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

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July 18, 2018

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. We find the first channel worked to reduce the employment effect in all of the three countries we focused but a direction of the last two channels is different across the countries.

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

*The author would like to thank Robert C. Feenstra for his comments and suggestions. Thanks are also given to Jota Ishikawa. All errors are mine.

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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, 2017, 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. The question we ask is if the size of employment generated by exports can be described by a one-to-one mapping from the size of exports. If yes, we do not necessarily have to use an input-output analysis to find employment effects of exports and we just need to look at the size of exports.

The answer we find from our analysis is that the employment effect of exports is not just the size of exports and the employment effect per exports vary substantially across destination countries. Then we further ask why some countries create more jobs per exports than others do. We find that service exports and agricultural exports lead to more jobs per dollar than manufacturing exports. This result is consistent with the recent literature on value added in trade, finding that there is 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 vary 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 on average.

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 is increasing over the period 2000-2014 while those are declining in the U.S. and Japan. There are several explanations for this. First, 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). Second, results from a regression analysis show that rising shares of natural resource, textile, and service exports are responsible for increasing employment effects of exports because these sectors have greater domestic value-added contents of exports as shown in Koopman, Z. Wang, and Wei (2012) and Ma, Z. Wang, and Zhu (2015).

Another unique aspect of China is that its forward linkages with other countries are increasing over the period 2000-2014 and backward linkages are declining, where these trends are not present in the U.S. and Japan. We also aim to understand how forward and backward linkages with other countries affect the employment effect of exports by distinguishing linkages with destination and all other countries as well as high-income and low-income countries. Results suggests that the impact of international production linkages on the employment effect of exports is much more complicated than implications from sectoral compositions of exports. The impact of 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]

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, 2017, 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 (2017), and Kiyota (2016) because we also use an input-output analysis. We go beyond the literature by highlighting the fact that the employment effect per exports vary 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 contents affect the employment effect of exports. Existence of GVCs must have a significant implication on various economic indicators in this integrated world (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).[2] 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

[1] Feng, Li, and Swenson (2016) shows that an increase in intermediate good imports increased exports from China because imported intermediate 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] 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.

(Baldwin, Ito, and Sato, 2014). This paper considers an implication of value added content of trade from a different angle. The question we ask is whether GVCs and value-added contents of trade affect the employment creation effect of exports from a country. In terms of focus, this paper is most closely related with 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. This paper finds that domestic value-added contents of exports have striking impacts on employment effects of exports through sectoral compositions in exports and through forward and backward linkages.

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 to find the employment effect, 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 (2017) 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 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 the two countries 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 the matrix notations and explanations. 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 × two sector input-output table. The 4×4 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 same sector and purchased by country 2. Using these, we can 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, $y_t^{j,r} = \sum_{s=1}^{N}\sum_{i=1}^{C} m_t^{(j,r),(i,s)} + \sum_{i=1}^{C} d_t^{(j,r),i}$.

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 that final demand is estimated as[3]

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

where

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

and $\mathbf{\Lambda}_t$ is a $(C \times N) \times (C \times N)$ matrix with 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

[3]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 was 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 (2017) for further clarification.

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. Superscripts $(1, All), 2$ indicate that this computation leads to the employment effect 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.[4]

A greater final demand implies a greater employment effect. A question we would like to ask is whether this employment effect is merely another measure of size of final demand. Therefore, we find 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 analysis in the previous section makes it possible to see 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:

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

[4]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 (2017) consider the employment impact of gross exports from the U.S. to foreign countries.

where

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

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 look 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 1 trillion, 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 vary substantially across destination countries. For example, million dollar exports to Netherlands create 7.69 jobs while the same value of exports to France lead to only 6.16 jobs. 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.[5]

However, this trend 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. The result 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 the U.S. 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 the top 10 countries.[6] 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. Contrary 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, there should be some merchandise sectors that create more

[5]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.

[6]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 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) (1)	Final good demand (million USD) (2)	Employment effect per million USD (jobs) (3)	Employment effect (thousand jobs) (4)	Final good demand (million USD) (5)	Employment effect per million USD (jobs) (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 $\sum_{s=1}^{56} L_t^{(US,s),j}|_{(US,All),j}$ and $\sum_{s=1}^{56} d_t^{(US,s),j}$, respectively, for each of top 10 contributors j. Column (3) shows $\sum_{s=1}^{56} L_t^{(US,s),j}|_{(US,All),j} / \sum_{s=1}^{56} d_t^{(US,s),j}$. Columns (4) and (5) report $\sum_{s=1}^{22} L_t^{(US,s),j}|_{(US,\text{Merchandise}),j}$ and $\sum_{s=1}^{22} d_t^{(US,s),j}$, respectively. Column (6) displays $\sum_{s=1}^{22} L_t^{(US,s),j}|_{(US,\text{Merchandise}),j} / \sum_{s=1}^{22} d_t^{(US,s),j}$. The ten countries are shown in descending order based on the aggregate employment effect reported in column (1). The share of employment effects (or final demand) to the overall value are in parentheses.

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 59 thousand, 45 thousand, and 9 thousand jobs, respectively. In terms of the number of jobs per million dollar final demand, Taiwan has the 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

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 China in 2014. Columns (1) and (2) report $\sum_{s=1}^{56} L_t^{(US,s),j}|_{(CHN,All),j}$ and $\sum_{s=1}^{56} d_t^{(CHN,s),j}$, for each of top 10 contributors j. Column (3) shows $\sum_{s=1}^{56} L_t^{(CHN,s),j}|_{(CHN,All),j} / \sum_{s=1}^{56} d_t^{(CHN,s),j}$. Columns (4) and (5) report $\sum_{s=1}^{22} L_t^{(CHN,s),j}|_{(US,\text{Merchandise}),j}$ and $\sum_{s=1}^{22} d_t^{(CHN,s),j}$, respectively. Column (6) displays $\sum_{s=1}^{22} L_t^{(CHN,s),j}|_{(US,\text{Merchandise}),j} / \sum_{s=1}^{22} d_t^{(CHN,s),j}$. The ten countries are shown in descending order based on the aggregate employment effect reported in column (1). The share of employment effects (or final demand) to the overall value are in parentheses.

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

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

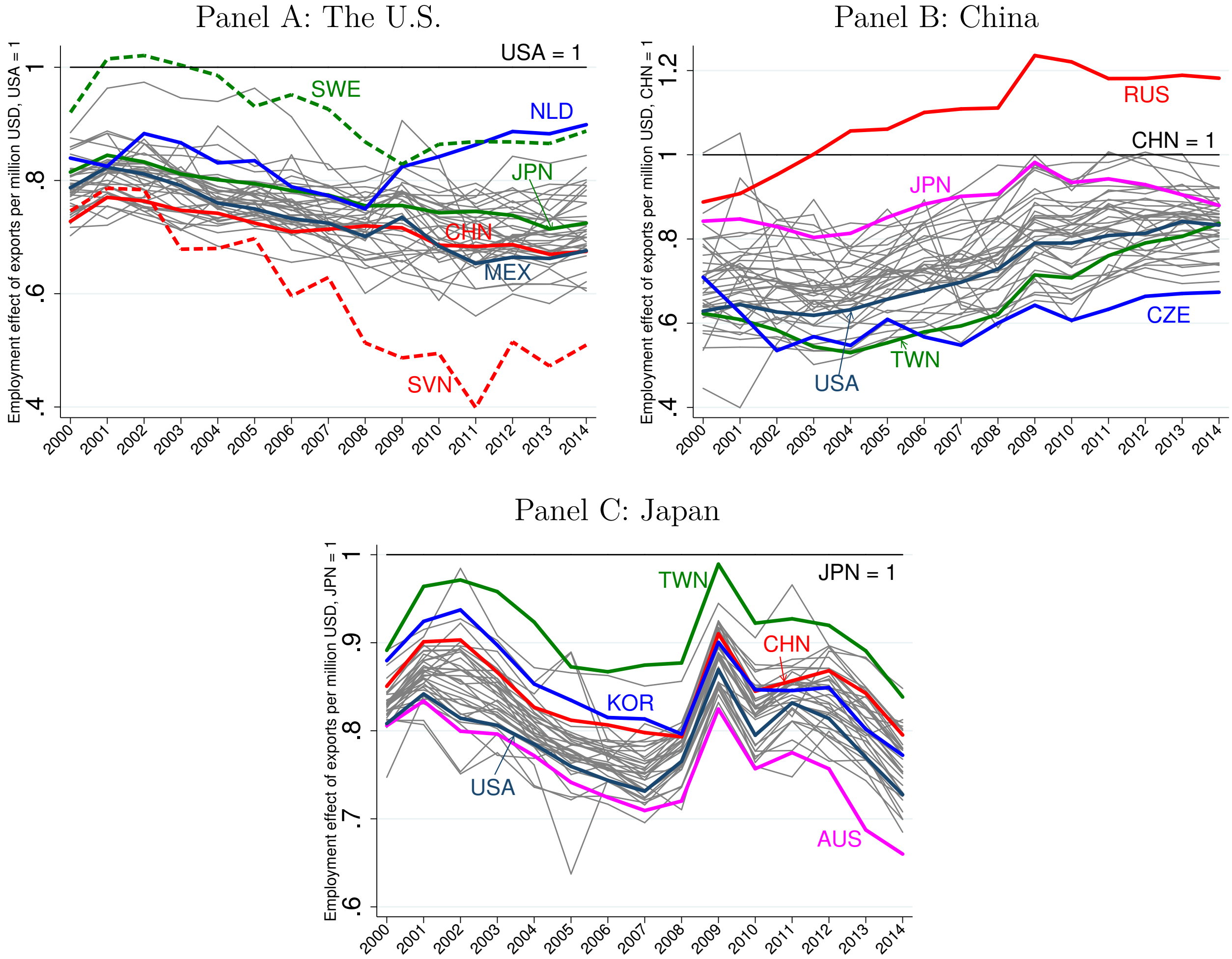
		Final demand to all sectors			Final demand to merchandise sectors		
		Employment effect (thousand jobs)	Final good demand (million USD)	Employment effect per million USD (jobs)	Employment effect (thousand jobs)	Final good demand (million USD)	Employment effect per million USD (jobs)
		(1)	(2)	(3)	(4)	(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 Japan in 2014. Columns (1) and (2) report $\sum_{s=1}^{56} L_t^{(US,s),j}|_{(US,All),j}$ and $\sum_{s=1}^{56} d_t^{(JPN,s),j}$, for each of top 10 contributors j. Column (3) shows $\sum_{s=1}^{56} L_t^{(JPN,s),j}|_{(JPN,All),j} / \sum_{s=1}^{56} d_t^{(JPN,s),j}$. Columns (4) and (5) report $\sum_{s=1}^{22} L_t^{(JPN,s),j}|_{(US,\text{Merchandise}),j}$ and $\sum_{s=1}^{22} d_t^{(JPN,s),j}$, respectively. Column (6) displays $\sum_{s=1}^{22} L_t^{(JPN,s),j}|_{(JPN,\text{Merchandise}),j} / \sum_{s=1}^{22} d_t^{(JPN,s),j}$. The ten countries are shown in descending order based on the aggregate employment effect reported in column (1). The share of employment effects (or final demand) to the overall value are in parentheses.

