{D}_t$ denotes a $(C\times N)\times 1$ matrix describing final good flows. In the hypothetical final demand vector $\mathbf{D}_t^{*(1,All),2}$, final demands from country 2 to country 1 represented in $d_t^{(1,M),2}$ and $d_t^{(1,S),2)}$ are replaced with zeros. Superscript "$(1,All),2$" indicates that this computation leads to the employment effect on country 1 generated by country 2's final demands to country 1's *all* sectors. The estimated employment effect is a $(C\times N)\times 1$ vector, $\mathbf{L}_t^{(1,All),2} = \left[L_t^{(1,M)}|_{(1,All),2}, L_t^{(1,S)}|_{(1,All),2}, L_t^{(2,M)}|_{(1,All),2}, L_t^{(2,S)}|_{(1,All),2}\right]'$. The overall employment effect of country 2's final demands to country 1 on country 1 is $L_t^{(1,M)}|_{(1,All),2} + L_t^{(1,S)}|_{(1,All),2}$, the employment effect on country 1's manufacturing sector plus the one on country 1's service sector. Note that this approach estimates the employment effect of exports from one country to another, which does not include the impact of foreign final demand through *other* foreign countries - so-called the third county effects.[5]

A greater final demand implies a greater employment effect. We are interested in whether this employment effect is merely another measure of size of final demand. Therefore, we find

[4]The exact approach employed by Los, Timmer, and Vries (2015) is what they call the demand-side analysis — the employment effect of exports from country 1 to country 2 is estimated as $\mathbf{\Lambda}_t(\mathbf{I}-\mathbf{A}_t)^{-1}\tilde{\mathbf{D}}_t^{(1,All),2}$ where $\tilde{\mathbf{D}}_t^{(1,All),2} = \mathbf{D}_t - \mathbf{D}_t^{*(1,All),2}$. The approach we employ here is the 'hypothetical extraction' technique (e.g., Los, Timmer, and De Vries, 2016), which measures the difference between the actual employment level and the counterfactual employment when there were no foreign demand from country 2. These two approaches give the exact same estimates regarding the domestic employment component in exports. One difference is that the 'hypothetical extraction' approach does not give foreign employment components for each of foreign countries and only lead to domestic contents. In Feenstra and Sasahara (2019), the demand-side analysis and the 'hypothetical extraction' technique led to slightly different results because they do not zeroing exports and instead they replaced with exports from the benchmark year. See section 2.2.2 of Johnson (2018) for further clarification.

[5]Another difference between the current approach and the approach employed by Los, Timmer, and Vries (2015) and Feenstra and Sasahara (2019) is that these studies examine the employment effect of total foreign final demand including final demand from foreign countries to *other* foreign countries. Therefore, their estimation takes the employment effect through third countries into account. For example, final demand from China to Japan has an employment effect on the U.S. through input demand from Japan to the U.S. in order to produce goods sold from Japan to China. However, we do not consider such third country effects here. We only consider the employment effect through bilateral exports from a country to another country on the exporting country as Feenstra and Sasahara (2018) consider the employment impact of gross exports from the U.S. to foreign countries.

the employment effect divided by the value of final demand:

$$l_t^{(1,M)}|_{(1,All),k} \equiv \frac{L_t^{(1,M)}|_{(1,All),k} + L_t^{(1,S)}|_{(1,All),k}}{d_t^{(1,M),k} + d_t^{(1,S),k}}, \quad \text{for} \quad k = 1, 2.$$

For example, $l_t^{(1,M)}|_{(1,All),2}$ is the *per final demand* employment effect of country 2's aggregate final demand to country 1 on country 1 as a whole. Subscript *All* indicates that exports from *all* sectors in country 1 is taken into account.

## 2.2 Sectoral Linkages of the Employment Effect

The employment effect of exports presented in the previous section quantifies the impact of a country's aggregate exports on employment in each sector in the exporting country. In order to see how sectoral linkages generate employment, we explore the employment effect by disaggregating the employment effects at the sector level.

The employment effect of country 2's final demand to country 1's manufacturing sector is found as:

$$\mathbf{L}_t^{(1,M),2} \equiv \mathbf{\Lambda}_t(\mathbf{I} - \mathbf{A}_t)^{-1}\mathbf{D}_t - \mathbf{\Lambda}_t(\mathbf{I} - \mathbf{A}_t)^{-1}\mathbf{D}_t^{*(1,M),2}, \tag{2}$$

where

$$\underbrace{\mathbf{D}_t^{*(1,M),2}}_{(C\times N)\times 1} \equiv \begin{bmatrix} d_t^{(1,M),1} + 0 \\ d_t^{(1,S),1} + d_t^{(1,S),2} \\ d_t^{(2,M),1} + d_t^{(2,M),2} \\ d_t^{(2,S),1} + d_t^{(2,S),2} \end{bmatrix}.$$

Under this hypothetical final demand $\tilde{\mathbf{D}}_t^{(1,M),2}$, only country 2's final demand to country 1's manufacturing sector $d_t^{(1,M),2}$ is replaced with zero and country 2's final demand to country 1's service sector $d_t^{(1,S),2}$ is kept as it is. The estimated employment effect is a vector $\mathbf{L}_t^{(1,M),2} = \left[L_t^{(1,M)}|_{(1,M),2}, L_t^{(1,S)}|_{(1,M),2}, L_t^{(2,M)}|_{(1,M),2}, L_t^{(2,S)}|_{(1,M),2}\right]'$. The first element $L_t^{(1,M)}|_{(1,M),2}$ measures the effect of impact of country 2's final demand to country 1's manufacturing sector on country 1's manufacturing sector – the *direct* effect on its own sector. The second element $L_t^{(1,S)}|_{(1,M),2}$ quantifies the effect of impact of country 2's final demand to country 1's manufacturing sector on country 1's service sector – the *indirect* effect through input-output linkages.

These estimated employment effects are normalized by dividing by final demand flows as follows:

$$l_t^{(1,M)}|_{(1,M),k} \equiv \frac{L_t^{(1,M)}|_{(1,M),k}}{d_t^{(1,M),k}} \quad \text{and} \quad l_t^{(1,S)}|_{(1,M),k} \equiv \frac{L_t^{(1,S)}|_{(1,M),k}}{d_t^{(1,M),k}}, \quad \text{for} \quad k = 1, 2$$

where the former is the *per final demand* employment effect of country $k$'s final demand to country 1's manufacturing sector on country 1's manufacturing sector and the latter is the *per final demand* employment effect of country $k$'s final demand country 1's manufacturing sector on country 1's service sector.

## 2.3 Estimated Employment Effects

We first present the employment effect of exports at the destination country-level for the U.S., China, and Japan, respectively. Table 2 reports the estimated impacts of final demand from 10 contributors to U.S. employment. The first three columns report the result for U.S. total exports and the last three columns describe the ones for U.S. merchandise exports, only. Column (1) shows that final demands from Canada, China, and Mexico, contribute to the U.S. to create 624 thousand, 263 thousand, and 246 thousand jobs, respectively. These countries have greater employment effects on the U.S. because U.S. exports to these countries are greater – U.S. exports to Canada, China, and Mexico are 104 billion, 46 billion, and 42 billion USD, respectively (see column (2)). In order to see if the size of employment effects is fully explained by the size of exports, column (3) displays the employment effect per million dollar exports. It shows that the employment effect per exports varies substantially across destination countries. For example, a million dollar exports to Netherlands create 7.69 jobs while the same value of exports to France leads to 6.16 jobs only. It also shows that a million dollar domestic final demand creates 8.56 jobs on average. Foreign final demand creates, on average, 6.07 jobs per million dollar final demand. Therefore, final demands from foreign countries lead to about $100 \times (8.56 - 6.07)/8.56 = 29$ percent less jobs than U.S. domestic final demand for the same value of final demand.[6]

However, this gap disappears once we focus on final demand to merchandise sectors only. Column (4) in Table 1 report the employment impact of merchandise final demand. The value of merchandise final demand and the employment effect per million dollar final demand are shown in columns (5) and (6), respectively. A million dollar domestic final demands to merchandise goods lead to 5.32 jobs while that from foreign countries generate 5.55 jobs on average, which is slightly greater than the domestic employment effect. It suggests that final demand for services create more jobs and the U.S. exports merchandise goods disproportionally more than services comparing with U.S. sales to its domestic market.

Table 3 shows results from China as an exporter. Column (1) shows that final demands from the U.S., Japan, and Russia, contribute to China to create 13 million, 7 million, and 4 million jobs, respectively. In terms employment effects per million dollar final demand, Russia creates the largest number of jobs, 90.49, and the U.S. has the smallest number, 63.78, among

[6] One may ask if these numbers are reasonable. Johnson and Noguera (2012) find that the value added ratio of U.S. exports is 77% using the data from 2004. Elsby, Hobijn, and Sahin (2013) report that the labor share in the U.S. is 58.3%. These numbers imply that a million dollar exports lead to 1 million $\times$ 0.77 $\times$ 0.583 = 449 thousand dollars labor compensation. We find that a million dollar foreign final demand creates 8.46 jobs on average. The labor compensation 449 thousand dollars dividend by 8.46 persons is equal to 53.07 thousand dollars per worker. The median annual household income in 2014 was 53.66 thousand dollars (U.S. Census Bureau, 2014), which is close to our estimates, 53.07 thousand dollars. These computations confirm that our estimation results are reasonable.

Table 2: The Impact of Final Demand from Top 10 Contributors on U.S. Employment, 2014

| | | Final demand to all sectors | | | Final demand to merchandise sectors | | |
|---|---|---|---|---|---|---|---|
| | | Employment effect (thousand jobs) | Final good demand (million USD) | Employment effect per million USD (jobs) | Employment effect (thousand jobs) | Final good demand (million USD) | Employment effect per million USD (jobs) |
| | | (1) | (2) | (3) | (4) | (5) | (6) |
| 1 | Canada | 624.24 | 104,186 | 5.99 | 542.04 | 94,180 | 5.76 |
| | | (0.42) | (0.59) | | (3.75) | (3.49) | |
| 2 | China | 263.37 | 45,595 | 5.78 | 221.17 | 39,680 | 5.57 |
| | | (0.18) | (0.26) | | (1.53) | (1.47) | |
| 3 | Mexico | 245.50 | 42,426 | 5.79 | 229.07 | 39,878 | 5.74 |
| | | (0.17) | (0.24) | | (1.59) | (1.48) | |
| 4 | The U.K. | 201.75 | 34,078 | 5.92 | 131.45 | 24,517 | 5.36 |
| | | (0.14) | (0.19) | | (0.91) | (0.91) | |
| 5 | Germany | 178.26 | 29,204 | 6.10 | 95.77 | 17,685 | 5.42 |
| | | (0.12) | (0.17) | | (0.66) | (0.66) | |
| 6 | Japan | 138.14 | 22,265 | 6.20 | 115.01 | 18,886 | 6.09 |
| | | (0.09) | (0.13) | | (0.80) | (0.70) | |
| 7 | France | 100.68 | 16,357 | 6.16 | 34.08 | 7,918 | 4.30 |
| | | (0.07) | (0.09) | | (0.24) | (0.29) | |
| 8 | South Korea | 90.48 | 13,683 | 6.61 | 52.16 | 8,832 | 5.91 |
| | | (0.06) | (0.08) | | (0.36) | (0.33) | |
| 9 | Netherlands | 87.50 | 11,375 | 7.69 | 30.06 | 5,562 | 5.40 |
| | | (0.06) | (0.06) | | (0.21) | (0.21) | |
| 10 | Australia | 72.79 | 12,356 | 5.89 | 52.02 | 9,198 | 5.66 |
| | | (0.05) | (0.07) | | (0.36) | (0.34) | |
| | The U.S. | 144,500.00 | 16,879,829 | 8.56 | 12,168.00 | 2,286,125 | 5.32 |
| | | (97.28) | (96.20) | | (84.23) | (84.77) | |
| | Foreign | 4,044.77 | 666,089 | 6.07 | 2,278.17 | 410,629 | 5.55 |
| | | (2.72) | (3.80) | | (15.77) | (15.23) | |

*Notes:* The table reports the employment effect of final demand from 10 contributors for the U.S. in 2014. Columns (1) and (2) report the employment effect of and final demand from each of top 10 contributors, respectively. Column (3) shows the employment effect per million dollar final demand. Columns (4)-(6) present the same variables as for columns (1)-(3), respectively, but focusing on merchandise exports only. The ten countries are shown in descending order based on the aggregate employment effect reported in column (1). Numbers in parentheses are the share of the employment effect (or final demand) to the overall value.

the top 10 countries.[7] A million dollar final demand from foreign countries as a whole creates 64.81 jobs while the same value of domestic final demand leads to 76.56 jobs. Hence, final demands from foreign countries lead to about $100 \times (76.56 - 64.81)/64.81 = 18$ percent less jobs than U.S. domestic final demand for the same value of final demand. This result is similar to the one from the U.S.

Columns (4)-(6) show the employment effect of final demand to merchandise sectors. Con-

[7]China has relatively large numbers of employment effect per million dollar final demand. A million dollar domestic final demand creates 8.56 jobs in the U.S. while the same value of domestic final demand in China leads to 76.56 jobs, which is 13 times greater than that of the U.S. There are two reasons for this. First, income per capita is lower in China compared with the U.S. According to the data from PWT (Feenstra, Inklaar, and Timmer, 2015), GDP per capita in the U.S. is five times greater than that of China in 2014. Second, Chinese economy is more labor intensive than the U.S. The data from the WIOD show that the labor-to-output ratio in China is four times greater than that of the U.S. in 2014.

