Cross-border Vertical Integration and Intra-firm Trade: New evidence from Korean and Japanese firm-level data

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Abstract

This paper gives two findings about the cross-border vertical integration and intra-firm trade of firms in Korean and Japanese manufacturing industries. First, the intra-firm trade between a parent firm and its affiliates is highly concentrated in a small number of large multinational corporations. Second, the input-output coefficient between the parent firm's industry and the affiliate's industry is weakly related to the presence and magnitude of intra-firm trade between the parent firm and its affiliates. Furthermore, these two findings are also found in domestic vertically integrated firms. In particular, the second fact casts doubt on the traditional view of the cost-saving motive of vertical multinational firms and indicates the need for further investigation on a new motive for cross-border vertical integration.

Keywords: Intra-firm trade, Multinational firms, Vertical integration
JEL: F12, F23, L14

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1. Introduction

The production-supply chain is a key factor to understand the recent upward trend in foreign direct investment (FDI) in Asia driven by multinational firms. Multinational firms have invested in setting up their own local suppliers or affiliates in Asia in order to procure intermediate inputs, and this has resulted in the total amount of intra-firm trade simultaneously increasing over the recent years. However, as one might know, the industrial structure in Asia is dominated by large corporations. Thus, an increase in intra-firm trade would have to be dominated by them as well. Furthermore, the local activities of foreign affiliates might have been diversified to sell specific intermediate goods to the local final goods producers. That is, intra-firm trade may differ by the characteristics of the firms and their affiliates. Thus, in this paper, we closely investigate firm-level datasets and the existence and patterns of firm heterogeneity in the intra-firm trade between parent firms and their foreign affiliates.

This paper gives two important facts that are common to the intra-firm trade of Korean and Japanese manufacturing firms: skewedness toward a small number of large firms, and weak input-output (IO) linkage between parent and affiliate firms. Our finding of skewedness of intra-firm trade toward large firms is consistent with the literature on exports and FDI. Helpman, Melitz, and Yeaple (2004) investigated the intra-firm trade and firm size in the United States. See also Tomiura (2005) and Tomiura, Ito, and Wakasugi (2011), who examined the role of firm productivity in the offshoring decision of Japanese firms, and Cho, Chun, and Hur (2014), who tested the effects of firm characteristics on the offshoring decision of Korean firms. These research papers in common show that larger or more productive firms own foreign affiliates and trade with them.

Our second finding of a weak IO link between the intra-firm trade of the parent firm and its foreign affiliates is consistent with Ramondo, Rappoport, and Ruhl (2016), who showed that US

multinational firms do not have much direct trade with their foreign affiliates. We also uncovered the same fact for multinational firms in Korea and Japan who own foreign affiliates in a vertical structure. However, our study is different in that we also examine whether the findings hold true for the domestic vertical structure as well. This is particularly important for Korea and Japan. Unlike as in the United States, the domestic market structure of these countries is dominated by large companies that own a number of domestic affiliates in the manufacturing sector. Interestingly, we find that many vertically integrated firms have no transactions even with their domestic affiliates.

Atalay, Hortaçsu, and Syverson (2014) provide an explanation for the weak intra-firm trade in domestic markets, with empirical evidence that "an acquired affiliate begins to resemble the acquiring firm" in terms of shipping location and product type. For example, we need not necessarily find much physical transaction between the parent firm and its affiliates in the US market. However, this explanation may not hold true for Korea and Japan because of the very typical hierarchical structure of their domestic markets. Within a hierarchical structure, we cannot simply ignore the contract relationship between large conglomerates and small subcontractors. These subcontractors are highly dependent on the purchasing power of the large firms. Affiliates

of a parent firm in a vertical structure produces intermediate inputs and supplies them to the parent firm, but the parent firm produces final goods and supplies them to consumers. Hence, the resemblance in terms of shipping location and product type may not be found from their activities. These firms in Korea and Japan play their distinctive roles in the vertical structure of domestic markets, unlike in the United States.

Furthermore, we doubt whether the "transferring capability" from parent firms to their affiliates can explain the lack of intra-firm trade in international markets. One possible route of

transfer capability in the international context is technology transfer between parent firms and their foreign affiliates. For instance, parent companies may deploy their professional managers and technicians to their foreign affiliate plants or export their R&D outcomes such as patents and copyrights to their foreign affiliates.

Thus, our findings for Korea and Japan raise quite challenging questions for the future. For example, if there is no intra-firm trade, what is the motivation for manufacturing firms to own affiliates? What is the relationship between integrated firms and the local final-good producers in foreign markets? Has the entire domestic supply network been relocated from domestic to foreign markets? We believe that this paper provides important basic facts about intra-firm trade in Asia and thus would induce further studies on these issues.

The paper proceeds as follows. Section 2 explains the data source and the main variables we use in this analysis. Section 3 elaborates our results by presenting summary statistics and regression analyses. Section 4 summarizes the implications of our findings.

2. Data

We use two sets of firm-level databases for 2010, the first one for Korea, the *Survey of Business Activities* (SBA), published by Statistics Korea of the Korean government, and the second for Japan, the *Basic Survey of Japanese Business Structure and Activities* (BSJBSA), collected by the Ministry of Economy, Trade and Industry of the Japanese government. Both databases cover all firms having more than 50 employees and more than 300 million Korean won (30 million Japanese yen) of equity capital) in the manufacturing, mining, and commerce sectors.

