Heckscher-Ohlin: Evidence from virtual trade in value added*

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Abstract

The fragmentation of production chains across borders is one of the most distinctive feature of the last 30 years of globalization. Nonetheless, our understanding of its implications for trade theory and policy is only in its infancy. We suggest that trade in value added should follow theories of comparative advantage more closely than gross trade, as value-added flows capture where factors of production, e.g. labor and capital, are used along the global value chain. We find empirical evidence that Heckscher-Ohlin theory does predict manufacturing trade in value-added, and it does so better than for gross shipment flows. While countries exports across a broad range of sectors, they specialize in techniques using their abundant factor intensively.

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1 INTRODUCTION

The second unbundling, or the fragmentation of production chains across borders, is one of the most distinctive feature of the last 30 years of globalization (Baldwin, 2011). Nonetheless, our understanding of its implications for trade theory and policy is only in its infancy. One explanation for this delay is the only-recent release of input-output matrices that cover the whole world and allow for a better understanding of the location of production across global value chains.

One implication of global value chains is that 'Made in China' no longer means 'Made in China'. Koopman et al. (2008) estimate that the share of domestic content in China exports is about 50%. One recurring example is that of Apple's iPad, 'Made in China' but with Chinese labor accounting for only about 3% of its value added. Gross trade figures, e.g. Chinese exports of iPads, are hence no perfect guide to understand where value addition occurs. They also imply a 'double-counting' of value added, as the value added embedded in parts and components is counted when both intermediates and final goods cross borders. The 'double-counting' means that trade data overstates the domestic value-added content of exports (see Figure 1).

Economists have thus recently focused on capturing the value-added content of trade Johnson and Noguera (2012) and the World Trade Organization launched a 'Made in the World' initiative to encourage research on the topic. Extracting the value-added embedded in exports allow us to trace where factors of production are used. For example, it allows us to identify that China's electronics exports embed wages paid to Chinese labor and profits pocketed by US wholesalers. It elucidates the paradox that labor-abundant China apparently exports capital-intensive and sophisticated products. When looking at trade in value added, we find that China actually exports only unskilled labor embedded in iPads. Another example is that of Boeing's Dreamliner. While is is 'Made in the USA', it embeds value from a long list of countries (Figure 2).

We suggest that trade in value added should follow theories of comparative advantage more closely than gross trade. The reason is that it tells you where factors of production, e.g. labor and capital, are used. As Daudin et al. (2011) notes, only a value-added trade measure can answer the question who produces for whom in the world economy?'. Value-added trade thus offers a new lens to test for theories of comparative advantage. Do labor-abundant countries export labor-intensive products? Or rather, do labor-abundant countries export labor-intensive value-added? Previous tests of comparative advantage theories based on facto endowments include Romalis (2004), who shows that the US imports more skill-intensive products from skill-abundant countries, Chor (2010) who explains industry trade flows using Heckscher-Ohlin and other sources of comparative advantage, and Trefler and Zhu (2010), who tests for factor content predictions in the presence of traded intermediates.

In this paper we combine Chor (2010) and Johnson and Noguera (2012) to provide a new test for Heckscher-Ohlin theory. The Heckscher-Ohlin prediction is that countries will export goods whose production uses its abundant factor intensively. Does Japan export more skill-intensive value added than labor-abundant countries? Our prediction is that the value-added trade patterns fit the Heckscher-Ohlin predictions better than gross trade patterns as they capture precisely the location of production factors. We mimic the regression setting of Chor (2010), who tested for theories of comparative advantage, but including value-added trade rather than gross trade data on the left-hand side. In doing so we generalize the approach of Davis and Weinstein (2001), Trefler and Zhu (2010) and others to test for Heckscher-Ohlin predictions to a framework with bilateral trade costs. We thus add to a resurgence of papers that decompose the factor content of trade to test Heckscher-Ohlin theory, e.g. Egger et al. (2011) and Fisher (2011) who show that it is important to take into account international differences in technology (see Figure 10), which depends largely on labor requirements across countries (Nishioka, 2012). Our paper is also in line with Fisher and Marshall (2013) who insist that the factor content of trade in labor is not an exchange of person-years, but trade in value added attributed to a worker.

We find empirical evidence that HO theory does predict manufacturing trade in value-added, and it does so better than for gross shipment flows.

The paper proceeds as follows. In the next section we describe the data and present our empirical strategy. A third section presents the results and a fourth concludes.

2 DATA AND EMPIRICAL STRATEGY

We use data from the World Input-Output Database (WIOD). It provides international input-output tables for 40 countries (Figure 4), 34 sectors, from 1995 to 2009 (Timmer, 2012). This data allows us to compute the value added embedded in final imports as the sale value of a product equals to the cost of intermediate inputs plus value added. Here value added refers to the cost of primary inputs such as labor as well as profits. For example we can identify where the workers involved into Chinese electronics were employed, by sector and by nation. It would most likely involve skilled labor in the US who designed and market the product, as well as workers in Taiwan that produced the parts and components, as well as other inputs from the chemical and metal industries in other countries. By tracking down the whole process until the sales value equals the sum of value added, we can trace the value added by industry and country. Computing value-added exports is straightforward using matrix algebra (see Johnson and Noguera (2012)):

$$VA = F(I-B)^{-1}X$$

where VA is value-added embodied in the final demand of a given country (N countries and J sectors), F is a (NJ, NJ) diagonal matrix with the ratio of *direct* value-added to gross output for each country and sector on the diagonal, $(I-B)^{-1}$ is the (NJ, NJ) Leontief inverse - it estimates the amount of intermediates per US$ of final output after all rounds intermediate shipments across sectors and countries. X is the $(NJ, 1)$ vector of gross shipments for final demand, i.e. the destination country.

Trade in value added may be direct (embodied in bilateral gross trade shipments) or indirect (traveling through intermediate shipments that cross multiple borders). See Figure 3. We label the total value added trade as 'Virtual VA trade'.

Figure 5 provides a network view of trade in value added and in gross terms. One clear observation is that the contribution of China in global value-added trade is smaller than in gross terms. This is also seen in Figure 6 which shows the difference between the two flows is even bigger in China's exports to Asia, as many of those are parts that will be re-exported to the US or EU and thus embedded in China's value-added exports to the US and EU. Figure 7 shows that China's top export sectors in value-added terms are different from those in gross terms. While electric equipment remains on top, plastics, transport equipment (cars), and leather fall out of the top 10. One explanation is that most of the leather exported from China embeds value added in Ethiopia for example, and plastic exports embed oil from Indonesia. Mining and agriculture enter the top 10 in value-added terms. This may be because China doesn't export its mining products, such as rare earths, but rather embeds them in electronic exports. Yet they account for a large share of value-added exported.

Figures 8 and 9 similarly display the case of Japan exports. Here we note that Japan's value-added exports to the US and EU are larger, not smaller, than its gross exports. This may be because of the Japanese value-added embedded in China's and other Southeast Asian countries exports of electronics. Note also that services such as finance, inland transport, and wholesale do not appear as top-10 gross exports but do make the list for value-added exports as they are embedded in Japan's sophisticated exports.

WIOD also provides data on factor use and payments - three types of labor (high-skilled, medium-skilled and low-skilled) and capital. We follow (Timmer et al., 2014) and merge the low and medium categories in an 'unskilled' aggregate. The factors are Labor (L), Unskilled labor (L_{US}) and High-skilled labor (L_{HS}). We leave physical capital aside as it is constructed as a residual and is thus not as precisely-measured as human capital endowments.

