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【要旨】
近年の海外直接投資がネットワーク型になっていることを日本のデータを用いて検証した。Baldwin=Okubo(2014)において強調されたネットワークFDIの概念を基に販売調達ボックスダイアグラムを拡張し分析した。

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Networked FDI and third-country intra-firm trade*

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Abstract

In the wave of globalization, foreign direct investment (FDI) is networked. Affiliates locate across countries and trade among them. This paper investigates the FDI networks, in particular, third-country intra-firm trade using the Japanese foreign affiliate data. We find active third-country sales and sourcing within the firm boundary, but only large firms tend to construct production networks. Driving forces for FDI networks are in the allocation of ownership and human resources by parent firms.

JEL Classification: F12, F15

Keywords: multinational firms, networked FDI, intra-firm trade, sales and sourcing, third-country

1 Introduction

In the wave of globalization, firms multinationally operate in search of cost efficiency, larger market, higher technology and abundant human resources. In the international trade literature, multinational firms (foreign direct investment, FDI) are traditionally categorized as two types, i.e., horizontal and vertical. Horizontal FDI is aimed at seeking a large local market with avoiding transport costs, so-called "market seeking" (e.g., Markusen, 1984). On the other hand, vertical FDI is aimed at saving costs by exploiting lower production cost by dispersed production stages, so-called "efficiency seeking" (e.g., Helpman, 1984). Beyond such a two-way decomposition, this paper provides some evidence on the network structure of foreign affiliates and studies the role of allocation of ownership and human resources across foreign affiliates using the Japanese FDI data.

Subsequent studies in the literature find horizontal FDI to be dominant (Carr et al., 2001; Blonigen et al., 2003; Markusen and Maskus, 2002; Irarrazabaly et al., 2013). Some more

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recent studies found that horizontal and vertical FDIs are mixed. Feinberg and Keane (2006) and Alfaro and Charlton (2009) found that few parent–affiliate pairs can be categorized as pure horizontal or vertical FDIs. Some other studies reveal the complexity of such two-way decomposition and propose new concepts beyond vertical vs horizontal FDIs. For instance, Hanson et al. (2001, 2005) provide three more FDI motives for (i) producing for export to third countries (export-platform FDI), (ii) adding value to inputs sourced from their parents and (iii) working as wholesale distributors. Yeaple (2003a, 2003b) found that many affiliates are mixed motives and can be placed in all FDI categories, named "*complex FDI*." Ekholm et al. (2007) proposed export-platform FDI. To summarize such complexity of FDIs, Baldwin and Okubo(2014) proposed the concept of "*networked FDI*" by showing a sales–sourcing box diagram to emphasize the importance of third-country sales and sourcing in particular since the 2000s. As emphasized by all of these previous studies, recent FDI cannot be categorized by two types and foster foreign affiliate networks across multiple countries. Our paper is in this line. Our paper shows sales and sourcing patterns of foreign affiliates located in multiple countries in the networked FDI, in particular, sales and sourcing with other affiliates in the same firm located in third countries and with their parent firm in Japan (i.e., intra-firm trade with third countries and with Japan).

Current studies using firm- or plant-level data in the international trade literature have documented that FDI and/or export firms tend to be larger, more productive and have a higher capital–labor ratio than purely domestic firms (e.g., Bernard et al., 2007a,b). The theoretical explanations for this are related to trade costs and market entry costs that make it more difficult to sell in foreign markets (Melitz, 2003; Helpman et al., 2005). Only the most productive firms find it profitable to pay beachhead costs for exporting and/or FDI. Using microdata, several studies provide some empirical evidence that only productive firms engage in FDI (Girma et al., 2005 for the UK; Wagner, 2006 for Germany; Head and Ries, 2003 for Japan).

Furthermore, as shown in Antras and Helpman (2004) by the contract theory of multinational firms, only large firms are allowed for affiliate–parent trade. Large multinationals can use intra-firm trade (trade of goods across affiliates within the firm boundary) rather than inter-firm trade (trade of goods outside the firm boundary). Once currently seen "*networked FDI*" is considered, beyond such parent–affiliate trade, they will heavily trade among affiliates across third countries within the firm boundary. The intra-firm trade could be formed by the structure of the network, i.e., not only parent and affiliate relationship but also the allocation of intangible assets and ownership across affiliates by parent firms.

Apart from a series of discussions on FDI, some studies investigate the formation of international production networks. The theory on production networks so-called fragmentation was first proposed by Jones and Kierzkowski (2001). Baldwin and Venables (2013) built a "snake and spider" theory of vertical linkage of production.[1] Regarding firm organization and produc-

[1] Baldwin and Okubo(2019) investigated global value chain (GVC) and dynamic comparative advantage using a simple model à la Baldwin and Venables (2013).

tion networks, according to Baldwin (2008), larger firms are more likely to unbundle production processes and corporate functions. Only large firms are allowed to construct global production networks where they concentrate corporate functions at headquarters offices and separate production lines. Their production lines are relocated to foreign countries via FDI. Thus, while some large foreign affiliates play a role in the hub of production, some other small affiliates work as the spokes of the production networks with support for production of the hub. In this hub–spoke affiliate network structure, the allocation of intangible assets and ownership is crucial in understanding trade flows within the firm boundary. Ownership and human resources could be intensively allocated to the hub affiliates by the parent.

However, relatively unknown in the FDI literature is intra-firm trade among foreign affiliates and the relationship between intangible asset and intra-firm trade in networked FDI. This paper sheds light on this issue. The question is addressed how the FDI network promotes intra-firm trade among affiliates and how this is affected through allocation of human capital and ownership. Closely related to our paper, Ramondo et al. (2016) investigated intra-firm trade between the parent and affiliates in US multinational firms. They found that intra-firm trade is concentrated among a small number of large affiliates and the median affiliates never engage intra-firm trade and parent–affiliate relationship yields upstream and downstream industries. This is similar to our findings. However, their focus remains on the traditional decomposition of two types of FDI, i.e., parent–affiliate relationship with verticalness. By contrast, our perspectives are 1) networks of affiliates across countries and thus intra-firm trade with third countries and 2) allocation of human resources and ownership as a driving force for networked FDI.

Antras and Foley (2015) produced another paper related to ours. Using US data, they examined the impact of the Asian Free Trade Agreement (AFTA) on affiliates and found that AFTA raised the number and size of affiliates in the areas as well as the share of sales to third countries. In this sense, AFTA fostered affiliates' networks rather than just parent–affiliate linkages. Although their focus on the sales pattern of affiliates is similar to ours, they did not investigate sourcing patterns. By contrast, our paper investigates both sales and sourcing patterns.

Our paper also has implications for the third-country effect (Baltagi et al., 2007; Blonigen et al., 2007; Garretsen and Peeters, 2009), although we do not use spatial econometrics and our focus is exports to and imports from third countries by foreign affiliates.

We note that although intra-firm trade among affiliates associated with the allocation of ownership and human resource is not well-known in the FDI literature, the industrial organization literature has a few studies related to this. Using US firm-level data, Atalay et al. (2014) found that transactions of goods among plants in upstream and downstream relations within the firm boundary are extremely rare and plant/firm size is the strongest determinant for vertical ownership. They proposed that the provision of corporate intangible inputs from the headquarters determines which plants are owned by vertically linked firms. In terms of

the firm organization in production networks, some studies investigated the separation of headquarters and plant and the decision for multiple plants (e.g., Davis and Henderson, 2008). By contrast, our paper is on foreign affiliates of multinationals. Unlike them, we do not focus on firm organization and network formation, that is, location choice of plants/headquarters nor organizational decisions for multiple plants and separation of headquarters and plant. Our focus is on intra-firm trade flows across foreign affiliates or inter-firm trade, given the location of foreign affiliates and given firm organization. More precisely, our interest is foreign affiliates' sales and sourcing within or outside the firm boundary as well as sales and sourcing in local, third countries or Japan.