of final demand from the U.S., China, and Japan are normalized as one in Panels A, B, and C, respectively.

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 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 relative to the U.S. This upward trend in the foreign employment effects is probably driven by a rise in domestic value added in China's exports as documented in previous studies (e.g., Kee and Tang, 2016;

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



Notes: The figure displays the employment effect of aggregate final demand per value of final demand on the U.S., $\sum_{s=1}^{N} L_t^{(US,s),j}|_{(US,All),j} / \sum_{s=1}^{N} d_t^{(US,s),j}$ relative to that due to U.S. final demand $\sum_{s=1}^{N} L_t^{(US,s),US}|_{(US,All),US} / \sum_{s=1}^{N} d_t^{(US,s),US}$ for Panel A. Panels B and C show the ones for China and Japan, respectively.

Xikang et al., 2012).

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 now 20% in 2014. 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 shows results from Japan. It shows 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 — there is a temporary hike in the foreign employment effects in 2009.[7]

[7]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. Second,

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 some differences between the employment effects of domestic and foreign final demands. The input-output table from the WIOD has 56 sectors but we aggregate the 56 sectors to three broad sectors, the natural resource (sectors 1-4) the manufacturing sector (sectors 5-22) and the service sector (sectors 23-56).[8]

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 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.[9] 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 not very different 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,

probably there was a disproportional decline in exports from sectors with greater value added content.

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

[9]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 6: The Impact of Final Demand on China'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	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, $\sum_{s=1}^{3} \text{Col}(4)_s \times \text{Col}(6)_s = 76.56$						

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	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, $\sum_{s=1}^{3} \text{Col}(4)_s \times \text{Col}(6)_s = 64.81$						

Notes: See the notes on Figure 5.

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: See the notes on Figure 5.

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 sectors have greater domestic value added contents (e.g., Johnson and Noguera, 2012; Johnson, 2014), which leads to a greater employment creation effect there, differences in sectoral composition of final demand are responsible for the gap between domestic and foreign employment effects.

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 partly 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.[10] 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 big difference in the employment effects in the manufacturing and the service sector across domestic and foreign final demands. However, there is a large gap 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 estimates domestic value-added contents in exports and show that the employment effect of exports is associated with the domestic value-added contents in exports. We follow literature in estimating value-added contents in exports 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

[10]This is because China's domestic demand is concentrated in labor-intensive less non-tradable natural resource sectors such as mining.

[11]See Johnson (2017) for a summary of various approaches estimating value-added contents in final good or gross exports using a global input-output table. We follow the summary in the paper.

[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.

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. 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 final good exports is

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

It also leads to foreign value-added contents embodied in aggregate exports from country 1 to country 2: $vaxT_t^{2,M}|_{(1,All),2} + vaxT_t^{2,S}|_{(1,All),2}$. Johnson (2017) calls this a decomposition of GVC income. We refer to equation (4) as the domestic value-added contents based on Timmer et al. and notation $vaxT$ stands for value-added in exports based on Timmer et al.

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 contents in gross 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

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

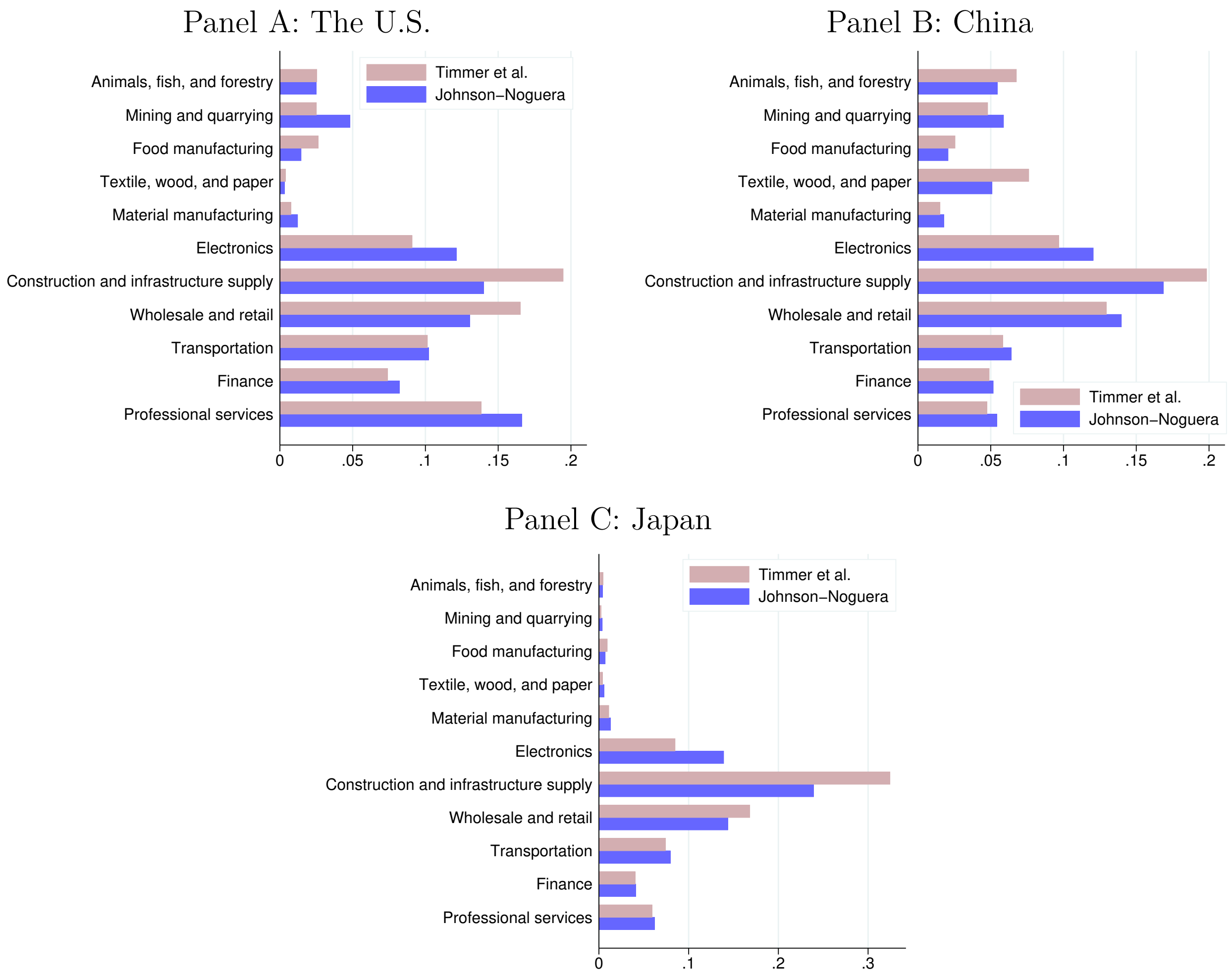
As in the previous measure, estimated value-added contents in the left hand side include domestic and foreign value-added contents. For example, $vaxJN_t^{1,M}|_{(1,All),2}$ is value-added from country 1's manufacturing sector required to produce gross exports from country 1 to country 2. Overall domestic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

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

We refer to equation (6) as the domestic value-added contents based on Johnson-Noguera and notation $vaxJN$ stands for value-added in exports based on Johnson-Noguera.