We regress virtual VA exports and gross exports on relative endowments interacted with relative intensities. Formally, we estimate the following model:

$$\ln(VA)_{ijkt} = \alpha_{ikt} + \sigma_{jt} + \beta_1 \ln(\frac{l_{hs}}{l_{us}})_{jkt} + \beta_2 \ln(\frac{l_{hs}}{l_{us}})_{jkt} \times \ln(\frac{L_{hs}}{L_{us}})_{jt} + \varepsilon_{ijkt}$$

where α_{ikt} and σ_{jt} are importer-industry-year and exporter-year fixed effects. L is for labor. Lower-case letters are for intensities, upper-case endowments. Our prediction is that $\beta 2$ is positive and significant, even more so for value-added exports than for gross exports.

3 RESULTS

When we focus on manufacturing sectors our prediction is confirmed. Countries export more skilled-intensive products if they are relatively skill abundant. The coefficient on the interaction of relative skill intensity $(\frac{l_{hs}}{l_{us}})$ and relative skill endowment $(\frac{L_{hs}}{L_{us}})$ is positive and significant in all 3 specifications. This is true both in the cross section (Table 1) and the panel (Table 2). In the second specification (column 2), we had terms that capture the relative capital abundance and intensities, on top of the skill terms. While we find no effect for capital intensity, this additional term does not alter the coefficients on the skill terms. As we mentioned earlier, physical capital is constructed as a residual and is thus not as precisely-measured as human capital endowments. Adding gravity controls (column 3) does not alter the results either.

These results are all the more interesting when compared to those with gross exports on the left-hand side (Columns 4-6). Indeed, we find no indication of Heckscher-Ohlin forces significantly affecting gross manufacturing trade patterns. These contrasting results are illustrated in Figure 11. The latter plots the elasticities estimated in columns 1 and 4 of Table 1. For a country with relatively high skill abundance, such as South Korea, a 10% increase in skill intensity corresponds to an increase in VA exports of about 4%. For a country with relative skill scarcity, such as India, a 10% increase in skill intensity corresponds to a decrease in VA exports of about 5%. This is exactly in line with countries exporting along their comparative advantage. When looking at gross exports, we do not find such clearly differing elasticities at the opposite end of the skill abundance distribution.

When looking at services and total trade (Tables 3 4 5 6) we find no significant difference between gross and virtual VA flows. This is illustrated in Figure 12. While the results still lean more in favor of Heckscher-Ohlin forces when looking at services in value-added terms, we find no significant difference between the 2 types of flows. This difference between services and manufacturing may be explained by the fact that is it mostly in manufacturing that global value chains have emerged.

4 CONCLUSION

Tests of the Heckscher-Ohlin theory have come a long way since Leontief's paradox, i.e. the observation in 1953 that the US, a capital abundant country, was importing mostly capital-intensive goods, and since Bowen et al. (1987) claimed that net factor exports are no better predicted by measured factor abundance than by a coin flip. While many studies have followed and claimed that the theory performed badly empirically, we find empirical evidence that it does predict manufacturing trade in value-added, and it does so better than for gross shipment flows. Countries exports 'value' that they produce using their abundant factor intensively. As Nishioka (2012) noted, the bulk of world factor content of trade does not arise from specialization across goods, but rather via specialization in abundance-inspired techniques. One note of caution is that when we look at total trade, we do not find any statistical difference between VA and gross flows. This may be because global value chains are still mostly national. The spread of global value chains should make HO theory more, rather than less,relevant.

References

Baldwin, R., 2011. Trade And Industrialisation After Globalisation's 2nd Unbundling: How Building And Joining A Supply Chain Are Different And Why It Matters. NBER Working Papers 17716. National Bureau of Economic Research, Inc.

Bowen, H.P., Leamer, E.E., Sveikauskas, L., 1987. Multicountry, Multifactor Tests of the Factor Abundance Theory. American Economic Review 77(5), 791–809.

Chor, D., 2010. Unpacking sources of comparative advantage: A quantitative approach. Journal of International Economics 82(2), 152–167.

Daudin, G., Rifflart, C., Schweisguth, D., 2011. Who produces for whom in the world economy? Canadian Journal of Economics 44(4), 1403–1437.

Davis, D.R., Weinstein, D.E., 2001. An Account of Global Factor Trade. American Economic Review 91(5), 1423–1453.

Egger, P., Marshall, K.G., Fisher, E.O., 2011. Empirical foundations for the resurrection of Heckscher-Ohlin theory. International Review of Economics & Finance 20(2), 146–156.

Fisher, E., Marshall, K.G., 2013. Testing the heckscher-ohlin-vanek paradigm in a world with cheap foreign labor. Unpublished manuscript .

Fisher, E.O., 2011. Heckscher-Ohlin theory when countries have different technologies. International Review of Economics & Finance 20(2), 202–210.

Johnson, R.C., Noguera, G., 2012. Accounting for intermediates: Production sharing and trade in value added. Journal of International Economics 86(2), 224–236.

Koopman, R., Wang, Z., Wei, S.J., 2008. How Much of Chinese Exports is Really Made In China? Assessing Domestic Value-Added When Processing Trade is Pervasive. Working Paper 14109. National Bureau of Economic Research.

Nishioka, S., 2012. International differences in production techniques: Implications for the factor content of trade. Journal of International Economics 87(1), 98–104.

Romalis, J., 2004. Factor Proportions and the Structure of Commodity Trade. American Economic Review 94(1), 67–97.

Timmer, M.P., 2012. The World Input-Output Database (WIOD): Contents, Sources and Methods. Technical Report. WIOD Working Paper Number 10.

Timmer, M.P., Erumban, A.A., Los, B., Stehrer, R., de Vries, G.J., 2014. Slicing Up Global Value Chains. Journal of Economic Perspectives 28(2), 99–118.

Trefler, D., Zhu, S.C., 2010. The structure of factor content predictions. Journal of International Economics 82(2), 195–207.

Table 1: Manufacturing trade - Cross-section

	(1)	(2)	(3)	(4)	(5)	(6)
	Virtual VA			Gross exports		
$\ln\left(\frac{l_{hs}}{l_{us}}\right) \times \ln\left(\frac{L_{hs}}{L_{us}}\right)$	0.309***	0.339***	0.339***	0.167	0.159	0.159
	(0.0800)	(0.0918)	(0.0945)	(0.112)	(0.129)	(0.132)
$\ln\left(\frac{l_{hs}}{l_{us}}\right)$	0.642***	0.560***	0.560**	0.222	0.109	0.109
	(0.209)	(0.215)	(0.221)	(0.266)	(0.283)	(0.290)
$\ln\left(\frac{k}{l_{us}}\right) \times \ln\left(\frac{K}{L_{us}}\right)$		-0.00931	-0.00931		0.0155	0.0155
		(0.0297)	(0.0302)		(0.0335)	(0.0344)
$\ln\left(\frac{k}{l_{us}}\right)$		0.272**	0.272**		0.137	0.137
		(0.125)	(0.127)		(0.138)	(0.142)
Log(distance)			-0.717***			-0.981***
			(0.0508)			(0.0678)
Same cty			2.029***			2.186***
			(0.195)			(0.238)
Share border			0.490***			0.655***
			(0.0918)			(0.113)
Common lang			0.0300			0.0501
			(0.0918)			(0.110)
Colony			0.158*			0.302***
			(0.0891)			(0.110)
Legal			0.187***			0.256***
			(0.0432)			(0.0510)
FTA			0.393***			0.506***
			(0.0919)			(0.123)
Obs	25,520	25,520	25,520	25,520	25,520	25,520
R^2	0.671	0.674	0.854	0.575	0.577	0.807

All regressions include importer-industry and exporter dummies. Two-way clustered standard errors by exporter-industry and country-pair are in parenthesis. Significant at: *10%, **5%, ***1% level.