There are several advantages to using the Japanese FDI data. First, the Japanese FDI is active. Many Japanese manufacturing firms form FDI networks in Asia, Europe and North America. Second, unlike US data, our data covers both sales and sourcing by destinations (Japan, local and third countries) for all foreign affiliates owned by Japanese firms. Third, our data distinguish intra-firm and inter-firm sales and sourcing by destinations, which is available for only a few years. We note that years of the data used in Baldwin and Okubo (2014) are unavailable for such information. For this reason, they did not investigate intra-firm vs inter-firm trade. We note that while Baldwin and Okubo (2014) mainly proposed the concept of networked FDI by showing sectoral-level data, they did not conduct microlevel investigations nor study firm heterogeneity, in sharp contrast with our paper.

In this paper, using the Japanese foreign affiliate data, we document stylized facts and simple regressions concerning third-country exports and imports by Japanese foreign affiliates. Section 2 provides data and some stylized facts. Section 3 provides a sales–sourcing box diagram and Section 4 investigates networked FDI. Section 5 reports simple estimation results. The final section is for concluding remarks.

2 Stylized Facts

2.1 Japanese FDI Data

Our data include extensive firm-level information on Japan's foreign affiliates, which is called "The Survey on Overseas Business Activities" prepared by the Research and Statistics Department of the Japanese Ministry of Economy, Trade and Industry (METI) "*Kaigai Jigyou Katsudou Kihon Chousa*" in Japanese. The yearly survey is conducted by METI using a questionnaire based on survey forms and covers all Japanese affiliates in all sectors and in all host countries, whose parents' firms are all sectors except some services. The parent firms and their foreign affiliates are surveyed. This dataset provides information on a representative selection of Japanese operated firms. To be eligible for inclusion in the survey, we use around 1053 manufacturing firms and their 4507 affiliates (incl. subaffiliates). The sector classifications used in the

survey do not correspond to international practices such as UNIDO and OECD classifications, but they can be broken down into 55 sectors in 2002.[2]

The survey questions cover a variety of variables such as the number of employees, capital assets, purchases, wage payment, ownership ratio and sales. More importantly, the questionnaire asks about imports or local purchases of intermediate inputs and raw materials (i.e., sourcing) and exports or local sales of products.

The biggest advantage of using the Japanese foreign affiliate data is to include information on local sales and sourcing, exports and imports of each foreign affiliate as well as third-country exports and imports of each foreign affiliate. Furthermore, some early years include third-country sales and sourcing decomposed by intra-firm trade and inter-firm trade. Only years 1997, 1999 and 2002 are available in intra-firm third-country exports and imports. We use the data for the year 2002.

The reasons for using the year 2002 are the following. The first and main reason is data availability. After 2002, the data on intra- and inter-firm third-country exports and imports are not available. Second, according to Baldwin and Okubo (2014), the 2000s is the starting period of networked FDI while the 1990s is still the period of traditional FDI, i.e., either horizontal or vertical. That is, in the 1990s sourcing and sales are local but not in third countries and thus FDI is classified as where affiliates sell at home country or host country. Third, the years 2000 to 2005 is the period of completing Asian production networks (Escaith and Inomata, 2013). It is much easier to identify the production networks as well as intra- and inter-firm trade.

Our paper uses all foreign affiliates by Japanese manufacturing parent firms. Affiliates include all sectors including services, although their parents are manufacturing sectors.

2.2 Overview of the Japanese FDI

Table 1 overviews the Japanese FDI. Table 1 reports FDI destinations. First, the main destination of the Japanese FDI is Asia. 2560 out of 4507 affiliates are located in Asia. Within Asia, China is the largest destination. The next region is Europe, and then North America, where the USA is dominant. In terms of the number of affiliates and employees, Asia accounts for around 50%. Table 2 reports affiliate sectors.[3] Machinery is a major FDI sector. Industry machinery and equipment (sector code 31), Electronic application devices (35), Communication equipment and related products (36), Motor vehicles (40) and Parts for motor vehicles (41) are, in particular, large sectors. Services such as Wholesales (affiliate sector code 48) are also a large portion. The Japanese FDI is biased to some specific destinations and sectors.

[2] See Appendix Table for industrial classification and definition.

[3] See Appendix Table for code and definition for sectors.

3 Augmented Sales–sourcing Box Diagram

First, we start from a traditional discussion of FDI types, e.g., horizontal and vertical FDIs. Baldwin and Okubo (2014) proposed the sales–sourcing box diagram on foreign affiliates' trade where all kinds of FDIs such as horizontal and vertical FDIs, export platforms can be plotted in a small box with two dimensions, i.e., local sales share and local sourcing share of affiliates. Figure 1 displays the concept. The vertical axis is the local sales share in total sales of foreign affiliates while the horizontal axis is the local sourcing share in total sourcing. Each dot indicates sectoral local sales share and local purchase share. We note that sourcing is defined as the purchase of intermediate inputs for production, but it does not include labor, land, human resources and technology. Consider horizontal FDI. Horizontal FDI is aimed at selling products at the local market, so-called market-seeking FDI. So, it would be located in the corner of North-East, i.e., 100% local sourcing and 100% local sales. On the other hand, consider vertical FDI. Pure vertical FDI is aimed at efficiency seeking and locates on the edge of the West. Furthermore, export-platform FDI is required to export all products produced at the affiliate to third countries, and thus 0% local sourcing and 0% local sales. It would be located at the origin point. Then, networked FDI can be defined as the central area, i.e., some percentages of local sourcing and sales. This notion includes fragmentation and global value chains.[4]

Using the sales–sourcing box diagram, Figure 2 plots our year 2002 data at the sectoral level. Many sectors can be categorized as networked FDI, which is fairly consistent with the year 2005 in Baldwin and Okubo (2014). No sectors can be categorized as pure vertical and horizontal FDI any more, almost all sectors are mixed in FDI types. The right panel of Figure 3 augments the diagram by adding the magnitude of intra-firm trade, where the size of the bubble indicates the size of intra-firm trade (intra-firm sourcing and sales shares in total sales and sourcing of affiliates). A large (small) bubble indicates a high share of intra-firm (inter-firm) trade. We find that many sectors in networked FDI tend to be larger bubbles. That is, networked FDI sectors largely depend on intra-firm trade rather than inter-firm trade. Furthermore, we dig into intra-firm trade. An extension is shown as the right panel of Figure 3, where the size of third-country intra-firm trade (share of intra-firm sourcing from and sales to third countries in total sales and sourcing) is now indicated as bubbles. Third-country intra-firm trade tends to be larger in the networked FDI. Therefore, we can conclude that networked FDIs construct production networks across countries associated with third-country intra-firm trade, i.e., third-country sales and sourcing within the firm.

[4] See Baldwin and Okubo (2014) for the concept of the networked FDI and sales–sourcing box diagram for more detail.

4 Networks of Foreign Affiliates

4.1 Sales and Sourcing of Affiliates

Now, we turn from sectoral-level FDI classification to microlevel affiliate activities. Sales and sourcing patterns are investigated.

Sales and sourcing patterns Table 3 reports the sales and sourcing patterns of all affiliates.

Local sales share in total sales accounts for 67%, while sales to Japan account for 16% and third countries is 17%. Local sourcing share in total sourcing is 41%, while sourcing from Japan is 43% and sourcing from third countries is 16%. Local sales (67%) is much larger than local sourcing (41%), while sales in Japan (16%) is much smaller than sourcing from Japan (43%). The pattern on the sales side is more asymmetric than that of the purchase side. Foreign affiliates tend to purchase more from Japan and sell more in host countries. In addition, sales and sourcing to third countries are both around 16–17%, which is not negligible.