For our research on the intra-firm flow of goods, we focus on the manufacturing sector. Our key variable is the intra-firm trade (export and import) between parent firms and their affiliates.

The above two databases for Korea and Japan contain the affiliate firms' information such as country, industry, and share of equity capital as well as actual share.[1] Moreover, they give detailed information on the firms' sales and purchase activities. In particular, intra-firm transactions are broken down into domestic and foreign ones. However, the datasets do not report transactions by affiliate or destination. Therefore, we consider intra-firm trade as the total transactions between a parent firm and all its foreign affiliates. Furthermore, since the intra-firm trade decisions of a firm should be determined independently, we exclude the firms owned by another parent firm from our data sample.

We define a firm's vertical integration (VI) and its affiliates as follows. We first define a *parent firm* as a firm that owns at least 50% of the equity capital of *its affiliates,* because the majority-owned affiliates account for most of the intra-firm trade. Next, to define the vertical relationship (producer-to-supplier) between a parent firm and its affiliates, we consider a *supplying industry* as one that supplies the intermediate input of the *producing industry* based on a 2-digit IO table. Thus, we can identify two types of VI between a parent firm and its affiliate. First, we define backward VI as when *a parent firm* belonging to a *producing industry* owns *an affiliate* in an industry *supplying* at least 5% of the total intermediate input of the producing industry. Forward VI is defined as when *an affiliate* belonging to a *producing industry* is owned by *a parent firm* belonging to an industry *supplying* at least 5% of the total intermediate input of the producing industry.

As regards the above definitions, we note one difference between the Korean and Japanese firm survey datasets. For the Korean SBA, we can identify the supplying industries that are matched to each affiliate that a parent firm may have. However, for the Japanese BSJBSA, since a parent firm reports only the names of the supplying industries in which it has affiliates, we do

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[1] For Japan, the countries are limited to China, North America, Europe, and Others.

not have a one-to-one matching of an affiliate with its industries. To resolve this problem in the Japanese dataset, as the representing supplying industry of the parent firm, we choose the supplying industry that provides the largest share of the intermediate inputs to the producing industry from among the supplying industries that the affiliates of the parent firm belong to.

3. Facts and Empirical Results

Now, we present our main findings for Korea and Japan in the following order. First, we provide a summary statistics on intra-firm trade and discuss the fact that a significant share of integrated firms do not have intra-firm trade flows. We also show that intra-firm trade gets mostly concentrated in a small number of large firms. Second, through simple linear regressions, we show that no positive correlations exist between the IO coefficients of the producing-supplying industry pairs and the actual intra-firm trade flows of the parent firm-affiliate pairs. Thus, we compare the similarities and differences of the Korean and Japanese firms.

[Table 1 about here]

3.1 Fact 1: Industry-level evidence for lack of intra-firm trade

Similarity between Korea and Japan

Table 1 shows 24 2-digit industrial distribution of intra-firm trades of Korea in 2010. We calculated the industrial transactions between domestic firms and their affiliates. Next to the transaction data, we report the share of vertically related firms with their affiliates that have positive transaction records. Surprisingly, as you observe in Table 1, the shares in almost all industries are not 100%. That is, the lacks of intra-firm trades are common in all industries. Furthermore, most of the

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industrial levels of the intra-firm trade in columns 1 and 2 are below 50%, indicating that they do not trade as much as normally expected. These patterns are similar to the *domestic* transactions between the Korean firms and their domestic affiliates. In columns 3 and 4, the amount of the transactions in each industry and shares of vertically integrated firms within domestic markets are summarized. Again, the shares of the firms with positive transactions are not 100% in almost all industries and most of them are below 50%.

[Table 2 about here]

Now, what about Japanese case? Table 2 shows the industrial distribution of intra-firm trade and transactions of Japan in 2010. Similar to the Korean case, the industry-levels of intra-firm trade in columns 1 and 2 and domestic transactions in columns 3 and 4 are not completely explained by the domestic vertical ownership.

Difference between Korea and Japan

Comparing between Korea and Japan, we can observe that there are two distinctive differences between Korea and Japan. First, the shares of the firms with foreign affiliates in Japanese case are higher than those in Korean case. In particular, the shares are greater than 50% in many industries of Japan. That is, the Japanese multinational firms are more likely to buy or sell their products to the affiliates in foreign countries, compared to the Korean multinational firms. However, in many industries the shares of Japanese firms with positive internal transactions are lower than those of Korean firms. That is, compared to Korean firms, Japanese firms are less procuring products from their domestic affiliates, and less providing products to them as well.

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3.2 Fact 2: Firm-level evidence for lack of intra-firm trade

Similarity between Korea and Japan

Table 3 presents the summary statistics of the integration decision of firms and their internal flow of goods. The total number of vertically integrated relationships between a Korean parent firm and its affiliate in foreign countries in 2010 is 1,078. Out of these, only 440 firms (40%) are exporting to their foreign affiliates and 331 firms (29%) are importing from their foreign affiliates. Surprisingly, the remaining number of firms do not trade at all with their foreign affiliates lying in a vertical structure.

Furthermore, top firms with the largest amount of exports and imports account for most of the exports and imports between the parent firms and their foreign affiliates. Moreover, employment is concentrated in the intra-firm trade of the top firms. For example, the top 50 firms account for approximately 95% of the total intra-firm trade, and their employment share of the total is approximately 52%. Our findings based on Korean firm-level data can be summarized as follows: (i) a large proportion of vertically integrated firms do not trade with their foreign affiliates, and (ii) intra-firm trade is concentrated in a small number of large firms.