Figure 2 shows sectoral composition of domestic value-added contents in aggregate exports from each of 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

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



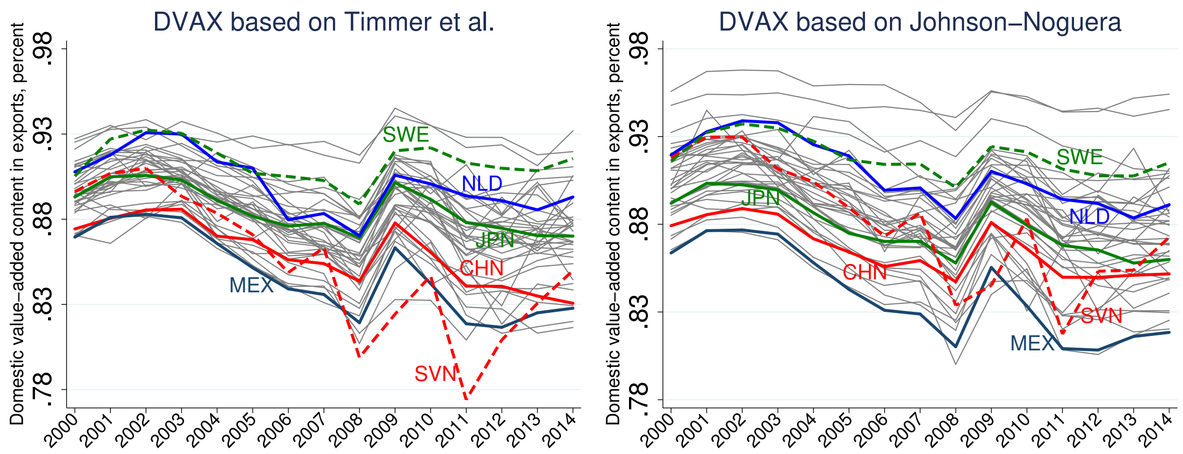
Notes: The figure shows sectoral composition of domestic value-added contents in a country's aggregate exports to all foreign countries in 2014. WIOD 56 sectors are aggregated to eleven major sectors. See Appendix for aggregation of sectors.

as construction and infrastructure supply and wholesale and retail services have higher value-added contents in all these 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 very 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

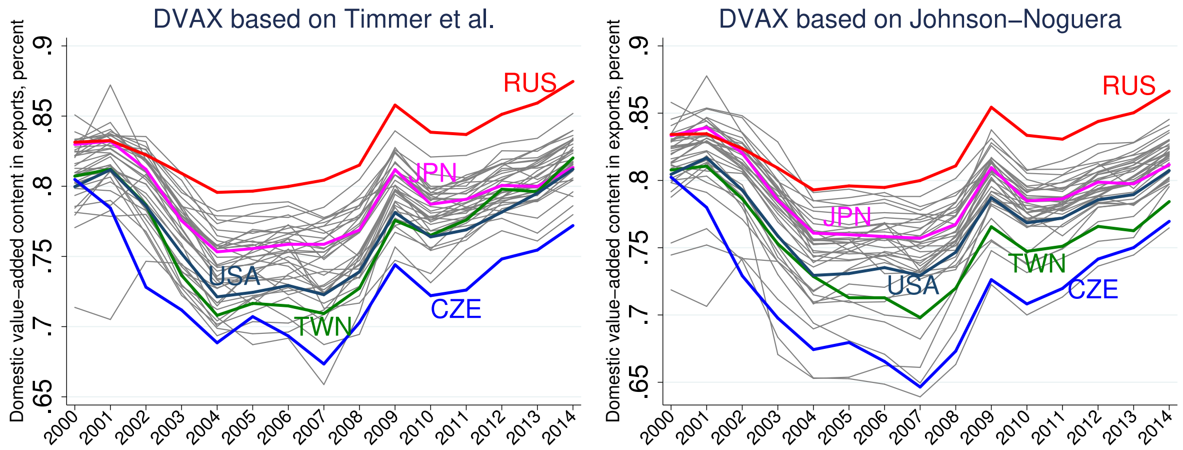
[13] Baldwin, Forslid, and Ito (2015) highlight contribution of service sectors in providing value-added in exports from Asian countries. They find that transport, wholesale and retail services are particularly contributing in adding value-added in exports.

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

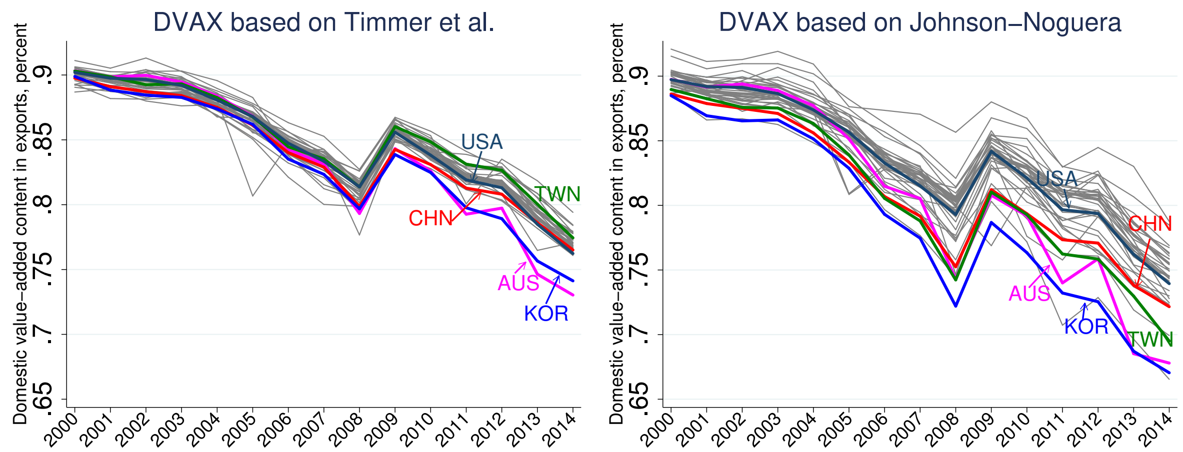
Panel A: The U.S.



Panel B: China

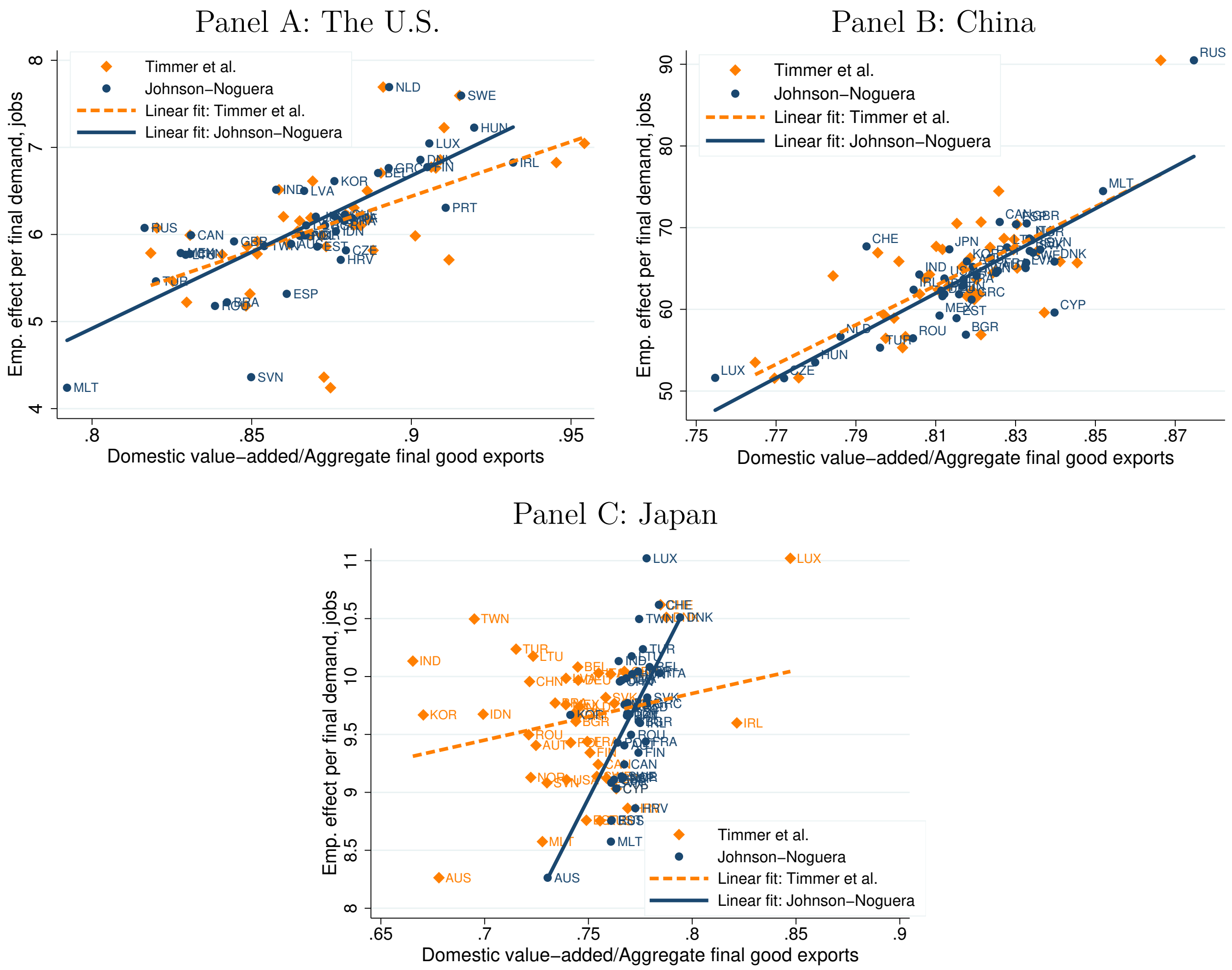


Panel C: Japan



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 exports using cross-sectional country-level observations from 2014.

domestic value-added contents across sectors within a country.

While Figure 2 displays a snapshot of sectoral composition of domestic value-added in 2014, 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 but it is almost flat after 2011. In China, domestic value-added content was 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

[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.

was the highest among the three countries in the beginning of 2000's, accounted for 90% of exports, but it is rapidly declining during the period 2000-2014. 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 now almost 70-80% in 2014, which is the lowest figure among the three countries. The long-run trends in domestic value-added shown in Figure 3 are similar to those in Figure 1.

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 and intermediate good exports are very different for Japan.[15]

To summarize, Figure 2 shows that domestic value-added contents vary substantially 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 estimate regressions and examine the relationships statistically.

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 $i = USA$, CHN, and JPN, where $\alpha^{i,j}$ indicates destination country fixed effects controlling for all time-invariant factors in each cross-sectional observation; α_t denotes year fixed effects controlling for macroeconomic shocks; $\epsilon_t^{i,j}$ is the error term; and $\alpha^1 - \alpha^5$ are parameters to be estimated.

