PRI Discussion Paper Series (No.25A-08)

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Faculty of Business and Commerce, Keio University, Japan
Masahiro Endoh
Faculty of International Social Sciences, Yokohama National University, Japan
Uraku Yoshimoto
Graduate School of Economics, Kyoto University, Japan
Naoto Jinji
Graduate School of Social Sciences, Chiba University, Japan
Keiko Ito

October 2025

Research Department Policy Research Institute, MOF
3-1-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8940, Japan
TEL 03-3581-4111

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Masahiro Endoh†, Uraku Yoshimoto‡, Naoto Jinji§, Keiko Ito¶

Abstract

Carry-along trade (CAT) is the phenomenon in which manufacturing firms export products that they have not produced themselves. This study examines the sizes and characteristics of CAT in both intrafirm and interfirm trade, using customs and production data from Japanese manufacturing firms from the 2014–2020 period. Depending on how CAT is defined, it may account for between one-third and two-thirds of total exports by Japanese manufacturing firms, underlining the importance of trade intermediation by producers. The ratio of CAT is notably higher in intrafirm trade than in interfirm trade. The distribution of Japanese trade flows indicates that the sizes of CAT components are influenced not only by demand-scope complementarities but also by country-specific economic factors. The high ratio of CAT in intrafirm trade can be attributed to the larger exports of both sourced and produced products by Japanese multinational firms, due to the elimination of bargaining inefficiency between sellers and buyers.

Keywords: Trade intermediation by producers, Carry-along trade, Intrafirm trade

JEL codes: F12; F13; F14; L11

*This study is the result of a joint research project conducted with the Policy Research Institute (PRI). A request was made to the Ministry of Finance (MOF) to provide us with the data of customs export and import declarations submitted to them. These declarations were made based on the "Guideline on the utilization of customs import and export declaration data in a joint research with the Policy Research Institute," and was approved in February 2022. The views expressed in this paper are those of the authors and do not represent the official views of MOF or PRI. The authors would like to thank Kenta Ando, Tetsushi Horie, Fumiharu Ito, Motoki Katano, Shintaro Negishi, and Kayo Takama of the PRI of MOF Japan for their guidance on the dataset used in this research and programs, as well as their most helpful comments. We are grateful to Vincent Rebeyrol, Yukiko Saito, Yushi Yoshida, the seminar participants at Keio University, the Otaru University of Commerce, and the 2024 Spring Meeting of the Japan Society of International Economics held at Tohoku Gakuin University for their invaluable comments. We would also like to thank the immense financial support from the Japan Society of the Promotion of Science, KAKENHI, under grant numbers 23K01396, 23K25514, and 24K16379, which has made this study possible. All subsequent errors are the responsibity of the authors.

†Faculty of Business and Commerce, Keio University, 2-15-45 Mita, Minato-ku, Tokyo 108-8345, Japan. E-mail: endoh@keio.jp.

‡Faculty of International Social Sciences, Yokohama National University, 79-3 Tokiwadai, Hodogaya-ku, Yokohama 240-8501, Japan. E-mail: uraku.yoshimoto@gmail.com.

§Graduate School of Economics, Kyoto University, Yoshida-honmachi, Sakyo-ku, Kyoto 606-8501, Japan. E-mail: jinji@econ.kyoto-u.ac.jp.

¶Graduate School of Social Sciences, Chiba University, 1-33 Yayoicho, Inage-ku, Chiba 263-8522, Japan. E-mail: keiko-i@chiba-u.jp.

1 Introduction

Evidence from various countries show that a small number of firms account for the majority of the value in international trade.[1] However, "the happy few" do not necessarily manufacture all the products they export. Even manufacturing firms—let alone wholesale and retail firms—often intermediate products they do not produce. This makes it more convenient in facilitating their entry into foreign markets. It should be noted that this intermediation accounts for a substantial portion of their total exports. The increased availability of firm-product level trade and production data has made it possible to identify such examples from several countries over the past decade. Some of the outstanding examples are Di Nino (2015) for Italy, Bernard et al. (2019) for Belgium, van den Berg et al. (2019) for the Netherlands, Abreha et al. (2020) for Denmark, Arnarson (2020) for Sweden, and Erbahar and Rebeyrol (2023) for Turkey.

Bernard et al. (2019) (hereafter, BBVV) identified the phenomenon of manufacturing firms exporting the products not produced by the firm itself as carry-along trade (CAT) and demonstrated that it constitutes a significant share of international trade in Belgium. Their findings show that CAT accounts for approximately three-quarters of the total number of exported products and 30% of the total export value.[2] BBVV also attempted to identify the reasons for why firms resort to CAT. It was concluded that demand-scope complementarity was the main factor. This suggests customer preference for purchasing from firms that offer a broader range of products.