Table 3: The Impact of Final Demand from Top 10 Contributors on China's Employment, 2014

| | | Final demand to all sectors | | | Final demand to merchandise sectors | | |
|---|---|---|---|---|---|---|---|
| | | Employment effect (thousand jobs) | Final good demand (million USD) | Employment effect per million USD (jobs) | Employment effect (thousand jobs) | Final good demand (million USD) | Employment effect per million USD (jobs) |
| | | (1) | (2) | (3) | (4) | (5) | (6) |
| 1 | The U.S. | 13,844 | 217,064 | 63.78 | 13,644 | 213,094 | 64.03 |
| | | (1.74) | (2.06) | | (4.58) | (5.51) | |
| 2 | Japan | 7,099 | 105,415 | 67.35 | 7,025 | 104,379 | 67.30 |
| | | (0.89) | (1.00) | | (2.36) | (2.70) | |
| 3 | Russia | 4,345 | 48,015 | 90.49 | 4,336 | 47,853 | 90.62 |
| | | (0.55) | (0.45) | | (1.46) | (1.24) | |
| 4 | Germany | 2,873 | 46,635 | 61.61 | 2,815 | 45,619 | 61.70 |
| | | (0.36) | (0.44) | | (0.94) | (1.18) | |
| 5 | The U.K. | 2,104 | 29,836 | 70.52 | 2,040 | 29,279 | 69.68 |
| | | (0.26) | (0.28) | | (0.68) | (0.76) | |
| 6 | South Korea | 1,824 | 27,685 | 65.87 | 1,772 | 26,806 | 66.10 |
| | | (0.23) | (0.26) | | (0.59) | (0.69) | |
| 7 | Canada | 1,732 | 24,497 | 70.69 | 1,566 | 23,155 | 67.61 |
| | | (0.22) | (0.23) | | (0.53) | (0.60) | |
| 8 | Australia | 1,634 | 25,067 | 65.20 | 1,560 | 24,222 | 64.39 |
| | | (0.21) | (0.24) | | (0.52) | (0.63) | |
| 9 | France | 1,267 | 19,579 | 64.71 | 1,137 | 17,345 | 65.58 |
| | | (0.16) | (0.19) | | (0.38) | (0.45) | |
| 10 | India | 1,264 | 19,670 | 64.27 | 970 | 17,996 | 53.87 |
| | | (0.16) | (0.19) | | (0.33) | (0.47) | |
| | China | 715,680 | 9,347,750 | 76.56 | 228,800 | 2,786,059 | 82.12 |
| | | (90.10) | (88.51) | | (76.77) | (72.01) | |
| | Foreign | 78,622 | 1,213,131 | 64.81 | 69,231 | 1,082,778 | 63.94 |
| | | (9.90) | (11.49) | | (23.23) | (27.99) | |

*Notes:* The table reports the employment effect of final demand from 10 contributors for the U.S. in 2014. Columns (1) and (2) report the employment effect of and final demand from each of top 10 contributors $j$, respectively. Column (3) shows the employment effect per million dollar final demand. Columns (4)-(6) present the same variables as for columns (1)-(3), respectively, but focusing on merchandise exports only. The ten countries are shown in descending order based on the aggregate employment effect reported in column (1). Numbers in parentheses are the share of the employment effect (or final demand) to the overall value.

trary to the U.S. case, the gap between domestic and foreign employment creation effect is still present even after restricting our focus on the merchandise sectors. Interestingly, the gap between the two becomes even greater. A million dollar domestic final demand to China's merchandise sectors create 82.12 jobs while foreign final demand to the same sectors leads to 63.94 — the gap is $100 \times (82.12 - 63.94)/63.94 = 28$ percent. This implies that service sectors in China do not have much greater value added content and/or service sectors are less labor-intensive in China. Furthermore, it suggests that there are some merchandise sectors that create more jobs and sell disproportionally more to abroad.

Lastly, Table 4 shows results from Japan. The U.S., China, and Taiwan are top three contributors for Japan — leading to 546 thousand, 449 thousand, and 96 thousand jobs, respectively. In terms of the number of jobs per million dollar final demand, Taiwan has the

Table 4: The Impact of Final Demand from Top 10 Contributors on Japan's Employment, 2014

| | | Final demand to all sectors | | | Final demand to merchandise sectors | | |
|---|---|---|---|---|---|---|---|
| | | Employment effect (thousand jobs) | Final good demand (million USD) | Employment effect per million USD (jobs) | Employment effect (thousand jobs) | Final good demand (million USD) | Employment effect per million USD (jobs) |
| | | (1) | (2) | (3) | (4) | (5) | (6) |
| 1 | The U.S. | 546 | 59,912 | 9.11 | 536 | 59,057 | 9.07 |
| | | (0.96) | (1.30) | | (5.96) | (7.17) | |
| 2 | China | 449 | 45,056 | 9.96 | 435 | 44,014 | 9.88 |
| | | (0.79) | (0.98) | | (4.84) | (5.34) | |
| 3 | Taiwan | 96 | 9,176 | 10.50 | 85 | 8,306 | 10.18 |
| | | (0.17) | (0.20) | | (0.94) | (1.01) | |
| 4 | Russia | 93 | 10,640 | 8.75 | 93 | 10,624 | 8.75 |
| | | (0.16) | (0.23) | | (1.03) | (1.29) | |
| 5 | Rep. of Korea | 80 | 8,301 | 9.67 | 76 | 8,054 | 9.42 |
| | | (0.14) | (0.18) | | (0.84) | (0.98) | |
| 6 | Germany | 80 | 7,980 | 9.97 | 75 | 7,629 | 9.88 |
| | | (0.14) | (0.17) | | (0.84) | (0.93) | |
| 7 | Australia | 68 | 8,279 | 8.26 | 68 | 8,244 | 8.24 |
| | | (0.12) | (0.18) | | (0.75) | (1.00) | |
| 8 | Canada | 43 | 4,657 | 9.24 | 42 | 4,566 | 9.15 |
| | | (0.08) | (0.10) | | (0.46) | (0.55) | |
| 9 | Mexico | 36 | 3,718 | 9.76 | 35 | 3,638 | 9.56 |
| | | (0.06) | (0.08) | | (0.39) | (0.44) | |
| 10 | The U.K. | 35 | 3,518 | 10.04 | 31 | 3,258 | 9.41 |
| | | (0.06) | (0.08) | | (0.34) | (0.40) | |
| | Japan | 53,661 | 4,285,776 | 12.52 | 6,534 | 561,858 | 11.63 |
| | | (94.38) | (92.93) | | (72.67) | (68.20) | |
| | Foreign | 3,194 | 326,213 | 9.79 | 2,458 | 261,974 | 9.38 |
| | | (5.62) | (7.07) | | (27.33) | (31.80) | |

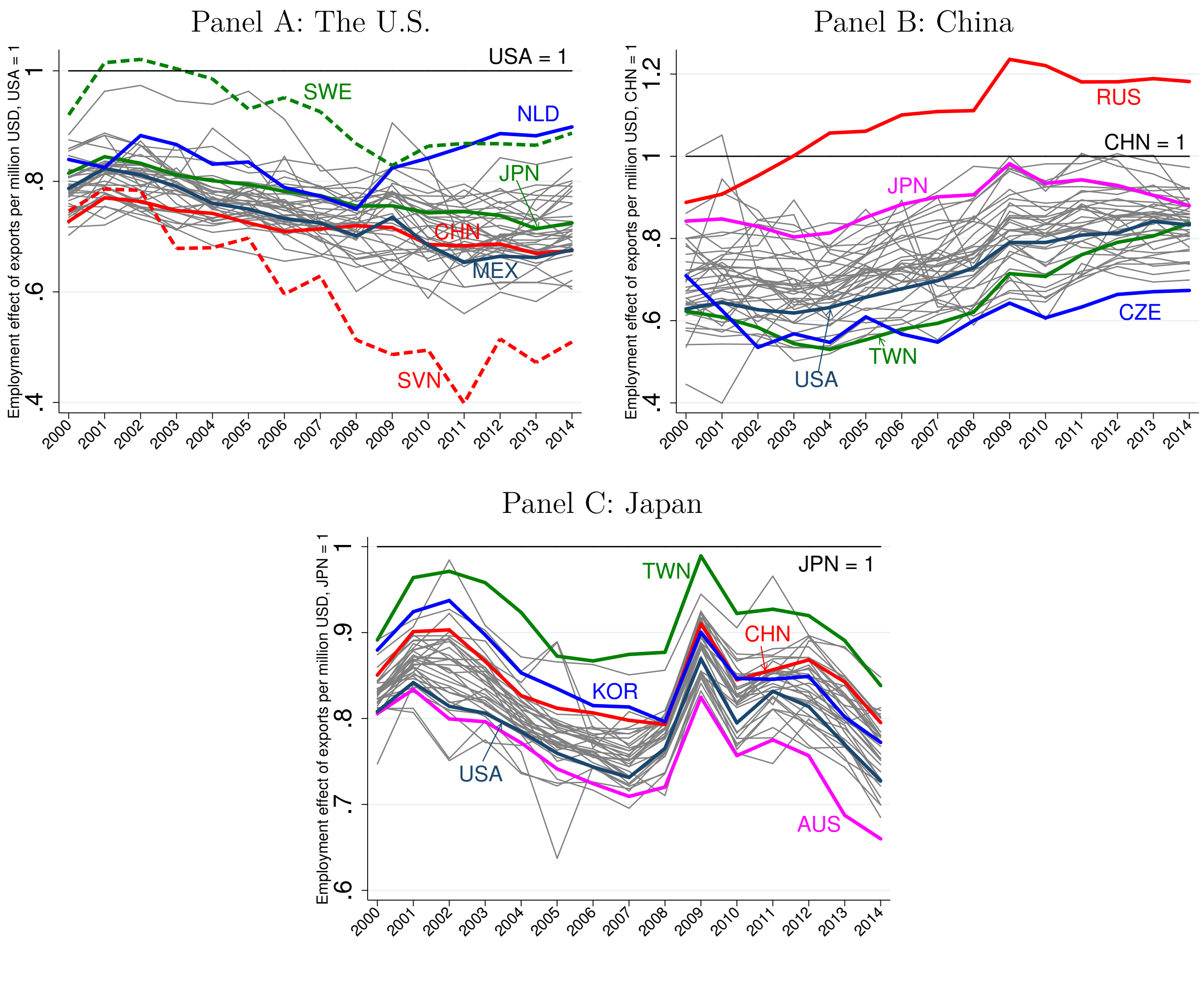
*Notes:* The table reports the employment effect of final demand from 10 contributors for the U.S. in 2014. Columns (1) and (2) report the employment effect of and final demand from each of top 10 contributors $j$, respectively. Column (3) shows the employment effect per million dollar final demand. Columns (4)-(6) present the same variables as for columns (1)-(3), respectively, but focusing on merchandise exports only. The ten countries are shown in descending order based on the aggregate employment effect reported in column (1). Numbers in parentheses are the share of the employment effect (or final demand) to the overall value.

greatest number, 10.50, and Australia has the smallest number, 8.26, among the top 10 contributors. A million dollar final demand from foreign countries as a whole leads to 9.79 jobs while that from Japan creates 12.52 jobs. The gap is $100 \times (12.52 - 9.79)/9.79 = 28$ percent. Restricting our focus on merchandise sectors makes the gap smaller but the gap does not become zero — $100 \times (11.63 - 9.38)/9.38 = 24$ percent.

Guided by these observations, we look at the employment effects of final demand at the country-sector level. Before going to that direction, we show how the employment effect of final demand from various countries evolved over the period 2000-2014 because the previous results only come from static cross-sectional observations in 2014.

Figure 1 describes the employment effects of final demand from various countries between 2000 and 2014 for the U.S. (Panel A), China (Panel B), and Japan (Panel C). The employment effects of country $j$ on country $i$ are first normalized by dividing by the value of final demand from country $j$ to country $i$, $\sum_{s=1}^{N} L_t^{(i,s),j}|_{(i,All),j} / \sum_{s=1}^{N} d_t^{(i,s),j}$. This measure varies over time due to various factors such as inflation because input-output tables are constructed in nominal values. In order to eliminate the effect of inflation, $\sum_{s=1}^{N} L_t^{(i,s),j}|_{(i,All),j} / \sum_{s=1}^{N} d_t^{(i,s),j}$ is divided by the impact of domestic final demand, $\sum_{s=1}^{N} L_t^{(i,s),i}|_{(i,All),i} / \sum_{s=1}^{N} d_t^{(i,s),i}$. As a result, the impacts of final demand from the U.S., China, and Japan are normalized as unity in Panels A, B, and C, respectively.

Figure 1: Employment Effect of Final Good Demand by Destination Country




*Notes*: Panels A-C in the figure display the employment effect of final good exports per value of final good exports on the U.S., China, and Japan, respectively. The employment effect per exports are normalized by dividing by the employment effect per domestic final demand. As a result, in Panels A-C, the employment effect of the U.S., China, and Japan are normalized as unity.

Panel A shows that almost all countries have a smaller employment creation effect relative to the U.S. — one exception is Sweden in early 2000's. It also shows that Sweden and Netherlands have relatively greater employment creation effects and Slovenia has an exceptionally lower employment creation effect for the U.S. — the employment effect of Slovenia is 50% less than that of U.S. domestic final demand for the same value of final demand in 2014. Overall, there is a slight downward trend in the employment effects of foreign demand.

Time-series changes of employment effects on China are presented in Panel B. Contrary to the U.S., there is an upward trend. The median gap between domestic and foreign employment effect was 30% in early 2000's but it is 20% in 2014. This upward trend in the foreign employment effects is probably driven by a rise in domestic value added contents in China's exports as documented in previous studies (e.g., Kee and Tang, 2016; Xikang et al., 2012). Russia has an exceptionally high employment effect on China — even greater than the effect of China's domestic final demand and Czech Republic has the lowest employment effect for China.

Panel C presents results from Japan, showing that there is a slight declining trend in foreign employment effects, which is similar to the result from the U.S. Also, contrary to the U.S. and China, the employment effects on Japan are strongly affected by the 2008-09 Great Trade Collapse, resulting in a temporary hike in the foreign employment effects in 2009.[8]

## 2.4 Employment Effects and Sectoral Linkages

The last set of analyses in this section is to look at the employments effect at the sectoral level and clarifies sectoral linkages to see if there are any differences between the employment effects of domestic and foreign final demands. The input-output table from the WIOD has 56 sectors and we aggregate them to three broad sectors, the natural resource, sectors 1-4, the manufacturing sector, sectors 5-22, and the service sector, sectors 23-56.[9]

Table 5 reports results from the U.S. where Panels A and B display the employment effects of domestic final demand and foreign final demand, respectively. Panel A shows that, for example, a million dollar domestic final demand to natural resources leads to 2.57 jobs, 0.27 jobs, and 1.47 jobs in the natural resource, manufacturing, and service sectors, respectively, totaling 4.31 jobs. It shows that there are considerable linkages from the natural resource sector to the service sector, and from the manufacturing sector to the service sector.[10] However, there is little linkages from the service sector to the other two sectors.

Comparing with Panels A and B, sectoral job creation effects of final demands are similar between domestic and foreign final demand — a million dollar domestic final demand leads to 4.31, 5.44, and 9.07 jobs in the natural resource, manufacturing, and service sectors, respectively, while a million dollar foreign final demand create 7.53, 5.47, and 6.92 jobs in the same sectors, respectively. However, the sectoral composition of domestic final demand and foreign final demand is strikingly different — 86% of domestic final demand goes to the service sector while 60% of foreign demand are for the manufacturing sector (see column (6)). Because service

[8]There are two possible explanations for this. First, exports from all sectors declined substantially but there was not much adjustment in employment, resulting in a substantial hike in employment-to-output ratio. An analysis presented in Section 4 confirms it is actually the case. Second, presumably there is a disproportional decline in exports from sectors with greater value added content.

[9]We conduct input-output computation using the original disaggregated data and then estimation results are aggregated after the input-output computation.

[10]This is consistent with Kiyota (2016)'s finding that service sectors' employment is largely depending upon other tradable sectors in the context of employment effects of exports on China, Japan, Indonesia, and Korea.