Table 2: Manufacturing trade - Panel

	(1)	(2)	(3)	(4)	(5)	(6)
	Virtual VA			Gross exports		
$\ln\left(\frac{l_{hs}}{l_{us}}\right) \times \ln\left(\frac{L_{hs}}{L_{us}}\right)$	0.285***	0.307***	0.307***	0.170*	0.164	0.164
	(0.0674)	(0.0752)	(0.0776)	(0.0950)	(0.107)	(0.110)
$\ln\left(\frac{l_{hs}}{l_{us}}\right)$	0.577***	0.507***	0.507***	0.236	0.145	0.145
	(0.174)	(0.177)	(0.182)	(0.220)	(0.232)	(0.238)
$\ln\left(\frac{k}{l_{us}}\right) \times \ln\left(\frac{K}{L_{us}}\right)$		-0.00686	-0.00686		0.0132	0.0132
		(0.0263)	(0.0268)		(0.0294)	(0.0302)
$\ln\left(\frac{k}{l_{us}}\right)$		0.235**	0.235**		0.123	0.123
		(0.110)	(0.112)		(0.121)	(0.124)
Log(distance)			-0.816***			-1.095***
			(0.0427)			(0.0566)
Same cty			1.945***			2.080***
			(0.202)			(0.246)
Share border			0.439***			0.595***
			(0.0867)			(0.107)
Common lang			0.0374			0.0593
			(0.0948)			(0.112)
Colony			0.112			0.252**
			(0.0898)			(0.110)
Legal			0.172***			0.238***
			(0.0440)			(0.0516)
FTA			0.0966			0.180**
			(0.0604)			(0.0758)
Obs	382,440	382,440	382,440	382,440	382,440	382,440
R^2	0.669	0.672	0.843	0.566	0.567	0.783

All regressions include importer-industry-year and exporter-year dummies. Two-way clustered standard errors by exporter-industry and country-pair are in parenthesis. Significant at: *10%, **5%, ***1% level.

Table 3: Services trade - Cross-section

	(1)	(2)	(3)	(4)	(5)	(6)
		Virtual VA			Gross exports	
$\ln\left(\frac{l_{hs}}{l_{us}}\right) \times \ln\left(\frac{L_{hs}}{L_{us}}\right)$	0.109***	0.109***	0.109***	0.0693*	0.0964**	0.0964**
	(0.0342)	(0.0349)	(0.0375)	(0.0388)	(0.0411)	(0.0443)
$\ln\left(\frac{l_{hs}}{l_{us}}\right)$	0.181**	0.201**	0.201**	0.0724	0.144	0.144
	(0.0778)	(0.0816)	(0.0883)	(0.0940)	(0.101)	(0.109)
$\ln\left(\frac{k}{l_{us}}\right) \times \ln\left(\frac{K}{L_{us}}\right)$		0.00662	0.00662		-0.0198	-0.0198
		(0.0104)	(0.0112)		(0.0134)	(0.0144)
$\ln\left(\frac{k}{l_{us}}\right)$		-0.0709	-0.0709		0.0110	0.0110
		(0.0549)	(0.0584)		(0.0602)	(0.0653)
Log(distance)			-0.564***			-0.280***
			(0.0461)			(0.0739)
Same cty			4.340***			6.728***
			(0.163)			(0.249)
Share border			0.347***			0.572***
			(0.0857)			(0.112)
Common lang			0.0571			0.108
			(0.0836)			(0.123)
Colony			0.210**			0.351***
			(0.0870)			(0.108)
Legal			0.205***			0.218***
			(0.0394)			(0.0487)
FTA			0.198**			0.207
			(0.0812)			(0.126)
Obs	27,200	27,200	27,200	27,200	27,200	27,200
R^2	0.644	0.644	0.882	0.377	0.377	0.739

All regressions include importer-industry and exporter dummies. Two-way clustered standard errors by exporter-industry and country-pair are in parenthesis. Significant at: *10%, **5%, ***1% level.

Table 4: Services trade - Panel

	(1)	(2)	(3)	(4)	(5)	(6)
		Virtual VA			Gross exports	
$\ln\left(\frac{l_{hs}}{l_{us}}\right) \times \ln\left(\frac{L_{hs}}{L_{us}}\right)$	0.0983***	0.0982***	0.0982***	0.0647*	0.0889**	0.0889**
	(0.0316)	(0.0323)	(0.0347)	(0.0359)	(0.0377)	(0.0407)
$\ln\left(\frac{l_{hs}}{l_{us}}\right)$	0.161**	0.175**	0.175**	0.0680	0.130	0.130
	(0.0706)	(0.0736)	(0.0796)	(0.0848)	(0.0906)	(0.0976)
$\ln\left(\frac{k}{l_{us}}\right) \times \ln\left(\frac{K}{L_{us}}\right)$		0.00591	0.00591		-0.0191	-0.0191
		(0.00924)	(0.00999)		(0.0125)	(0.0134)
$\ln\left(\frac{k}{l_{us}}\right)$		-0.0582	-0.0582		0.0165	0.0165
		(0.0471)	(0.0504)		(0.0543)	(0.0588)
Log(distance)			-0.648***			-0.371***
			(0.0398)			(0.0620)
Same cty			4.290***			6.675***
			(0.169)			(0.264)
Share border			0.307***			0.530***
			(0.0818)			(0.106)
Common lang			0.0608			0.112
			(0.0870)			(0.126)
Colony			0.162*			0.300***
			(0.0872)			(0.105)
Legal			0.194***			0.207***
			(0.0401)			(0.0481)
FTA			-0.0863*			-0.0957
			(0.0523)			(0.0747)
Obs	408,000	408,000	408,000	408,000	408,000	408,000
R^2	0.645	0.645	0.870	0.374	0.375	0.707

All regressions include importer-industry-year and exporter-year dummies. Two-way clustered standard errors by exporter-industry and country-pair are in parenthesis. Significant at: *10%, **5%, ***1% level.

Table 5: Total trade - Cross-section

	(1)	(2)	(3)	(4)	(5)	(6)
	Virtual VA			Gross exports		
$\ln\left(\frac{l_{hs}}{l_{us}}\right) \times \ln\left(\frac{L_{hs}}{L_{us}}\right)$	0.207***	0.197***	0.197***	0.205***	0.217***	0.217***
	(0.0301)	(0.0321)	(0.0335)	(0.0392)	(0.0417)	(0.0433)
$\ln\left(\frac{l_{hs}}{l_{us}}\right)$	0.370***	0.325***	0.325***	0.448***	0.446***	0.446***
	(0.0768)	(0.0798)	(0.0833)	(0.0970)	(0.102)	(0.106)
$\ln\left(\frac{k}{l_{us}}\right) \times \ln\left(\frac{K}{L_{us}}\right)$		0.00321	0.00321		-0.0185	-0.0185
		(0.0115)	(0.0119)		(0.0154)	(0.0159)
$\ln\left(\frac{k}{l_{us}}\right)$		0.0510	0.0510		0.108	0.108
		(0.0544)	(0.0563)		(0.0668)	(0.0692)
Log(distance)			-0.638***			-0.620***
			(0.0466)			(0.0645)
Same cty			3.222***			4.530***
			(0.177)			(0.215)
Share border			0.416***			0.612***
			(0.0877)			(0.102)
Common lang			0.0434			0.0789
			(0.0861)			(0.0949)
Colony			0.185**			0.328***
			(0.0874)			(0.0941)
Legal			0.196***			0.237***
			(0.0401)			(0.0432)
FTA			0.292***			0.352***
			(0.0835)			(0.112)
Obs	52,720	52,720	52,720	52,720	52,720	52,720
R^2	0.653	0.653	0.859	0.503	0.504	0.757

All regressions include importer-industry and exporter dummies. Two-way clustered standard errors by exporter-industry and country-pair are in parenthesis. Significant at: *10%, **5%, ***1% level.