Interestingly, a similar pattern can be observed in the domestic market as well. When we investigate the domestic market only, we find 804 VI pairs, of which only 303 firms (38%) sell to their domestic affiliates while 291 firms (36%) purchase from them. That is, more than 60% of the domestic VI pairs show no transaction flow of goods. As with the cross-border VI pairs, intra-firm transactions are also highly concentrated in a small number of firms. For example, the top 50 firms

account for 95% of the total intra-firm domestic transactions of goods and their employment share is 57%.

[Table 4 about here]

Now, we turn to Japanese manufacturing firms. The results for Japanese firms in Table 4 are similar to those in Table 3 for Korean manufacturing firms. Out of 1,420 numbers of vertically integrated Japanese parent firms with foreign affiliates, 876 (62%) firms are exporting and 789 (56%) firms are importing from them. On average, 71 % of firms (1,006) have trading records with their vertically related affiliates in foreign countries. Again, like Korean case, non-negligible proportions of the firms do not trade at all with their foreign affiliates. This pattern is observed in domestic transactions as well. 464 firms (29%) in domestic markets actually provide their products to domestic affiliates, and only 413 firms (25%) buy products from them, out of 1,626 numbers of firms.

Difference between Korea and Japan

Here, we summarize some notable differences of the firm-level data samples between Korea and Japan. First, while the Korean firm sample data shows a smaller number of domestic VI pairs (804) compare to cross-border VI pairs (1,078), the Japanese firm sample data are the opposite fact – 1,626 domestic VI pairs and 1,420 cross-border VI pairs. Second, while a smaller share of VI firms in Korea trade with their foreign affiliates (45%) than with their domestic affiliates (46%), a larger share of VI firms in Japan trade with their foreign affiliates (71%) than with their domestic affiliates (35%). In particular, the shares are noticeably different in Japan.

More specifically about exports (sales) and imports (purchases) for Japanese case, out of the 1,420 cross-border vertically integrated Japanese firms, 876 firms (62%) export to and 789 firms (56%) import from their foreign affiliates. However, among 1,626 domestic VI pairs, only 464 (29%) VI firms engage in selling transactions and 413 (25%) VI firms engage in buying transactions with their affiliates. In sum, compared to Korean firms, a larger share of Japanese VI firms are active in intra-firm trade in the global market.

Second, we note one more significant difference between Korea and Japan. While the top-ranked firms in Korea accounting for the large share of intra-firm trade also explain a large share of employment in the manufacturing industries, this is not the case in Japan. The top-ranked firms in Japan with a large share of intra-firm trade do not necessarily account for a large share of employment. For example, the top 50 cross-border VI firms in Japan account for only 35% of employment share, whereas those firms in Korea explain 58% of the total employment in manufacturing industries. The lower degree of skewedness toward large corporations in Japan is due to the economic restructuring policies of Japan during the 1990s. On the contrary, since the Korean economy depends heavily on the role of large firms, intra-firm trade in Korea is still dominated by large firms.

3.3 Regression results

Firm size

As shown in the previous subsection, intra-firm trade tends to concentrate in a small number of large firms. In this section, we formally analyze the regression models that highlight firm size as a key factor determining the intra-firm trade between a parent firm and its affiliates after

controlling for the affiliates' industry and country fixed effects. We estimate the following two regression models:

$$D(X_{ij}) = \alpha_0 + \alpha_1 \ln(EMP_p) + \alpha_2 \ln(NAF_p) + \gamma_{ai} + \delta_{ac} + \epsilon_{ij} \qquad (1)$$

$$\ln(X_{ij}) = \beta_0 + \beta_1 \ln(EMP_p) + \beta_2 \ln(NAF_p) + \gamma_{ai} + \delta_{ac} + \epsilon_{ij}. \qquad (2)$$

The dependent variable in (1), $D(X_{ij})$, is equal to 1 if the amount of intra-firm trade, X_{ij}, is positive, and 0 otherwise. The dependent variable in (2), $\ln(X_{ij})$, is the natural logarithm of the amount of intra-firm trade flows. The second model considers the firms with a positive value for the intra-firm trade variable. For $ij=ap$, the direction of transaction is from the affiliates (a) to a parent firm (p); we call this intra-firm imports or purchases under backward VI. For $ij=pa$, the direction of transaction is from a parent firm (p) to the affiliates (a); we refer to this as intra-firm exports or sales under forward VI.

Unlike Ramondo, Rappoport, and Ruhl (2016), who focus on the size of affiliates, we consider the parent firms' employment, $\ln(EMP_p)$, and number of affiliates, $\ln(NAF_p)$, as key regressors for the following reasons. First, our Korean and Japanese firm-level datasets do not report the affiliates' employment level. Second, the parent firms' characteristics can be a proxy for the affiliates' characteristics. Unlike the US economy, the Korean and Japanese economies are relatively well led by large companies and hence the affiliates' performance and activities are highly correlated to the parent firms. Finally, γ_{ai} is the control dummy for industry (i) of the affiliates (a) and δ_{ac} is the control dummy for destination-country (c) of the affiliates (a). For Korea, we consider 23 industry dummies for both foreign and domestic affiliates, 67 country dummies for foreign affiliates, and 16 province dummies for domestic affiliates. For Japan also,

we consider 23 industry dummies for both foreign and domestic affiliates. However, since we have limited location information on the Japanese firms' affiliates, we consider only four regional dummies (China, North America, Europe, and Others) for foreign affiliates, with no location information for the domestic affiliates.