In addition to this hypothesis, Erbahar and Rebeyrol (2023) (hereafter, ER) proposed that manufacturers also act as trading companies, facilitating connections between domestic producers and foreign buyers to generate revenue. ER defined trade intermediation by producers (TIP) as the practice in which manufacturers export goods that they do not produce themselves, categorizing it into two types. The first type, carry-along trade (CAT, as defined by ER), refers to the export of sourced products bundled with products produced by the manufacturer exporter themselves to a destination country. The second type, purely intermediated (PI) trade, involves sourced products being exported solely to a destination country.[3] (Hereafter, the definitions of

[1] For example, Mayer and Ottaviano (2008) for European countries, Bernard et al. (2018) for the United States, and Ito et al. (2025) for Japan.

[2] Citing figures from other countries, Abreha et al. (2020) and Arnarson (2020) report that the ratio of CAT in total export value was 18% in Denmark in 2012 and 21% in Sweden during 1997–2011, respectively.

[3] Since BBVV's definition of CAT includes the export of items produced by manufacturer exporters where the

CAT by BBVV and ER will be referred to as CAT(BBVV) and CAT(ER), respectively, with the authors indicated in parentheses. Other definitions will follow the same notation.) Using these definitions and firm-product-destination data from Turkish manufacturers, ER demonstrated that CAT(ER) and PI(ER) each account for approximately half of TIP(ER). This finding supports the view that some manufacturers not only export their own products but also engage in pure trading activities to generate additional revenue.

Trade intermediation consists of two components: 1. a domestic transaction, where manufacturers purchase products from other firms, and 2. an international transaction, where they export these products.[4] These transactions can be implemented either as intrafirm or interfirm trade. In BBVV's theoretical model, domestic transactions are assumed to be interfirm. Conversely, in the model of Eckel and Riezman (2020), the intermediator determines the export volume of CAT(BBVV) to maximize the joint profit of the manufacturer of the sourced products and the intermediator. As a result, domestic transactions are interpreted as intrafirm. Eckel and Riezman (2020) further explained that the benefit of CAT lies in the ability of the exporter to internalize the strategic relationship between the product it produces itself and those it sources from other firms.

The natural extension of examining the differing implications of interfirm and intrafirm domestic transactions on CAT, is to consider how they differ in international transactions. The distinction is significant in the context of international trade, as intrafirm trade constitutes a substantial share of global trade. For instance, in Japan, 55% of exports and 32% of imports in the fiscal year 2022 occurred between related parties. This ratio rises to as high as 74% for exports to North America.[5] Similarly, in the United States (US), Ruhl (2015) demonstrated that intrafirm trade accounted for one-third of its exports and imports. This study examines the distinction between intrafirm and interfirm CAT in international transactions, in an attempt to identify the outstanding issues of CAT.

The differences in the scale of CAT(ER) between intrafirm and interfirm trades has not been

export value exceeds the production value, while ER's CAT does not, ER's CAT is a subset of BBVV's CAT. A detailed explanation of BBVV's and ER's classifications is provided in Section 2.

[4]Manufacturers may also purchase products from foreign countries and sell them in foreign markets. However, as demonstrated in Appendix 1, the value of internationally sourced products is very limited in Japan.

[5]These figures are based on *The Basic Survey of Japanese Business Structure and Activities*, conducted annually by the Ministry of Economy, Trade and Industry. This survey, which covered 7,800 large exporting firms and 8,215 large importing firms in the fiscal year 2022, reliably represents the characteristics of Japanese trading activities.

thoroughly examined in previous studies. Intrafirm international trade is expected to enhance the export value of products—whether sourced or produced—by eliminating the inefficiency arising from the interplay of monopolistic power between sellers and buyers. Transitioning a portion of a firm's exports from interfirm to intrafirm trade increases the ratio of sourced products to total export, provided the CAT(ER) is more active in intrafirm trade. (Please refer to the appendix of this study for the theoretical model explaining this effect, which is an extension of the study of Eckel and Riezman (2020).) Through empirical analysis, this study shows that the ratio of sourced products to total products, is in fact, higher in firms engaged in intrafirm trade.

Among the various findings in this study, three have novel implications that are applicable to other countries. Firstly, the sizes of CAT components are influenced not only by demand-scope complementarities, but also by country-specific factors. In the case of Japan, these include the prevalence of trading companies engaged in export activities and the outsourcing practices of multinational firms to affiliated domestic firms. Secondly, CAT(ER) is larger and PI(ER) is smaller in intrafirm trade than in interfirm trade, which can be explained by the incentives multinational firms consider when selecting foreign partners. Thirdly, the high ratio of CAT(ER) in intrafirm trade is driven by an increase in exports of both sourced and manufactured products, rather than sourced products alone. This is in line with theoretical predictions.

The size of intrafirm trade by multinationals depends on the extent to which they have expanded their business operations overseas. Previous empirical studies have identified several factors that promote intrafirm trade, including incomplete contracting (Antràs, 2003), high levels of capital intensity, skill intensity, productivity, the quality of the judiciary and the enforcement of contracts (Corcos et al., 2013), as well as significant tax differentials (Egger and Seidel, 2013).[6] This study demonstrates a positive correlation between CAT and intrafirm trade. It also suggests that these factors contribute to the trade intermediations of the firm by facilitating the activation of intrafirm trade.