Table 5: The Impact of Final Demand on U.S. Employment and Sectoral Linkages, 2014

Panel A: Domestic Final Demand

| Employment creation in | Resource | Manuf. | Services | Total | Final demand | |
|---|---|---|---|---|---|---|
| | (jobs) | (jobs) | (jobs) | (jobs) | (million USD) | (share) |
| A million dollar final demand to | (1) | (2) | (3) | (4) | (5) | (6) |
| Resource | 2.57 | 0.27 | 1.47 | 4.31 | 239,806 | 0.01 |
| Manufacturing | 0.51 | 2.78 | 2.15 | 5.44 | 2,046,319 | 0.12 |
| Services | 0.05 | 0.26 | 8.76 | 9.07 | 14,593,704 | 0.86 |
| Total | | | | | 16,879,829 | 1 |
| Weighted average of the employment effects, $\sum_{s=1}^{3}$ Col$(4)_s \times$ Col$(6)_s = 8.56$ | | | | | | |

Panel B: Foreign Final Demand

| Employment creation in | Resource | Manuf. | Services | Total | Final demand | |
|---|---|---|---|---|---|---|
| | (jobs) | (jobs) | (jobs) | (jobs) | (million USD) | (share) |
| A million dollar final demand to | (1) | (2) | (3) | (4) | (5) | (6) |
| Resource | 5.66 | 0.40 | 1.47 | 7.53 | 14,280 | 0.02 |
| Manufacturing | 0.30 | 3.10 | 2.07 | 5.47 | 396,349 | 0.60 |
| Services | 0.03 | 0.19 | 6.69 | 6.92 | 255,460 | 0.38 |
| Total | | | | | 666,089 | 1 |
| Weighted average of the employment effects, $\sum_{s=1}^{3}$ Col$(4)_s \times$ Col$(6)_s = 6.07$ | | | | | | |

*Notes:* The table reports the employment effect of domestic final demand (Panel A), foreign final demand (Panel B) on the U.S. in 2014. The input-output computation is done using the original WIOD input-output table with 56 sectors and 44 economies, and then the employment effects in the WIOD 56 sectors are aggregated into the three aggregate sectors: the natural resource sector, the manufacturing sector, and the service sector.

Table 6: The Impact of Final Demand on China's Employment and Sectoral Linkages, 2014

Panel A: Domestic Final Demand

| Employment creation in | Resource | Manuf. | Services | Total | Final demand | |
|---|---|---|---|---|---|---|
| | (jobs) | (jobs) | (jobs) | (jobs) | (million USD) | (share) |
| A million dollar final demand to | (1) | (2) | (3) | (4) | (5) | (6) |
| Resource | 149.18 | 4.19 | 6.65 | 160.02 | 453,306 | 0.05 |
| Manufacturing | 27.51 | 23.01 | 16.47 | 66.99 | 2,332,753 | 0.25 |
| Services | 9.11 | 8.54 | 56.55 | 74.20 | 6,561,691 | 0.70 |
| Total | | | | | 9,347,750 | 1 |
| Weighted average of the employment effects, $\sum_{s=1}^{3}$ Col$(4)_s \times$ Col$(6)_s = 76.56$ | | | | | | |

Panel B: Foreign Final Demand

| Employment creation in | Resource | Manuf. | Services | Total | Final demand | |
|---|---|---|---|---|---|---|
| | (jobs) | (jobs) | (jobs) | (jobs) | (million USD) | (share) |
| A million dollar final demand to | (1) | (2) | (3) | (4) | (5) | (6) |
| Resource | 114.46 | 4.65 | 8.02 | 127.13 | 11,926 | 0.01 |
| Manufacturing | 15.83 | 30.93 | 16.48 | 63.23 | 1,070,852 | 0.88 |
| Services | 6.02 | 4.74 | 61.29 | 72.05 | 130,353 | 0.11 |
| Total | | | | | 1,213,131 | 1 |
| Weighted average of the employment effects, $\sum_{s=1}^{3}$ Col$(4)_s \times$ Col$(6)_s = 64.81$ | | | | | | |

*Notes:* The table reports the employment effect of domestic final demand (Panel A), foreign final demand (Panel B) on China in 2014. Also see the notes on Table 5.

sectors have greater domestic value added contents (e.g., Johnson and Noguera, 2012; Johnson, 2014), exports from those sectors lead to a greater employment creation effect there. As a result, differences in sectoral composition of final demand explain the gap between domestic and foreign employment effects.

Table 7: The Impact of Final Demand on Japan's Employment and Sectoral Linkages, 2014

Panel A: Domestic Final Demand

| Employment creation in / A million dollar final demand to | Resource (jobs) (1) | Manuf. (jobs) (2) | Services (jobs) (3) | Total (jobs) (4) | Final demand (million USD) (5) | Final demand (share) (6) |
|---|---|---|---|---|---|---|
| Resource | 31.45 | 1.23 | 2.23 | 34.91 | 28,263 | 0.01 |
| Manufacturing | 2.01 | 5.58 | 2.82 | 10.40 | 533,595 | 0.12 |
| Services | 0.22 | 0.76 | 11.67 | 12.66 | 3,723,918 | 0.87 |
| Total | | | | | 4,285,776 | 1 |
| Weighted average of the employment effects, $\sum_{s=1}^{3} \text{Col}(4)_s \times \text{Col}(6)_s = 12.52$ | | | | | | |

Panel B: Foreign Final Demand

| Employment creation in / A million dollar final demand to | Resource (jobs) (1) | Manuf. (jobs) (2) | Services (jobs) (3) | Total (jobs) (4) | Final demand (million USD) (5) | Final demand (share) (6) |
|---|---|---|---|---|---|---|
| Resource | 11.85 | 0.83 | 2.23 | 14.90 | 914 | 0.003 |
| Manufacturing | 0.20 | 6.07 | 3.10 | 9.36 | 261,060 | 0.800 |
| Services | 0.12 | 0.51 | 10.84 | 11.47 | 64,239 | 0.197 |
| Total | | | | | 326,213 | 1 |
| Weighted average of the employment effects, $\sum_{s=1}^{3} \text{Col}(4)_s \times \text{Col}(6)_s = 9.79$ | | | | | | |

*Notes:* The table reports the employment effect of domestic final demand (Panel A), foreign final demand (Panel B) on Japan in 2014. See the notes on Table 5.

Table 6 displays sectoral employment effects in China — where Panels A and B show the employment effects from domestic final demand and foreign final demand, respectively. Comparing column (6) in the two panels, again there is a stark difference in sectoral compositions in the final demand from domestic and foreign markets — 70% of the domestic final demand goes to the service sector while 88% is going to the manufacturing sector. This is in part responsible for the gap between the domestic and foreign employment effects. Another interesting observation is that a million dollar domestic final demand to the natural sector create a significantly greater jobs in the same sector compared with foreign final demand — 149.18 jobs versus 114.46. This gap is the reason why there is a large difference between the employment effect of domestic and foreign final demands in China even after restricting our focus on merchandise sectors.

Sectoral employment effects in Japan are presented in Table 7. Comparing column (4) in Panels A and B, there is no sectoral difference in the employment effects in the manufacturing and the service sector across domestic and foreign final demands. However, there is a large difference in the employment effects in the natural resource sector between domestic and foreign demand — 34.91 versus 14.90. This is similar to the case from China.

# 3 Domestic Value-Added Content and the Employment Effect of Exports

This section presents the techniques we use to estimate the employment effect exports, using a two country-two sector case. Then we examine how it is related with the employment effect of exports. We follow the literature and use two approaches.[11] The first approach is the one employed by Timmer et al. (2013), Timmer, Erumban, et al. (2014), and Los, Timmer, and Vries (2015). It measures value-added contents in exports as follows:[12]

$$\begin{bmatrix} vaxT_t^{1,M}|_{(1,All),2} \\ vaxT_t^{1,S}|_{(1,All),2} \\ vaxT_t^{2,M}|_{(1,All),2} \\ vaxT_t^{2,S}|_{(1,All),2} \end{bmatrix} = \mathbf{v}_t(\mathbf{I}-\mathbf{A}_t)^{-1} \begin{bmatrix} d_t^{(1,M),2} \\ d_t^{(1,S),2} \\ 0 \\ 0 \end{bmatrix}, \tag{3}$$

where $\mathbf{v}_t$ is a $(C \times N) \times (C \times N)$ matrix containing the value-added to gross output ratio as diagonal elements and zeros as off diagonal elements. Estimated value-added contents in the left hand side include domestic and foreign value-added contents. For example, $vaxT_t^{1,M}|_{(1,All),2}$ is the value-added from country 1's manufacturing sector embodied in aggregate exports from country 1 to country 2. Subscript "$(1, All), 2$" indicates that it is *aggregate* exports from country 1 to country 2. Therefore, overall domestic value-added contents in aggregate exports from country 1 to country 2 is found as $vaxT_t^{1,M}|_{(1,All),2} + vaxT_t^{1,S}|_{(1,All),2}$ and the share of domestic value-added in gross final good exports is

$$DVAX_t^{T\,1,2} \equiv \frac{vaxT_t^{1,M}|_{(1,All),2} + vaxT_t^{1,S}|_{(1,All),2}}{d_t^{(1,M),2} + d_t^{(1,S),2}}. \tag{4}$$

Johnson (2018) calls this a decomposition of GVC income. We refer to equation (4) as the domestic value-added contents based on Timmer et al. and it is denoted as $DVAX^T$.

The second approach is the one employed by Johnson and Noguera (2012), Koopman, Z. Wang, and Wei (2014), and Los, Timmer, and Vries (2016). While the previous approach gives value-added contents embodied in final good exports, this approach considers value-added

[11] See Johnson (2018) for a summary of various approaches estimating value-added contents in final good or total (including final and intermediate goods) exports using a global input-output table. We follow the summary in Johnson (2018).

[12] To be precise, they also include final demand from country 1's domestic market as well. In their measure, $d_t^{(1,M),2}$ in equation (3) is replaced with $d_t^{(1,M),1} + d_t^{(1,M),2}$ and $d_t^{(1,S),2}$ is replaced with $d_t^{(1,S),1} + d_t^{(1,S),2}$. We are interested in value-added contents in exports so we do not include domestic final demand.

contents in total exports, including final and intermediate good exports. It is estimated as:

$$\begin{bmatrix} vaxJN_t^{1,M}|_{(1,All),2} \\ vaxJN_t^{1,S}|_{(1,All),2} \\ vaxJN_t^{2,M}|_{(1,All),2} \\ vaxJN_t^{2,S}|_{(1,All),2} \end{bmatrix} = \mathbf{v}_t(\mathbf{I}-\mathbf{A}_t^*)^{-1} \begin{bmatrix} \sum_{r=1}^{2} m_t^{(1,M),(2,r)} + d_t^{(1,M),2} \\ \sum_{r=1}^{2} m_t^{(1,S),(2,r)} + d_t^{(1,S),2} \\ 0 \\ 0 \end{bmatrix}, \tag{5}$$

where

$$\underbrace{\mathbf{A}_t^*}_{(C\times N)\times(C\times N)} \equiv \begin{bmatrix} \mathbf{A}_t^{11} & \mathbf{0} \\ \mathbf{A}_t^{21} & \mathbf{A}_t^{22} \end{bmatrix}.$$

As in the previous measure, estimated value-added contents in the left hand side include domestic and foreign value-added contents. For example, $vaxJN_t^{1,M}|_{(1,All),2}$ is value-added from country 1's manufacturing sector required to produce gross exports from country 1 to country 2. Overall domestic value-added contents required to produce gross exports from country 1 to country 2 is therefore $vaxJN_t^{1,M}|_{(1,All),2} + vaxJN_t^{1,S}|_{(1,All),2}$ and its share in gross exports is

$$DVAX_t^{JN\,1,2} \equiv \frac{vaxJN_t^{1,M}|_{(1,All),2} + vaxJN_t^{1,S}|_{(1,All),2}}{\sum_{r=1}^{2} m_t^{(1,M),(2,r)} + d_t^{(1,M),2} + \sum_{r=1}^{2} m_t^{(1,S),(2,r)} + d_t^{(1,S),2}}. \tag{6}$$

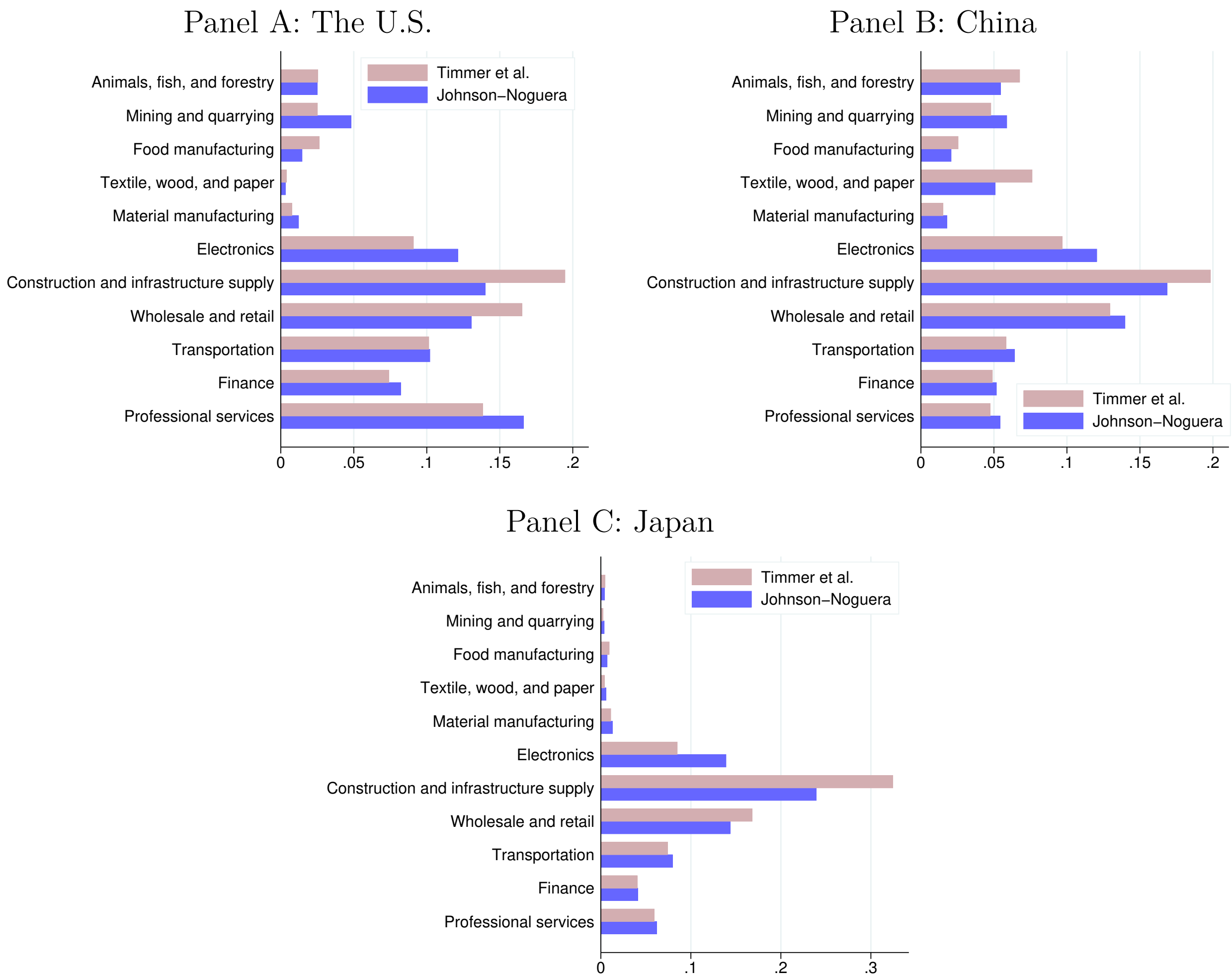
We refer to equation (6) as the domestic value-added contents based on Johnson-Noguera and it is denoted as $DVAX^{JN}$.

