Usefulness of Japan's Extended Input-out Table Incorporating Firm Heterogeneity

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Abstract

This paper demonstrates main features of updated OECD TiVA indicators and examines the usefulness of an extended input-out table (EIOT) incorporating firm heterogeneity of Japanese firms in terms of differences in their ratio of imported intermediate goods to total output. Using such an EIOT, we calculated the vertical specialization indicator of Japan, which corresponds to the foreign value added included in exports. In this process, we measured the differences in intermediate input ratios between different types of firms using firm-level microdata from the Basic Survey of Japanese Business Structure and Activities. Our analysis shows that distinguishing between exporting and non-exporting firms is relevant for assembly industries such as the electronic and automobile industries, as widely discussed in the literature. In contrast, for primary materials industries such as paper, chemical and metal industries, other distinctions appear more important. More specifically, for the chemical industry, where firms tend to have large, integrated manufacturing plants, the differences in intermediate import ratios are largest when distinguishing large firms from small and medium firms. For the paper and metal industries, which rely on foreign raw materials, the difference is largest when distinguishing between firms with and without foreign affiliates. By incorporating such heterogeneity, the vertical specification indicator increases by 70 percent, and thus, the EIOT could the foreign value added more comprehensively.

1. Introduction

This paper demonstrates main features of updated OECD TiVA indicators and examines the usefulness of an extended input-out table (EIOT) incorporating firm heterogeneity of Japanese firms in terms of differences in their ratio of imported intermediate goods to total output. Using such an EIOT, we calculated the vertical specialization indicator of Japan, which corresponds to the foreign value added included in exports.

In this process, we measured the differences in intermediate input ratios between different types of firms using firm-level microdata from the Basic Survey of Japanese Business Structure and Activities. So far, the OECD has proposed taking heterogeneity between exporters and non-exporters, domestically- and foreign-owned, and large and small firms as well as firms with and without foreign subsidiaries into account (Chart 1). We examined which heterogeneity is the most relevant for Japanese industries.

(Table 1) Extended Input-output Table

| | | | Country A | | | | | | Country B | | | | | | Country C | | | | | | Final demand | | |
			Industry 1		Industry 2		Industry 3		Industry 1		Industry 2		Industry 3		Industry 1		Industry 2		Industry 3		A	B	C
			Exporting	Non-exporting	Large	Small	With foreign subsidiarie	Without foreign subsidiarie	Exporting	Non-exporting	Large	Small	With foreign subsidiarie	Without foreign subsidiarie	Exporting	Non-exporting	Large	Small	With foreign subsidiarie	Without foreign subsidiarie			
Country A	Industry 1	Exporting																					
		Non-exp.																					
	Industry 2	Large																					
		Small																					
	Industry 3	With sub.																					
		Without																					
Country B	Industry 1	Exporting																					
		Non-exp.																					
	Industry 2	Large																					
		Small																					
	Industry 3	With sub.																					
		Without																					
Country C	Industry 1	Exporting																					
		Non-exp.																					
	Industry 2	Large																					
		Small																					
	Industry 3	With sub.																					
		Without																					
Value added																							
Total output																							

Source: Authors' design based on OECD 2015.

2. Main feature of updated OECD TiVA indicators

In December 2021, the OECD updated its TiVA indicators. The TiVA indicators now include data until 2018. The share of foreign value added (Figure 1) demonstrates the contributions of foreign countries in a country's exports. The shares of EU, Japan and US hover between 10 and 15 percent. The China's share has turned from downward to upward trend. This might be due to the recent development of inter-country production networks by Chinese firms, in the same way

as those of EU, Japan and U.S., after developing domestic production network to provide for substitutes of imported intermediate inputs.