The remainder of this study is organized as follows. Section 2 is a review of the defini-

[6]It is intriguing that, based on the findings of empirical studies, input–output linkages have only a limited positive impact on intrafirm trade. For example, Ramondo et al. (2016) and Chun et al. (2017) found that input–output linkages do not have a statistically significant effect on intrafirm trade for multinationals headquartered in the US and for those in South Korea and Japan, respectively. Furthermore, Matsuura et al. (2023) observed that input–output linkages have a significant positive effect only on intrafirm imports to Japanese headquarters from subsidiaries in developing countries.

tions of trade intermediation by producers as proposed by BBVV and ER, underlining their differences. Section 3 summarizes the dataset used in this study. Section 4 is a practical application of the definition of BBVV and ER to Japanese exports, and analyzes the characteristics of Japanese trade intermediation. Section 5 covers the concepts of intrafirm and interfirm trade utilizing Japanese export data, while Section 6 empirically analyzes the relationship between intrafirm trade and CAT. Finally, Section 7 summarizes the conclusions of this study. The appendix provides some figures of CAT based on alternative definitions and a simple theoretical model for predicting the impact of intrafirm trade on CAT.

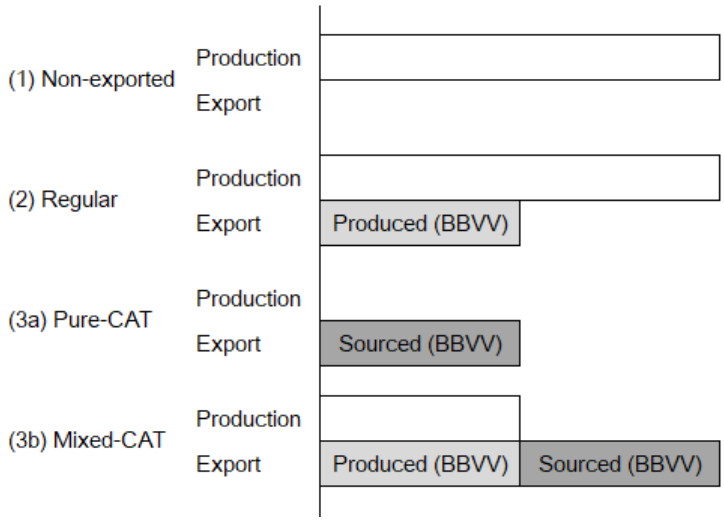
2 Classification of exported goods

The definitions of the value of produced and sourced goods vary, and therefore it is necessary to be clear as to how these are defined by BBVV and ER in this study.

BBVV calculated the value of produced and sourced commodities for each firm, based on the size of the produced and exported values of each of these. They classified the commodities that each firm produced and/or exported into four categories, as illustrated in Figure 1: 1. Non-exported goods are products that the firm manufactures but does not export, 2. Regular goods are products that the firm both manufactures and exports, where the manufactured value exceeds the exported value. 3. (3a) pure-CAT goods are products that the firm does not manufacture, but exports. 4. (3b) mixed-CAT goods are products that the firm both manufactures and exports, where the exported value to the foreign countries exceeds the produced value.

The firm's total export value can be decomposed into two components: The parts produced by the firm and the parts sourced from other firms. The produced value of exports is calculated as the sum of the total export value of (2) regular goods and the total produced value of (3b) mixed-CAT goods. These calculations are done under the assumption that the exported value covered by the produced value is entirely covered by the firm. The sourced value of exports is calculated as the sum of the total export value of (3a) pure-CAT goods and the sourced portion of (3b) mixed-CAT goods. The sourced portion of (3b) mixed-CAT goods is defined as the amount by which their total exported value exceeds their production value. BBVV report that, in Belgium in 2005, the total export value of €85.0 billion can be broken down into €59.6