[Table 5 about here]

The upper panel of Table 5 reports the parent firms' size effect on the Korean firms' intra-firm trade with their foreign affiliates. Column (1) uses as dependent variable a dummy for the positive values of the parent firm's intra-firm import variable from its affiliate, and column (2) considers the amount of intra-firm imports. The main findings are as follows. As the parent firms' (i) employment level and (ii) number of affiliates become larger, their intra-firm imports become larger as well. We obtain these results after controlling for the unobserved characteristics of the country the affiliates are located at and the industry they belong to.

As regards forward VI, the intra-firm exports from parent firms to their affiliates, we also examine whether the size of the parent firm matters. From column (3), which considers the dummy for the positive value of intra-firm exports as the dependent variable, and column (4), which considers the amount of exports, these variables are significantly related to the employment level and number of affiliates of the parent firms.

Thus, as the summary statistics show, the size of the parent firms matters for the scale of their intra-firm trade with their foreign affiliates when they are vertically related. When we focus on the parent firms' domestic affiliates, the results remain qualitatively similar to the case of cross-border VI. The lower panel of Table 5 shows the results for the Korean domestic firm VI sample.

[Table 6 about here]

Now, we turn to the case of Japan. Note that there are slight differences in the setting of the VI variables. For Korea's SBA, we could identify the supplying industries of a parent firm that are matched to each affiliate. However, for Japan's BSJBSA, since a parent firm reported only the supplying industries in which it has affiliates, we could not find a one-to-one matching between an affiliate and its industries. The upper panel in Table 6 summarizes the regression results for the parent firms' foreign affiliates and the lower panel gives the results for their domestic affiliates. The results are similar to those for Korea. However, the employment variable in the upper panel of Table 6 does not have a statistically significant effect on the dummy variable for the parent firms' imports and exports with their foreign affiliates. For the domestic affiliates in the lower panel of Table 6, we find that the number of domestic affiliates have no impact on the dummy for intra-firm transactions (both purchases and sales).

Overall, we might argue that firm size matters for intra-firm trade in Korea and Japan. From these findings as well as the summary statistics in the previous subsection, a large number of small parent firms have no transactions with either their domestic or foreign affiliates. Because the parent firm-affiliate pairs are defined by the producer-supplier relationship, we next test whether the IO coefficients of industries that the parent firms and affiliates belong to are related to the corresponding intra-firm trade.

IO coefficients

In this subsection, we compare the intra-firm trade of vertically integrated firms and their corresponding industrial IO coefficients. Formally, we estimate the following regression models:

Backward VI:

$$D(X_{ap}) = \alpha_0 + \alpha_1 drxz + \gamma_{ai} + \delta_{ac} + \epsilon_{ij} \tag{3}$$

$$\ln(X_{ap}) = \beta_0 + \beta_1 \ln(drxz) + \gamma_{ai} + \delta_{ac} + \epsilon_{ij} \tag{4}$$

Forward VI:

$$D(X_{pa}) = \alpha_0 + \alpha_1 drzx + \gamma_{ai} + \delta_{ac} + \epsilon_{ij} \tag{5}$$

$$\ln(X_{pa}) = \beta_0 + \beta_1 \ln(drzx) + \gamma_{ai} + \delta_{ac} + \epsilon_{ij} . \tag{6}$$

Here, *drxz* is the coefficient of direct requirement of the parent firm's producing industry (*z*) from the affiliate's supplying industry (*x*). That is, it is the producing industry's share of purchases from its supplying industry when the parent firm belongs to the producing industry and its primary affiliate belongs to the supplying industry. Furthermore, *drzx* is the coefficient of direct sales of the parent firm's supplying industry (*x*) to the affiliate's producing industry (*z*). That is, it is the supplying industry's share of sales to its producing industry when the parent firm belongs to the supplying industry and its affiliate belongs to the producing industry.

[Table 7 about here]

As regards Korea, the upper panel of Table 7 summarizes the regression results for the foreign affiliates showing that the industry IO coefficients are not related to the corresponding intra-firm trade flows. Columns (1) and (3) of the table show that the IO coefficients do not have any statistically significant relationship with the dummy variables for intra-firm import and export.

Furthermore, these results appear quite robust to the variables for the intensive margin of intra-firm trade in columns (2) and (4) as well.

The lower panel of Table 7 gives the results for domestic affiliates. These results are similar to those in the upper panel of Table 7, except for the dummy variable for intra-firm sales in column (3). That is, the sales of a parent firm to its domestic affiliates seem to be unrelated to its corresponding IO coefficients of their industries of operation.

[Table 8 about here]

As Table 8 shows, we obtain similar results for Japan. The table summarizes the findings for the Japanese firms' foreign and domestic affiliates. Overall, we observe insignificant effects of IO coefficients on the intra-firm trade of vertically integrated firms. However, we observe two exceptions: the forward VI in column (3) of the upper panel of Table 8, and that in column (4) of the lower panel of Table 8. These show a rather weak positive relationship between the IO coefficients and intra-firm exports (or sales) from the parents to their affiliates. Nonetheless, we have a very weak ground to argue for strong positive correlations between the industrial IO structure and intra-firm transactions in Japan.