Decomposition by intra-firm and inter-firm trade Once we decompose intra-firm and inter-firm trade, sales and sourcing patterns are even more asymmetric. Table 4 reports affiliate-level sales and sourcing share. Sales to other affiliates within the firm, i.e., intra-firm trade, account for 24% while sales to nonaffiliates, i.e., inter-firm trade, accounts for 76%. We note that inter-firm trade includes sales to final consumers. Sourcing from other affiliates within the firm, i.e., intra-firm trade, accounts for 43% while sourcing from nonaffiliates, i.e., inter-firm trade, accounts for 57%. intra-firm trade is more often seen in sourcing than sales.

Next, intra-firm trade in sales is composed of sales to parents in Japan (12%) and to affiliates in third countries (6%) and local sales (5%). Turning to inter-firm trade, sales to Japan account for 3% and sales to third countries account for 11%, and local sales are 62%. In the median point (p50), inter-firm sales share for local is 83%, while all other shares are zero. Thus, this indicates that all intra-firm trade as well as the inter-firm trade with third countries and Japan concentrate on a small number of affiliates. This is similar to the findings of Ramondo et al. (2016).

Turning to the sourcing side, intra-firm trade in sourcing is composed of sourcing from parent firms in Japan (30%) and from affiliates in third countries (9%), and local sourcing (4%). In terms of inter-firm trade in sourcing, sourcing from Japan accounts for 13% and sourcing from third countries accounts for 7% and local sourcing 37%. In the median point (p50), compared with the sales side, the skewness is smaller. However, intra- and inter-firm trade with third countries are zero. Thus, this indicates that third-country trade concentrates on a small number of affiliates. Therefore, a small number of affiliates dominate sales and sourcing in third-country trade.

While inter-firm trade is dominant in total sales (76%), sourcing patterns are almost equal between inter-firm (43%) and intra-firm trade (57%). In other words, compared with sales, sourcing relatively hinges on intra-firm trade. In particular, sales to the local market by inter-firm trade is dominant, 62%, and sourcing from parents in Japan tends to be dominant, 30%. Roughly, affiliates tend to source from parents in Japan and then they tend to sell to nonaffiliate firms locally. Sales to third countries are 6% for intra-firm trade and 11% for inter-firm trade, while sourcing from third countries is 8% for intra-firm trade and 7% for inter-firm trade. This is not a negligible share, but skewness is high and thus a small number of affiliates dominates third-country trade.

Firm size matters We decompose by firm size, measured by employees in the Japanese parent firms (Table 5). First, on the sales side, larger firms tend to engage the larger third-country intra/inter-firm trade and smaller Japan intra/inter-firm trade. In particular, intra-firm sales in third countries and in Japan increase with firm size. Second, the sourcing side has a rather unclear relationship in terms of firm size. Next, we decompose by the number of foreign affiliates (Table 6). Third-country sales and purchase both increase with the number of foreign affiliates. In particular, intra-firm third-country sales clearly increase with the number of affiliates. Therefore, firm size matters in intra-firm third-country sales. This can be explained by the mechanism of Helpman et al. (2004) and Antras and Helpman (2004). Because the larger firms are more profitable, they can pay more fixed FDI costs and fixed export costs and thus can construct production networks, resulting in more affiliates in more countries and trade with each other within a firm.

4.2 Location Patterns of Affiliates

Figure 4 shows a firm's probability of locating an affiliate in a country in terms of the number of foreign affiliates. The horizontal axis is the number of foreign affiliates and the vertical axis is the probability of the location. The probability "1" in a certain country indicates that all firms choose the country and at least one affiliate is located there. Each country sees different probabilities, although almost all countries increase the location probabilities with the number of affiliates. According to the figure, the USA is the highest. Firms tend to choose the USA as the first FDI destination. If a firm has 10 foreign affiliates, all firms choose the USA and at least one affiliate will be established. The second highest is China. They choose China as the second destination. The third and fourth choices are Thailand and Taiwan. In sum, the order of destinations is almost monotonic, the USA is the first.

4.3 Industry Patterns

Sectoral patterns in the parent–affiliate relationship Next, we investigate whether parent and affiliate are in the same sector. Figure 5 plots sectors of parent (vertical axis) and

affiliates (horizontal axis). Each dot is an affiliate. Many are concentrated on the diagonal, which means that both parent and affiliate are in the same sector. We note that our foreign affiliate data do not cover parent firms in services although affiliates are allowed to be in all sectors including services if their parents are nonservices. Some specific sectors of affiliates see more spread in parent sectors such as machinery, e.g., Industry machinery and equipment (Affiliate sector code 31), Electronic application devices (35), Parts for motor vehicles (41) and Wholesales (48) in affiliates.[5] In the figure, these affiliate sectors' lines have many dots vertically.

Industry mix of affiliates As the number of affiliates increases, the sector combinations have more variety. We calculate the combination of sectors in affiliates at the firm level. The index is calculated as the number of sectors over the number of affiliates. If all affiliates in a firm are in the same sector, the index is $\frac{1}{n}$ where the number of foreign affiliates is n. On the other hand, if all affiliates are in different sectors, the index is 1. As we expected, Figure 6 shows that the index decreases with the number of affiliates. Compared with the case of all the same sector, plotted as a reference line, our index is always higher. More affiliates increase the gap from the reference. Thus, the variety of sectors gradually increases with the number of affiliates.

4.4 Allocation of Ownership and Human Resources

To construct production networks by foreign affiliates, allocation of ownership and human resources by parent firms might be a key. This idea is consistent with the traditional multinational firm theory, OLI paradigm (Dunning, 1981), where ownership advantages and firm-specific assets of parent firms, namely "O" in OLI, are crucial in understanding the organization of multinational firms. "O" includes intangible assets and governance by ownership. Based on this idea, here we consider driving forces for intra-firm trade in affiliates. One possible factor is the allocation of ownership of parent firms. The Japanese parent ownership ratio is a key. Foreign affiliates with a higher ownership ratio are more controlled by parent firms and thus tend to be the hub of production networks, increasing third-country intra-firm trade. Figure 7 shows bin scattered plots in terms of ownership. Higher ownership results in more intra-firm sales and sourcing. The other possibility is the allocation of human resources. This can be measured by the number of Japanese workers in affiliates. They are sent from parent firms in Japan and can be considered as a transfer of know-how or tacit knowledge from parent to affiliates. Figure 8 shows bin scattered plots in terms of Japanese workers. The intra-firm sales share and purchase share both increase with Japanese workers. Therefore, foreign affiliates with higher Japanese ownership and with more Japanese workers tend to be the hub of production networks.

[5] See Appendix Table for sector classification.

5 Simple Estimation

We conduct a simple estimation. Our strategy is to estimate simultaneous equations on intra-firm third-country trade share, local share, Japanese share as well as inter-firm third-country share, local share and Japanese share by SUR (seemingly unrelated regressions).

$$SHARE_{ij} = \alpha AFF_i + \beta JPNGOV_i + \gamma Firm_j + \mathrm{sec}_i + \mathrm{sec}_j + c_i + \varepsilon_{ij},$$

where i is an affiliate and j is the parent firm of the affiliate i. $SHARE_{ij}$ is a set of variables for intra-firm trade share, i.e., shares of intra-firm sales, 1) third-country sales to other affiliates within the firm, 2) local sales to other affiliates within the firm, 3) sales to affiliates in Japan within the firm and shares of inter-firm sales, 4) third-country sales to other firms, 5) local sales to other firms, 6) sales to other Japanese firms. We can drop one equation out of the six because the total share is unity, i.e., 1) + 2) + 3) + 4) + 5) + 6) = 1, and thus the number of equations to solve is five. Another set of five equations we solve applies to purchase equations. AFF is a set of affiliate i's variables such as labor intensity derived by wage payment per sales ($Labor$) and the number of affiliate employees (Emp). $JPNGOV$ is a set of variables for the degree of governance by parent j in affiliate i. One variable is the share of the Japanese workers in the affiliate (JPN_share) and the other is the percentage of Japanese parent ownership ($JPN\_ownership$). $Firm$ is a set of variables for parent firm j, the Japanese parent j's employees (Hq_emp), the number of all foreign affiliates (n_aff) and industry mix index across their foreign affiliates as mentioned above ($industry\_mix$). c is the country dummy located in affiliate i, sec is the sector dummy of affiliate i and parent firm j and ε is the error term.