Figure 1: BBVV: Classification of the Types of Transactions



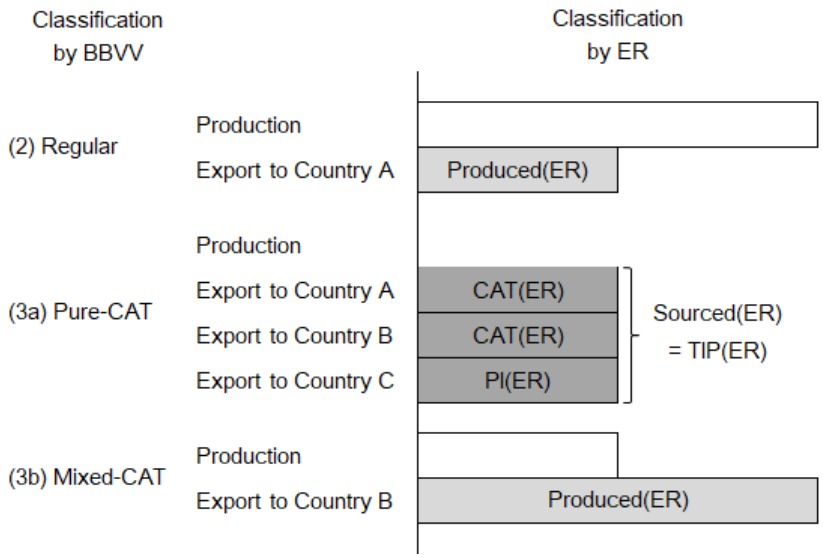
billion from produced products and €25.4 billion from sourced products. Approximately 30% of total exports consisted of sourced products. According to this study, the total export value of CAT, which included (3a) pure-CAT and (3b) mixed-CAT goods, amounted to €41.5 billion, accounting for approximately half of their total exports. These figures underline that CAT is a significant phenomenon in the export activities of a firm.

ER considered the dimensions of the destination countries for exports and were cautious in defining CAT, narrowing the scope of CAT through two criteria. Firstly, ER reclassified all export values of (3b) mixed-CAT goods by BBVV, as exports of produced goods.[7] Secondly, ER defined CAT(ER) as sourced products that are exported to a specific country, alongside products produced by the firm itself. Sourced products of (3a) pure-CAT goods which were not classified as CAT(ER) were labeled PI(ER).

Figure 2 illustrates the correspondences between BBVV's global comprehensive definition and ER's country-specific definition, using the example of a firm exporting products to Countries A, B, and C. According to ER's definition, only (3a) pure-CAT goods were categorized as sourced products. These were labeled as TIP(ER). TIP(ER) was further divided into CAT(ER) and PI(ER). These exports included both produced products, classified as (2) regular goods, and sourced products, classified as TIP(ER), to Country A. TIP(ER) to Country A is regarded

[7]This treatment by ER is justifiable for two reasons. First, some of the exported products categorized as sourced products in (3b) mixed-CAT goods during a given year may, in fact, have been produced by the exporting firm in the previous year and carried over as inventory. Secondly, there is no information regarding the proportion of exported products in (3b) mixed-CAT goods to a specific country that originates from the firm's production.

Figure 2: ER: Classification of the Types of Transactions



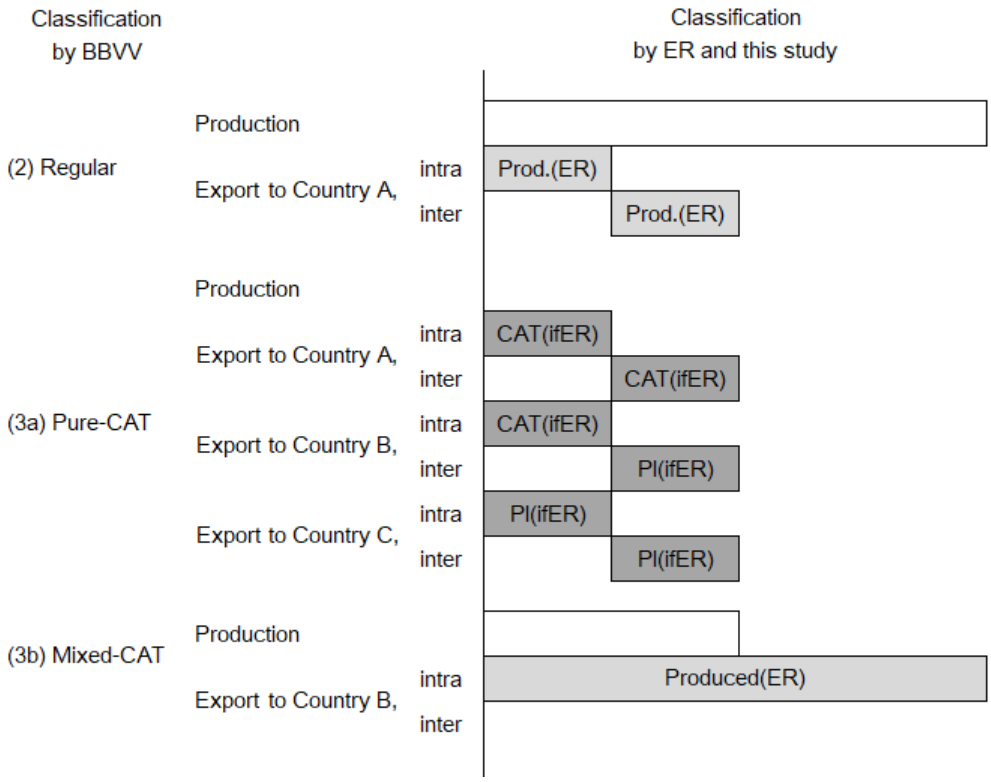
as CAT(ER). The firm exported both manufactured products in (3b) mixed-CAT and sourced products in TIP(ER) to Country B. In this instance, TIP(ER) to Country B was also classified as CAT(ER). On the other hand, the firm exported only sourced products categorized as TIP(ER) to Country C, so TIP(ER) to Country C was classified as PI(ER).