Figure 1. Share of Foreign Value added included in exports
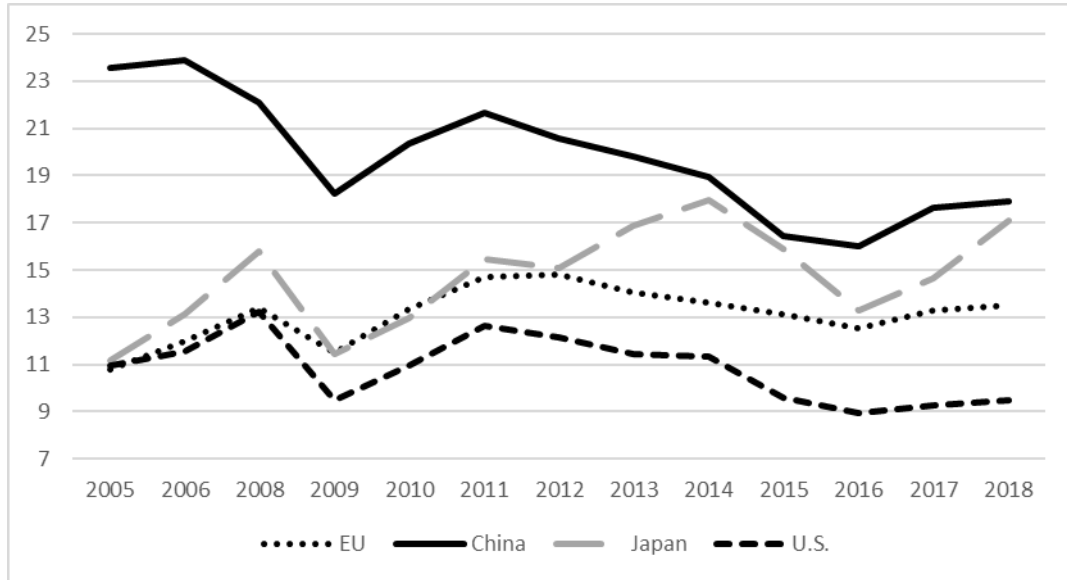
Source: OECD. Stat.

3. Heterogeneity to be incorporated in EIOT

In many developing and emerging economies as well as highly internationalized developed economies, foreign-owned firms play a significant role in international trade, so that it is useful to distinguish between foreign- and domestically-owned firms. That said, in Japan, foreign-owned firms do not play a pivotal role in international trade, and therefore, this distinction may be less relevant than in other countries.

In contrast, the distinction between firms with and without foreign subsidiaries is relevant. We examined the share of exports and imports accounted for firms with foreign subsidiaries. The results are shown in Figure 2 and indicate that for Japan, firms with foreign subsidiary corporations account for more than 95% of all exports and imports, which is considerably higher than for France and the U.K.

Figure 2: Share of firms with and without foreign subsidiaries in exports and imports (2017)
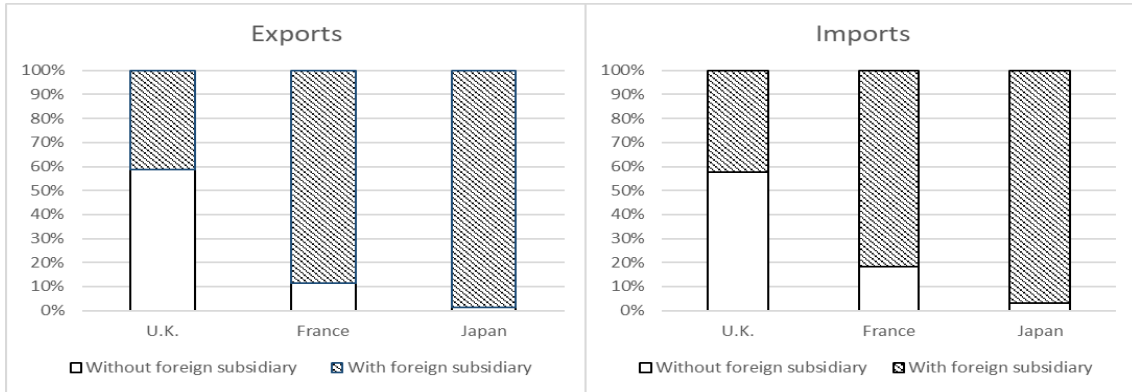
We therefore calculated the differences in the intermediate import ratio between firms with and without foreign subsidiaries. The results are presented in Figure 3 and show that in the metal and paper industries difference between firms with and without foreign subsidiaries are larger than those between exporters and non-exporters as well as those between small and large firms. This reflects that metal and paper corporations, which need to import materials, have established subsidiaries to explore and mine raw materials or grow and harvest wood. In contrast, distinguishing between exporting and non-exporting firms is relevant for assembly industries such as the electronic and automobile industries, as widely discussed in the literature. For chemicals industry, distinguishing large and small firms is the most relevant.