Figure 2 shows sectoral composition of domestic value-added contents in aggregate exports from each of the three countries to all other foreign countries in 2014. Because these value-added contents are computed for aggregate exports, these include value-added driven by direct exports from each of these sectors and indirect effect through sectoral linkages. Service sectors such as construction and infrastructure supply and wholesale and retail services have higher value-added contents in all of the three countries. This result is consistent with previous findings (e.g., Baldwin, Forslid, and Ito, 2015).[13] One unique aspect of the U.S. is that domestic value-added contents from professional services is higher than China and Japan. In China, natural resource and service sectors have greater domestic value-added contents than manufacturing sectors, consistent with previous work (e.g., Koopman, Z. Wang, and Wei, 2012; Ma, Z. Wang, and Zhu, 2015; and Xikang et al., 2012). Some manufacturing industries such as electronics and textile have greater domestic value-added contents. In Japan, manufacturing sectors overall have a small domestic value-added contents probably due to the fact that Japan imports a greater value of intermediate inputs for these sectors. To summarize, there is strong heterogeneity in domestic value-added contents across sectors within a country.

While Figure 2 displays a snapshot of sectoral composition of domestic value-added in 2014,

[13] Baldwin, Forslid, and Ito (2015) highlight contribution of service sectors in providing value-added in exports from Asian countries. They find that transport, wholesale and retail services are particularly contributing in adding value-added in exports.

Figure 2: Sectoral Compositions of Domestic Value-Added Content in Exports



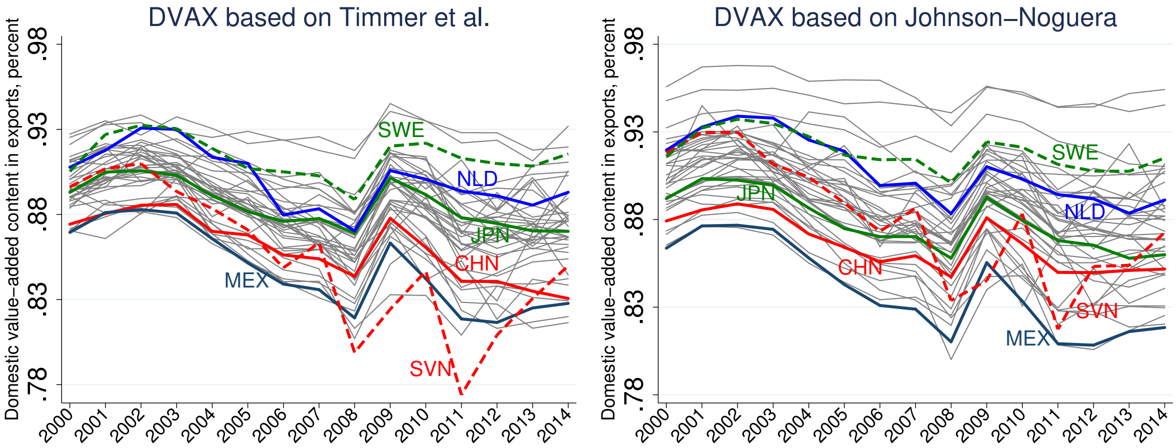

*Notes*: The figure shows sectoral composition of domestic value-added contents in a country's aggregate exports to all foreign countries in 2014. WIOD 56 sectors are aggregated to eleven major sectors. See Appendix for aggregation of sectors.

Figure 3 shows domestic value-added contents embodied in exports to each of the destination countries during the period 2000-2014. The same countries as Figure 1 are highlighted to see the link between the employment effect of exports and domestic value-added contents. The figure shows striking differences across the three countries in terms of long-run trend in domestic value-added contents in exports. In the U.S., domestic value-added content is slightly declining over the period 2000-2014 and it is almost flat after 2011. In China, domestic value-added content is declining between 2000 and 2004 but it is increasing after 2007. This overall increasing trend in China's domestic value-added contents in exports is consistent with previous research (e.g., Kee and Tang, 2016 and Ito and Vézina, 2016).[14] Japan's domestic value-added content is the highest among the three countries in the beginning of 2000's, accounted for 90% of exports, but

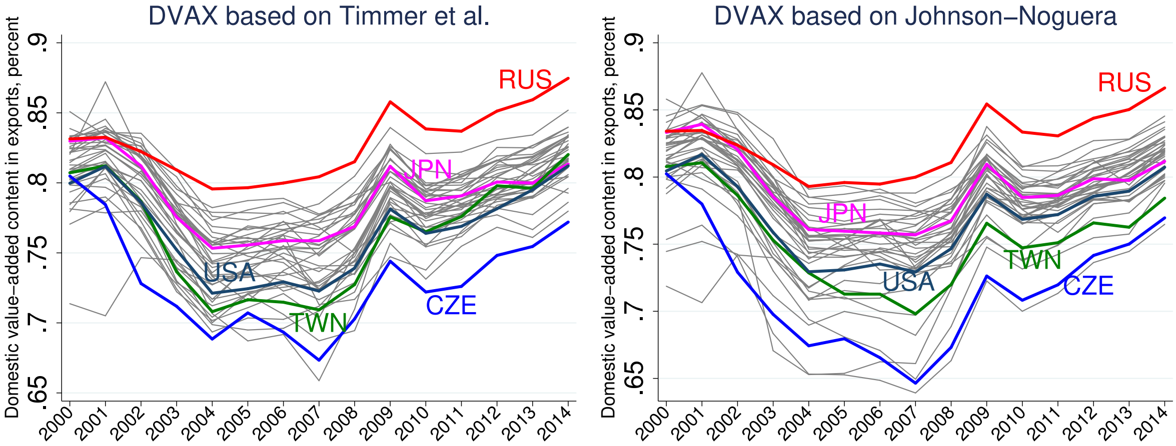
[14] Kee and Tang (2016) show that China's domestic value-added contents are increasing over the period 2000-2007 using firm-level data from China. Ito and Vézina (2016) also find that China's final goods include a smaller share of foreign value-added than those produced in other Asian countries using the data from 1990 and 2005.

Figure 3: Domestic Value-Added Content in Exports by Destination Country

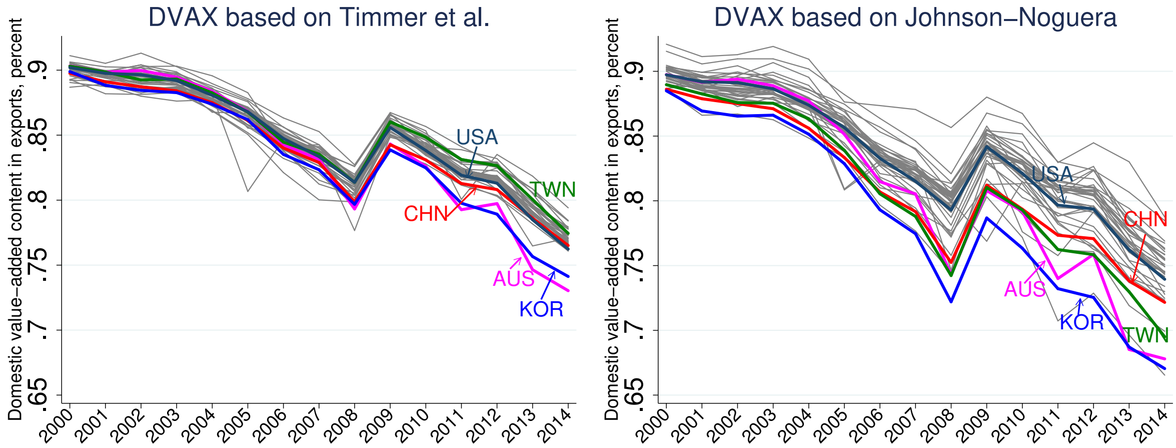
Panel A: The U.S.




Panel B: China

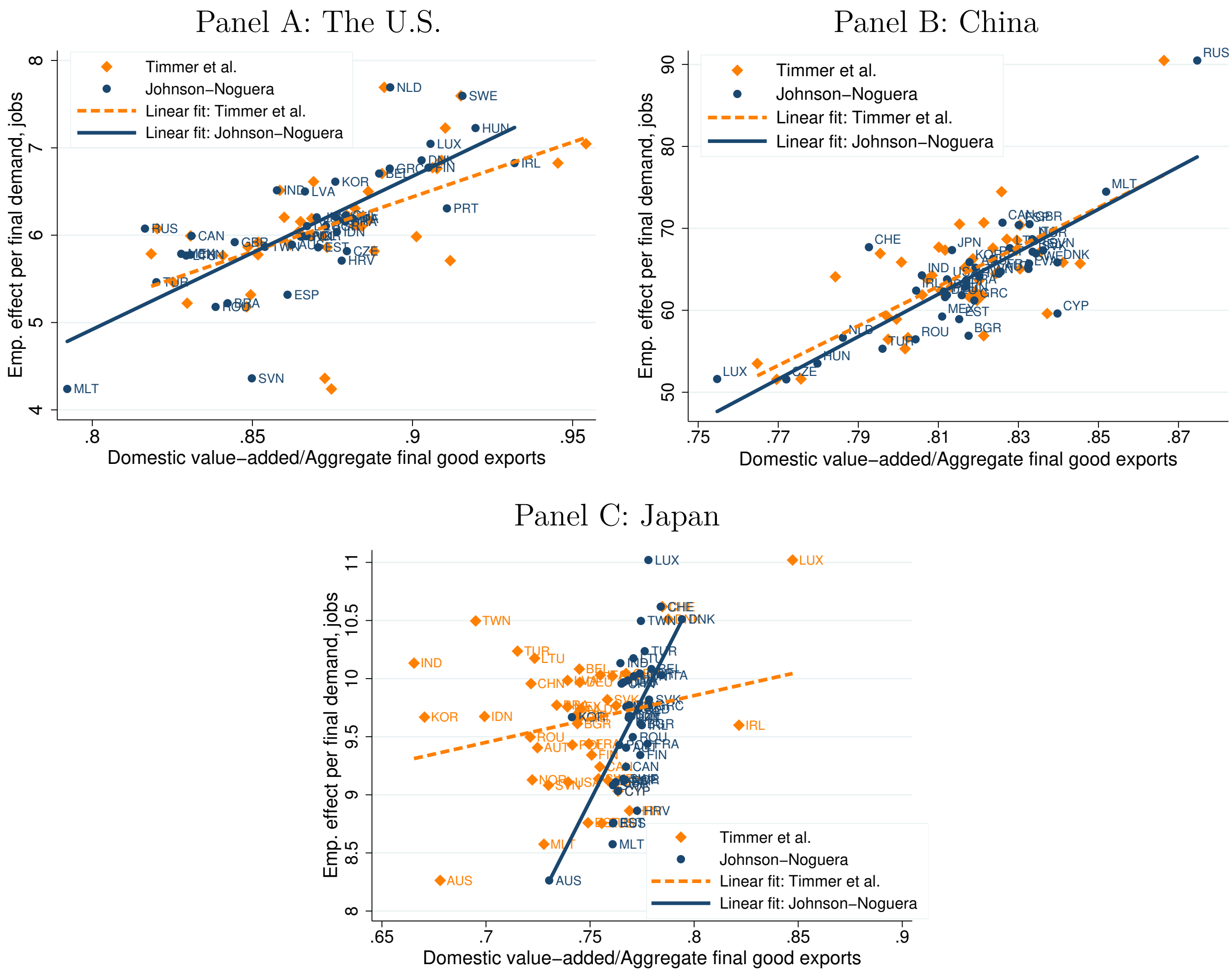



Panel C: Japan




*Notes*: The figure displays the domestic value-added content relative to the country's aggregate final good export by destination country.

Figure 4: Domestic Value-Added Contents in Exports and the Employment Effects of Exports




*Notes*: The figure shows relationships between the domestic value-added content in exports and the employment effect of a million dollar aggregate exports using cross-sectional country-level observations from 2014.

it is rapidly declining during the period 2000-2014. This swift decline in domestic value-added contents in Japan is due to deepening backward linkages with foreign countries and increase in imported inputs.[15] There is a temporary increase in the domestic value-added contents due to the Great Trade Collapse in 2008-09 but it is declining after the crisis. As a result, the domestic value-added content is almost 70-80% in 2014, which is the lowest among the three countries.

Figure 4 shows a cross-sectional relationship between the employment effect of exports per value of exports — in the vertical axis — and the domestic value-added contents in exports — in the horizontal axis. There is a positive association between the two variables regardless the choice of estimation approaches for the U.S. and China (see Panels A and B). However, for Japan, the two domestic value-added contents based on Timmer et al. and Johnson-Noguera are different. This is probably due to the fact that destination countries of final good exports

[15] See Appendix for backward and forward linkages with other WIOD countries.

and intermediate good exports are very different for Japan.[16]

To summarize, Figure 2 shows that domestic value-added contents vary across sectors, which implies that sectoral composition in aggregate exports must have an important implication on cross-country differences in the employment effect of exports. Furthermore, there seem to be a relationship between the employment effect of exports and domestic value-added contents based on time-series variations (see Figures 1 and 3) and cross-sectional relationships (see Figure 4). In order to confirm that there are such relationships, we rely on statistical methods.

**Country-level regressions**: We first estimate a regression using country-level data. It regresses natural log of employment effect of aggregate exports from country $i$ to country $j$ divided by the value of aggregate exports from country $i$ to country $j$, $\ln\left(\sum_{s=1}^{N} L_t^{(i,s),j}|_{(i,All),j} / \sum_{s=1}^{N} d_t^{(i,s),j}\right)$ on the share of domestic value-added to aggregate final good exports from country $i$ to country $j$, $DVAX_t^{i,j}$. Therefore, our regression equation is:

$$\ln\left(\frac{\sum_{s=1}^{N} L_t^{(i,s),j}|_{(i,All),j}}{\sum_{s=1}^{N} d_t^{(i,s),j}}\right) = \alpha^{i,j} + \alpha_t + \alpha_1 DVAX_t^{i,j} + \epsilon_t^{i,j}, \tag{7}$$

for exporting country $i = USA$, $CHN$, and $JPN$, where $j$ denote destination country; $\alpha^{i,j}$ indicates destination country fixed effects controlling for all time-invariant factors in each cross-sectional observation; $\alpha_t$ denotes year fixed effects controlling for macroeconomic shocks; $\epsilon_t^{i,j}$ is the error term; and $\alpha_1$ is a parameter to be estimated.