Country-sector level regressions: Because the data are available at the country-sector level, we also estimate 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

[15] 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.

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. As a result, the regression equation is:

$$\ln\left(L_t^{(i,s)}|_{(i,All),j}\right) = \beta^{(i,s),j} + \beta_t + \beta_0 \ln\left(d_t^{(i,s),j}\right) + \beta_1 \ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right) + \mathbf{X}_t^{DVAX\prime}\boldsymbol{\beta}_3 + e_t^{(i,s),j}, \quad (8)$$

for $i = USA$, CHN, and JPN, where $\beta^{(i,s),j}$ are source sector-destination country fixed effects; β_t denotes year fixed effects controlling for macroeconomic shocks including changes in price levels; and $e_t^{(i,s),j}$ is the error term; β_0, β_1, and $\boldsymbol{\beta}_3$ are (scalar and vectors of) coefficients to be estimated.

Table 8 reports results from estimating equation (7) where regressions in Panels A and B use the $DVAX$ variable based on Timmer et al. and Johnson-Noguera, respectively. The results are very 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 $DVAX$ share 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 contents 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 now the unit of observations is source sector-destination country, we are unable to include separate sectoral value-added variables. Estimated coefficients quantify the relationship between the employment effect driven by a country's aggregate exports in each sector in the exporting country and the domestic value-added in that same sector. The result shows that sectors with greater domestic value-added contents tend to be more positively affected by a country's aggregate exports. According to regressions using the $DVAX$ measure based on Timmer et al. 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 the $DVAX$ measure based on Johnson-Noguera. These suggest that a 1% increase in the share of domestic 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 checking time-series

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)
$DVAX$ share	3.839***		5.269***		2.019***	
	(0.903)		(0.633)		(0.349)	
$DVAX$ share, natural resource		2.206**		4.494***		4.128***
		(0.821)		(0.504)		(0.940)
$DVAX$ share, manufacturing		2.952***		1.443***		1.322***
		(0.764)		(0.495)		(0.289)
$DVAX$ share, textile		1.343		1.397***		3.177**
		(2.048)		(0.242)		(1.340)
$DVAX$ share, 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)
$DVAX$ share	3.380**		2.967***		0.540**	
	(1.454)		(0.439)		(0.229)	
$DVAX$ share, natural resource		2.884**		2.441***		3.832***
		(1.386)		(0.612)		(0.838)
$DVAX$ share, manufacturing		3.094**		0.649		0.401*
		(1.466)		(0.773)		(0.212)
$DVAX$ share, textile		-0.912		2.142***		0.851***
		(2.812)		(0.404)		(0.307)
$DVAX$ share, 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-sector level, are in rounded parentheses. The sample period is 2000-2014. All regressions include a constant term, destination country fixed effect, and year fixed effects. $DVAX$ share is the share of domestic value-added contents to aggregate final good exports. For example, if $DVAX$ share takes a value of 0.20, it means that domestic value-added contents account for 20% of aggregate final good exports.

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 very surprising to see the positive association because these two are estimated using similar input-output methods. We further attempt to understand how the employment effect of exports is determined by using sectoral composition in exports and backward/forward linkages as explanatory variables.

Sectoral export shares are simply calculated as aggregate sectoral export shares from sector

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)
$DVAX$ share, Timmer et al.	1.199***		5.114***		0.914***	
	(0.251)		(0.833)		(0.259)	
$DVAX$ share, Johnson-Noguera		2.158***		7.740***		1.495***
		(0.266)		(0.627)		(0.236)
Constant	-0.341***	-0.367***	-0.826***	-0.875***	-0.548***	-0.558***
	(0.037)	(0.037)	(0.104)	(0.101)	(0.048)	(0.048)
Destination country fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
R-squared	0.285	0.314	0.417	0.434	0.218	0.230
# of cross-sectional observations	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 rounded parentheses. The sample period is 2000-2014. All regressions include a constant term, destination country fixed effect, and year fixed effects. $DVAX$ share is the share of domestic value-added contents to aggregate final good exports. For example, if $DVAX$ share takes a value of 0.20, it means that domestic value-added contents account for 20% of aggregate final good exports.

s of country i to country j:

$$\begin{aligned} EX(Res)_t^{i,j} &\equiv x_t^{(i,\text{Resource}),j} / \sum_{s=1}^{N} x_t^{(i,s),j}, \\ EX(Tex)_t^{i,j} &\equiv x_t^{(i,\text{Textile}),j} / \sum_{s=1}^{N} x_t^{(i,s),j}, \\ EX(Ser)_t^{i,j} &\equiv x_t^{(i,\text{Service}),j} / \sum_{s=1}^{N} x_t^{(i,s),j}, \end{aligned}$$

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.[16] 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

[16]The share of exports from other manufacturing sectors as a whole 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 sectoral 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:[17]

$$\begin{aligned} \ln\left(\frac{\sum_{s=1}^{N} L_t^{(i,s),j}|_{(i,All),j}}{\sum_{s=1}^{N} d_t^{(i,s),j}}\right) &= \gamma^{i,j} + \gamma_t + \gamma^1 FL_t^{i,j} + \gamma^2 BL_t^{i,j} \\ &\quad + \gamma^3 EX(Res)_t^{i,j} \gamma^4 EX(Tex)_t^{i,j} + \gamma^5 EX(Ser)_t^{i,j} + u_t^{i,j}, \end{aligned} \tag{9}$$

where $\gamma^{i,j}$ indicates destination country fixed effects; γ_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 i of the three exporters. 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.[18]

[17] We also estimate a similar regression using country-sector level data. See Appendix for our regression model and estimation results.

[18] 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, $FL_t^{i,j}$	2.048*	1.984*	-0.770	-0.736	0.242	0.246
	(1.163)	(1.124)	(0.616)	(0.633)	(0.303)	(0.440)
	[0.085]	[0.083]	[-0.032]	[-0.031]	[0.010]	[0.010]
Backward linkages, $BL_t^{i,j}$	1.134	5.392	0.504	0.267	-1.267	-5.379***
	(2.164)	(7.480)	(2.335)	(2.422)	(1.233)	(1.116)
	[0.008]	[0.038]	[0.004]	[0.002]	[-0.009]	[-0.038]
Resource export share, $EX(Res)_t^{i,j}$	0.231*	0.240*	0.459**	0.461*	0.042	0.040
	(0.122)	(0.125)	(0.222)	(0.228)	(0.033)	(0.029)
Textile export share, $EX(Tex)_t^{i,j}$	0.937*	0.915	0.545***	0.556***	0.052***	0.062***
	(0.513)	(0.548)	(0.070)	(0.073)	(0.013)	(0.016)
Service export share, $EX(Ser)_t^{i,j}$	0.266**	0.281**	0.584***	0.581***	0.064*	0.060*
	(0.109)	(0.112)	(0.180)	(0.182)	(0.036)	(0.035)
Destination country fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
# of observations	630	600	630	615	630	585
R-squared	0.930	0.930	0.983	0.983	0.961	0.963
F-stat.	1.43	1.53	19.08	19.11	3.82	7.12
p-val. (F-stat.)	0.2331	0.2024	0.000	0.000	0.006	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-sector 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 panel regressions. 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. Sectoral export shares have much more explanatory powers. 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 resource export share raises the employment effect by 0.24% and the same increase in the service export share increases it by 0.28%. The textile share also has a significant coefficient in column (1) but it turns to be insignificant after dropping outliers. Column (4) shows that greater resource, textile, and service exports are related with more employment effects in China. The magnitudes are greater than those for the U.S. — a 1% point increase in the resource export share, the textile share, and the service share raises the employment effect by 0.45%, 0.55%, and 0.58%, 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).[19] Xikang et al. (2012) estimate domestic value added contents in Chinese exports and show that, using the 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 much smaller compared with China.

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 coming from a change 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:

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

where

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

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 the one representing final good flows from country i are zero matrices $\mathbf{0}$ and final good flows from country i to all other countries besides

[19] Koopman, Z. Wang, and Wei (2012) finds 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 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.

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:

$$\left[\begin{array}{cccc} \mathbf{L}_t^1|_{(i,All),-i} & \mathbf{L}_t^2|_{(i,All),-i} & \dots & \mathbf{L}_t^C|_{(i,All),-i} \end{array} \right]',$$

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 are interested in 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:

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

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

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

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.[20] In that 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:

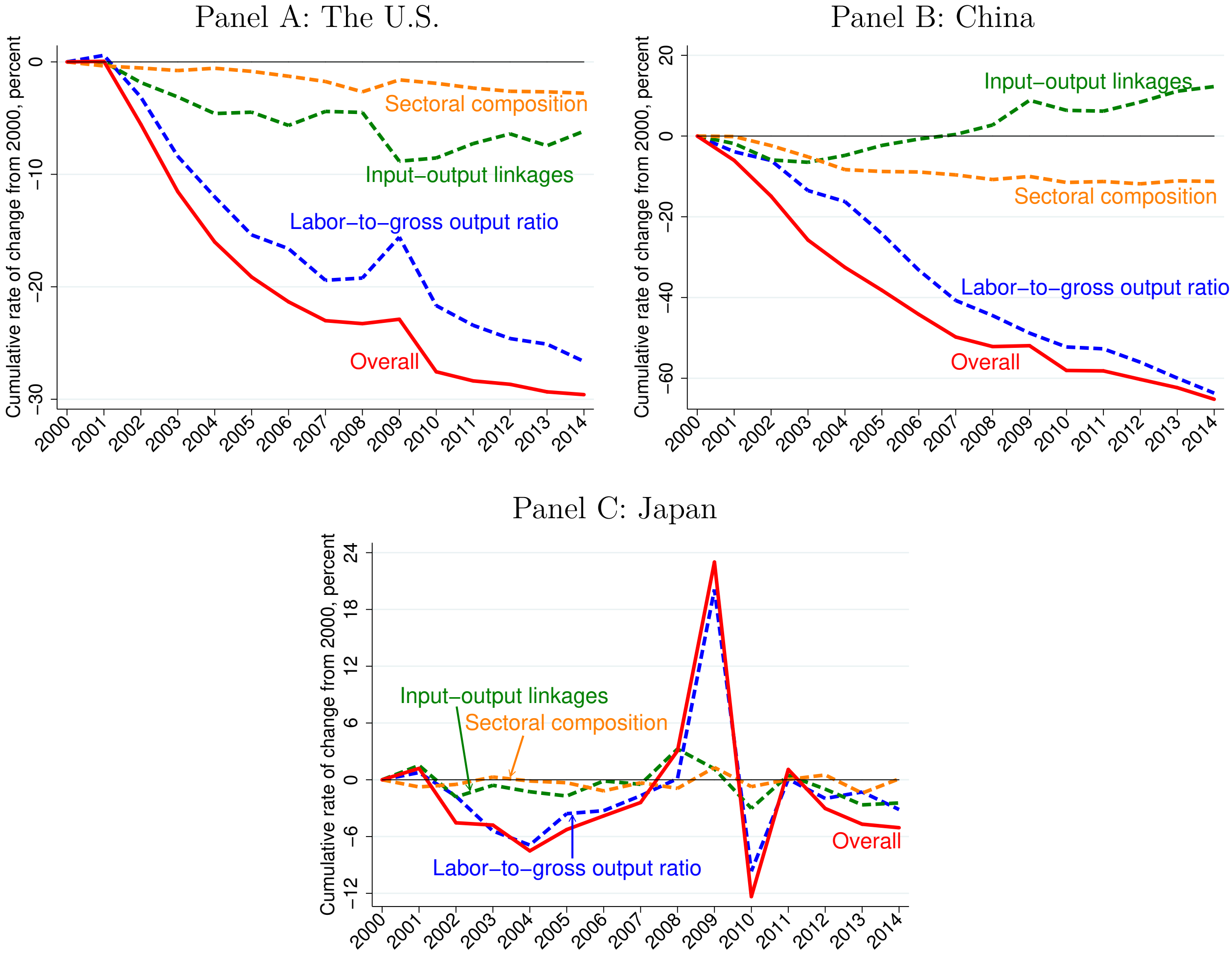
$$\mathbf{L}_{2000,t}^{(i,All),-i}|^{\text{Overall}} = \mathbf{\Lambda}_t(\mathbf{I} - \mathbf{A}_t)^{-1}\tilde{\mathbf{D}}_t^{*(i,All),-i}. \tag{14}$$

Note that time-series changes in the employment effects (11)-(14) are not influenced by changes in prices.[21]

[20] See Appendix for further details.

[21] 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

Figure 5: 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 to the overall effect.

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 5 where panels A, B, and C show 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. This is consistent with increasing

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.

backward linkages of the U.S. with other countries.

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. 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. Declining employment effects of exports due to changes in sectoral composition in exports in China are due to increasing manufacturing exports which contain foreign value-added. On the other hand, changes in sectoral composition in exports have almost no 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. This is 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).[22]

5 Conclusions

This paper has examined the employment effect of exports by comparing employment effects generated by the same value of exports from various countries. 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.

Our analyses suggest several implications. First, a recent trend in expanding vertical linkages 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

[22] 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 Asian countries were less likely to be affected by the Great Trade Collapse and also declines in those exports were more likely to be revived after the crisis.

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. 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.

A.4 List of High-income and Low-income Countries

In the regression analysis using the country-sector level data, the sample of countries is divided into two groups, high-income countries and low-income countries, based on the data on GDP per capita in 2000 obtained from the Penn World Table 9.0 (Feenstra, Inklaar, and Timmer, 2015). The list of high-income countries (above median) is as follows:

> Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Luxembourg, Malta, Netherlands, Norway, Spain, Sweden, Switzerland, Taiwan, the United Kingdom, and the United States

The list of low-income countries (below median) is as follows:

> Brazil, Bulgaria, China, Croatia, Czech Republic, Estonia, Greece, Hungary, India, Indonesia, Rep. of Korea, Latvia, Lithuania, Mexico, Poland, Portugal, Romania, Russian Federation, Slovak Republic, Slovenia, and Turkey

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	0.049	0.087	0	0.786
Textile export share	1,890	0.103	0.160	0	1.115
Service export share	1,890	0.402	0.410	0	1.943

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.

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

	Sample size	Mean	Std. Dev.	Minimum	Maximum
$\ln\left(L_t^{(i,s)}\vert_{(i,All),j}\right)$	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
$FL^{High-income}$	105,840	0.030	0.025	0	0.179
$FL^{Low-income}$	105,840	0.020	0.021	0	0.286
$BL^{High-income}$	105,840	0.004	0.003	0	0.022
$BL^{Low-income}$	105,840	0.003	0.002	0	0.015
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: $\ln\left(L_t^{(i,s)}\vert_{(i,All),j}\right)$ 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. We first 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 would like to find hypothetical final good flows in current year t by taking sectoral compositions from current year t and total export value from 2000 because we want to keep the total export value constant 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

Results from the main text show that the employment effect per final demand differ across destination countries and source sectors. Furthermore, there are substantial inter-sectoral linkages, especially from the manufacturing to the service sector, and from the natural resource sector to the service sector. Guided by these results, this section investigates the determinants of the employment effect of exports by focusing on sectoral share of final demands and by using a number of variables capturing forward and backward linkages.

D.1 Simple Observations from Data

This section looks at cross-sectional relationships between our dependent variable — the employment effect of foreign final demand (relative to the one due to domestic final demand) — and various variables expected to have a correlation with the dependent variable using the data from the latest year 2014.

Panel I of Figure A1 shows scatter plots from the U.S. as an exporter. Forward linkages and the service export share have positive slope and other variables have negative slopes. Among these, the service export share reported in Panel E seems to have the best fit. This is consistent with empirical observations from Johnson and Noguera (2012) that service sectors have greater value added content in the U.S. As a result, greater exports from the service sectors are associated with greater employment effects.

Scatter plots from China are shown in Panel II of Figure A1. Contrary to the case from the U.S., the service sector share does not seem to be related with the employment effects of exports but there is a striking positive relationship between the textile export share and the employment effect of exports (see Panel E). The backward linkage measure and the agriculture share also seem to be positive related with the employment effect but the correlations are not very strong (see Panels B and C).

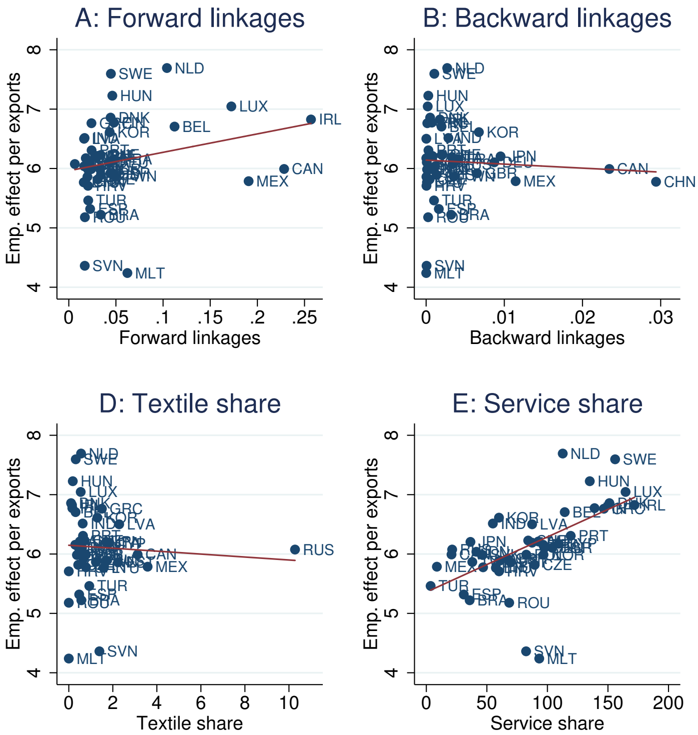
Panel III shows scatter plots from Japan as an exporter. The agricultural export share and the service export share are positively related (see Panels C and E). The forward linkage also has a positive slope but it is probably due to Taiwan, which might be considered as an outlier. Based on these scatter plots, China and Russia are considered as outliers for the U.S., Russia is an outlier for China, and China, Taiwan, and Latvia are outliers for Japan. These are omitted from regressions for robustness checks.

Figure A2 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 A2 describes forward and backward linkages for China. It shows that China's

Figure A1: Explaining the Employment Effect of Exports, 2014

Panel I: The U.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.