Figure 3: Differences in intermediate import ratios between firms
with and without-foreign-subsidiaries
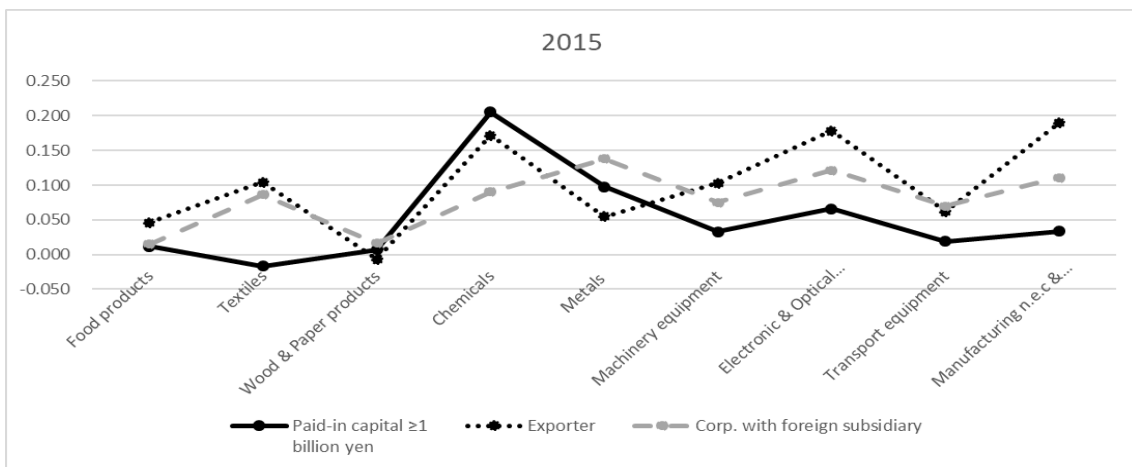
4. Compilation of EIOT

Based on above-mentioned analyses, we compiled an EIOT that incorporates these aspects of firm heterogeneity (Table 2). Our analysis demonstrated that that differences in industries' intermediate import ratios are mainly due to the import of goods that an industry produces, we assume that such differences derive from differences in within-industry imports. We therefore reflect differences in intermediate import ratios in the diagonal cells (the shaded parts in Table 6).

Table 2: 2015 Extended domestic IO and import tables (in billion yen)

Extended domestic table

	3		4		5		6		7		8		9		10		11	
	Exporting	Non-exporting	Exporting	Non-exporting	With foreign subsidiaries	Without foreign subsidiaries	Large firms	Small firms	With foreign subsidiaries	Without foreign subsidiaries	Exporting	Non-exporting	Exporting	Non-exporting	Exporting	Non-exporting	Exporting	Non-exporting
1	1,964	3,864	0	0	69	169	3	1	0	0	0	0	0	0	0	0	5	2
2	0	0	0	0	2	4	210	52	15	21	0	0	0	0	0	0	0	0
3	1,694	3,332	0	0	5	12	92	23	0	0	0	0	0	0	0	0	1	0
4	8	17	159	380	12	30	63	16	11	15	22	9	61	19	50	12	15	6
5	298	587	18	10	1,052	2,563	518	128	41	57	89	36	267	84	97	23	130	52
6	380	748	209	119	309	753	11,666	2,872	282	387	836	339	1,544	483	2,178	522	321	127
7	173	340	5	3	80	194	541	133	6,781	9,297	3,359	1,361	2,065	646	3,385	812	169	67
8	0	0	0	0	4	10	51	12	9	12	2,986	1,210	264	82	329	79	5	2
9	0	0	0	0	1	2	1	0	13	18	954	387	4,777	1,494	1,681	403	33	13
10	0	0	0	0	0	0	0	0	0	0	6	2	0	0	18,379	4,409	0	0
11	14	27	8	4	32	77	96	24	156	213	12	5	20	6	20	5	42	16
Total output	12,920	25,421	2,281	1,305	4,926	12,001	52,557	12,937	20,197	27,690	24,244	9,823	26,705	8,350	44,663	10,715	3,307	1,307

Extended import table

	3		4		5		6		7		8		9		10		11	
	Exporting	Non-exporting	Exporting	Non-exporting	With foreign subsidiaries	Without foreign subsidiaries	Large firms	Small firms	With foreign subsidiaries	Without foreign subsidiaries	Exporting	Non-exporting	Exporting	Non-exporting	Exporting	Non-exporting	Exporting	Non-exporting
1	559	1,101	18	11	36	88	163	40	0	0	0	0	0	0	0	0	40	16
2	4	7	1	0	14	34	8,129	2,001	538	737	1	0	2	1	5	1	3	1
3	1,065	884	5	3	1	2	87	21	0	0	0	0	0	0	0	0	7	3
4	4	9	175	131	12	28	43	11	2	3	7	3	14	4	25	6	7	3
5	12	24	1	1	390	372	33	8	3	5	4	2	10	3	5	1	21	8
6	81	159	84	48	29	71	4,582	1,213	32	44	84	34	197	62	233	56	55	22
7	2	4	1	0	9	22	45	11	1,598	1,042	218	88	661	207	484	116	11	4
8	0	0	0	0	0	0	0	0	3	4	838	582	11	3	75	18	1	0
9	0	0	0	0	1	2	0	0	5	7	426	173	2,403	1,495	487	117	23	9
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,145	915	0	0
11	2	4	20	11	2	5	5	1	3	4	15	6	8	3	10	2	89	23
Total	1,730	2,191	305	205	494	624	13,087	3,307	2,184	1,845	1,593	889	3,307	1,778	2,471	1,233	255	89

1:Agriculture	2:Mining	3:Food	4:Textiles	5:Paper	6:Chemicals	7:Metal	8:Machinery	9:Electronics	10:Transport equipment	11:Other manufacturing

Source: Authors' calculations based on the Benchmark IOT and firm-level data of the Basic Survey of Japanese Business Structure and Activities, METI.