Based on the Turkish data ER analyzed, the ratio of TIP to total exports for each exporting firm was, on the average, 55%, with a median of 62%. This underlines the significance of sourced products in overall exports. Furthermore, the ratio of PI(ER) to TIP(ER) for each exporting firm was on the average 51%, with a median of 50%. This suggests that firms are incentivized to export sourced products not only to stimulate demand by offering a wider variety of goods to foreign consumers but also to generate additional revenue by acting as intermediaries for products in foreign markets, similar to wholesale and retail businesses.

This study constructs an exporter-goods-destination-intrafirm/interfirm-level dataset by incorporating the criterion of whether the exporting firm and the importing firms in a destination country belong to the same multinational corporation (MNC). In other words, it adds the criterion of whether a firm's exports constitute intrafirm or interfirm trade, in addition to the exporter-goods-destination dimension defined by ER. Through making the distinction between intrafirm and interfirm trade to CAT(ER) and PI(ER), this study redefines CAT(ER) and PI(ER) for each trade type. These redefined metrics are labelled as CAT(ifER) and PI(ifER), where

"if" in parentheses refers to the inclusion of the intrafirm and interfirm trade dimension in this definition.[8]

Figure 3: Introducing Intrafirm and Interfirm Trade



CAT(ifER) and PI(ifER) are defined in Figure 3. Exports to each destination country under each definition are further categorized into intrafirm and interfirm exports. With reference to Figure 3, it is assumed that exports to each destination country in each classification include both intrafirm and interfirm trades, except for the export of (3b) mixed-CAT goods to Country B, which consists solely of intrafirm trade. In this context, exports of sourced products to Country A are accompanied by exports of produced products in both intrafirm and interfirm trades. As a result, both are labeled as CAT(ifER). Consequently, the total value of the two CAT(ifER) categories equals CAT(ER) for Country A. Similarly, for exports to Country C, the firm exports only sourced products as defined by ER. This means, that both intrafirm and

[8]CAT(ifER) and PI(ifER) are defined based on each bundle of intrafirm or interfirm trades within a destination country. The importing firm is irrelevant in this instance. To illustrate this point, a Japanese firm exporting goods to two subsidiaries in China were analyzed. The firm exports only sourced products to Subsidiary A and both sourced and produced products to Subsidiary B. In such a case, the intrafirm trade of the firm with China is collectively defined as CAT(ifER) after bundling the exports to both subsidiaries. This study does not use the definition of CAT or PI that applies to individual importers, such as defining the export to Subsidiary A as PI(ifER) and that to Subsidiary B as CAT(ifER).

interfirm exports to Country C are labeled as PI(ifER). However, for exports to Country B, produced products in ER's definition are exclusively exported as intrafirm trade. Consequently, interfirm exports of sourced products, categorized as CAT(ER) in Figure 2, were reclassified as PI(ifER). This illustrates that the total value of CAT(ifER) can become smaller than that of CAT(ER) when a stricter definition of CAT, which incorporates the distinction between intrafirm and interfirm trades is applied.

3 Export and production data of Japanese firms

Transaction-level customs data from Japan Customs, Ministry of Finance, for the period 2014–2020, was used to analyze the export activities of Japanese firms. This dataset contains a comprehensive record of both exports and imports at the transaction level, comprising 18–21 million export transactions and 21–28 million import transactions annually. This study includes all export records with the exception of those involving non-manufacturing Japanese firms, reexports, entrepôt trade, and special trade activities such as gold transactions and small-scale transactions valued at ¥200,000 or less.[9]

In terms of production, this study uses data from *The Census of Manufacturers* for the years 2014 and 2016–2019 and *The Economic Census for Business Activity* for the years 2015 and 2020. *The Census of Manufacturers*, conducted by the Ministry of Economy, Trade and Industry (METI), covers Japanese manufacturing establishments with four or more workers. *The Economic Census for Business Activity*, jointly implemented by the Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC) and METI, encompasses all manufacturing establishments.[10] These datasets provide detailed production information for each manufactured product, covering 182,000–221,000 establishments annually.

Export data and production data are linked using firm identification numbers from the export dataset, establishment identification numbers from the production dataset, and a correspondence table of firm and establishment identification numbers provided by the Statistics Bureau

[9]For an overview of transaction-level Japanese customs data, please refer to Ito et al. (2025). This study also covers some fundamental characteristics of Japanese trade, such as a decomposition into intensive and extensive margins as well as the substantial concentration of trading firms.