3.4 Full sample results

So far, our data sets included only vertically integrated firms. Using these data sets, we could find that a significant share of vertically integrated firms do not trade with their affiliates at all. Our findings for Korea and Japan are quite robust. However, our survey database also includes horizontally integrated firms. That is, there may be many cases where a parent firm owns an

affiliate that is not vertically related to it through either supply or production. Therefore, we included all firms that are horizontally integrated affiliates in our sample and repeated all the data analyses and regression estimations. The main results remain qualitatively intact even with such a full sample dataset for both Korea and Japan. All our results are readily available upon request.

3.5 Exclusion of Industry Dummies

In our main results from regressions in Table 7 and Table 8, we used the regressors that are based on the IO coefficients of vertically related industry pairs. However, in the regressions (3) ~ (6), we also included γ_{ai}, industry dummies for affiliates. So, one may have a doubt on our main results for the co-existence of industry dummies and the IO coefficient in the regressions. To check the robustness of our results, we attempted to exclude the industry dummies and re-tested the models (3) ~ (6). The results are summarized in Table 9 and Table 10.

Table 9 is Korean case. In regression models of (3) and (5) where we used binary variables for intra-firm trade and transactions for the dependent variable, we found a different result that the IO coefficients are positively related to the intra-firm trade and transactions. However, in the models of (4) and (6) in which the logarithms of the intra-firm trade and transactions are the dependent variable, the statistical significance disappears once again. The significant results from the first models (3) and (5) may be due to the fact that the intra-firm trade and transactions are mostly done by the larger conglomerates in Korea. But, the influences of those extremely large firms may be reduced by the logarithmic transformation. Indeed, as shown in the second models (4) and (6), we were able to support a consistent result to our main findings.

For the same reason, Japan case may not have such problems appeared in Korean case because the firm sizes are relatively even in Japan than in Korea, as we summarized ealier in Table 3 and

4. Indeed, the regression results in Table 10 show Japanese cases, where the IO coefficients cannot explains the intra-firm trade or transactions, even without the industrial dummies of affiliates.

4. Concluding Remarks

We found two important facts related to intra-firm trade between parent firms and their foreign affiliates by using two datasets for Korean and Japanese firms. First, firms having high levels of employment and owning a large number of affiliates accounted for most of the intra-firm trade flows between parent firms and their foreign affiliates. Second, the IO structure of the parent firms' and affiliates' industries cannot explain the presence and magnitude of intra-firm trade between vertically integrated parent firms and their affiliates. These findings are robust to domestic VI firms as well as to a full sample including horizontally integrated firms.

However, our findings do not disprove the traditional belief that intra-firm trade can be observed in the cross-border production sharing system and that the export platform model is a dominant form of FDI. Thus, once a production "network" system is developed in a region, firms can certainly manage the sophisticated combination of not only intra-firm trade but also arm's length transactions. Athukorala (2011) investigated the global production networks, with emphasis on trade flows, and found a strong network influence on the intensity of goods flows. Ando and Kimura (2015) further found that the expansion of multinational firms stimulates the activities of headquarters to actively organize global production networks and trade. Nonetheless, the findings cast a doubt on the traditional wisdom of cost-saving FDI being beneficial to maintain the comparative advantage in international markets. Furthermore, our findings open up a challenging question on the motivation for the lack of intra-firm trade of firms with their foreign affiliates. One may consider some forms of transactions other than the flow of "goods," for example, knowledge

transfer through relocation of professional workers and technicians, etc. We leave these topics for future studies.

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Table 1. Industry-level Intra-firm trade and transactions: Korea, 2010

Industry	Export to foreign affiliates	Import from foreign affiliates	Sales to domestic affiliates	Purchase from domestic affiliates
10	178,419(28%)	318,665(23%)	1,978,811(56%)	2,972,546 (46%)
11	6,538(100%)	0(0%)	36,471(50%)	20,702(25%)
12	11,115(100%)	35(100%)	9,469(100%)	7,568(100%)
13	1,237,482(36%)	394,405(33%)	187,271(31%)	860,783(31%)
14	135,482(27%)	297,535(25%)	677,257(44%)	546,271(44%)
15	167,150(44%)	414,384(19%)	68,378(100%)	695,403(100%)
16	4,533(0%)	11,875(100%)	1,608(0%)	9,708(50%)
17	311,562(33%)	11,510(8%)	230,621(30%)	551,534(41%)
18	21,971(67%)	3,722(33%)	10,392(25%)	3,120(25%)
19	2,166,286(67%)	1,380,891(33%)	140,633(75%)	100,410(100%)
20	1,600,076(47%)	1,100,750(33%)	7,495,842(60%)	6,348,175(46%)
21	31,737(23%)	50,163(8%)	223,988(43%)	461,959(33%)
22	3,152,446(30%)	724,299(24%)	903,582(40%)	1,138,548(40%)
23	179,264(33%)	143,096(33%)	471,727(58%)	558,126(48%)
24	6,882,991(42%)	2,443,507(42%)	4,986,666(56%)	6,235,081(52%)
25	282,596(37%)	165,078(20%)	504,127(13%)	302,543(17%)
26	80,919,764(46%)	29,107,479(34%)	53,740,431(30%)	24,859,547(30%)
27	468,980(54%)	81,369(28%)	389,079(35%)	145,905(26%)
28	1,371,557(37%)	439,206(30%)	670,731(28%)	510,540(20%)
29	3,294,495(38%)	585,638(26%)	1,141,790(24%)	1,333,989(27%)
30	24,554,833(47%)	954,757(25%)	12,163,418(37%)	19,059,390(41%)
31	1,966,484(63%)	1,854,161(56%)	1,270,519(29%)	2,668,218(36%)
32	102,547(36%)	13,524(36%)	29,222(50%)	14,833(50%)
33	4,494(25%)	33,715(19%)	103,928(0%)	106,302(50%)