Table 6: Total trade - Panel

	(1)	(2)	(3)	(4)	(5)	(6)
	Virtual VA			Gross exports		
$\ln\left(\frac{l_{hs}}{l_{us}}\right) \times \ln\left(\frac{L_{hs}}{L_{us}}\right)$	0.189***	0.180***	0.180***	0.182***	0.193***	0.193***
	(0.0275)	(0.0293)	(0.0306)	(0.0356)	(0.0374)	(0.0389)
$\ln\left(\frac{l_{hs}}{l_{us}}\right)$	0.329***	0.288***	0.288***	0.388***	0.384***	0.384***
	(0.0684)	(0.0706)	(0.0735)	(0.0854)	(0.0893)	(0.0926)
$\ln\left(\frac{k}{l_{us}}\right) \times \ln\left(\frac{K}{L_{us}}\right)$		0.00401	0.00401		-0.0164	-0.0164
		(0.0103)	(0.0107)		(0.0142)	(0.0147)
$\ln\left(\frac{k}{l_{us}}\right)$		0.0444	0.0444		0.0992	0.0992
		(0.0478)	(0.0496)		(0.0603)	(0.0625)
Log(distance)			-0.730***			-0.722***
			(0.0398)			(0.0538)
Same cty			3.155***			4.451***
			(0.184)			(0.230)
Share border			0.371***			0.561***
			(0.0834)			(0.0962)
Common lang			0.0489			0.0853
			(0.0895)			(0.0988)
Colony			0.138			0.277***
			(0.0879)			(0.0931)
Legal			0.184***			0.222***
			(0.0410)			(0.0436)
FTA			0.00189			0.0374
			(0.0546)			(0.0676)
Obs	790,440	790,440	790,440	790,440	790,440	790,440
R^2	0.652	0.652	0.847	0.495	0.495	0.731

All regressions include importer-industry-year and exporter-year dummies. Two-way clustered standard errors by exporter-industry and country-pair are in parenthesis. Significant at: *10%, **5%, ***1% level.