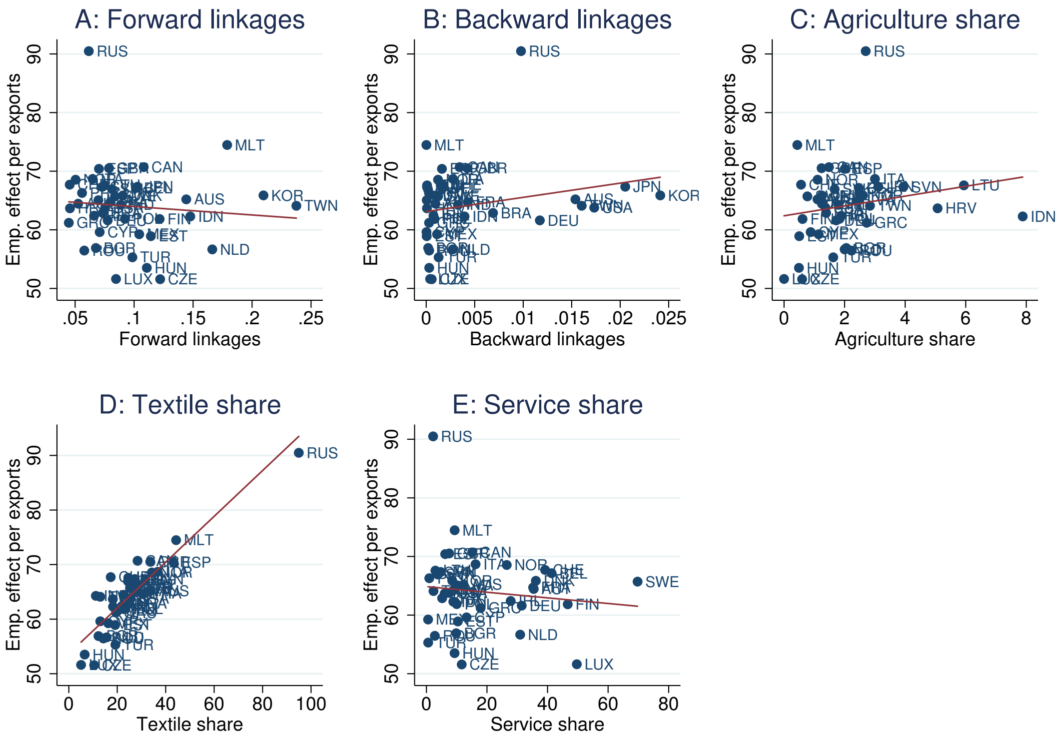
Production linkages for Japan are shown in Panel III. Forward linkages with most countries are constant over the period but those with major trading partners, Taiwan and Korea, are declining after 2011. Japan's backward linkages are slightly increasing over the period and those with China is especially 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.

D.2 Regressions with Country-Sector Level Data

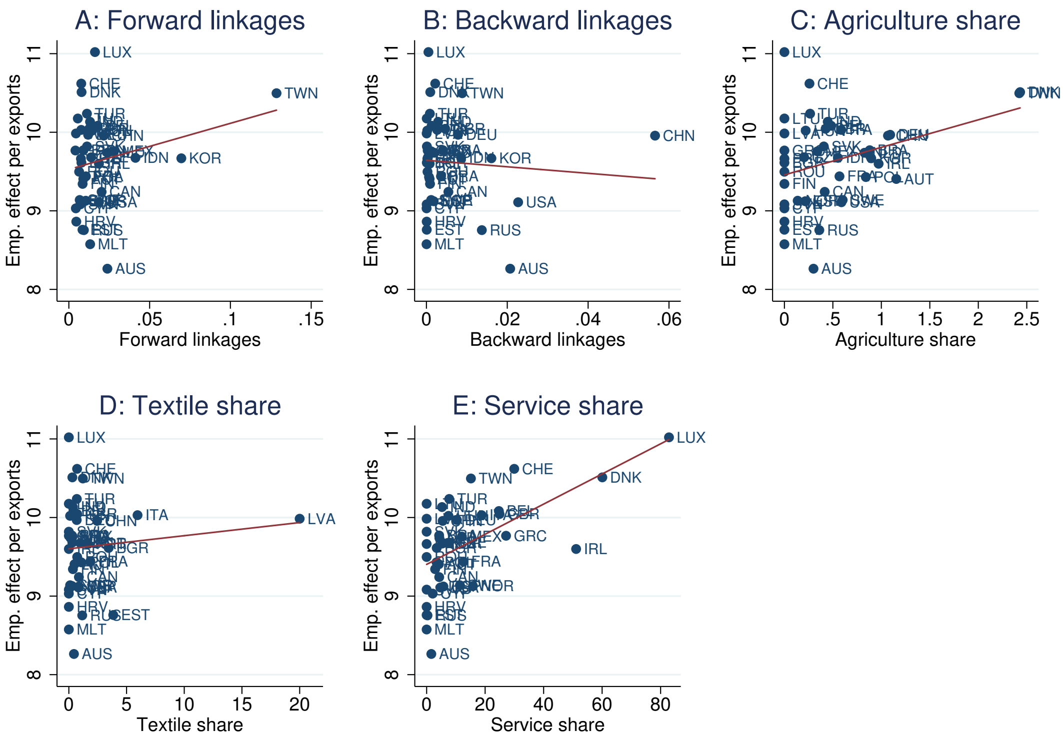
Country-level regressions are informative to capture overall relationship between variables, but we further investigate the determinants of employment effects of exports by employing the destination country-source sector level observations. Because the unit of observations is country-sector now, we extend the measures of forward/backward linkages to distinguish the impact of forward/backward linkages with a destination country, home country, and all other countries besides the destination and home.

Forward linkages: Consider an exporter i and its trading partner j (i.e., a destination country). All of the following measures are for exporting country i's exporting sector s's point of view. Forward

Panel II: China



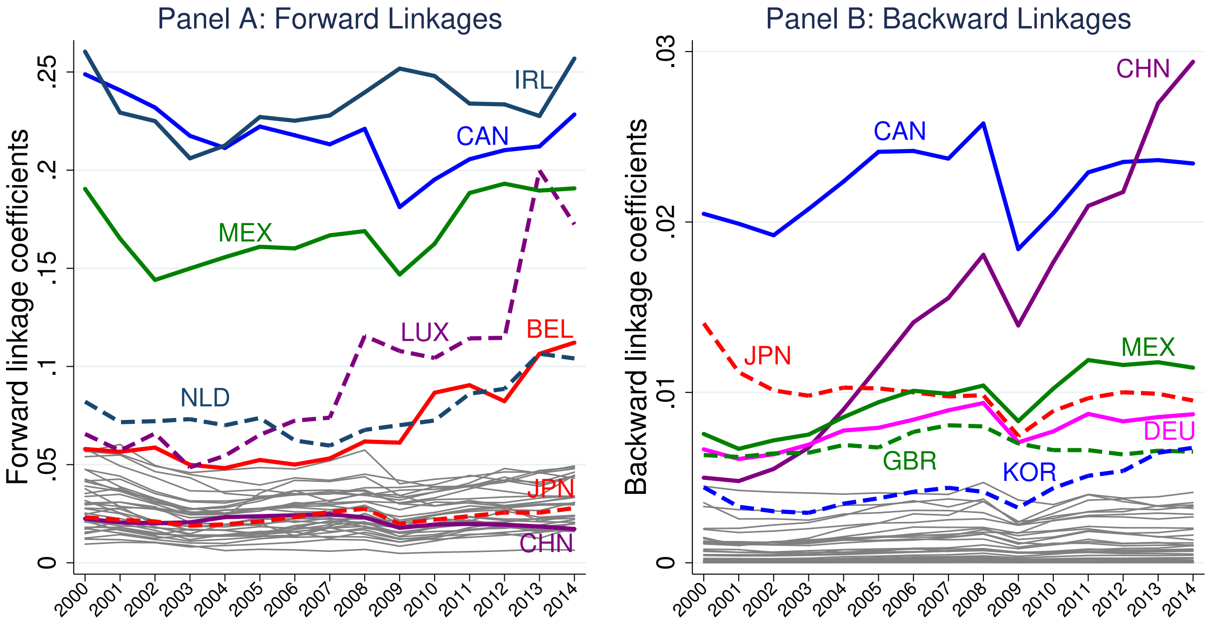
Panel III: Japan



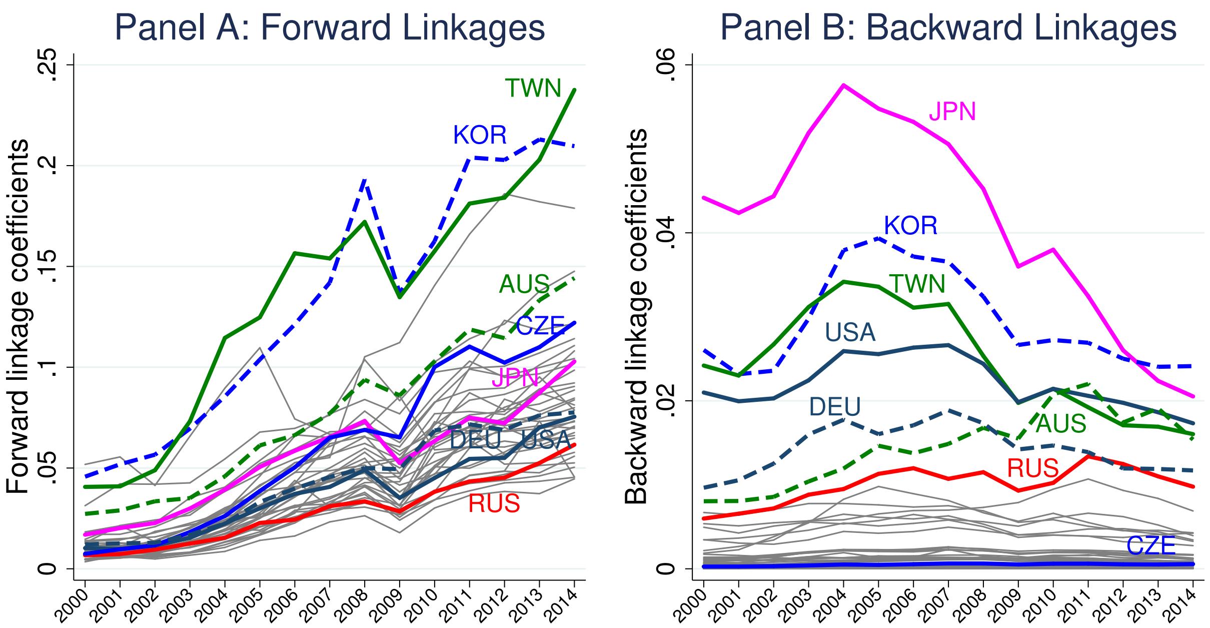
Notes: The figure shows cross-sectional relationships between the employment effect of final good exports per million dollar exports and various variables shown in each panel.