Table 7 reports estimation results on sales. Equations on intra-firm trade tend to be more significant in many variables than those of inter-firm trade. In affiliate variables, affiliate size (Emp) and labor intensity ($Labor$) are significantly positive in equations on intra-firm sales to third countries and Japan. In governance variables, the share of Japanese employees (JPN_share) and parent ownership ratio ($JPN\_ownership$) are significantly positive in equations on intra-firm sales in third countries and Japan. JPN_share is also significantly positive in the equation on intra-firm local sales. In firm variables, industry mix($industry\_mix$) is significantly negative and parent employment size (Hq_emp) and the number of affiliates (n_aff) are weakly significant and positive in equations on the intra-firm sales in third countries. Bigger parent firms and affiliates with strong ownership by parents are more likely to build networks as a hub and engage intra-firm sales to their third-country affiliates. Likewise, bigger affiliates with strong ownership by the parent boosts intra-firm trade with Japan. This result is an analogy of firm heterogeneity models of Helpman et al. (2005) and Antras and Helpman (2004).

Table 8 reports estimation results on the purchase side. The intra-firm third-country purchase is the mirror image of the intra-firm sales in third countries. Affiliate size (Emp) and the share of the Japanese workers (JPN_share) are both significantly negative. This indicates

that smaller affiliates with less ownership of the parent tend to purchase from other affiliates within the firm. This is a counterpart of the equation on intra-firm sales (Table 7). Then, the share of Japanese workers (JPN_share) and parent ownership ratio ($JPN\_ownership$) are significantly positive in intra-firm trade with Japan. Affiliates strongly controlled by parents tend to buy from parents in Japan. Thus, as a counterpart of sales, smaller affiliates with less Japanese ownership and fewer Japanese workers tend to be a spoke in networks and buy from hub affiliates within the same firm. In terms of relationships with the parent in Japan, affiliates with more ownership tend to buy more from their parents in Japan. These results are consistent with the sales-side equations.

6 Conclusion

This paper investigates FDI networks, in particular, third-country intra-firm trade using Japanese foreign affiliate data. Not only sales, i.e., seeking market size of the host country (HFDI) or lower cost in production (VFDI) but also sourcing is crucial in understanding the current FDI. In this sense, we adopt the sales–sourcing box diagram à la Baldwin and Okubo (2014) to show the current Japanese FDI categorized as networked FDI in the sense of active third-country sales and sourcing patterns. As a result, larger firms and affiliates tend to construct production networks as a hub, which increases intra-firm third-country trade. Firm size is crucial in understanding third-country trade and production networks. Furthermore, as driving forces for networks, allocation of ownership as well as human resources, i.e., the parent ownership ratio and the number of Japanese workers, is key.

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Figure 1: Sales-sourcing Box Diagram (source: Baldwin and Okubo, 2014, p.1056, Figure 1)