**Country-sector level regressions**: The data are available at the country-sector level. Therefore, we also estimate a regression by exploiting country-sector variations. The dependent variable is natural log of country-sector level employment effect resulting from total exports of country $i$ to country $j$, $\ln\left(L_t^{(i,s)}|_{(i,All),j}\right)$. Explanatory variables include natural log of final good exports from country $j$'s sector $s$ to country $j$, $\ln\left(d_t^{(i,s),j}\right)$, final good exports from other sectors in country $i$ to country $j$, $\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$; and variables capturing domestic value-added contents estimated using the two approaches based on Timmer et al. and Johnson-Noguera.

[16] For example, Japan exports a greater value of intermediate goods to countries such as Taiwan, Indonesia and Korea but final good exports to these countries are probably proportionally less than intermediate inputs. As a result, the measure based on Johnson-Noguera, taking intermediate good flows into account, implies greater domestic value-added contents for these countries.

As a result, the regression equation is:[17]

$$\ln\left(L_t^{(i,s)}|_{(i,All),j}\right) = \beta^{(i,s),j} + \beta_t + \beta_1 \ln\left(d_t^{(i,s),j}\right) + \beta_2 \ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right) + \mathbf{X}_t^{DVAX\prime}\boldsymbol{\beta}_3 + e_t^{(i,s),j}, \quad (8)$$

for exporting country $i = USA$, $CHN$, and $JPN$, where $s$ and $j$ denote source sector and destination country, respectively; $\beta^{(i,s),j}$ are source sector-destination country fixed effects; $\beta_t$ denotes year fixed effects controlling for macroeconomic shocks including changes in price levels; and $e_t^{(i,s),j}$ is the error term; $\beta_1$, $\beta_2$, and $\boldsymbol{\beta}_3$ are (scalars and a vector of) coefficients to be estimated. $\mathbf{X}_t^{DVAX}$ is a vector of variables measuring domestic value-added contents in exports.

Table 8 reports results from estimating equation (7) where regressions in Panels A and B use the domestic value-added content variables based on Timmer et al., $DVAX^T$, and Johnson-Noguera, $DVAX^{JN}$, respectively. The results are similar between the two panels. Odd number columns regress the employment effect of exports on the *total* domestic value-added share in exports and even number columns break down the $DVAX$ into ones coming from the natural resource sector, the textile sector, and the service sector. Almost all of estimated coefficients for $DVAX$ are positive and statistically significant. For example, according to Pane A, a 1% increase in $DVAX$ raises the employment effect by 3.84%, 5.27%, and 2.02% in the U.S., China, and Japan, respectively. Column (2) of Panel A shows that the domestic value-added content from the service sector has the largest coefficient for the U.S. Columns (4) and (5) show that domestic value-added contents from natural resource sector has the largest coefficient in China and Japan.

Results from regressions with country-sector level are shown in Table 9. Because the unit of observations is source *sector*-destination country, we cannot include separate *sectoral* value-added variables. We introduce two control variables — the values of exports from sector $s$, $\ln\left(d_t^{(i,s),j}\right)$, and exports from other sectors besides sector $s$, $\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$. Both of these coefficients have statistically significant and positive coefficients in all columns. In addition, the result shows that the employment effect of exports is greater in sectors with greater domestic value-added contents. According to regressions using $DVAX^T$ reported in odd number columns, a 1% increase in the share of domestic value-added contents in exports raises the employment effect by 1.2%, 5.1%, and 0.9% in the U.S., China, and the U.S., respectively. Even number columns show results using $DVAX^{JN}$. These suggest that a 1% increase in the share of domestic

[17] The dependent variable for equation (7) is the employment effect of final good exports per final good exports while it is the employment effect of exports in (8). We use the *per export* employment effect in the regressions with the country level data because estimating an equation like (8) using the country-level data leads to an over-fitting. This is because, at the country level observations, a large part of the cross-country variations in the employment effect of exports is explained by the size of exports. On the other hand, at the country-sector level data, the dependent variable is employment effect generated by exports from *all* sectors in the country on each sector $s$ of the country. Therefore, we are supposed to have two explanatory variables measuring exports from the country — the one is exports from sector $s$ and the other is exports from other sectors besides $s$. Therefore, the employment effect of exports instead of the *per export* employment effect is used as dependent variable in (8).

Table 8: $DVAX$ and the Employment Effect of Exports with Country-level Data, Dep. Var. = $\ln\left(\frac{\sum_{s=1}^{N} L_t^{(i,s),j}|_{(i,All),j}}{\sum_{s=1}^{N} d_t^{(i,s),j}}\right)$, Natural log of Employment Effect of Exports per Million Dollar Exports

Panel A: $DVAX$ based on Timmer et al.

| Exporter | The U.S. | | China | | Japan | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $DVAX^T$ | 3.839*** | | 5.269*** | | 2.019*** | |
| | (0.903) | | (0.633) | | (0.349) | |
| $DVAX^T$, natural resource | | 2.206** | | 4.494*** | | 4.128*** |
| | | (0.821) | | (0.504) | | (0.940) |
| $DVAX^T$, manufacturing | | 2.952*** | | 1.443*** | | 1.322*** |
| | | (0.764) | | (0.495) | | (0.289) |
| $DVAX^T$, textile | | 1.343 | | 1.397*** | | 3.177** |
| | | (2.048) | | (0.242) | | (1.340) |
| $DVAX^T$, services | | 3.073*** | | 3.950*** | | 1.758*** |
| | | (0.706) | | (0.371) | | (0.270) |
| Destination country fixed effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year fixed effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $R$-squared | 0.957 | 0.960 | 0.991 | 0.997 | 0.968 | 0.973 |
| # of countries | 42 | 42 | 42 | 42 | 42 | 42 |
| # of observations | 630 | 630 | 630 | 630 | 630 | 630 |

Panel B: $DVAX$ based on Johnson-Noguera

| Exporter | The U.S. | | China | | Japan | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $DVAX^{JN}$ | 3.380** | | 2.967*** | | 0.540** | |
| | (1.454) | | (0.439) | | (0.229) | |
| $DVAX^{JN}$, natural resource | | 2.884** | | 2.441*** | | 3.832*** |
| | | (1.386) | | (0.612) | | (0.838) |
| $DVAX^{JN}$, manufacturing | | 3.094** | | 0.649 | | 0.401* |
| | | (1.466) | | (0.773) | | (0.212) |
| $DVAX^{JN}$, textile | | -0.912 | | 2.142*** | | 0.851*** |
| | | (2.812) | | (0.404) | | (0.307) |
| $DVAX^{JN}$, services | | 3.159** | | 1.631*** | | 0.482** |
| | | (1.433) | | (0.535) | | (0.206) |
| Destination country fixed effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year fixed effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $R$-squared | 0.919 | 0.921 | 0.977 | 0.980 | 0.961 | 0.964 |
| # of countries | 42 | 42 | 42 | 42 | 42 | 42 |
| # of observations | 630 | 630 | 630 | 630 | 630 | 630 |

*Notes:* ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors, clustered at the country level, are in parentheses. The sample period is 2000-2014. All regressions include a constant term, destination country fixed effects, and year fixed effects. $DVAX$ is the share of domestic value-added contents to aggregate final good exports. For example, if $DVAX$ takes a value of 0.20, it means that domestic value-added contents account for 20% of aggregate final good exports.

value-added contents in exports raises the employment effect by 2.2%, 7.7%, and 1.5% in the U.S., China, and the U.S., respectively.

To summarize, we show that the employment effect of exports is associated with the domestic value-added contents of exports. The positive association is confirmed by observing time-series and cross-sectional variations in the employment effect of exports and the domestic value-added contents and by running regressions. To be fair, it is not surprising to see a positive association because these two are estimated using similar input-output methods. We further attempt to

Table 9: $DVAX$ and the Employment Effect of Exports with Country-Sector level Data, Dep. Var. $= \ln\left(\sum_{s=1}^{N} L_t^{(i,s),j}|_{(i,All),j}\right)$, Natural log of Employment Effect of Exports

| Exporter | The U.S. | | China | | Japan | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\ln\left(d_t^{(i,s),j}\right)$ | 0.113*** | 0.099*** | 0.187*** | 0.176*** | 0.091*** | 0.085*** |
| | (0.006) | (0.005) | (0.007) | (0.008) | (0.006) | (0.006) |
| $\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$ | 0.063*** | 0.068*** | 0.195*** | 0.198*** | 0.087*** | 0.088*** |
| | (0.004) | (0.004) | (0.013) | (0.013) | (0.006) | (0.006) |
| $DVAX$, Timmer et al. | 1.199*** | | 5.114*** | | 0.914*** | |
| | (0.251) | | (0.833) | | (0.259) | |
| $DVAX$, Johnson-Noguera | | 2.158*** | | 7.740*** | | 1.495*** |
| | | (0.266) | | (0.627) | | (0.236) |
| Destination country fixed effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year fixed effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $R$-squared | 0.285 | 0.314 | 0.417 | 0.434 | 0.218 | 0.230 |
| # of country-sector pairs | 2,352 | 2,352 | 2,352 | 2,352 | 2,352 | 2,352 |
| # of observations | 35,280 | 35,280 | 35,280 | 35,280 | 35,280 | 35,280 |

*Notes:* ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors, clustered at the country-sector level, are in parentheses. The sample period is 2000-2014. All regressions include a constant term, destination country fixed effects, and year fixed effects. $DVAX$ denotes the share of domestic value-added contents to aggregate final good exports. For example, if $DVAX$ takes a value of 0.20, it means that domestic value-added contents account for 20% of aggregate final good exports.

understand how the employment effects of exports are determined by sectoral composition in exports and backward/forward linkages.

Sectoral export shares are calculated as the share of exports of sector $s$ of country $i$ to country $j$ to total exports from country $i$ to country $j$:

$$EX(Res)_t^{i,j} \equiv x_t^{(i,\text{Resource}),j} / \sum_{s=1}^{N} x_t^{(i,s),j},$$

$$EX(Tex)_t^{i,j} \equiv x_t^{(i,\text{Textile}),j} / \sum_{s=1}^{N} x_t^{(i,s),j},$$

$$EX(Ser)_t^{i,j} \equiv x_t^{(i,\text{Service}),j} / \sum_{s=1}^{N} x_t^{(i,s),j},$$

where $x_t^{(i,s),j}$ denotes the final and intermediate good flows from sector $s$ of country $i$ to country $j$. Instead of the share of exports from manufacturing sectors as a whole, we use the share of textile exports because it appears to be related with employment effects of exports in China.[18] Sectoral linkages are measured using variables constructed based on Rasmussen (1956). We use coefficients $\theta_t^{(i,s),(j,r)}$ — measuring sectoral linkages from in country $i$'s sector $s$ to country $j$'s sector $r$ — to construct forward/backward linkages. The coefficients come from the following

[18]The share of exports from other manufacturing sectors is omitted due to perfect multicollinearity.

matrix:

$$\underbrace{(\mathbf{I}-\mathbf{A}_t)^{-1}}_{(C\times N)\times(C\times N)} = \begin{bmatrix} \theta_t^{(1,1),(1,1)} & \theta_t^{(1,1),(1,2)} & \dots & \theta_t^{(1,1),(j,r)} & \dots & \theta_t^{(1,1),(C,N)} \\ \theta_t^{(1,2),(1,1)} & \theta_t^{(1,2),(1,2)} & \dots & \theta_t^{(1,2),(j,r)} & \dots & \theta_t^{(1,2),(C,N)} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ \theta_t^{(i,s),(1,1)} & \theta_t^{(i,s),(1,2)} & \dots & \theta_t^{(i,s),(j,r)} & \dots & \theta_t^{(i,s),(C,N)} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ \theta_t^{(C,N),(1,1)} & \theta_t^{(C,N),(1,2)} & \dots & \theta_t^{(C,N),(j,r)} & \dots & \theta_t^{(C,N),(C,N)} \end{bmatrix}.$$

The forward linkage measure is

$$FL_t^{i,j} \equiv \sum_{s=1}^{N} \frac{GO_t^{i,s}}{\sum_{s=1}^{N} GO_t^{i,s}} \sum_{r=1}^{N} \theta_t^{(i,s),(j,r)},$$

which is a weighted average of the sectoral forward linkage with destination country $j$, $\sum_{r=1}^{N} \theta_t^{(i,s),(j,r)}$ where the weights are the share of country $i$'s sector $s$'s gross production $GO_t^{i,s} / \sum_{s=1}^{N} GO_t^{i,s}$ obtained from the WIOD SEA database. The backward linkage is constructed as:

$$BL_t^{i,j} \equiv \sum_{s=1}^{N} \frac{GO_t^{i,s}}{\sum_{s=1}^{N} GO_t^{i,s}} \sum_{r=1}^{N} \theta_t^{(j,r),(i,s)}.$$

The regression equation is therefore:

$$\begin{aligned} \ln\left(\frac{\sum_{s=1}^{N} L_t^{(i,s),j}|_{(i,All),j}}{\sum_{s=1}^{N} d_t^{(i,s),j}}\right) &= \gamma^{i,j} + \gamma_t + \gamma_1 FL_t^{i,j} + \gamma_2 BL_t^{i,j} \\ &\quad + \gamma_3 EX(Res)_t^{i,j} \gamma_4 EX(Tex)_t^{i,j} + \gamma_5 EX(Ser)_t^{i,j} + u_t^{i,j}, \end{aligned} \tag{9}$$

where $\gamma^{i,j}$ indicates destination country fixed effects; $\gamma_t$ denotes year fixed effects; $u_t^{i,j}$ is the error term; and $\gamma_1 - \gamma_5$ are parameters to be estimated. This equation is estimated for each of the three exporters, the U.S., China, and Japan. We expect the coefficient for forward linkages to be positive because it would lead to a greater input demand from foreign countries. One may expect the coefficient for backward linkages to be negative because greater inputs from abroad reduce domestic value-added contents. However, the direction of the effect is nontrivial. For instance, Feng, Li, and Swenson (2016) find that an increase in intermediate good imports in China increased China's exports due to quality upgrading caused by better intermediate inputs. If there are such channels, deeper backward linkages may increase the employment effect of exports. Sectoral export shares in the natural resource, textile, and service sectors are expected to have positive signs because these sectors have greater domestic value-added contents.[19]

[19]See Johnson and Noguera (2012), for the case in the U.S., Koopman, Z. Wang, and Wei (2012), Ma, Z. Wang, and Zhu (2015), and Xikang et al. (2012), for the case in China.