[10]Although *The Economic Census for Business Activity* includes a larger population of establishments than *The Census of Manufacturers*, the former including small establishments with one to three workers, this difference has little impact on the results, as these smaller establishments rarely engage in international trade.

of MIC. It is important to note that the correspondence table is based on data from 2017. Firms and establishments that were not in operation in 2017 were excluded from the analysis.

Regarding the correspondence between export and production goods, a correspondence table was created to link the Harmonized System (HS) 6-digit codes with the 6-digit product codes provided by *The Census of Manufacturers*. The correspondence table was originally developed and utilized by Baek et al. (2021) and has been modified for the purposes of this study. In the 6-digit product classification of *The Census of Manufactures*, there are approximately 1,800 manufacturing product codes, whereas in the HS 6-digit classification for trade data, there are slightly over 5,000 product codes. Japan's product classification system is structured so that the first four digits correspond to the Japan Standard Industrial Classification (JSIC), which broadly aligns with the International Standard Industrial Classification (ISIC), though many JSIC four-digit industries do not correspond directly to the ISIC four-digit industries. Each four-digit industry category is further subdivided into a six-digit classification, which is the product classification employed in *The Census of Manufactures*. Due to differences in the classification principles between *The Census of Manufactures* and the HS, it was necessary to integrate product codes to construct a concordance table for these two classifications. Nevertheless, after aligning the HS codes with the product codes, there was a total 1,530 unified codes. Hereafter, each unified code will be referred to as "item."[11]

The classification of export records into intrafirm and interfirm trades is conducted as follows. A list of Japanese parent firms and their foreign subsidiaries and related firms is first compiled using data from *The Survey on Overseas Business Activities* conducted by METI, the *Orbis* database by Bureau van Dijk, and *The Directory of Overseas Japanese Companies* by Toyo Keizai Inc.[12] The names of Japanese firms in this parent-subsidiary list are then matched with the names of exporters in the Japanese customs data, while the names of foreign sub-

[11]The number of items in this study is smaller than those in BBVV (2,923) and ER (2,494) because the classification principles of *The Census of Manufactures* in Japan and the HS differ. In contrast, BBVV explain that the European Prodcom List is developed to enable a comparison between production and foreign trade statistics, and therefore the Prodcom List has a close relationship with the Combined Nomenclature (CN) classification, which corresponds to the HS classification. Although the Prodcom is also closely linked to industry classification, it should be more comparable to the HS product classification than the product classification of the Japanese Census of Manufactures. Additionally, in the case of Turkey, ER mentions that Turkey's product code system can be linked directly to both the CN classification of the EU, and the HS codes.

[12]This study defines intrafirm trade as exports from Japanese parent firms to their foreign subsidiaries and related firms. Consequently, the definition excludes exports from Japanese subsidiaries to foreign subsidiaries and exports from subsidiaries of foreign firms in Japan to their foreign parent firms or subsidiaries.

sidiaries are similarly matched with the names of importers, using the Jaro–Winkler distance to measure the similarity of names.[13] Based on an examination of the matching results, 11 countries and regions with a satisfactory matching quality were selected and included in this study. These countries and regions were China, India, Indonesia, Malaysia, the Philippines, Singapore, South Korea, Taiwan, Thailand, the US, and Vietnam. Finally, export transactions were classified as intrafirm trade if the exporter-importer pair in the customs record appeared on the parent-subsidiary list, and as interfirm trade if it did not. Since this list was applied to all export records from 2014 to 2020, the parent-subsidiary relationships remained consistent during this period.

4 Size of CATs

4.1 Comparison of CATs: BBVV versus ER

Table 1 summarizes the export values for each category in terms of the classifications of BBVV and ER among exporting firms, whose trade and production data can be linked to those in the years 2014, 2017, and 2020. As explained in Section 2, BBVV define CAT at the global level without considering the dimensions of the destination countries, whereas ER define CAT at the destination country level, taking into account the dimensions of the destination countries. In 2014, the total export value of these firms amounted to ¥44.2 trillion, with CAT in BBVV's global definition accounting for ¥28.2 trillion. Consequently, the ratio of CAT(BBVV) to total export was about two-thirds of this, a figure higher than the corresponding ratio in Belgium which was about half. Furthermore, sourced goods in BBVV's definition contributed to ¥23.0 trillion of the exports, representing over 80% of CAT(BBVV). This suggests that the proportion of produced goods within CAT(BBVV) is very small in Japan. Similar observations were made in the data for 2017 and 2020.[14]

[13] The similarity indices between the names of two firms are calculated using the Jaro–Winkler distance, after preprocessing their names by removing words that indicate the type of firms (e.g., "Corp" and "Ltd"), converting all the letters to lowercase, and eliminating spaces. The Jaro–Winkler distance is considered a suitable metric for this purpose, as it tends to assign higher similarity scores to strings that match from the beginning, making it effective for firm names with minor variations.