FIGURE 1

Virtual value-added exports vs. exports

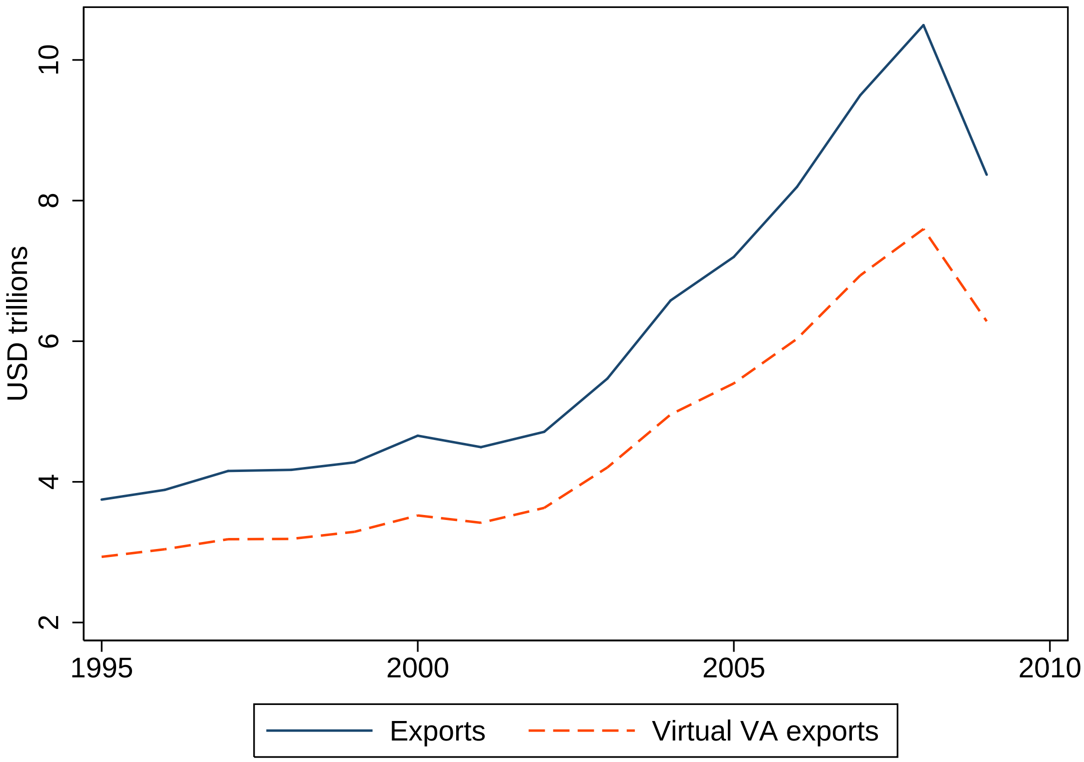


FIGURE 2

Sources of value added in the Dreamliner

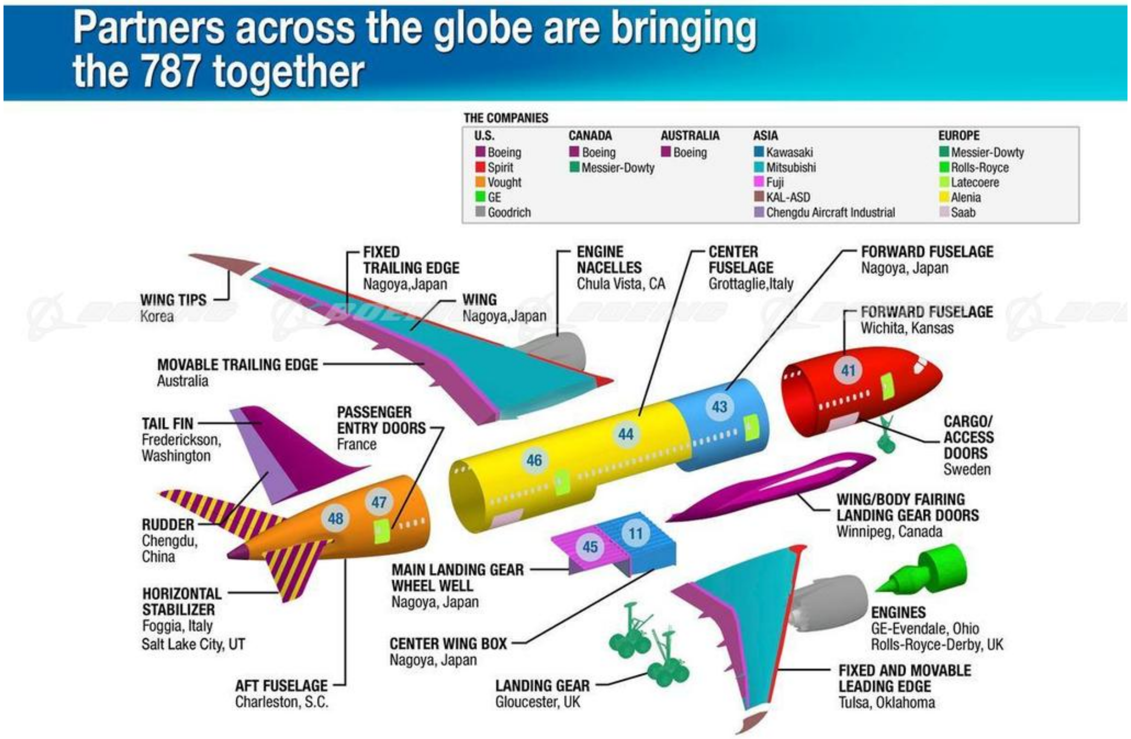


FIGURE 3

Virtual trade in value added

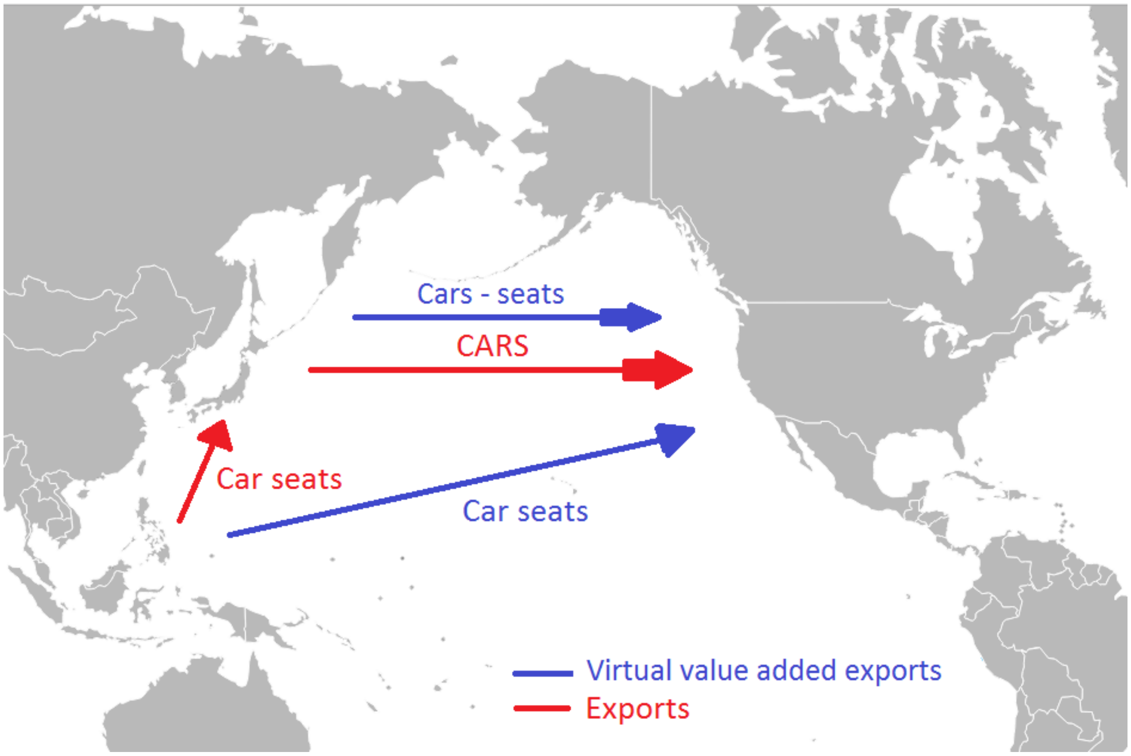


FIGURE 4

Country coverage

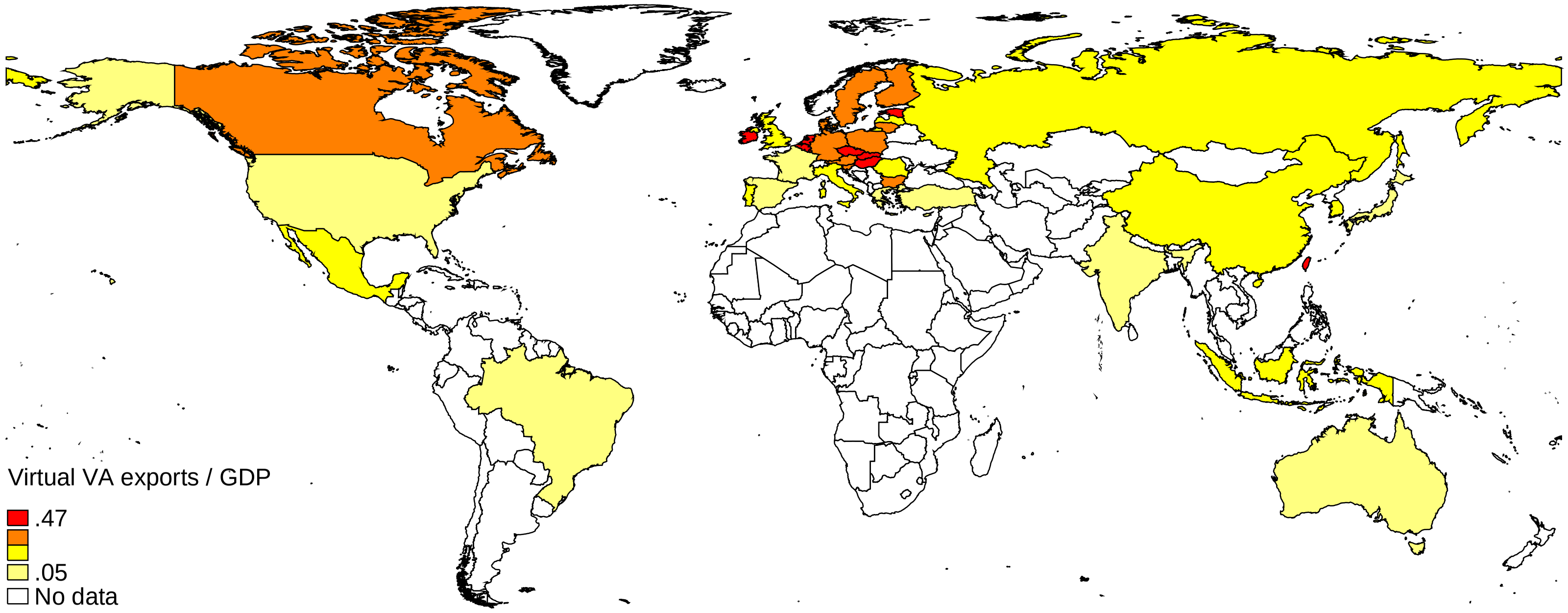
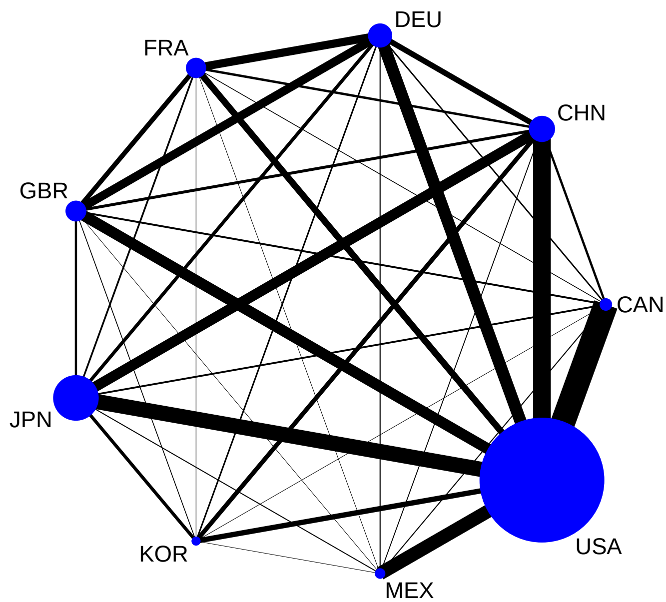