Table 10: Determinants of the Employment Effect of Exports, with Country-level Data, Dep. Var. $= \ln \left( \frac{\sum_{s=1}^{N} L_t^{(i,s),j}|_{(i,All),j}}{\sum_{s=1}^{N} d_t^{(i,s),j}} \right)$, the Employment Effect of Exports per Million Dollar Exports

| Exporter | The U.S. | | China | | Japan | |
|---|---|---|---|---|---|---|
| | Full sample | Outliers dropped | Full sample | Outliers dropped | Full sample | Outliers dropped |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Forward linkages, $FL_t^{i,j}$ | 2.561* | 2.525* | -0.588 | -0.518 | 0.235 | 0.230 |
| | (1.508) | (1.485) | (0.704) | (0.710) | (0.291) | (0.413) |
| | [0.107] | [0.105] | [-0.025] | [-0.022] | [0.010] | [0.010] |
| Backward linkages, $BL_t^{i,j}$ | 1.580 | 4.069 | 0.967 | 0.530 | -0.916 | -5.137*** |
| | (2.042) | (7.910) | (2.470) | (2.547) | (1.227) | (0.997) |
| | [0.011] | [0.029] | [0.007] | [0.004] | [-0.006] | [-0.036] |
| Resource export share, $EX(Res)_t^{i,j}$ | 0.249 | 0.260 | 1.326*** | 1.311** | 0.877 | 0.770 |
| | (0.161) | (0.167) | (0.483) | (0.491) | (0.554) | (0.515) |
| Textile export share, $EX(Tex)_t^{i,j}$ | 1.266 | 1.042 | 1.006*** | 1.050*** | 0.394*** | 0.643*** |
| | (0.908) | (1.040) | (0.124) | (0.125) | (0.122) | (0.181) |
| Service export share, $EX(Ser)_t^{i,j}$ | 0.395** | 0.422** | 0.680*** | 0.673*** | 0.089* | 0.081* |
| | (0.178) | (0.186) | (0.094) | (0.095) | (0.046) | (0.046) |
| Destination country fixed effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year fixed effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| # of destination countries | 42 | 40 | 42 | 41 | 42 | 39 |
| # of observations | 630 | 600 | 630 | 615 | 630 | 585 |
| $R$-squared | 0.920 | 0.920 | 0.979 | 0.979 | 0.961 | 0.963 |
| $F$-stat. | 1.40 | 1.53 | 26.01 | 26.57 | 4.24 | 8.46 |
| $p$-val. ($F$-stat.) | 0.244 | 0.202 | 0.000 | 0.000 | 0.003 | 0.000 |

*Notes:* China and Russia are dropped as outliers in (2). Russia is dropped as an outlier in (4). China, Taiwan, and Latvia are dropped as outliers in (6). ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors, clustered at the country level, are in rounded parentheses. Numbers in square brackets are the impact of a one standard deviation change. If $EX(Res)_t^{i,j} = 0.33$, for example, the natural resource exports account for 33% of the total exports.

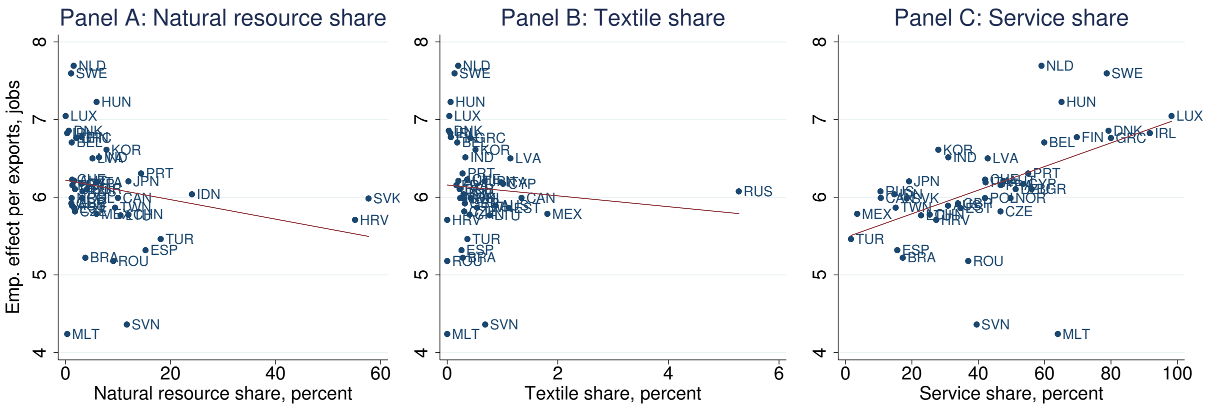
Table 10 presents results from estimating equation (9). Forward linkages are positively related with the employment effect of exports in the U.S. and backward linkages have a negative effect in Japan. There is no statistically significant relationship between production linkages in the employment effect in China. The sectoral export shares have a greater explanatory power. For example, for the U.S., greater resource exports and greater service exports are related with the greater employment effect of exports — according to column (2), a 1% point increase in the service export share raises the employment effect by 0.42%.

Column (4) shows that greater exports from the resource, textile, and service sectors are associated with greater employment effects in China. The magnitudes are sizable — a 1% point increase in the resource export share, the textile share, and the service share raises the employment effect by 1.31%, 1.05%, and 0.67%, respectively. Previous studies find that China's textile sector has a greater domestic value added content compared with other sectors in China (e.g., Koopman, Z. Wang, and Wei, 2012; Ma, Z. Wang, and Zhu, 2015).[20] Xikang et al.

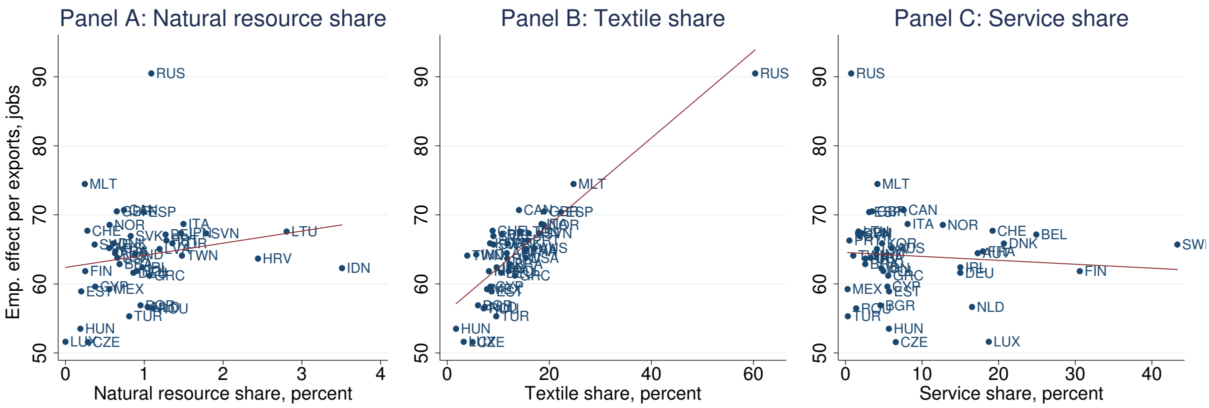
[20] Koopman, Z. Wang, and Wei (2012) find that, using the data from 2007 and by taking processing and non-processing trade into consideration, domestic value added contents account for 82.4% of gross production

Figure 5: Employment Effects of Exports and Sectoral Composition of Exports

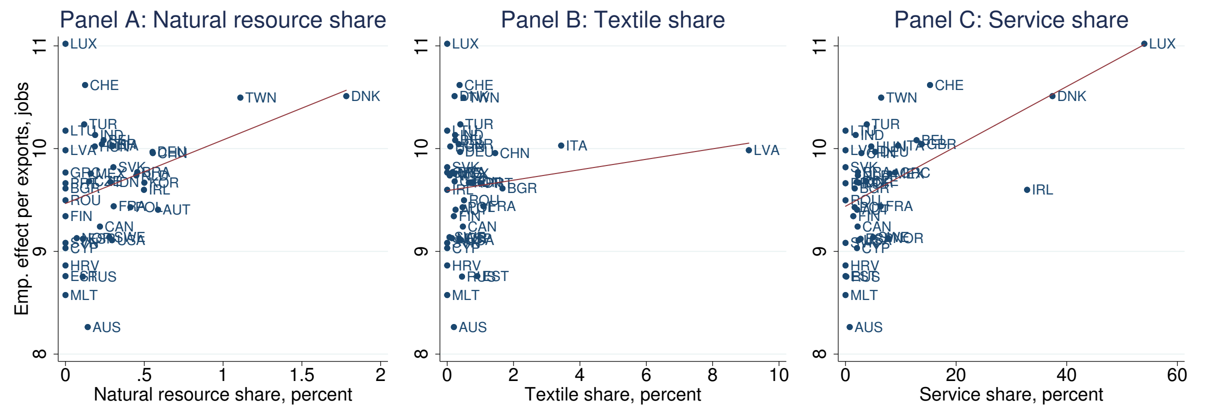
Part I: The U.S.




Part II: China




Part III: Japan




*Notes*: The figure displays the relationship between the employment effect of a million dollar aggregate exports and sectoral composition of total exports in 2014. Linear regression lines are in all panels.

(2012) estimate domestic value added contents in Chinese exports and show that, using the

in China's textile industry while the overall average in China is 60.6%. Ma, Z. Wang, and Zhu (2015) further distinguish foreign-owned and state-owned enterprises to estimate domestic value-added contents and show that these figure become 81.2% and 59.2%, respectively. These two studies show that domestic value-added contents are greater in the textile sector than other sectors in China.

data from 2002, domestic value-added contents account for 81.7% and 57.2% of final demand in the agriculture and the textile sectors while the country average is 46.6%. Results from column (6) suggest that the textile export share and the service export share are related with the greater employment effect of exports in Japan but the magnitude is smaller compared with China.

Figure 5 shows cross-sectional relationships between the employment effect of a million dollar exports and sectoral composition of total (final and intermediate goods) exports, focusing on the natural resource, textile and service sectors. Panel B of Part II shows that, in China, there is a striking positive correlation between the employment creation effect of exports and the share of exports from the textile industry. It clearly explains the reason why Russia has by far the largest employment effect of exports on China — because the majority of Chinese exports to Russia come from the textile industry. Because producing textiles is labor-intensive and there are not much GVCs in producing textiles, exports from the textile industry has a greater employment effect in China. On the other hand, in the U.S. and Japan, the employment effect of exports is positively associated with exports from the service sector (see Panel C of Panels I and III). Interestingly, these results suggest that a country' level of development is related with which sectors are important in creating jobs in the country.

# 4 Decomposing the Employment Effect of Exports

The previous analysis suggests that the employment effect of exports is in large part explained by domestic value-added content of exports. This section investigates through which channels the employment effects of exports change over time. In so doing we decompose changes in the employment effect into changes in (1) the labor-to-gross output ratio represented in $\mathbf{\Lambda}_t$, (2) input-output linkages captured by $\mathbf{A}_t$, and (3) the sectoral composition in final good exports in $\mathbf{D}_t$. We decompose *aggregate* final good exports of a country because now we are interested in understanding why the employment effects of final demand change over time rather than their cross-sectional differences across destination countries.

We use a general $C$-country and $N$-sector case in this section. The employment effect of final good exports from country $i$ to country $j$ on country $i$'s employment is estimated as:[21]

$$\mathbf{L}_t^{(i,All),-i} \equiv \mathbf{\Lambda}_t(\mathbf{I} - \mathbf{A}_t)^{-1}\mathbf{D}_t^{*(i,All),-i}, \tag{10}$$

[21]Employment effect equation (10) looks different from equation (1). However, these two equations lead to the exact same employment effect if they focus on the same destination countries. Equation (10) is so-called the demand-side analysis (Los, Timmer, and Vries, 2015; Feenstra and Sasahara, 2019). Equation (1) is so-called the hypothetical extraction (Los, Timmer, and Vries, 2016). We use the demand-side expression here because it makes it easier to decompose the employment effect into several components.

where

$$\underbrace{\mathbf{D}_t^{*(i,All),-i}}_{(C\times N)\times 1} \equiv \begin{bmatrix} \mathbf{0} \\ \vdots \\ \mathbf{0} \\ \sum_{k\neq i}^{C} \mathbf{d}_t^{i,k} \\ \mathbf{0} \\ \vdots \\ \mathbf{0} \end{bmatrix} \quad \text{and} \quad \underbrace{\mathbf{d}_t^{i,j}}_{N\times 1} \equiv \begin{bmatrix} \mathbf{d}_t^{(i,1),j} \\ \mathbf{d}_t^{(i,2),j} \\ \vdots \\ \mathbf{d}_t^{(i,S),j} \end{bmatrix},$$

where superscript "$(i, All), -i$" indicates that it is an impact of country $i$'s aggregate ($All$) exports to all countries besides country $i$, denoted by $-i$. The vector $\mathbf{D}_t^{*(i,All),-i}$ consists of a number $C$ of sub-matrices where all sub-matrices except for one sub-matrix are replaced with zero matrices $\mathbf{0}$. Final good flows from country $i$ to all other countries besides country $i$ is inserted to the remaining sub-matrix. Resulting employment effect of final demand from countries $-i$ is a $(C \times N) \times 1$ vector:

$$\begin{bmatrix} \mathbf{L}_t^1|_{(i,All),-i} & \mathbf{L}_t^2|_{(i,All),-i} & \dots & \mathbf{L}_t^C|_{(i,All),-i} \end{bmatrix}',$$

where $\mathbf{L}_t^i|_{(i,All),-i}$ is an $N \times 1$ vector and this is the one we are interested, the employment effect of final demand from countries $-i$ to country $i$ on country $i$. The employment effect is then divided by final demand flows to find the employment effect per final demand as in the previous section: $(\mathbf{L}_t^i|_{(i,All),-i})'\mathbf{i}/(\mathbf{d}_t^{i,-i})'\mathbf{i}$ where $\mathbf{i}$ is an $N \times 1$ vector of ones. We examine why the employment effect of final demand from foreign countries $-i$ per final demand $(\mathbf{L}_t^i|_{(i,All),-i})'\mathbf{i}/(\mathbf{d}_t^{i,-i})'\mathbf{i}$ change over time since the earliest year of the data, 2000. Therefore we choose 2000 as the benchmark year.

The employment effect of aggregate final good exports is decomposed to three components as follows:

$$\mathbf{L}_{2000,t}^{(i,All),-i}|^{\text{Labor ratio}} \equiv \mathbf{\Lambda}_t(\mathbf{I} - \mathbf{A}_{2000})^{-1}\mathbf{D}_{2000}^{*(i,All),-i}, \tag{11}$$

$$\mathbf{L}_{2000,t}^{(i,All),-i}|^{\text{Input-output}} \equiv \mathbf{\Lambda}_{2000}(\mathbf{I} - \mathbf{A}_t)^{-1}\mathbf{D}_{2000}^{*(i,All),-i}, \tag{12}$$

$$\mathbf{L}_{2000,t}^{(i,All),-i}|^{\text{Sectoral composition}} \equiv \mathbf{\Lambda}_{2000}(\mathbf{I} - \mathbf{A}_{2000})^{-1}\tilde{\mathbf{D}}_t^{*(i,All),-i}. \tag{13}$$

In the first equation, only the labor-to-output ratios $\mathbf{\Lambda}_t$ are allowed to change over time while other components are fixed at the 2000 level. Estimated employment effect per exports $(\mathbf{L}_t^i|_{(i,All),-i}^{\text{Labor ratio}})'\mathbf{i}/(\mathbf{d}_t^{i,-i})'\mathbf{i}$ measures the employment effect of exports driven by a change in labor-to-gross output ratios $\mathbf{\Lambda}_t$. In the second equation, only the input-output matrix $\mathbf{A}_t$ is allowed to change over time while other components are fixed at the 2000 level. Therefore $(\mathbf{L}_t^i|_{(i,All),-i}^{\text{Input-output}})'\mathbf{i}/(\mathbf{d}_t^{i,-i})'\mathbf{i}$ quantifies the employment effect of exports driven by a change in the input-output linkages. In the last equation, we quantify the impact of a change in sectoral composition in final good exports captured in $\tilde{\mathbf{D}}_t^{*(i,All),-i}$, which fixes the total value of final good flows from a country to another but the sectoral shares are taken from current year $t$ and compute final good flows according to the sectoral share of final good flows.[22] In the last equation, the sectoral composition in final good exports captured in $\tilde{\mathbf{D}}_t^{*(i,All),-i}$ are allowed change over time while other components are fixed at the 2000 level. Overall changes in the employment effect of exports are the one allowing all of these three components to vary over time:

$$\mathbf{L}_{2000,t}^{(i,All),-i}|^{\text{Overall}} \equiv \mathbf{\Lambda}_t(\mathbf{I} - \mathbf{A}_t)^{-1}\tilde{\mathbf{D}}_t^{*(i,All),-i}. \tag{14}$$

Note that time-series changes in the employment effects (11)-(14) are not influenced by changes in prices.[23] We compute the cumulative rate of change in each component of the employment effect of aggregate final good exports per value of final good exports since year 2000.