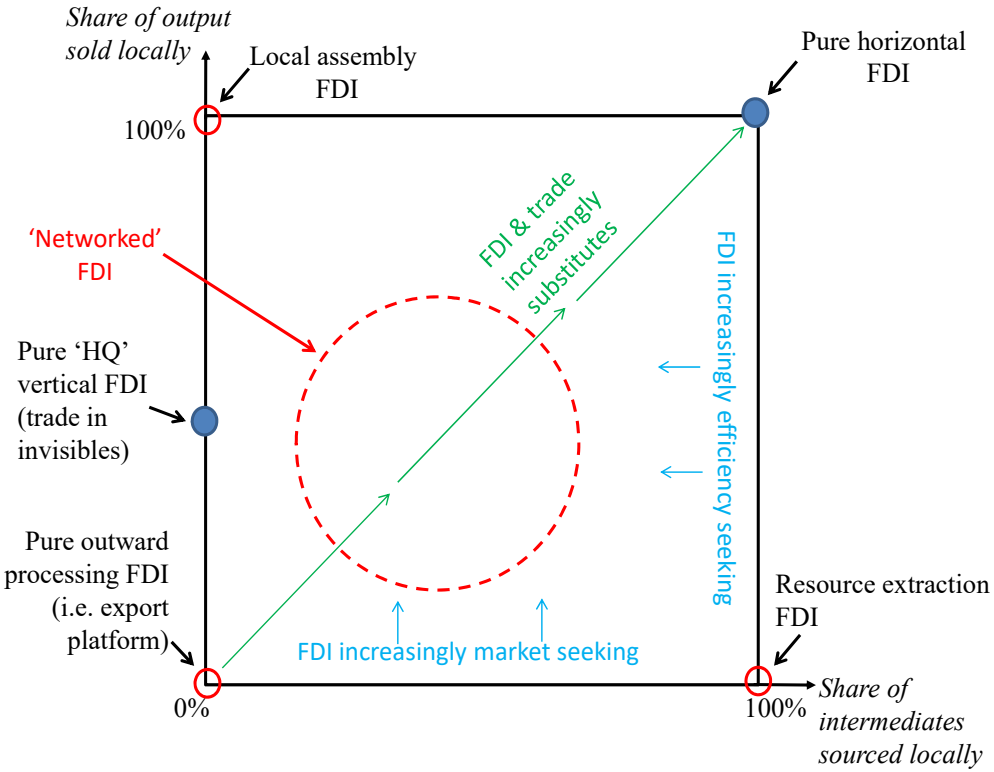


Figure 2: Sales-sourcing Box Diagram in 2002

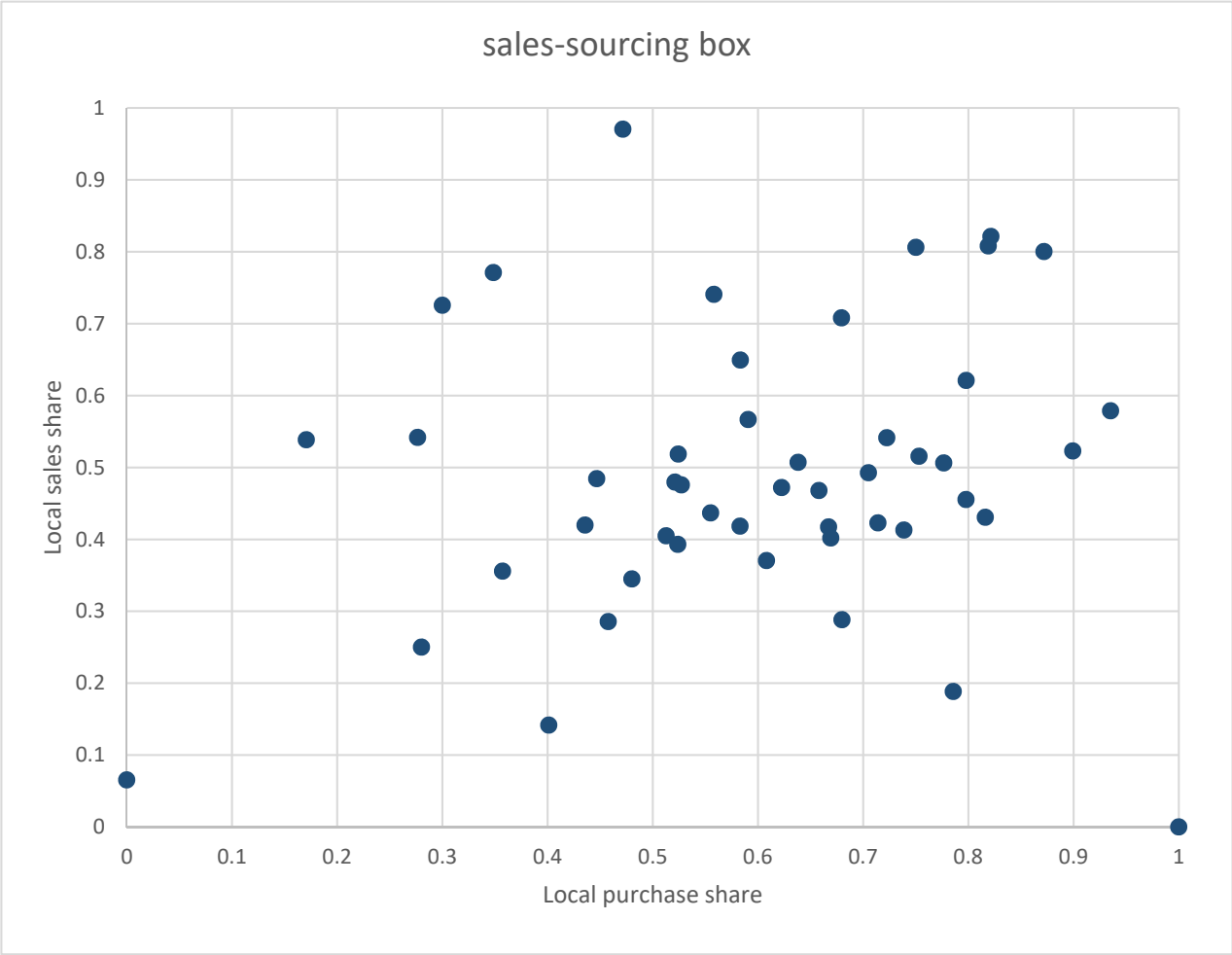
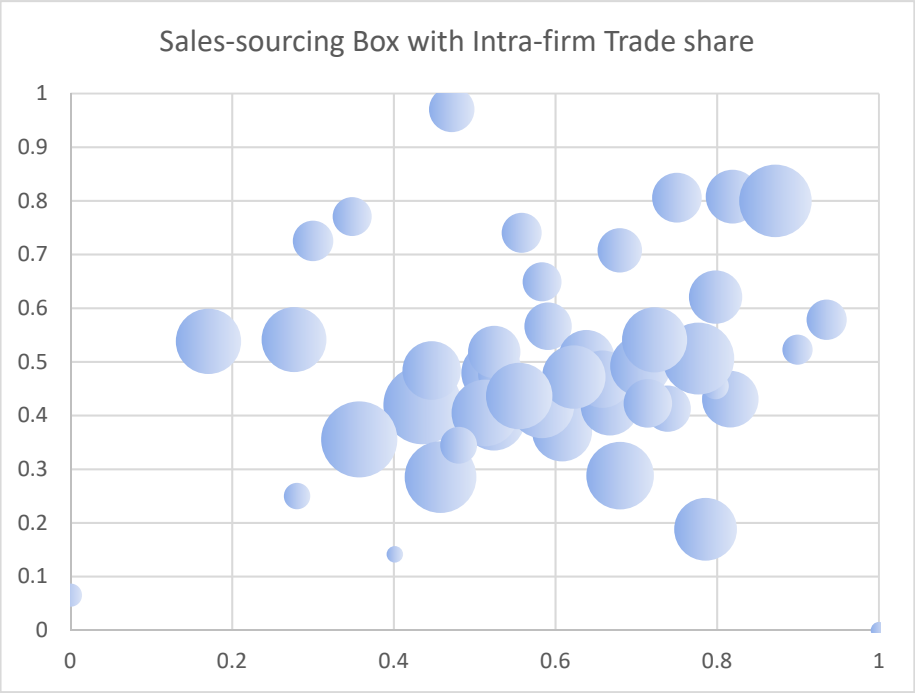