Source: 2010 *Survey of Business Activities* (SBA), Statistics Korea of Korean government.
Note: The unit of intra-firm trade and transaction is million KRW. The numbers in the first column is the 2-digit industry classification. The industry names are listed in Appendix. The % in parenthesis is the share of vertically integrated firms with positive intra-firm trade or transaction.

Table 2. Industry-level Intra-firm trade and transactions: Japan 2010

Industry	Export to foreign affiliates	Import from foreign affiliates	Sales to domestic affiliates	Purchase from domestic affiliates
10	24,864(36%)	30,083(40%)	274,788(12%)	231,512(11%)
11	3,100(75%)	560(63%)	48,876(24%)	66,127(18%)
12	-	-	-	-
13	7,762(46%)	10,715(46%)	21,615(11%)	28,996(11%)
14	6,594(30%)	24,122(51%)	31,145(11%)	33,584(18%)
15	757(71%)	3,919(71%)	75(40%)	136(40%)
16	134(30%)	16,466(60%)	399(9%)	4,446(9%)
17	30,978(35%)	2,333(29%)	165,441(14%)	3,113(5%)
18	67,799(59%)	2,852(50%)	35,221(8%)	36,771(5%)
19	8,123(80%)	403(60%)	78,984(44%)	30,657(44%)
20	432,300(64%)	84,295(51%)	1,615,172(45%)	437,600(32%)
21	168,367(52%)	18,681(60%)	123,336(27%)	80,632(27%)
22	565,650(58%)	273,438(51%)	1,002,842(25%)	313,248(26%)
23	252,237(67%)	35,914(44%)	99,810(22%)	35,646(12%)
24	270,957(63%)	106,418(50%)	1,491,197(30%)	1,600,416(23%)
25	54,555(57%)	27,587(44%)	118,087(18%)	90,355(17%)
26	5,805,514(74%)	642,400(66%)	6,098,675(43%)	6,552,542(39%)
27	787,816(73%)	255,349(71%)	167,437(43%)	229,435(43%)
28	822,454(69%)	295,635(71%)	898,703(40%)	712,478(41%)
29	1,487,400(68%)	957,105(60%)	633,030(35%)	1,472,725(36%)
30	9,967,008(69%)	406,599(47%)	5,411,086(39%)	6,821,708(41%)
31	265,321(57%)	81,052(54%)	94,016(24%)	137,839(24%)
32	1,312(40%)	10,672(80%)	3,816(13%)	47,722(38%)
33	267,428(74%)	135,939(71%)	207,345(46%)	172,130(37%)

Source: 2010 *Basic Survey on Japanese Business Structure and Activities* (BSJBSA),
Ministry of Economy, Trade and Industry of the Japanese government
Note: The unit of intra-firm trade and transaction is million JPY. The numbers in the first column is the 2-digit industry classification. The industry names are listed in Appendix. The transaction data for Industry 12 (Tobacco Products) are not available. The % in parenthesis is the share of vertically integrated firms with positive intra-firm trade or transaction.

Table 3. Intra-firm trade and transactions: Korean firms in 2010

	(A) All	(B) Positive	(B)/(A)	Top 5	Top 10	Top 50	Top 100
			Parent–foreign affiliate				
Export to affiliates	1,078	440	0.40	0.77 (0.29)	0.85 (0.37)	0.96 (0.51)	0.98 (0.56)
Import from affiliates	1,078	311	0.29	0.77 (0.18)	0.84 (0.29)	0.96 (0.43)	0.99 (0.47)
Intra-firm trade	1,078	481	0.45	0.74 (0.29)	0.83 (0.37)	0.95 (0.52)	0.98 (0.58)
			Parent–domestic affiliate				
	(A) All	(B) Positive	(B)/(A)	Top 5	Top 10	Top 50	Top 100
Sales to affiliates	804	303	0.38	0.78 (0.15)	0.89 (0.43)	0.97 (0.56)	0.99 (0.61)
Purchase from affiliates	804	291	0.36	0.61 (0.36)	0.80 (0.45)	0.95 (0.57)	0.98 (0.64)
Intra-firm transaction	804	369	0.46	0.66 (0.34)	0.84 (0.48)	0.95 (0.57)	0.98 (0.64)

Notes: The sample includes Korean manufacturing parent firms that have foreign (in the upper panel) and domestic (in the lower panel) manufacturing affiliates in vertical structures respectively. It excludes parent firms that are owned by other firms. The numbers in parentheses give the employment share of top firms with intra-firm trade and transactions.