The computed cumulative rates of change are shown in Figure 6 where panels A, B, and C present the results for the U.S., China, and Japan as an exporter, respectively. It shows that overall employment effect of exports declined by about 30% over the period 2000-2014 in the U.S. Changes in all of the three components worked to reduce the employment effect. Among the three, a decline in the labor-to-output ratio explained the largest part of the overall decline in the employment effect of exports. The declining labor shares are consistent with previous findings (e.g., Elsby, Hobijn, and Sahin, 2013). Changes in input-output linkages explain the second largest part of the overall decline in the employment effect of exports.

Panel B shows decomposition results for China as an exporter. Changes in sectoral composition in final good exports and the labor-to-output ratio worked to reduce the employment effect of exports while changes in input-output linkages increased the employment effect of exports. China's forward linkages are deepening during the period 2000-2014 and its backward linkages declining after 2005. These changes are responsible for rising employment effects of exports.[24] Because the former negative effect is greater than the positive effect of the latter, the overall employment effect of exports decreased by 60% over the period 2000-2014.

Panel C displays results for Japan. There is not clear long-run trend for Japan. The observation from 2014 shows that the overall employment effect of exports declined by 5% in Japan and changes in the labor-to-output ratio and input-output linkages are responsible for this declining employment effect of exports and there is almost no change in the employment effect due to changes in sectoral composition of exports.

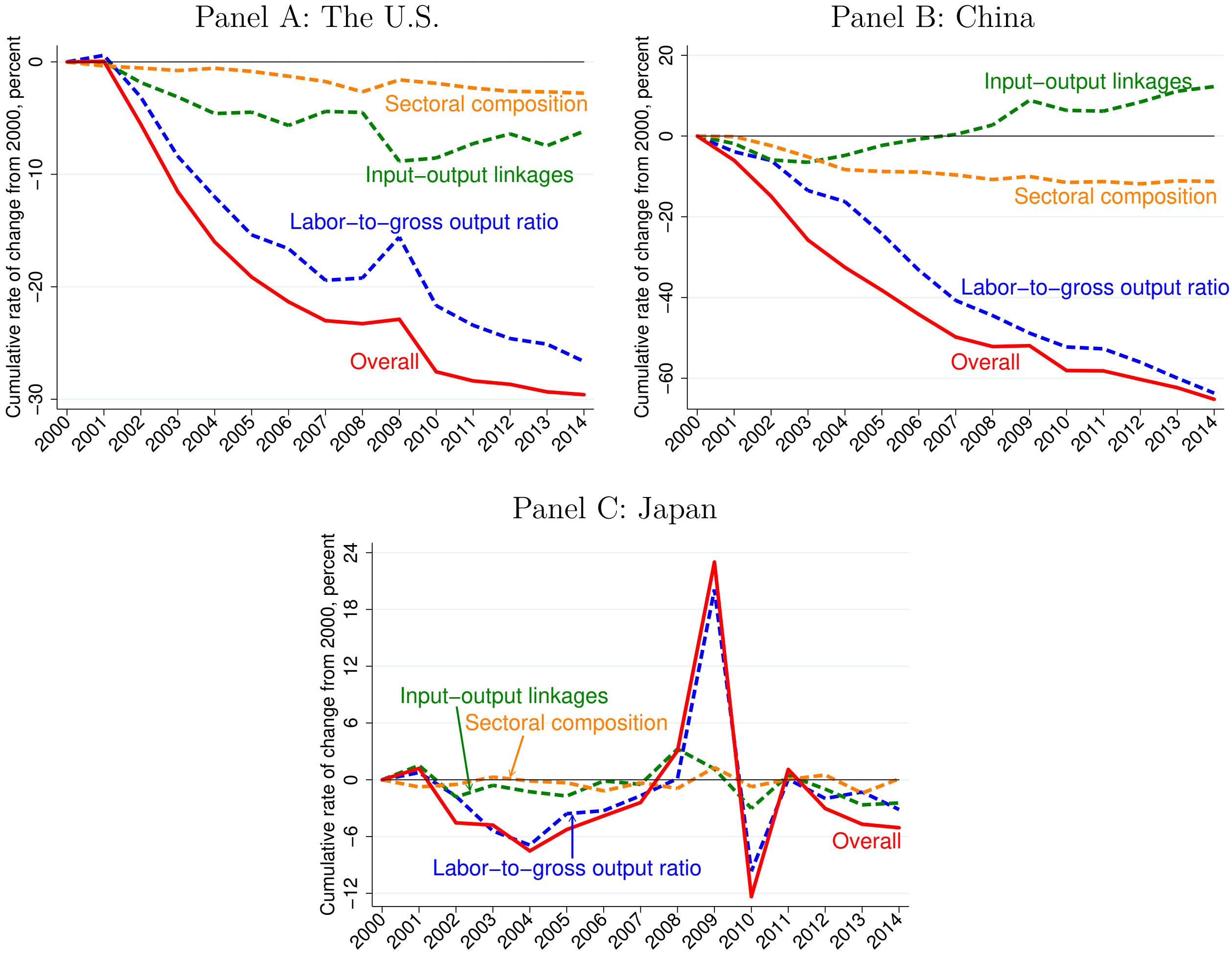
The results from input-output linkages are consistent with increasing forward linkages in China and declining forward linkages in the U.S. and Japan (see Appendix). Declining em-

[22]See Appendix for further details.

[23]Current labor-to-output ratios in $\mathbf{\Lambda}_t$ are found by using current labor force and current *real* gross output at the 2010 price. Entries in the current input-output matrix $\mathbf{A}_t$ are input-to-output ratios so these are unaffected by changes in prices. Also, we keep the total value of gross exports in $\tilde{\mathbf{D}}_t^{*(i,All),-i}$ fixed at the 2000 level and only sectoral compositions are allowed to change. As a result, time-series changes in the employment effects (11)-(14) are not influenced by changes in prices.

[24]Note that this paper estimates the number of employment generated per exports, and not the overall number of employment generated by exports as in Ito (2018). Deepening forward and backward linkages may increase the overall number of jobs, but it can have different impacts on the number of employment per exports.

Figure 6: Decomposing the Employment Effects of Exports




*Notes*: The figure shows the cumulative rate of change in the employment effect of exports estimated using (11)-(13), decomposing the employment effect of aggregate final good exports, and the overall effect (14). The sum of the three decomposed effects indicated by dashed lines does not necessarily equal the overall effect.

ployment effects of exports due to changes in sectoral composition in exports in China are presumably due to increasing manufacturing exports which contain foreign value-added. On the other hand, changes in sectoral composition in exports have a small influence on the employment effect of exports in the U.S. and Japan. Japan reacted to the Great Trade Collapse in 2008-09 by changing the labor-to-output ratio. It increased sharply in 2009 and then declined in 2010, then went back to the pre-crisis level in 2011. Input-output linkages declined slightly due to the crisis but it went back to the pre-crisis level in a few years. These observations are consistent with previous empirical research showing that Japan's trade in parts and components revived quickly after the crisis (e.g., Ando and Kimura, 2012; Okubo, Kimura, and Teshima, 2014).[25]

[25] Ando and Kimura (2012) find that trade in parts and components declined from 2007 to 2008 due to Global Financial Crisis but it quickly recovered from 2008 to 2009, suggesting the production networks in East Asia are stable. Okubo, Kimura, and Teshima (2014) also find that Japanese exports in parts and components to

# 5 Conclusions

This paper has examined the employment effect of exports by comparing employment effects generated by the same value of exports from three countries, the U.S., China, and Japan. We go beyond the existing literature by highlighting the new fact that the employment effects per exports vary greatly depending upon destination countries. The results suggest that final good exports from natural resource, some manufacturing sectors such as textile, and service sectors create more jobs per dollar. Therefore, sectoral compositions of exports explain a large part of variations in the employment effects of exports across destination countries.

The results suggest several implications. First, a recent trend in expanding GVCs across countries may work to increase or decrease the employment effect of trade because an expansion of GVCs works in different directions sometimes, depending upon how forward and backward linkages change. Second, as suggested in the literature on value added in trade (e.g., Johnson and Noguera, 2012; Johnson, 2014), gross export values are not identical to value added in trade. Therefore, policy discussions based on gross exports would lead to a misleading conclusion. The same logic applies to the employment effect of exports. A greater value of gross exports does not necessarily mean a greater employment effect. Third, as suggested in Baldwin, Ito, and Sato (2014), value-added contents in exports have implications on geographical location of 'good' jobs with higher value-added and 'bad' jobs with lower value-added. Therefore, different value-added contents in trade may have a large impact on wages.

Lastly, we once again acknowledge that the input-output analysis employed in this paper focuses on the demand-side of the labor market. In a counterfactual employment we consider a hypothetical situation that final demands from foreign countries are zero, which would affect the supply-side of the labor market therefore alter equilibrium wages and employment. Since we do not attempt to close the model and rely on the demand-side only, the employment effect of exports may be different from the one taking general equilibrium feedbacks into account as in Caliendo, Dvorkin, and Parro (2015). These considerations are left for further investigation.

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# Appendix

## A Dataset

This section summarizes details on the global input-output table from the WIOD (Timmer, Dietzenbacher, et al., 2015; Timmer et al., 2016).

### A.1 List of Countries

The list of 44 economies in the WIOD global input-output table is as follows.

> Australia (AUS), Austria (AUT), Belgium (BEL), Brazil (BRA), Bulgaria (BGR), Canada (CAN), China (CHN), Croatia (HRV), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hungary (HUN), India (IDN), Indonesia (IND), Ireland (IRL), Italy (ITA), Japan (JPN), Republic of Korea (KOR), Latvia (LVA), Lithuania (LTU), Luxembourg (LUX), Malta (MLT), Mexico (MEX), Netherlands (NLD), Norway (NOR), Poland (POL), Portugal (PRT), Romania (ROU), Russia (RUS), Slovak Republic (SVK), Slovenia (SVN), Spain (ESP), Sweden (SWE), Switzerland (CHE), Taiwan (TWN), Turkey (TUR), United Kingdom (GBR), United States (USA) and the rest of the world (ROW)

### A.2 List of WIOD Sectors

Each country in the WIOD input-output table is comprised of 56 sectors. The list of the sectors is as follows. It also shows aggregation of the 56 sectors.

Table A1: WIOD 56 Sectors

| # | WIOD Sectors | Aggregation 1 | Aggregation 2 |
|---|---|---|---|
| 1 | Crop and animal production, hunting | Natural resources | Animals, fish, and forestry |
| 2 | Forestry and logging | Natural resources | Animals, fish, and forestry |
| 3 | Fishing and aquaculture | Natural resource | Animals, fish, and forestries |
| 4 | Mining and quarrying | Natural resources | Mining and quarrying |
| 5 | Manufacture of food products | Manufacturing | Food manufacturing |
| 6 | Manufacture of textiles, wearing apparel | Manufacturing | Textile, wood, and paper |
| 7 | Manufacture of wood | Manufacturing | Textile, wood, and paper |
| 8 | Manufacture of paper and paper products | Manufacturing | Textile, wood, and paper |
| 9 | Printing and reproduction of recorded media | Manufacturing | Material manufacturing |
| 10 | Manufacture of coke and refined petroleum products | Manufacturing | Material manufacturing |
| 11 | Manufacture of chemicals and chemical products | Manufacturing | Material manufacturing |
| 12 | Manufacture of basic pharmaceutical products | Manufacturing | Material manufacturing |
| 13 | Manufacture of rubber and plastic products | Manufacturing | Material manufacturing |
| 14 | Manufacture of other non-metallic mineral products | Manufacturing | Material manufacturing |
| 15 | Manufacture of basic metals | Manufacturing | Material manufacturing |
| 16 | Manufacture of fabricated metal products | Manufacturing | Material manufacturing |
| 17 | Manufacture of computer, electronic and optical products | Manufacturing | Electronics |
| 18 | Manufacture of electrical equipment | Manufacturing | Electronics |
| 19 | Manufacture of machinery and equipment n.e.c. | Manufacturing | Electronics |
| 20 | Manufacture of motor vehicles, trailers and semi-trailers | Manufacturing | Electronics |
| 21 | Manufacture of other transport equipment | Manufacturing | Electronics |
| 22 | Manufacture of furniture; other manufacturing | Manufacturing | Electronics |

WIOD 56 Sectors, continued

| # | WIOD Sectors | Aggregation 1 | Aggregation 2 |
|---|---|---|---|
| 23 | Repair and installation of machinery and equipment | Services | Construction and infra. |
| 24 | Electricity, gas, steam and air conditioning supply | Services | Construction and infra. |
| 25 | Water collection, treatment and supply | Services | Construction and infra. |
| 26 | Sewerage; waste collection, treatment and disposal activities | Services | Construction and infra. |
| 27 | Construction | Services | Construction and infra. |
| 28 | Wholesale and retail trade and repair services | Services | Wholesale and retail |
| 29 | Wholesale trade, except of motor vehicles | Services | Wholesale and retail |
| 30 | Retail trade, except of motor vehicles | Services | Wholesale and retail |
| 31 | Land transport and transport via pipelines | Services | Transportation |
| 32 | Water transport | Services | Transportation |
| 33 | Air transport | Services | Transportation |
| 34 | Warehousing and support activities for transportation | Services | Transportation |
| 35 | Postal and courier activities | Services | Transportation |
| 36 | Accommodation and food service activities | Services | Transportation |
| 37 | Publishing activities | Services | Transportation |
| 38 | Motion picture, video and television programme production | Services | Transportation |
| 39 | Telecommunications | Services | Transportation |
| 40 | Computer programming, consultancy and related activities | Services | Transportation |
| 41 | Financial service activities | Services | Finance |
| 42 | Insurance, reinsurance and pension funding | Services | Finance |
| 43 | Activities auxiliary to financial services | Services | Finance |
| 44 | Real estate activities | Services | Professional services |
| 45 | Legal and accounting activities; activities of head offices | Services | Professional services |
| 46 | Architectural and engineering activities | Services | Professional services |
| 47 | Scientific research and development | Services | Professional services |
| 48 | Advertising and market research | Services | Professional services |
| 49 | Other professional, scientific and technical activities | Services | Professional services |
| 50 | Administrative and support service activities | Services | Professional services |
| 51 | Public administration and defence | Services | Professional services |
| 52 | Education | Services | Professional services |
| 53 | Human health and social work activities | Services | Professional services |
| 54 | Other service activities | Services | Professional services |
| 55 | Activities of households as employers | Services | Professional services |
| 56 | Activities of extraterritorial organizations and bodies | Services | Professional services |

*Notes:* Aggregation 1 is used in Tables 5, 6, 7, 8, and 10. The textile sector in Tables 8 and 10 are WIOD sector 6. Aggregation 2 is employed in Figure 2.