Figure 3: Augmented Sales-sourcing box



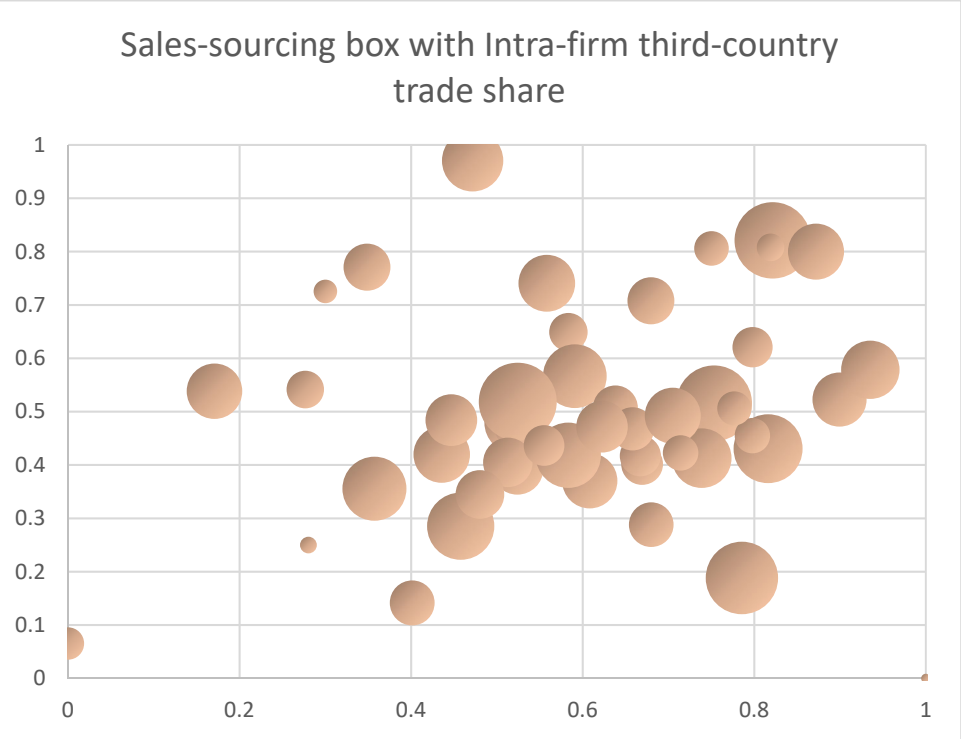


Figure 4: Location Probabilities in Major Countries

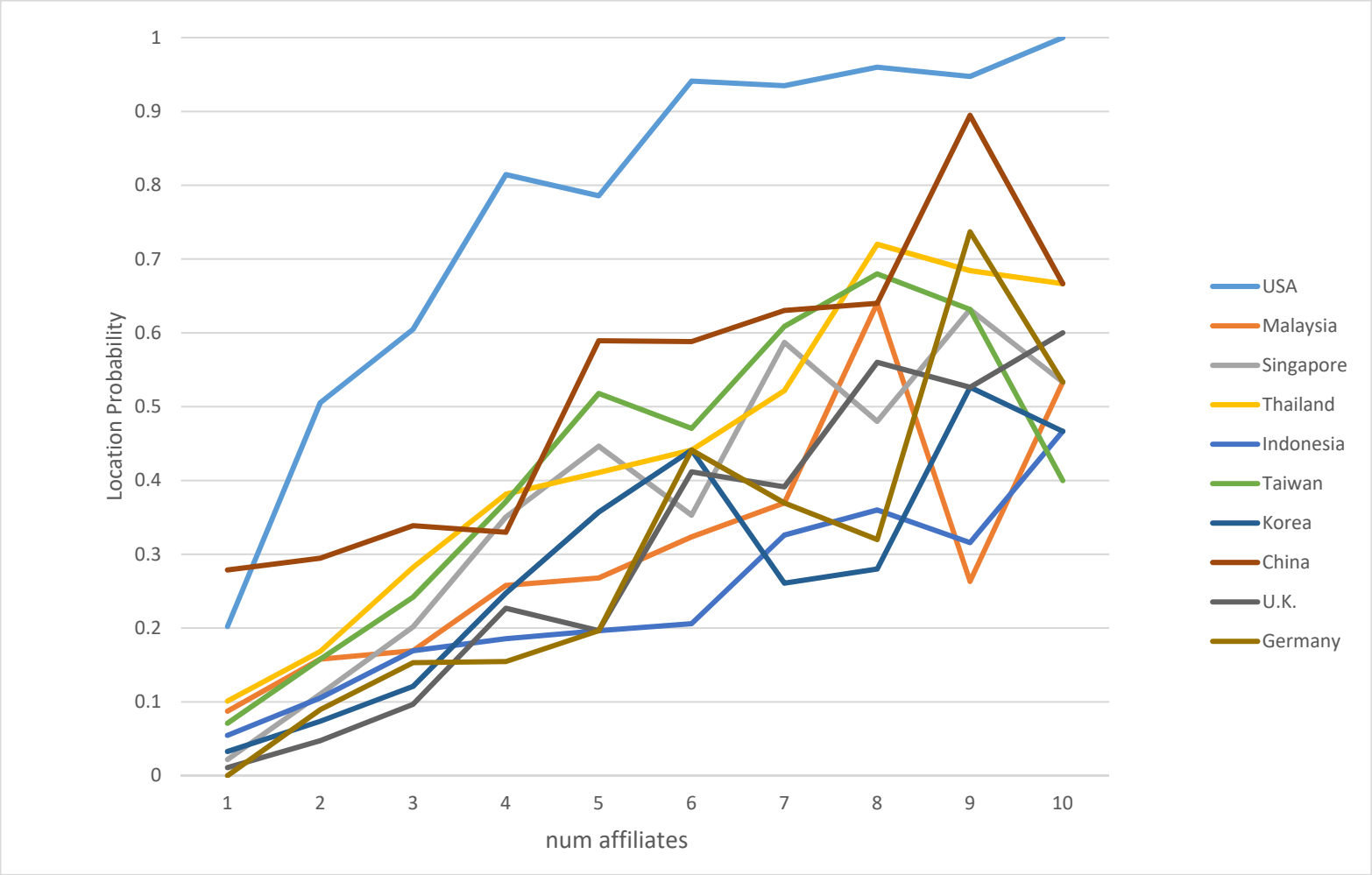


Figure 5: Industry patterns (vertical: parent sector code, horizontal: affiliate sector code)

Figure 6: Industry Mix Index

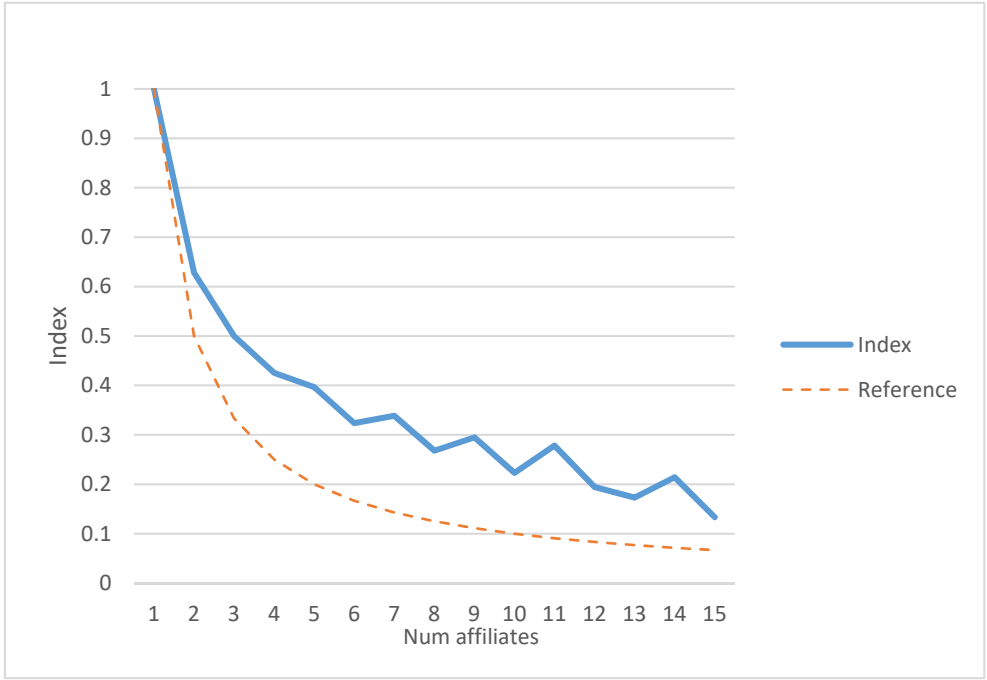
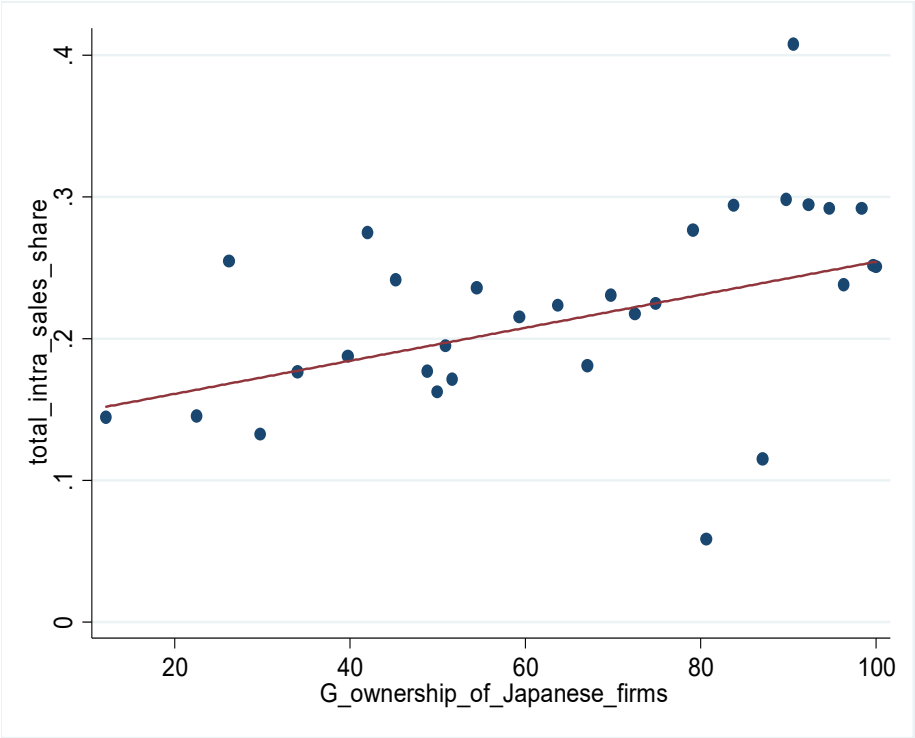