[14] The total export value of manufacturing firms in 2017 totals to ¥54.5 trillion (Ito et al., 2025, Table A.2), while the corresponding value in Table 1 is ¥48.3 trillion, approximately 90% of the former figure. This discrepancy arises from the differences in the criteria used to define manufacturing firms in the two tables and the fact that Table 1 includes only firms in the customs data that could be successfully linked to firms in the production data.

Table 1: Values of CATs in Japan

	2014	2017	2020
Production value of exporting firms	183.8	199.7	188.9
Export value of exporting firms	44.2	48.3	43.0
Classification by BBVV			
Produced goods	21.1	23.9	20.2
Sourced goods	23.0	24.4	22.8
CAT(BBVV)	28.2	30.9	28.1
Pure-CAT	19.5	20.0	18.1
Mixed-CAT	8.8	10.9	9.9
Classification by ER			
Produced goods	24.7	28.3	24.8
Sourced goods = TIP(ER)	19.5	20.0	18.1
CAT(ER)	14.9	15.1	13.5
PI(ER)	4.5	4.9	4.6
Number of exporting firms	13,676	15,184	15,675

Note: The unit of values is in trillion ¥.
Source: Calculated by authors based on customs data from Japan Customs (2014–2020), *The Census of Manufacturers* (2014, 2016–2019), and *The Economic Census for Business Activity* (2015, 2020).

Pure-CAT in BBVV's global definition, or TIP in ER's country-specific definition, can be further categorized into CAT(ER) and PI(ER). In 2014, CAT(ER) accounted for ¥14.9 trillion, representing three-quarters of TIP(ER) and one-third of total exports. Compared to Turkey, where ER report that CAT(ER) and PI(ER) each constitute approximately half of TIP(ER), the share of CAT(ER) among Japanese firms was significantly higher. This high proportion of CAT(ER) contributed to the elevated ratio of CAT(BBVV) to total exports in Japan. It may reflect the tendency of Japanese manufacturers, who manage export procedures for their own products as well as sourced products, to seek revenue from carry-along trade. As BBVV explained, offering a wider variety of products boosts demand for their produced goods due to the presence of demand-scope complementarities. These features were similarly observed in 2017 and 2020.

Table 2 presents the average number of items produced per firm, the average export value per item, and the average production value per item in 2014. These were grouped by firms categorized according to the number of their exported items. Similar to the patterns observed in BBVV and ER, the number of produced items increased in correlation with the number of

exported items, and the degree of increase was smaller in the former than in the latter. As a result, firms that exported 21-30 items produced only 2.7 items on average, for instance. Interesting observations were made in terms of the average export and production values per item. These numbers hit a ceiling when the number of exported items was 6 or 7, decreased thereafter, and then increased again once the number of exported items exceeded 10.

Table 2: Number and value of exported and produced items

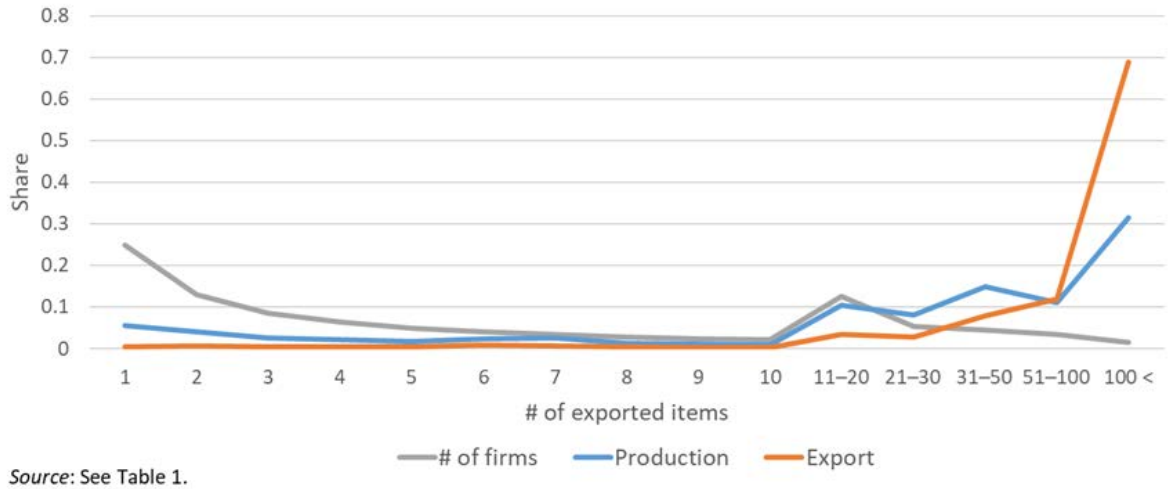
No. of exported items	Average no. of produced items	Average exports per item (billion ¥)	Average production per item (billion ¥)	No. of firms
1	1.9	0.05	1.62	3,406
2	2.0	0.09	2.11	1,791
3	2.0	0.07	1.96	1,167
4	2.0	0.06	2.11	879
5	2.1	0.07	2.16	679
6	2.2	0.11	3.60	549
7	2.1	0.10	4.79	457
8	2.2	0.06	2.61	389
9	2.1	0.04	3.21	315
10	2.2	0.05	2.74	297
11–20	2.4	0.06	4.53	1,727
21–30	2.7	0.07	7.50	719
30–50	3.3	0.14	13.19	623
51–100	4.0	0.16	10.65	471
100 <	9.0	0.96	30.94	207

Source: See Table 1.