Figure A2: Forward and Backward Linkages, 2000-2014

Panel I: The U.S.



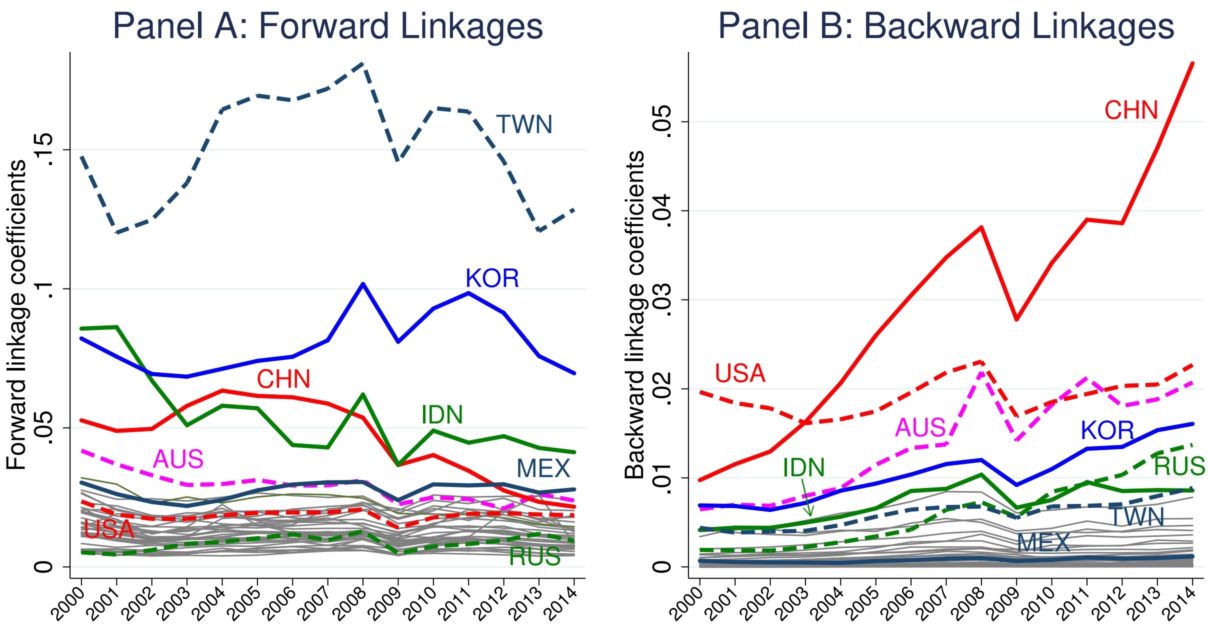
Panel II: China



linkages with destination country j, with the home country i, and other countries $(-i,-j)$ are

$$
\begin{aligned}
(FL^{\text{Destination}}): FL_t^{(i,s),j} &\equiv \sum_{r=1}^{N} \theta_t^{(i,s),(j,r)}, \\
(FL^{\text{Home}}): FL_t^{(i,s),i} &\equiv \sum_{r=1}^{N} \theta_t^{(i,s),(i,r)}, \\
(FL^{\text{Others}}): FL_t^{(i,s),-i,-j} &\equiv \frac{1}{C-2} \sum_{\substack{k \neq i \\ k \neq j}}^{C} \sum_{r=1}^{N} \theta_t^{(i,s),(k,r)},
\end{aligned}
$$

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).

Backward linkages: Consider importer i and its trading partner j (i.e., a source country). All of the following measures are for importing country i's importing sector s's point of view.

Backward linkages with destination country j, with the home country i, and other countries $(-i, -j)$ are

$$
\begin{aligned}
(BL^{\text{Destination}}) : BL_t^{(i,s),j} &\equiv \sum_{r=1}^{N} \theta_t^{(i,r),(j,s)} \\
(BL^{\text{Home}}) : BL_t^{(i,s),i} &\equiv \sum_{r=1}^{N} \theta_t^{(i,r),(i,s)}, \\
(BL^{\text{Others}}) : BL_t^{(i,s),-i,-j} &\equiv \frac{1}{C-2} \sum_{\substack{k\neq i \\ k\neq j}}^{C} \sum_{r=1}^{N} \theta_t^{(k,r),(i,s)},
\end{aligned}
$$

respectively. **Backward-and-forward linkages with its own sector in its own country** is just a coefficient from its own sector in the same country:

$$
(OwnLinkages) : OwnLinkage_t^{i,s} \equiv \theta_t^{(i,s),(i,s)}.
$$

We employ natural log of country-sector level employment effect resulting from total exports of country i to country j, $\ln\left(L_t^{(i,s)}|_{(i,All),j}\right)$, as the dependent variable. 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, $\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$; a vector of forward/backward linkages $\mathbf{X}_t^{Linkages}$ including $FL^{Destination}$, FL^{Home}, FL^{Others}, $BL^{Destination}$, BL^{Home}, BL^{Others}, and $OwnLinkage$, which are based on Rasmussen (1956); another vector of variables $\mathbf{X}_t^{Controls}$ including variables controlling for source country - source sector characteristics, the capital-to-output ratio and the labor-to-output ratio. As a result, the regression equation is:

$$\ln\left(L_t^{(i,s)}|_{(i,All),j}\right) = \gamma^{s,j} + \gamma_t + \gamma_0 \ln\left(d_t^{(i,s),j}\right) + \gamma_1 \ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right) + \mathbf{X}_t^{Linkages\prime}\boldsymbol{\gamma}_3 + \mathbf{X}_t^{Controls\prime}\boldsymbol{\gamma}_4 + e_t^{s,j},$$

where $\gamma^{s,j}$ are source sector-destination country fixed effects; γ_t denotes year fixed effects controlling for macroeconomic shocks including changes in price levels; and $e_t^{s,j}$ is the error term; γ_0, γ_1, $\boldsymbol{\gamma}_3$, and $\boldsymbol{\gamma}_4$ are (scalar and vectors of) coefficients to be estimated. We estimate this regression for each of the three source countries, the U.S., China, and Japan. Contrary to the previous country-level regressions, this regression controls for time-invariant omitted factors and sectoral variations in the employment effect generated from a country's aggregate exports.

Guided by previous work distinguishing offshoring to low-income and high-income countries (e.g., Harrison and McMillan, 2011), we also construct forward/backward linkage measures based on income levels of trading partners. Forward and backward linkages with high-income countries are:

$$(FL^{\text{High-income}}) : FL_t^{(i,s),High} \equiv \frac{1}{n(\Omega^{High}\setminus\{i\})} \sum_{j\in\Omega^{High}\setminus\{i\}} \sum_{r=1}^{N} \theta_t^{(i,s),(j,r)},$$

$$(BL^{\text{High-income}}) : BL_t^{(i,s),High} \equiv \frac{1}{n(\Omega^{High}\setminus\{i\})} \sum_{j\in\Omega^{High}\setminus\{i\}} \sum_{r=1}^{N} \theta_t^{(j,r),(i,s)},$$

where Ω^{High} is a set of high-income countries based on GDP per capita in 2000 obtained from the Penn World Table 9.0 (Feenstra, Inklaar, and Timmer, 2015).[23] We exclude exporting country i from the set Ω^{High} if country i is a high-income country. $n(\Omega^{High}\setminus\{i\})$ denotes the number of high-income countries besides country i. Similarly, forward/backward linkages with low-income countries are

$$(FL^{\text{Low-income}}) : FL_t^{(i,s),Low} \equiv \frac{1}{n(\Omega^{Low}\setminus\{i\})} \sum_{j\in\Omega^{Low}\setminus\{i\}} \sum_{r=1}^{N} \theta_t^{(i,s),(j,r)},$$

$$(BL^{\text{Low-income}}) : BL_t^{(i,s),Low} \equiv \frac{1}{n(\Omega^{Low}\setminus\{i\})} \sum_{j\in\Omega^{Low}\setminus\{i\}} \sum_{r=1}^{N} \theta_t^{(j,r),(i,s)},$$

where Ω^{Low} is a set of low-income countries.

Table A4 shows baseline regression results. Columns (1) and (2) report results from the U.S. as an exporter and those from China and Japan are shown in columns (3)-(4) and columns (5)-(6), respectively. Odd number columns show results from all sectors. Even number columns display results from restricting the sample to merchandise sectors only, which deals with possible bias due to the fact that some service sectors have small values of exports. Exports from that sector and from other sectors, $\ln\left(d_t^{(i,s),j}\right)$ and $\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$, have positive signs and statistically significant. It shows that a 1% increase in exports from that sector raises the employment effect by 0.112%, 0.179%, and 0.089%, respectively. The impact of exports from other sectors is a half of the impact of exports from its own sector for the U.S. but the former is even greater than the latter for China and Japan (see coefficients for $\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$). It captures the greater sectoral linkages in China and Japan.

The result also shows that deeper forward linkages with destination countries are associated with a greater employment effect in the U.S. — a one standard deviation change increases the employment effect by 1.5% and 1.6% in all sectors and merchandise sectors, respectively. Forward linkages with

[23] The 43 countries are divided into two groups of countries, high-income and low-income countries based on the 50th percentile of GDP per capita in 2000. We apply the same definition of high-income and low-income countries over the period 2000-2014. See Appendix for a list of the two groups of countries.