Table 4. Intra-firm trade and transactions: Japanese firm in 2010

			Parent–foreign affiliate				
	(A) All	(B) Positive	(B)/(A)	Top 5	Top 10	Top 50	Top 100
Export to affiliates	1,420	876	0.62	0.48 (0.10)	0.59 (0.14)	0.84 (0.27)	0.92 (0.34)
Import from affiliates	1,420	789	0.56	0.45 (0.06)	0.56 (0.09)	0.79 (0.16)	0.87 (0.23)
Intra-firm trade	1,420	1,006	0.71	0.42 (0.11)	0.54 (0.15)	0.80 (0.29)	0.89 (0.35)
			Parent–domestic affiliate				
	(A) All	(B) Positive	(B)/(A)	Top 5	Top 10	Top 50	Top 100
Sales to affiliates	1,626	464	0.29	0.46 (0.19)	0.64 (0.15)	0.90 (0.27)	0.97 (0.34)
Purchase from affiliates	1,626	413	0.25	0.62 (0.08)	0.74 (0.12)	0.90 (0.22)	0.96 (0.28)
Intra-firm transaction	1,626	569	0.35	0.51 (0.09)	0.66 (0.14)	0.87 (0.29)	0.94 (0.37)

Notes: The sample includes Japanese manufacturing parent firms that have foreign (in the upper panel) and domestic (in the lower panel) manufacturing affiliates in vertical structures respectively. It excludes parent firms that are owned by other firms. The numbers in parentheses give the employment share of top firms with intra-firm trade and transactions.

Table 5. Intra-firm trade and firm size: Korea

	Parent–foreign affiliate			
	Import		Export	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
ln(Employment)	0.075***	0.893***	0.087***	0.980***
	(0.018)	(0.143)	(0.016)	(0.079)
ln(Number of	0.120***	0.745***	0.076***	0.903***
foreign affiliates)	(0.029)	(0.193)	(0.027)	(0.138)
Observations	2,269	888	2,269	1,143
R-squared	0.243	0.513	0.208	0.703
	Parent–domestic affiliate			
	Purchase		Sales	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
ln(Employment)	0.099***	1.029***	0.099***	0.960***
	(0.015)	(0.077)	(0.015)	(0.103)
ln(Number of	0.115***	0.811***	0.129***	0.788***
domestic affiliates)	(0.035)	(0.190)	(0.036)	(0.209)
Observations	1,387	611	1,387	646
R-squared	0.247	0.651	0.266	0.557

Notes: The regressions in the upper panel include foreign affiliates' industry and country dummies, and those in the lower panel include domestic affiliates' industry and province dummies. The sample includes Korean manufacturing parent firms that have foreign (in the upper panel) and domestic (in the lower panel) manufacturing affiliates in vertical structures respectively. The numbers in parentheses give the cluster standard errors at the parent-firm level. The estimates for constant terms are not reported in the table. The significance levels are indicated by ***, **, and * for 1%, 5%, 10%, respectively.

Table 6. Intra-firm trade and firm size: Japan

	Parent–foreign affiliate			
	Import		Export	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
ln(Employment)	-0.019	0.523***	0.000	0.887***
	(0.015)	(0.087)	(0.015)	(0.072)
ln(Number of	0.045***	0.705***	0.068***	0.782***
foreign affiliates)	(0.023)	(0.126)	(0.023)	(0.101)
Observations	1,420	789	1,420	876
R-squared	0.056	0.309	0.072	0.570
	Parent–domestic affiliate			
	Purchase		Sales	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
ln(Employment)	0.050***	0.837***	0.059***	1.065***
	(0.012)	(0.117)	(0.012)	(0.136)
ln(Number of	-0.025	0.938***	0.016	0.736***
domestic affiliates)	(0.017)	(0.143)	(0.018)	(0.152)
Observations	1,626	413	1,626	464
R-squared	0.208	0.57	0.239	0.469

Notes: The regressions in the upper panel include foreign affiliates' industry and region dummies, and those in the lower panel include domestic affiliates' industry dummies. The sample includes Japanese manufacturing parent firms that have foreign (in the upper panel) and domestic (in the lower panel) manufacturing affiliates in vertical structures respectively. The numbers in parentheses give the cluster standard errors at the parent-firm level. The estimates for constant terms are not reported in the table. The significance levels are indicated by ***, **, and * for 1%, 5%, 10%, respectively.

Table 7. Intra-firm trade and input-output linkage: Korea

	Parent–foreign affiliate			
	Import		Export	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
drxz	-0.046			
	(0.186)			
drzx			-0.128	
			(0.147)	
ln(drxz)		-0.089		
		(0.366)		
ln(drzx)				-0.059
				(0.122)
Observations	2,269	888	2,269	1,143
R-squared	0.104	0.173	0.096	0.212
	Parent–domestic affiliate			
	Purchase		Sales	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
drxz	0.196			
	(0.144)			
drzx			0.201*	
			(0.118)	
ln(drxz)		-0.236		
		(0.229)		
ln(drzx)				-0.048
				(0.073)
Observations	1,387	611	1,387	646
R-squared	0.105	0.136	0.116	0.128

Notes: The regressions in the upper panel include foreign affiliates' industry and country dummies, and those in the lower panel include domestic affiliates' industry and province dummies. The sample includes Korean manufacturing parent firms that have foreign (in the upper panel) and domestic (in the lower panel) manufacturing affiliates in vertical structures respectively. The numbers in parentheses give the cluster standard errors at the parent-firm level. The estimates for constant terms are not reported in the table. The significance levels are indicated by ***, **, and * for 1%, 5%, 10%, respectively.