Figure 7: Ownership and intra-firm trade share

Sales



Purchase

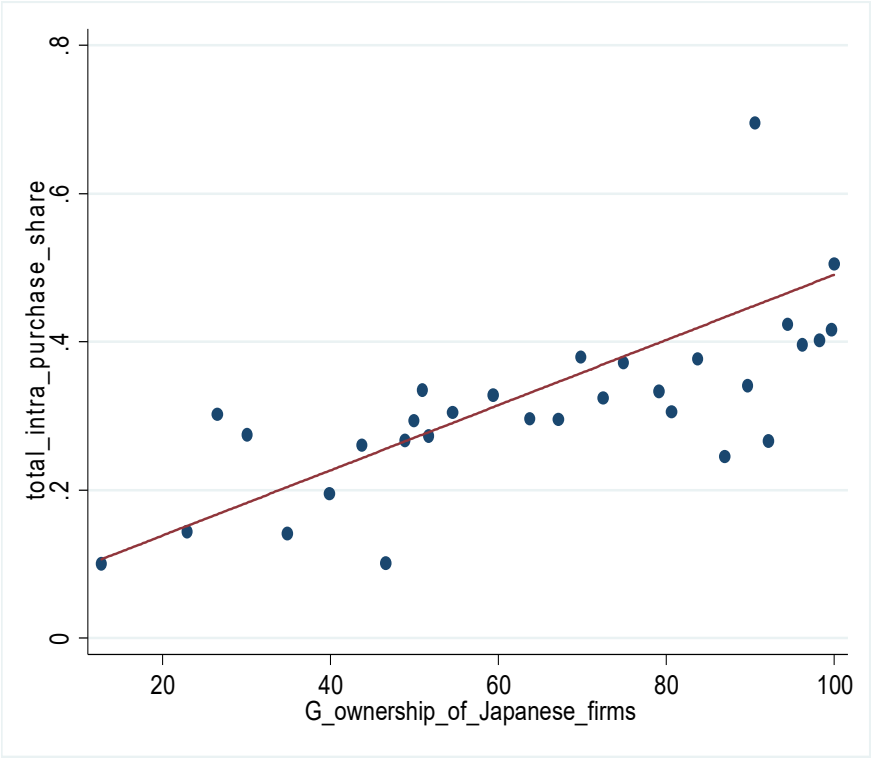
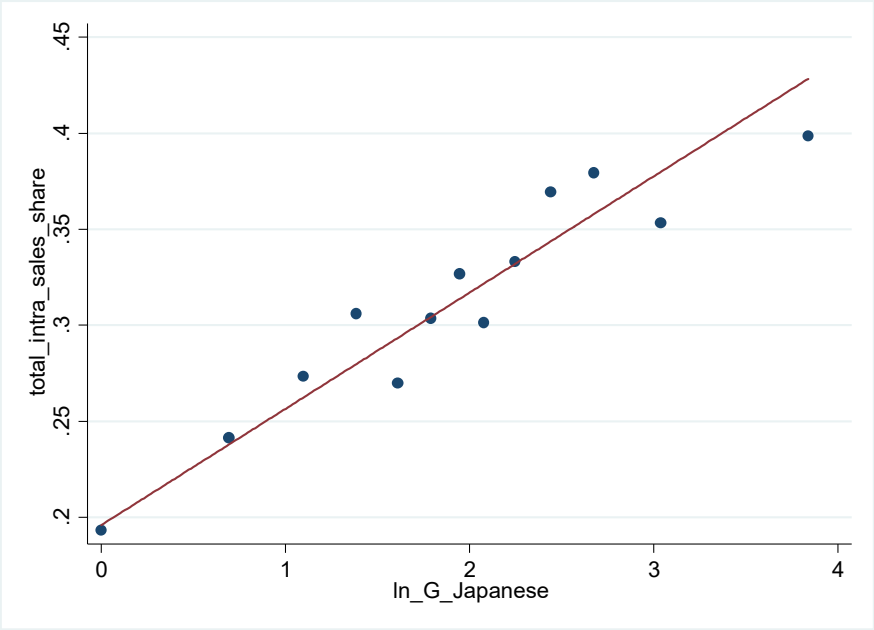


Figure 8: Japanese worker share and intra-firm trade share

Sales



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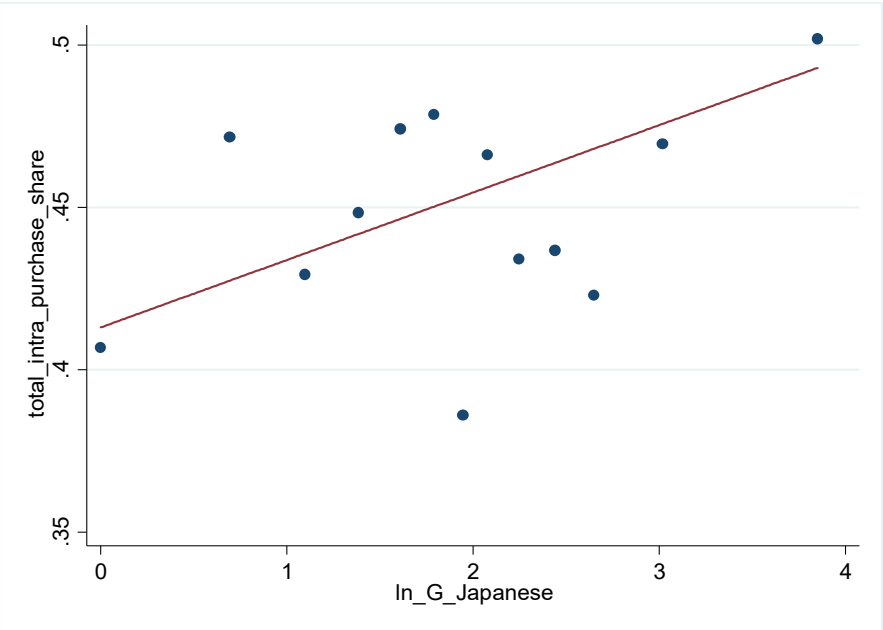

Table 1: FDI by Destination

	Num aff	Total sale	Total Emp
Asia	2560	1.18E+07	883684
China	553	1300276	223452
Europe	906	7994826	116217
North America	879	1.73E+07	235941
USA	792	1.54E+07	218163
Other	162	3997851	46959
Total	4507	4.11E+07	1282801

Table 2: FDI by sector

Sector	Sales	Employee	Num of affiliates
1	150	65	2
3	1779	152	2
4	21380	763	5
6	33221	9618	20
7	81850	6494	23
8	151477	42856	82
9	12589	1777	9
10	10295	2007	9
11	138143	3374	15
12	25253	4996	19
13	85248	6946	20
15	58808	2034	25
16	596797	15741	155
17	121008	16556	38
18	967211	13563	65
19	749208	30700	195
20	63694	1090	15
21	104438	9853	38
22	193	456	3
23	224783	15803	31
24	103107	2491	14
25	82642	8514	52
26	785893	13148	20
27	50087	4214	32
28	185804	2592	10
29	299847	31097	75
30	171734	17497	100
31	935927	56169	350
32	454272	14334	35
33	978559	63799	189
34	927664	47110	28
35	2332509	205079	338
36	5504261	131159	231
38	285859	29075	45
40	3226152	62769	65
41	4383454	224307	516
42	424330	4219	24
43	527005	32995	108
44	154774	23554	97
45	380606	25855	124
46	152406	7887	37
47	30930	1898	19
48	1.50E+07	82709	1106
49	78222	145	32
50	3449	36	10
52	1107	0	2
53	12542	104	3
55	132207	3841	65
Total	4.11E+07	1281441	4498

Table 3: Sales and Sourcing share

	Third-country	Local	Japan
Sales	0.17	0.67	0.16
Sourcing	0.16	0.41	0.43

Table 4: Intra-firm and inter-firm Sales and Sourcing

	Intra-firm sales share				Inter-firm sales share			
Sales	Total	Third-country	Local	Japan	Total	Third-country	Local	Japan
mean	0.24	0.06	0.05	0.12	0.76	0.11	0.62	0.03
sd	0.37	0.19	0.20	0.27	0.37	0.25	0.42	0.15
p50	0.00	0.00	0.00	0.00	1.00	0.00	0.83	0.00
p75	0.39	0.00	0.00	0.04	1.00	0.05	1.00	0.00
p95	1.00	0.50	0.49	0.92	1.00	0.79	1.00	0.19
N	4088							