FIGURE 5

Virtual VA exports



Exports

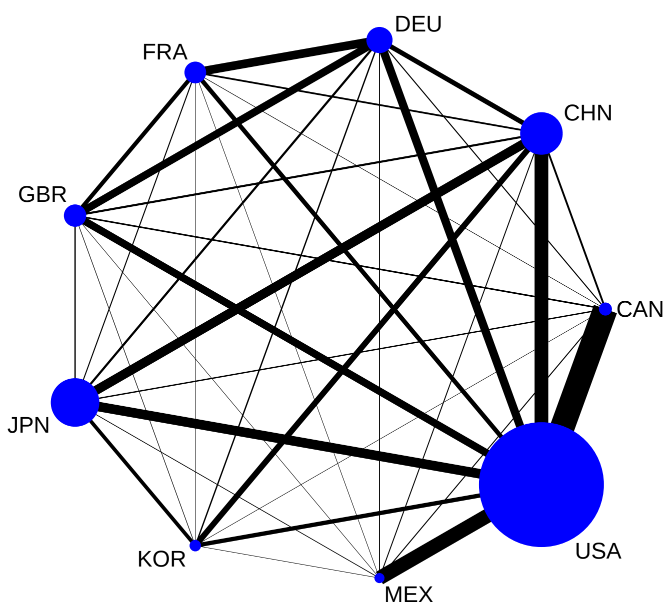
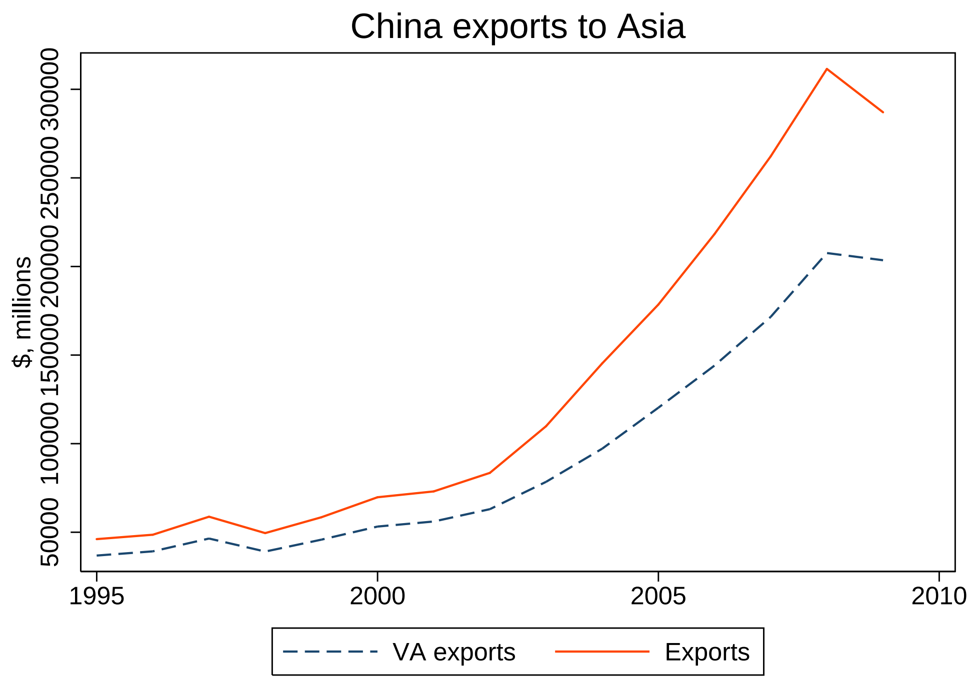