Table 8. Intra-firm trade and input-output linkage: Japan

	Parent–foreign affiliate			
	Import		Export	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
drxz	-0.094			
	(0.104)			
drzx			0.121*	
			(0.073)	
ln(drxz)		-0.022		
		(0.210)		
ln(drzx)				-0.058
				(0.050)
Observations	1,420	789	1,420	873
R-squared	0.045	0.145	0.054	0.322
	Parent–domestic affiliate			
	Purchase		Sales	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
drxz	-0.128			
	(0.079)			
drzx			0.032	
			(0.057)	
ln(drxz)		-0.257		
		(0.267)		
ln(drzx)				0.139*
				(0.078)
Observations	1,626	413	1,626	461
R-squared	0.179	0.192	0.197	0.211

Notes: The regressions in the upper panel include foreign affiliates' industry and region dummies, and those in the lower panel include domestic affiliates' industry dummies. The sample includes Japanese manufacturing parent firms that have foreign (in the upper panel) and domestic (in the lower panel) manufacturing affiliates in vertical structures respectively. The numbers in parentheses give the cluster standard errors at the parent-firm level. The estimates for constant terms are not reported in the table. The significance levels are indicated by ***, **, and * for 1%, 5%, 10%, respectively.

Table 9. Intra-firm trade and input-output linkage without industry dummies: Korea

	Parent–foreign affiliate			
	Import		Export	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
drxz	0.267**			
	(0.120)			
drzx			0.208*	
			(0.110)	
ln(drxz)		0.260		
		(0.354)		
ln(drzx)				0.136
				(0.152)
Observations	2,269	888	2,269	1,143
R-squared	0.052	0.086	0.056	0.010
	Parent–domestic affiliate			
	Purchase		Sales	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
drxz	0.216**			
	(0.107)			
drzx			0.213**	
			(0.098)	
ln(drxz)		0.229		
		(0.209)		
ln(drzx)				0.017
				(0.066)
Observations	1,387	611	1,387	646
R-squared	0.052	0.042	0.055	0.049

Notes: The regressions exclude foreign and domestic affiliates' industry dummies from Table 7. The sample includes Korean manufacturing parent firms that have foreign (in the upper panel) and domestic (in the lower panel) manufacturing affiliates in vertical structures respectively. The numbers in parentheses give the cluster standard errors at the parent-firm level. The estimates for constant terms are not reported in the table. The significance levels are indicated by ***, **, and * for 1%, 5%, 10%, respectively.

Table 10. Intra-firm trade and input-output linkage without industry dummies: Japan

	Parent–foreign affiliate			
	Import		Export	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
drxz	-0.086			
	(0.055)			
drzx			0.051	
			(0.050)	
ln(drxz)		0.173		
		(0.123)		
ln(drzx)				0.019
				(0.048)
Observations	1,420	789	1,420	873
R-squared	0.023	0.092	0.017	0.265
	Parent–domestic affiliate			
	Purchase		Sales	
	(1) $D(X_{ap})$	(2) $\ln(X_{ap})$	(3) $D(X_{pa})$	(4) $\ln(X_{pa})$
drxz	-0.087**			
	(0.039)			
drzx			0.022	
			(0.037)	
ln(drxz)		-0.16		
		(0.172)		
ln(drzx)				0.131*
				(0.075)
Observations	1,626	413	1,626	461
R-squared	0.155	0.127	0.164	0.129

Notes: The regressions exclude foreign and domestic affiliates' industry dummies from Table 8. The sample includes Japanese manufacturing parent firms that have foreign (in the upper panel) and domestic (in the lower panel) manufacturing affiliates in vertical structures respectively. The numbers in parentheses give the cluster standard errors at the parent-firm level. The estimates for constant terms are not reported in the table. The significance levels are indicated by ***, **, and * for 1%, 5%, 10%, respectively.

Appendix: 2-digit industry classification list

10: Manufacture of Food Products
11: Manufacture of Beverages
12: Manufacture of Tobacco Products
13: Manufacture of Textiles, Except Apparel
14: Manufacture of Wearing Apparel, Clothing Accessories and Fur Articles
15: Tanning and Dressing of Leather, Manufacture of Luggage and Footwear
16: Manufacture of Wood and of Products of Wood and Cork: Except Furniture
17: Manufacture of Pulp, Paper and Paper Products
18: Printing and Reproduction of Recorded Media
19: Manufacture of Coke, Hard-coal and Lignite Fuel Briquettes and Refined Petroleum Products
20: Manufacture of Chemicals and Chemical Products except Pharmaceuticals and Medicinal Chemicals
21: Manufacture of Pharmaceuticals, Medicinal Chemicals and Botanical Products
22: Manufacture of Rubber and Plastic Products
23: Manufacture of Other Non-metallic Mineral Products
24: Manufacture of Basic Metal Products
25: Manufacture of Fabricated Metal Products, Except Machinery and Furniture
26: Manufacture of Electronic Components, Computer, Radio, Television and Communication Equipment and Apparatuses
27: Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
28: Manufacture of Electrical Equipment
29: Manufacture of Other Machinery and Equipment
30: Manufacture of Motor Vehicles, Trailers and Semitrailers
31: Manufacture of Other Transport Equipment
32: Manufacture of Furniture
33: Other manufacturing