## A.3 List of Final Demand Categories

In the final demand matrix, each of the destination countries consist of five final demand categories:

· Final consumption expenditure by households
· Final consumption expenditure by non-profit organizations serving households (NPISH)
· Final consumption expenditure by government
· Gross fixed capital formation
· Changes in inventories and valuables

In input-output calculation, we compute the sum of these.

# B Summary Statistics

Summary statistics of the country level and the country-sector level samples are presented in Tables A2 and A3, respectively.

Table A2: Summary Statistics of the Country Level Sample

| | Obs. | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| $\ln\left(\sum_{s=1}^{N} L_t^{(i,s)}\|_{(i,All),j}\right)$ | 1,890 | 3.361 | 2.610 | -4.502 | 10.112 |
| $\ln\left(\sum_{s=1}^{N} d_t^{(i,s),j}\right)$ | 1,890 | 7.116 | 2.126 | 0 | 12.317 |
| $\ln\left(\frac{\sum_{s=1}^{N} L_t^{(i,s)}\|_{(i,All),j}}{\sum_{s=1}^{N} d_t^{(i,s),j}}\right)$ | 1,890 | 3.152 | 1.397 | 1.286 | 6.784 |
| $DVAX^T$, total | 1,890 | 0.836 | 0.057 | 0.598 | 0.961 |
| $DVAX^T$, natural resource | 1,890 | 0.053 | 0.049 | 0.003 | 0.218 |
| $DVAX^T$, manufacturing | 1,890 | 0.460 | 0.092 | 0.105 | 0.628 |
| $DVAX^T$, textile | 1,890 | 0.032 | 0.049 | 0 | 0.356 |
| $DVAX^T$, services | 1,890 | 0.323 | 0.127 | 0.167 | 0.840 |
| $DVAX^{JN}$, total | 1,890 | 0.835 | 0.062 | 0.639 | 0.968 |
| $DVAX^{JN}$, natural resource | 1,890 | 0.062 | 0.057 | 0.003 | 0.428 |
| $DVAX^{JN}$, manufacturing | 1,890 | 0.413 | 0.113 | 0.034 | 0.622 |
| $DVAX^{JN}$, textile | 1,890 | 0.024 | 0.037 | 0 | 0.316 |
| $DVAX^{JN}$, services | 1,890 | 0.360 | 0.158 | 0.169 | 0.921 |
| Forward linkages | 1,890 | 0.038 | 0.042 | 0.003 | 0.260 |
| Backward linkages | 1,890 | 0.004 | 0.007 | 0 | 0.058 |
| Resource export share | 1,890 | 0.026 | 0.051 | 0 | 0.577 |
| Manufacturing export share | 1,890 | 0.713 | 0.226 | 0.009 | 1 |
| Textile export share | 1,890 | 0.056 | 0.096 | 0 | 0.803 |
| Service export share | 1,890 | 0.205 | 0.228 | 0 | 0.982 |

*Notes:* $\ln\left(\sum_{s=1}^{S} L_t^{(i,s)}|_{(i,All),j}\right)$ denotes natural log of employment effect of country $i$'s aggregate exports to country $j$ on country $i$. $\ln\left(\sum_{s=1}^{S} d_t^{(i,s),j}\right)$ is natural log of aggregate final good exports from country $i$ to country $j$. $\ln\left(\frac{\sum_{s=1}^{N} L_t^{(i,s)}|_{(i,All),j}}{\sum_{s=1}^{N} d_t^{(i,s),j}}\right)$ denotes the employment effect of exports from country $i$ to country $j$ on country $i$ per million dollar exports. $DVAX^T$ and $DVAX^{JN}$ indicate the share of domestic contents in exports to aggregate final good exports based on Timmer et al. and Johnson-Noguera, respectively. The variable of the manufacturing export share does not include textile exports.

Table A3: Summary Statistics of the Country-Sector Level Sample

| | Sample size | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| $\ln\left(L_t^{(i,s)}\|_{(i,All),j}\right)$ | 105,840 | 0.622 | 1.071 | 0 | 8.855 |
| $\ln\left(d_t^{(i,s),j}\right)$ | 105,840 | 8.650 | 2.370 | 3.871 | 16.658 |
| $\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$ | 105,840 | 8.644 | 2.371 | 3.401 | 16.658 |
| $DVAX^T$ | 110,880 | 0.015 | 0.027 | 0 | 0.457 |
| $DVAX^{JN}$ | 110,880 | 0.015 | 0.025 | 0 | 0.518 |
| $FL^{Destination}$ | 105,840 | 0.025 | 0.066 | 0 | 2.240 |
| $FL^{Home}$ | 105,840 | 0.808 | 0.921 | 0 | 5.843 |
| $FL^{Others}$ | 105,840 | 0.025 | 0.022 | 0 | 0.231 |
| $BL^{Destination}$ | 105,840 | 0.003 | 0.009 | 0 | 0.210 |
| $BL^{Home}$ | 105,840 | 0.808 | 0.444 | 0 | 2.143 |
| $BL^{Others}$ | 105,840 | 0.003 | 0.003 | 0 | 0.016 |
| Own Linkage | 105,840 | 1.107 | 0.147 | 1 | 1.851 |
| Capital-to-output ratio | 96,390 | 0.014 | 0.019 | 0 | 0.139 |
| Labor-to-output ratio | 105,840 | 0.030 | 0.095 | 0 | 1.162 |

*Notes:* $\ln\left(L_t^{(i,s)}|_{(i,All),j}\right)$ denotes natural log of employment effect of country $i$'s aggregate exports to country $j$ on sector $s$ of country $i$. $\ln\left(d_t^{(i,s),j}\right)$ is natural log of final good exports from sector $s$ of country $i$ to country $j$. $\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$ indicates natural log of exports from all sectors besides sector$s$ of country $i$ to country $j$. $DVAX^T$ and $DVAX^{JN}$ indicate the share of domestic contents in exports to aggregate final good exports based on Timmer et al. and Johnson-Noguera, respectively.

# C Some Details on the Decomposition Exercise in Section 4

This section explains how $\tilde{\mathbf{D}}_t^{*(i,All),-i}$ is found. First, we find the sectoral share of final good exports from country $i$ to country $j$ at the current year $t$, denoted by $\boldsymbol{\rho}_t^{i,j}$:

$$\boldsymbol{\rho}_t^{i,j} = \begin{bmatrix} \rho_t^{(i,1),j} \\ \rho_t^{(i,2),j} \\ \vdots \\ \rho_t^{(i,N),j} \end{bmatrix} = \begin{bmatrix} d_t^{(i,1),j} / \sum_{s=1}^N d_t^{(i,s),j} \\ d_t^{(i,2),j} / \sum_{s=1}^N d_t^{(i,s),j} \\ \vdots \\ d_t^{(i,S),j} / \sum_{s=1}^N d_t^{(i,s),j} \end{bmatrix},$$

where $N$ is the number of sectors. $\rho_t^{(i,s),j}$ is the share of final good exports from country $i$'s sector $s$ to country $j$ in the total exports from country $i$ to country $j$. We find hypothetical final good flows in current year $t$ by using sectoral compositions from current year $t$ and total export value from 2000. This way, we keep the total export value of exports constant to the one from 2000. Therefore, final good flows from country $i$ to country $j$ are found using $\boldsymbol{\rho}_t^{i,j}$ and the total export values from country $i$ to country $j$ in 2000. The vector we want to find is:

$$\underbrace{\tilde{\mathbf{D}}_t^{*(i,All),-i}}_{(C\times N)\times 1} = \begin{bmatrix} \mathbf{0} \\ \vdots \\ \mathbf{0} \\ \sum_{k\neq i}^C \tilde{\mathbf{d}}_{2000,t}^{i,k} \\ \mathbf{0} \\ \vdots \\ \mathbf{0} \end{bmatrix} \quad \text{and} \quad \underbrace{\tilde{\mathbf{d}}_{2000,t}^{*i,j}}_{N\times 1} = \begin{bmatrix} \rho_t^{(i,1),j} \sum_{k=1}^N d_{2000}^{(i,1),j} \\ \rho_t^{(i,2),j} \sum_{k=1}^N d_{2000}^{(i,1),j} \\ \vdots \\ \rho_t^{(i,N),j} \sum_{k=1}^N d_{2000}^{(i,1),j} \end{bmatrix}.$$

# D Some Additional Analyses

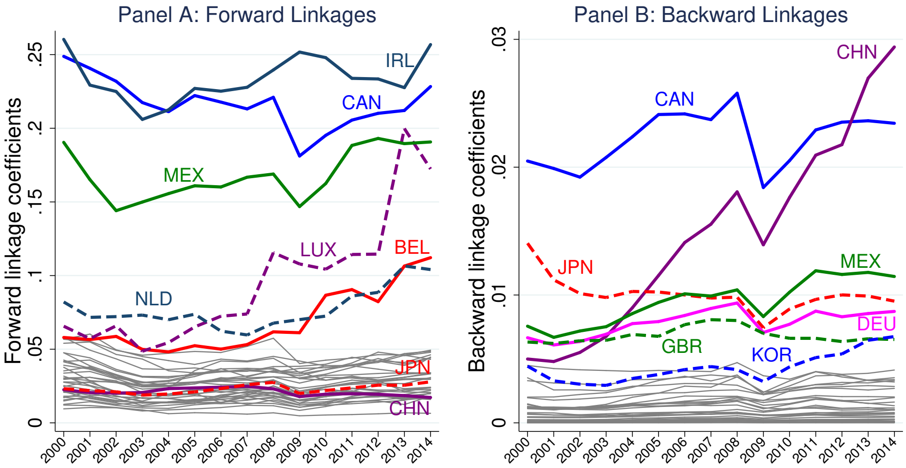
Figure A1 displays how forward and backward linkages have evolved during 2000-2014 for the U.S. (Panel I), China (Panel II), and Japan (Panel III). For the U.S., there is no clear trend in forward linkages. Forward linkages to Luxembourg, Belgium, and Netherlands are increasing after 2009 but this trend is not present with other countries. Forward linkages with most countries — shown in the bottom of Panel A — are declining during 2000-2014. Backward linkages with other countries are almost constant during the period with one exception: China. Backward linkages with China is continuously increasing over time except for the period of the 2008-09 Global Financial Crisis.

Panel II of Figure A1 describes forward and backward linkages for China. It shows that China's forward linkages with other countries are increasing over time. This is consistent with previous results documented in Kee and Tang (2016). They find that trade and FDI liberalization in China led to deeper input-output linkages and positive spillovers, which increased the number of available domestic input varieties. Contrary to forward linkages, China's backward linkages with other countries are declining after the peak around 2004. These increasing forward linkages and declining backward suggest that China has become an intermediate good supplier for countries in the world and it is moving down the global supply chains.

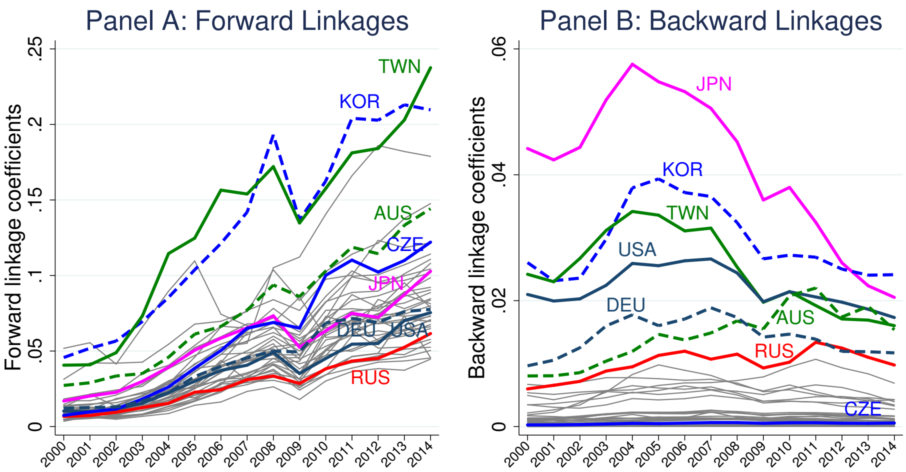
Production linkages for Japan are shown in Panel III. Forward linkages with most countries are constant over the period but those with major trading partners, Taiwan and Korea, are declining after 2011. Japan's backward linkages are slightly increasing over the period and those with China is especially skyrocketing. Overall, time-series trends in forward and backward linkages are very different across the three countries. We investigate how these trends in production linkages are associated with the employment effect of exports by running regressions.

Figure A1: Forward and Backward Linkages, 2000-2014

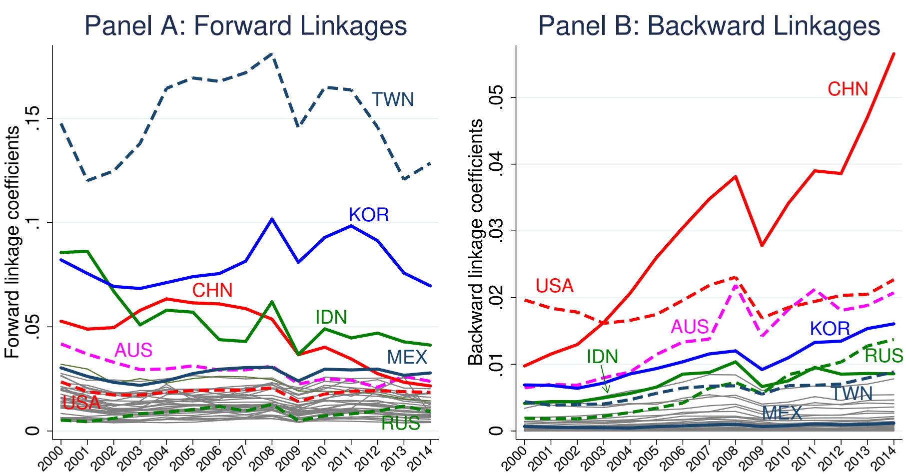
Panel I: The U.S.




Panel II: China




Panel III: Japan




*Notes*: The figure shows time-series variations in forward and backward linkages with trading partners. The forward/backward linkage measures are based on Rasmussen (1956).