FIGURE 6

China exports and virtual VA exports



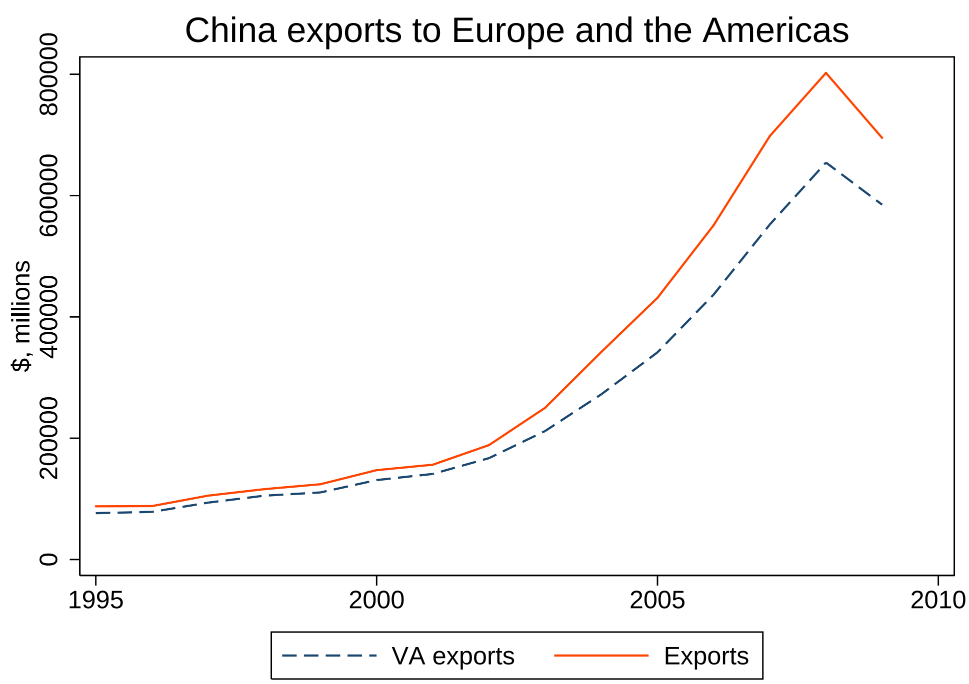


FIGURE 7

China virtual value-added exports vs. exports

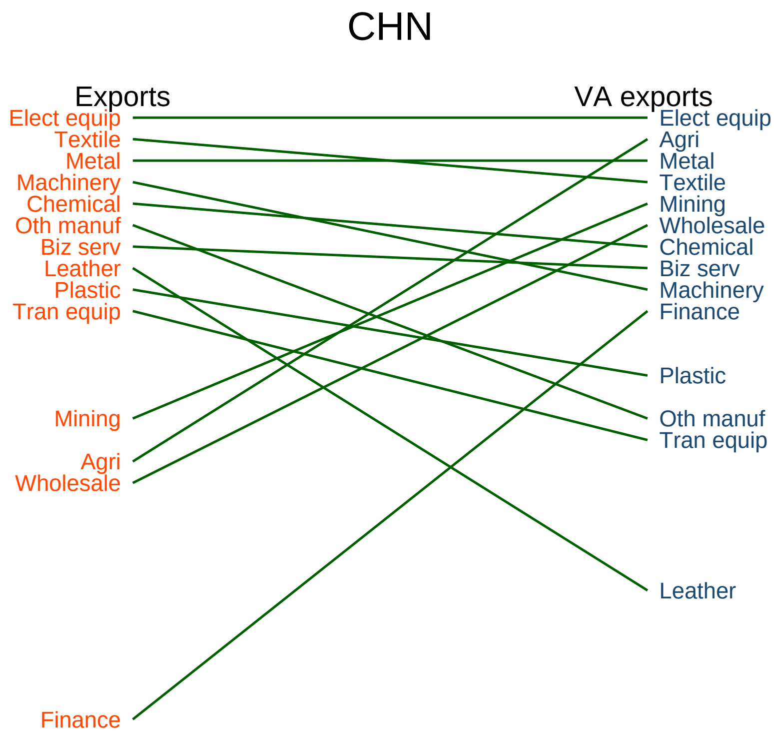
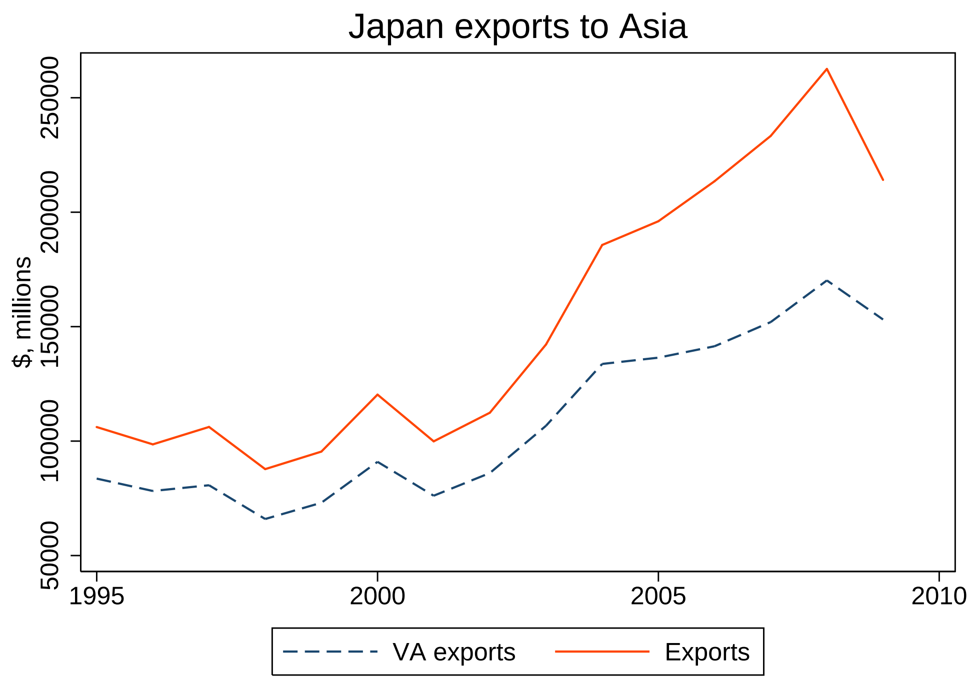