	Intra-firm sourcing share				Inter-firm sourcing share			
Sourcing	Total	Third-country	Local	Japan	Total	Third-country	Local	Japan
mean	0.43	0.09	0.04	0.30	0.57	0.07	0.37	0.13
sd	0.42	0.23	0.17	0.36	0.42	0.20	0.38	0.28
p50	0.32	0.00	0.00	0.09	0.68	0.00	0.24	0.00
p75	0.91	0.01	0.00	0.60	1.00	0.00	0.73	0.04
p95	1.00	0.75	0.30	1.00	1.00	0.58	1.00	0.93
N	4088							

Table 5: Firm Size

Sales pattern	Intra-firm share				Inter-firm share			
	Total	Third-country	Local	Japan	Total	Third-country	Local	Japan
All	0.24	0.06	0.05	0.12	0.76	0.11	0.62	0.03
Below p50	0.23	0.05	0.04	0.14	0.77	0.11	0.61	0.04
Above p50	0.24	0.07	0.07	0.10	0.76	0.12	0.62	0.03
Above p95	0.26	0.14	0.06	0.06	0.74	0.13	0.59	0.02

Sourcing Pattern	Intra-firm share				Inter-firm share			
	Total	Third-country	Local	Japan	Total	Third-country	Local	Japan
All	0.43	0.09	0.04	0.30	0.57	0.07	0.37	0.13
Below p50	0.42	0.08	0.03	0.31	0.58	0.06	0.39	0.13
Above p50	0.43	0.09	0.05	0.29	0.57	0.09	0.35	0.13
Above p95	0.44	0.10	0.06	0.29	0.56	0.09	0.30	0.17

Table 6: Number of affiliates

Sales pattern	Intra-firm share				Inter-firm share			
	Total	Third-country	Local	Japan	Total	Third-country	Local	Japan
All	0.24	0.06	0.05	0.12	0.76	0.11	0.62	0.35
Locate less than five countries	0.25	0.03	0.04	0.17	0.75	0.11	0.58	0.06
Locate five to seven countries	0.21	0.06	0.05	0.10	0.79	0.13	0.64	0.02
Locate than more than seven countries	0.24	0.09	0.06	0.09	0.76	0.11	0.63	0.02

Sourcing Pattern	Intra-firm share				Inter-firm share			
	Total	Third-country	Local	Japan	Total	Third-country	Local	Japan
All	0.43	0.09	0.04	0.30	0.57	0.07	0.37	0.13
Locate less than five countries	0.35	0.04	0.03	0.28	0.65	0.06	0.45	0.14
Locate five to seven countries	0.46	0.07	0.05	0.34	0.54	0.06	0.36	0.11
Locate than more than seven countries	0.47	0.13	0.05	0.30	0.53	0.09	0.32	0.12

Table 7: Sales

SUR estimations Reference: Local inter-firm sales

	Sales	1		2		3		4		5	
		Third-country intra-firm sales		**JPN intra-firm sales**		**Local intra-firm sales**		**Third-country Inter-firm sales**		**JPN inter-firm sales**	
AFF	Labor	0.01436	2.44 **	0.0139	1.77 *	-0.0008	-0.12	-0.01702	-2.25 **	0.0005	0.11
	Emp	0.01495	6.41 ***	0.0191	6.12 ***	-0.0009	-0.34	0.00118	0.39	-0.0018	-1.05
JPNGOV	JPN_ownership	0.00071	4.65 ***	0.002	9.8 ***	-0.0003	-1.69 *	-1.9E-05	-0.1	1E-04	0.88
	JPN_share	0.03569	1.67 *	0.1087	3.82 ***	0.10853	4.67 ***	0.03605	1.31	-0.0206	-1.35
Firm	Hq_emp	0.00571	1.82 *	-0.006	-1.54	0.00522	1.52	0.00758	1.87 *	-0.0065	-2.88 ***
	industry_mix	-0.0297	-2.11 **	0.0764	4.06 ***	-0.0118	-0.77	0.06531	3.61 ***	0.0578	5.73 ***
	n_aff	0.00055	1.74 *	-5E-05	-0.11	0.00058	1.68 *	-0.00067	-1.65 *	0.0006	2.53 **
	NoB										
	3639										

Notes: (i) ***, ** and * indicate 1, 5, 10 percent significance levels

(ii) Parent industry, affiliate industry, and country dummies included but not reported.

Table 8: Sourcing

SUR estimations Reference: Local inter-firm sourcing

	Sourcing	1		2		3		4		5	
		Third-country intra-firm sourcing		JPN intra-firm sourcing		Local intra-firm sourcing		Third-country Inter-firm sourcing		JPN inter-firm sourcing	
AFF	Labor	-0.0027508	-0.39	-0.01349	-1.2	0.000603	0.11	0.001876	0.3	-0.00576	-0.66
	Emp	-0.0163928	-5.84 ***	-0.00975	-2.19 **	0.003014	1.38	0.009749	3.89 ***	-0.01203	-3.47 ***
JPNGOV	JPN_ownership	0.0002845	1.55	0.001992	6.85 ***	0.000235	1.65 *	-0.00046	-2.78 **	3.32E-05	0.15
	JPN_share	-0.0648552	-2.49 **	0.132795	3.21 ***	0.097061	4.78 ***	-0.00333	-0.14	-0.03892	-1.21
Firm	Hq_emp	-0.0073518	-1.95 *	0.001781	0.3	0.003559	1.21	0.0018	0.53	0.011004	2.36 **
	industry_mix	-0.0872196	-5.19 ***	-0.0888	-3.33 ***	-0.02196	-1.68 *	0.016852	1.12	0.072455	3.49 ***
	n_aff	0.0010962	2.89 ***	-0.00143	-2.37 **	0.000402	1.36	0.000686	2.02 **	-0.00043	-0.93
	Nob										
	3541										

Notes: (i) ***, ** and * indicate 1, 5, 10 percent significance levels

(ii) Parent industry, affiliate industry, and country dummies included but not reported.

Appendix Table: Industry Code and Definition

Code	Industry
1	Agriculture
2	Forestry
3	Fisheries and Aquaculture
4	Metal mining
5	Textile mill products
6	Apparel and other finshed products
7	Other textiles
8	Clothes
9	Lumber and wood products
10	Furniture and fixtures
11	Pulp and paper
12	Paper products
13	Printing and Allied Industry
14	Chemical fertilizers
15	Inorganic products
16	Organic chemicals
17	Chemical fibers
18	Drugs and medicines
19	Chemical and allied products
20	Petroleum and coal products
21	Rubber products
22	Leather tanning and leather products
23	Glass and its products
24	Cement and its products
25	Miscellaneous ceramic, stone and clay products
26	Iron and Steel
27	Miscellaneous iron and steel
28	Smelting and refining of non-ferrous metals
29	Non-ferrous metals worked products
30	Fabricated metal products
31	Industry machinery and equipment
32	Office, servce industry and household machines
33	Household electric appliances
34	Electronic data processing machines, digital and analog computer, equipment and accessories
35	Electronic application device
36	Communication equipment and related products
37	Electronic parts and devices
38	Industrial electrical machinery equipment
39	Miscellaneous electrical machinery equipment and supplies
40	Motor vehicles
41	Parts for motor vehicles
42	Miscellaneous transportation equipment
43	Precision instruments and machinery
44	Plastic products
45	Manufacturing industries, n.e.c.
46	Food, beverages, tabacco and prepared animal foods
47	Construction
48	Wholesale and retail trade
49	Finance and insurance
50	Real estate
51	Transport, electricity, gas, heat supply and water
52	Railway services and ship
53	Warehouse and transportation
54	Telecommunication
55	Miscellaneous industries

Appendix Table: Basic Statistics

	n	mean	min	max
Labor	3662	0.124996	0	20.22222
JPN_share	4507	0.05669	0	1
Hq_emp	4507	7.414627	0	11.16325
JPN_ownership	4507	85.79696	10	100
Emp	4387	4.274386	0	10.6502
Industry_mix	4507	0.370313	0.037037	1
n_aff	4507	13.01065	1	81