Table A4: Results from Panel Regressions with Country-Sector Level Observations, 2000-2014
Dep. Var. = $\ln\left(L_t^{(i,s)}|_{(i,All),j}\right)$, Baseline

	The U.S.		China		Japan	
	All sectors	Merchandise sectors only	All sectors	Merchandise sectors only	All sectors	Merchandise sectors only
	(1)	(2)	(3)	(4)	(5)	(6)
Exports						
$\ln\left(d_t^{(i,s),j}\right)$	0.112***	0.113***	0.179***	0.243***	0.089***	0.116***
	(0.005)	(0.007)	(0.009)	(0.010)	(0.006)	(0.010)
$\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$	0.056***	0.063***	0.222***	0.266***	0.091***	0.090***
	(0.004)	(0.007)	(0.014)	(0.016)	(0.006)	(0.008)
Forward linkages						
$FL^{Destination}$	0.220***	0.245**	0.147	0.161	0.153	0.131
	(0.070)	(0.123)	(0.137)	(0.157)	(0.267)	(0.276)
	[0.015]	[0.016]	[0.010]	[0.011]	[0.010]	[0.009]
FL^{Home}	-0.001	-0.103***	0.099***	0.068***	0.076***	-0.056**
	(0.014)	(0.023)	(0.013)	(0.018)	(0.021)	(0.028)
	[-0.001]	[-0.095]	[0.091]	[0.063]	[0.070]	[-0.052]
FL^{Others}	0.129	0.817	0.394	2.065***	1.054	0.532
	(0.418)	(0.629)	(0.403)	(0.484)	(1.297)	(1.513)
	[0.003]	[0.018]	[0.008]	[0.045]	[0.023]	[0.012]
Backward linkages						
$BL^{Destination}$	10.27***	9.200***	6.998***	5.750***	5.515***	4.640***
	(1.104)	(1.331)	(1.528)	(1.229)	(0.793)	(0.937)
	[0.090]	[0.081]	[0.062]	[0.051]	[0.049]	[0.041]
BL^{Home}	0.068***	-0.098***	-0.200***	-0.043	-0.023	-0.104***
	(0.023)	(0.038)	(0.041)	(0.061)	(0.019)	(0.032)
	[0.030]	[-0.044]	[-0.089]	[-0.019]	[-0.010]	[-0.046]
BL^{Others}	-29.10***	-22.72***	-55.23***	-52.73***	-16.89***	-16.15***
	(2.861)	(4.167)	(6.397)	(7.970)	(1.934)	(2.794)
	[-0.077]	[-0.060]	[-0.147]	[-0.140]	[-0.045]	[-0.043]
Forward/backward linkages with its own country-sector						
Own linkage	0.332***	0.506***	-0.403***	-0.009	-0.037	0.221***
	(0.084)	(0.137)	(0.083)	(0.127)	(0.065)	(0.081)
	[0.040]	[0.074]	[-0.059]	[-0.001]	[-0.005]	[0.032]
Source country-sector characteristics						
Labor-to-output ratio	0.629	9.536**	0.213***	-0.126***	4.036***	0.843
	(1.955)	(4.331)	(0.047)	(0.049)	(0.975)	(1.190)
Capital-to-output ratio	0.519	0.766	-3.807***	14.88***	0.020	0.732
	(0.473)	(2.137)	(1.296)	(2.164)	(0.340)	(0.468)
Country-sector fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
# of obs.	34,650	13,860	29,610	13,860	32,130	13,860
# of cross-sectional obs.	2,310	924	1,974	924	2,142	924
R-squared	0.329	0.326	0.466	0.626	0.264	0.314
F-stat.	51.01	23.74	145.40	133.63	34.79	20.00
p-val. (F-stat.)	0.000	0.000	0.000	0.000	0.000	0.000

Notes: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors, clustered at the country-sector level, are in rounded parentheses. Numbers in square brackets are the impact of a one standard deviation change. Observations from domestic final demand and the rest of the world are dropped from the sample. The unit of observations is source sector-destination country. All regressions include a constant term, country-sector fixed effects, and year fixed effects.

Table A5: Results from Panel Regressions with Country-Sector Level Observations, 2000-2014 Dep. Var. = $\ln\left(L_t^{(i,s)}|_{(i,All),j}\right)$, Forward/Backward Linkages are Based on Income Levels of Destination Countries

	The U.S.		China		Japan	
	All sectors	Merchandise sectors only	All sectors	Merchandise sectors only	All sectors	Merchandise sectors only
	(1)	(2)	(3)	(4)	(5)	(6)
Exports						
$\ln\left(d_t^{(i,s),j}\right)$	0.119***	0.124***	0.177***	0.238***	0.094***	0.119***
	(0.006)	(0.008)	(0.009)	(0.010)	(0.006)	(0.010)
$\ln\left(\sum_{r\neq s}^{N} d_t^{(i,r),j}\right)$	0.063***	0.070***	0.230***	0.273***	0.095***	0.096***
	(0.004)	(0.007)	(0.014)	(0.016)	(0.006)	(0.009)
Forward linkages						
$FL^{High-income}$	-0.625**	-1.039*	-2.116***	3.035***	0.817	2.026*
	(0.285)	(0.558)	(0.678)	(0.737)	(0.980)	(1.165)
	[-0.015]	[-0.026]	[-0.052]	[0.075]	[0.020]	[0.050]
FL^{Home}	0.025*	-0.096***	0.110***	0.089***	0.075***	-0.055**
	(0.014)	(0.023)	(0.013)	(0.018)	(0.021)	(0.025)
	[0.023]	[-0.088]	[0.101]	[0.082]	[0.069]	[-0.050]
$FL^{Low-income}$	0.935	2.237***	3.460***	0.766	0.481	-0.716
	(0.587)	(0.806)	(0.580)	(0.542)	(0.993)	(1.207)
	[0.020]	[0.048]	[0.074]	[0.016]	[0.010]	[-0.015]
Backward linkages						
$BL^{High-income}$	15.61***	12.19***	24.08***	-2.659	-7.034***	-9.765***
	(3.279)	(4.612)	(7.012)	(7.003)	(2.468)	(3.488)
	[0.052]	[0.041]	[0.080]	[-0.009]	[-0.023]	[-0.032]
BL^{Home}	0.034	-0.089**	-0.195***	-0.069	-0.024	-0.098***
	(0.022)	(0.039)	(0.041)	(0.061)	(0.018)	(0.031)
	[0.015]	[-0.039]	[-0.087]	[-0.031]	[-0.011]	[-0.044]
$BL^{Low-income}$	-23.89***	-19.96***	-141.6***	-66.98***	-4.757**	-2.122
	(3.194)	(5.046)	(15.310)	(13.760)	(2.380)	(3.424)
	[-0.053]	[-0.044]	[-0.313]	[-0.148]	[-0.011]	[-0.005]
Forward/backward linkages with its own country-sector						
Own Linkage	0.0544	0.259*	-0.407***	-0.128	-0.0216	0.244***
	(0.089)	(0.143)	(0.085)	(0.129)	(0.066)	(0.081)
	[0.008]	[0.038]	[-0.060]	[-0.019]	[-0.003]	[0.036]
Source country-sector characteristics						
Labor-to-output ratio	3.376*	11.36**	0.252***	-0.132***	4.095***	0.573
	(2.045)	(4.658)	(0.047)	(0.048)	(0.948)	(1.110)
Capital-to-output ratio	0.778	-0.956	-5.253***	13.67***	0.0319	0.871*
	(0.508)	(2.139)	(1.286)	(2.161)	(0.361)	(0.506)
Country-sector fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
# of obs.	34,650	13,860	29,610	13,860	32,130	13,860
# of cross-sectional obs.	2,310	924	1,974	924	2,142	924
R-squared	0.285	0.278	0.464	0.617	0.224	0.265
F-stat.	45.01	20.08	148.20	129.84	33.29	17.73
p-val. (F-stat.)	0.000	0.000	0.000	0.000	0.000	0.000

Notes: See the notes on Table 9.

destination countries are not statistically significant for China and forward linkages with home country are positive and significant — a one standard deviation change increases the employment effect by 9.1% and 6.3% in all sectors and merchandise sectors, respectively. For Japan, the coefficient from forward linkages with home is positive and significant for all sectors but the sign turns to be negative once we restrict the sample to merchandise sectors.

Overall, there is no systematic relationship between forward linkages and the employment effect of exports that is common to all of the three exporters. However, the impact of backward linkages with destination countries is common to all of them. Looking at the results from all sectors (odd number columns), a one standard deviation increase in backward linkages with destination countries raises the employment effect by 9%, 6.2%, and 4.9% in the U.S., China, and Japan, respectively. Coefficients for $BL^{Destination}$ in even number columns are also similar. On the other hand, backward linkages with other countries (all countries besides exporting country and its trading partner), BL^{Others}, have negative signs. A one standard deviation increase in backward linkages with other countries reduces the employment effect by 7.7%, 14.7%, and 4.5% in the U.S., China, and Japan, respectively (see odd number columns).

The coefficients from BL^{Others} are intuitive while those from $BL^{Destination}$ are counterintuitive. We have expected that greater backward linkages would lead to smaller employment effects of exports because stronger backward linkages work to reduce value added content of exports. This conjecture is only true if intermediate goods are not coming from its destination country and are coming from other countries. There are two possible reasons for this. First, it presumably captures the nature of input-output linkages. The employment effects are estimated based on the input-output table. If a country purchases more intermediate goods from its destination country, final good demand from the destination country has a greater impact on the exporting country through intermediate good demand from the destination country. Second, there might be some positive externalities thorough intermediate good purchases from the destination country, and the positive effect becomes greater when the exporting country sells goods to the destination country.

Table A5 presents the results with forward/backward linkage measures based on income-levels of trading partners. For the United States, forward linkages with high-income countries seem to have a negative effect but those with low-income countries have positive signs. Interestingly, an opposite pattern is observed from backward linkages — backward linkages with high-income countries have positive effects while those with low-income countries have negative impacts. A similar result is found from China (see column (3)). This result is consistent with Harrison and McMillan (2011) where they find that offshoring to low-income countries is job-reducing. Positive signs from $BL^{High-income}$ are presumably capturing positive spillover effects embedded in better intermediate inputs. This pattern is not observed from Japan — both $BL^{High-income}$ and $BL^{Low-income}$ have negative signs.