FIGURE 8

Japan exports and virtual VA exports



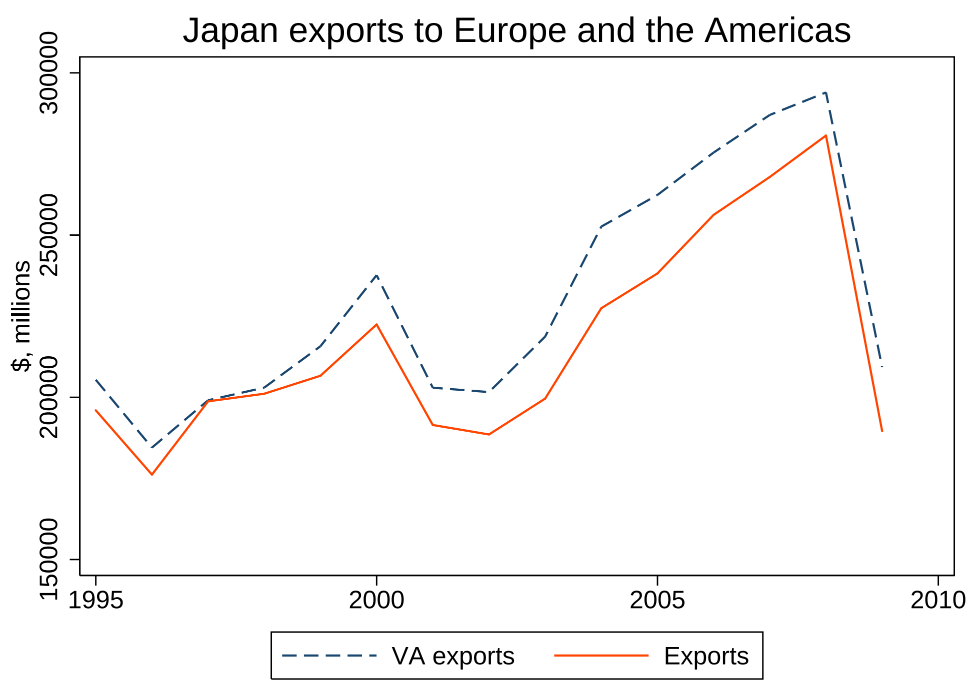


FIGURE 9

Japan virtual value-added exports vs. exports

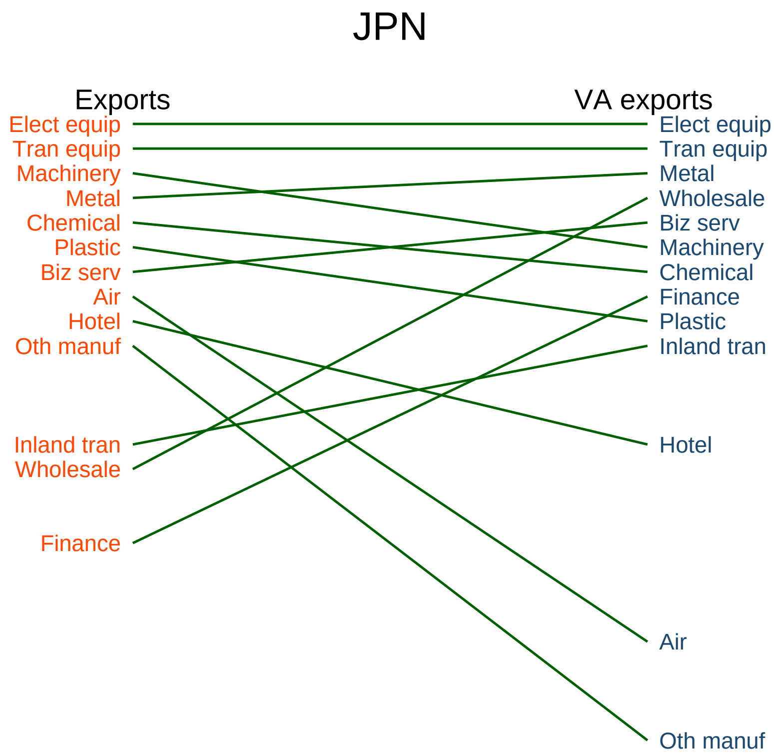


FIGURE 10

Skill intensity across countries and industries

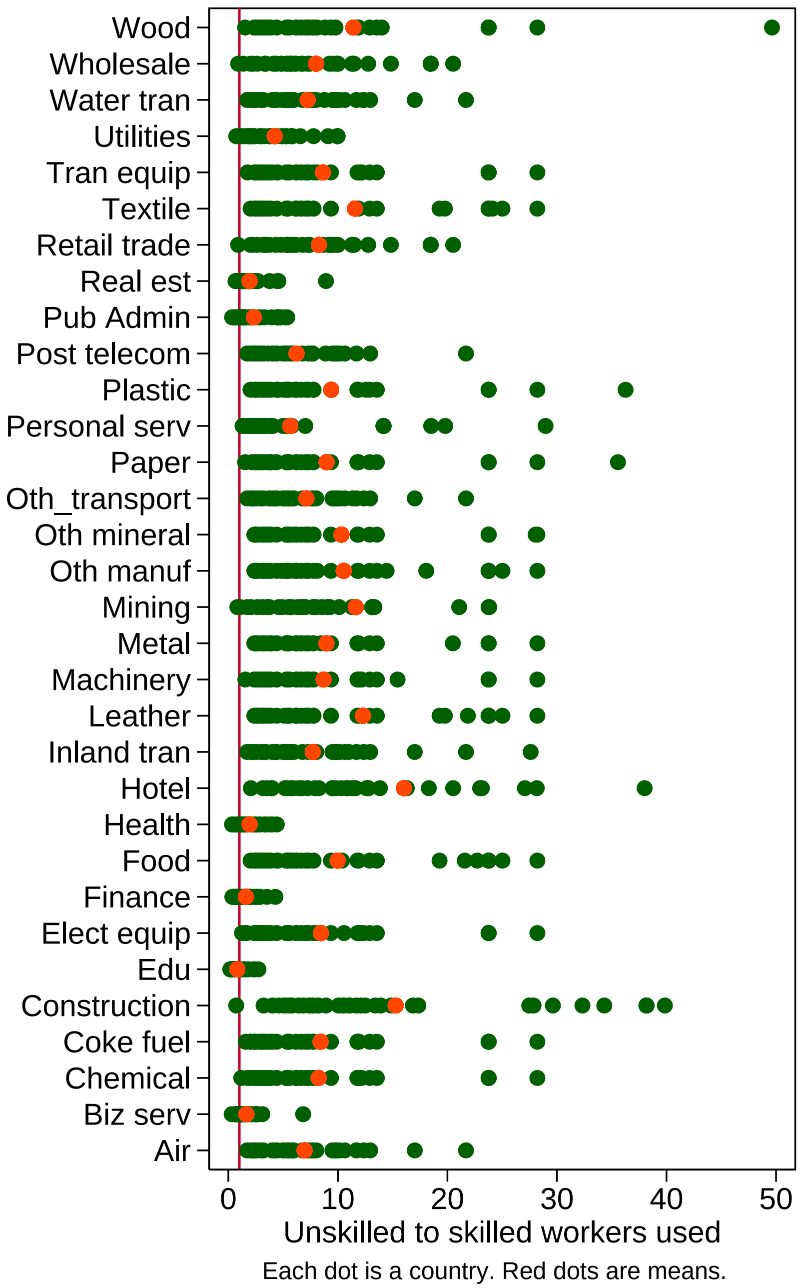
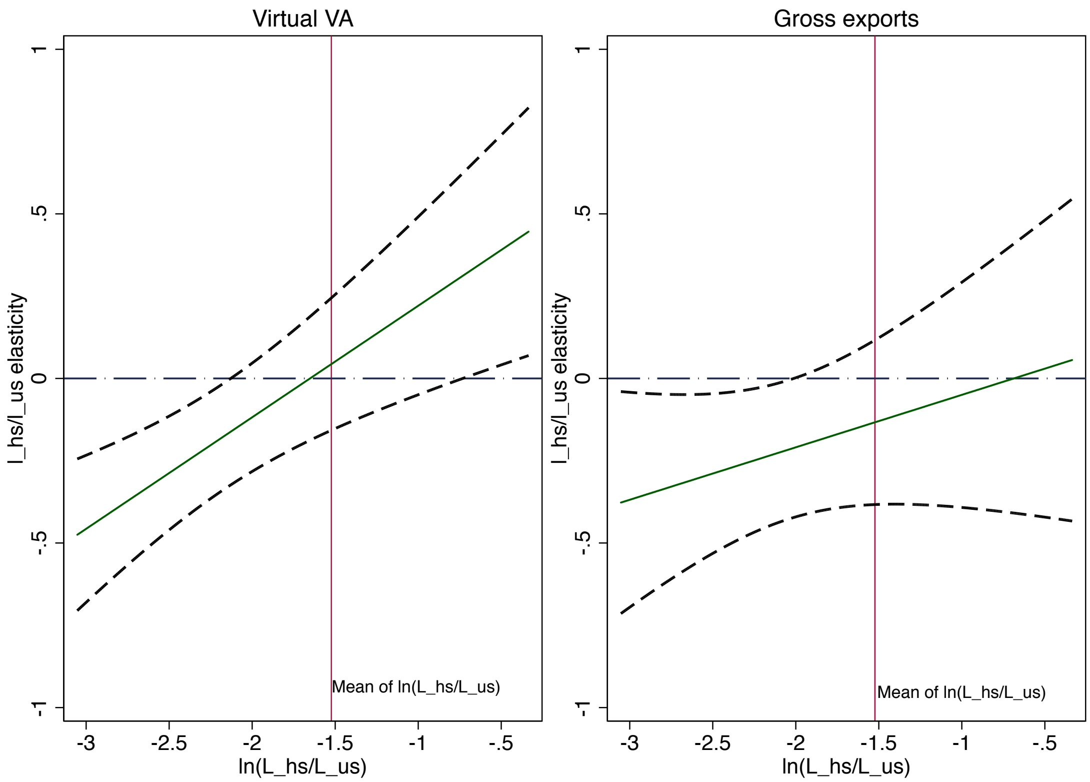


FIGURE 11

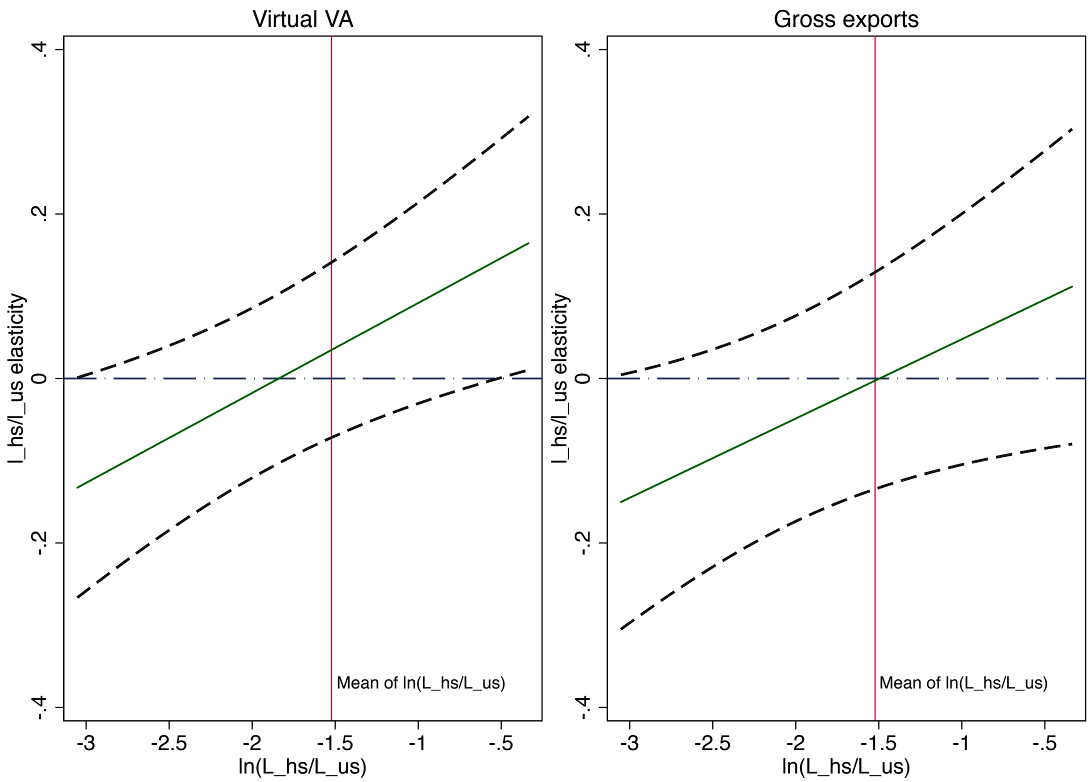
Manufacturing



The solid line is the estimated elasticities. The dashed lines ar 95% confidence intervals.

FIGURE 12

Services



The solid line is the estimated elasticities. The dashed lines ar 95% confidence intervals.