7. Usefulness of the EIOT

The roots of the development of TiVA indicators can be traced back to the estimation of vertical specialization (hereafter, VS) indicators (Hummels et al. 1999). VS indicators are calculated as the ratio of imported intermediate goods included in exports and are estimated using OECD IOTs. The VS indicator corresponds to foreign value added included in exports in the TiVA. We calculated VS indicators based on Japan's benchmark IO (Table 3). The results show that the VS indicator based on the extended IOT (34.3%) is 70% larger than that based on the non-extended

IOT (20.5%). This implies that the extension of IOTs incorporating differences in intermediate import ratios makes it possible to more comprehensively capture vertical specialization and, potentially, foreign value added.

Table 3: VS indicators calculated from the extended and non-extended IOTs

Industry	Extension elements	Calculation based on extended IOT				Calculation based on non-extended IOT						
		Industry total of VS coefficient	Exports	Amount of VS	VS indicator	Industry total of VS coefficient	Exports	Amount of VS	VS indicator	Domestic value Added included in imported intermediates	Amount of VS after deducting domestic value added	VS indicator after deducting domestic value added
Agriculture		0.17	0	0		0.12	0	0		0.6%	0.0	
Mining		0.10	33	3		0.07	33	2		0.5%	2	
Food	Exporting	0.43	155	66		0.18	155	29		1.2%	28	
	Non-exporting	0.38	0	0								
Textile	Exporting	0.96	131	126		0.24	131	32		1.6%	31	
	Non-exporting	0.41	0	0								
Paper	With foreign subsidiaries	0.47	289	135		0.16	375	60		0.9%	59	
	Without foreign subsidiaries	0.42	86	36								
Chemical	Large	0.54	6,811	3,673		0.36	7,521	2,679		1.8%	2,630	
	Small	0.55	711	388								
Metal	With foreign subsidiaries	0.35	2,866	1,014		0.16	4,535	739		1.9%	725	
	Without foreign subsidiaries	0.31	1,669	521								
Machinery	Exporting	0.34	8,685	2,943		0.16	8,685	1,348		7.1%	1,253	
	Non-exporting	0.36	0	0								
Electronics	Exporting	0.43	14,294	6,200		0.25	14,294	3,536		8.2%	3,245	
	Non-exporting	0.52	0	0								
Transport equipment	Exporting	0.42	22,919	9,644		0.21	22,919	4,756		4.3%	4,552	
	Non-exporting	0.48	0	0								
Other manu-facturing	Exporting	0.52	526	275		0.16	526	86		7.9%	79	
	Non-exporting	0.51	0	0								
Electric, gas and water		0.31	23	7		0.30	23	7		0.8%	7	
Construction		0.08	23	2		0.10	23	2		1.5%	2	
Wholesale and retail		0.09	18,051	1,602		0.15	18,051	2,650		1.2%	2,618	
Transportation and warehouse		0.12	158	20		0.08	158	13		2.7%	13	
Finance and insurance		0.08	0	0		0.06	0	0		1.1%	0	
Real estate and leasing		0.05	16	1		0.04	16	1		1.0%	1	
Community, society and individual services		0.09	278	25		0.07	278	21		2.4%	20	
Total		9.50	77,725	26,680	34.3%	2.87	77,725	15,961	20.5%	2.1%	15,632	20.1%

Source: Authors' calculations based on the Benchmark IOT, firm-level data of the Basic Survey of Japanese Business Structure and Activities, METI, and OECD TiVA indicators.

OECD TiVA indicators show that Japan's foreign value added included in exports is about 15%. Despite the similarity of the underlying concept of the VS indicator and foreign value added, the former is 30% larger than the latter. This gap may be caused by the fact that the VS indicator we calculated in this paper is based on one country's IOT and therefore does not exclude the domestic value added included in imported intermediate goods, which is not negligible in machinery industries. If we deduct the domestic value added included in imported intermediate goods using corresponding data from the OECD TiVA indicators, the VS indicator is reduced slightly to 20.1%. In order to calculate the foreign value added included in imported intermediate goods in this way, we need to take data of Japan's trade partners into account and make them endogenous in the analysis. This means that we need an international IOT.