All exporting firms were classified into bins, based on the number of exported items as can be seen in Table 2. Figure 4 shows the three types of shares for each bin: 1. The share of the number of firms in each bin relative to the total number of exporting firms, 2. The share of production in each bin relative to the total production value of exporting firms, 3. The share of exports in each bin relative to the total export value. While firms exporting more than 100 items constitute only 1.5% of all firms, these account for 31% of total production value and 69% of total export value. The Japanese data used in this research similarly showed that a small number of large firms dominated production and export values, as is the case in other countries.

Firm categories, based on the number of exported items as shown in Table 2 and Figure 4, exhibited varying characteristics in terms of the share of each component classified by BBVV and ER. Figure 5 presents the average share of CAT(ER), PI(ER), mixed-CAT, and regular

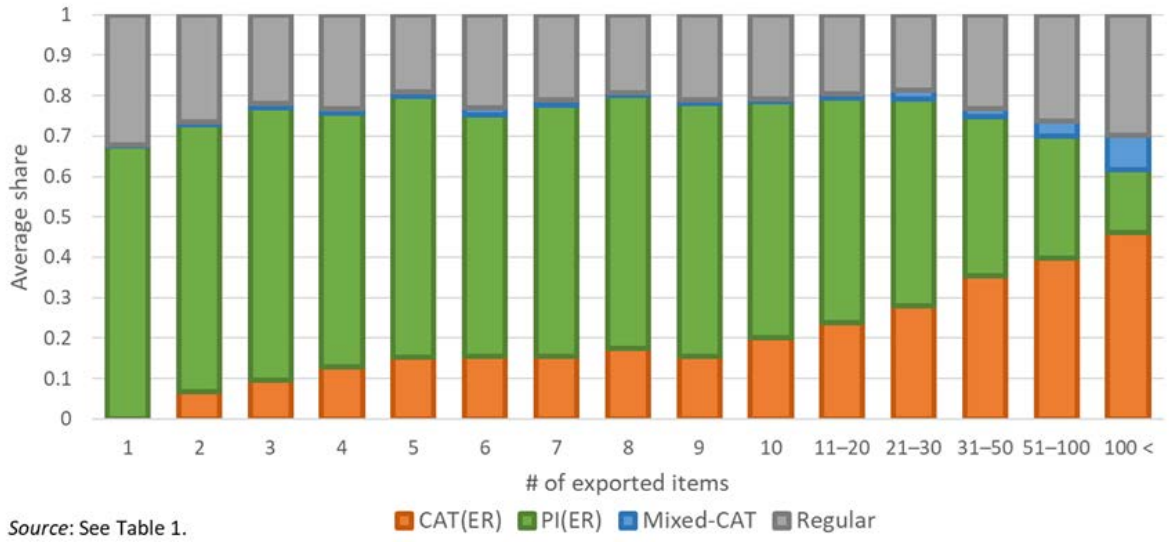
Figure 4: Share of the number of firms, production, and exports



Source: See Table 1.

exports as a proportion of total exports across all firms in each category in 2014.

Figure 5: Average share of trade components



Source: See Table 1.

The average share of CAT(ER) increases with the number of exported items, starting from 0 when firms export only one item to 0.46 when the number of exported items exceeds 100. This suggests that the benefit of carry-along trade grows as exporters produce and export a larger variety of items. Conversely, the average share of PI(ER) decreases with the number of exported items, falling from 0.67 when only one item is exported to 0.15 when the number exceeds 100. Notably, PI(ER) accounts for more than half of all exports for firms exporting up to 30 items.

This indicates that for manufacturing firms with up to 30 exported items, the primary motivation for engaging in export activities is not the benefits related to their manufactured commodities (regular, mixed-CAT, or CAT(ER)), but based on the advantages of acting as intermediaries, such as wholesalers and retailers.

The average share of TIP(ER), or sourced products based on ER's definition, is the sum of those of CAT(ER) and PI(ER). The TIP(ER) share remains relatively high across all firm categories, reaching approximately 0.8 for firms exporting 7–30 items. Mixed-CAT remains negligible, accounting for less than 1% of total exports for manufacturing firms that exported up to ten items. As a result, the average share of CAT(BBVV)—the sum of those of mixed-CAT and TIP(ER)—differs from that of TIP(ER) only in firm categories that exported a large number of items. The share of regular exports, which is the remaining portion of CAT(BBVV) when subtracted from one, exhibits a U-shaped trend. It begins at 0.32 for firms exporting one item, declines with an increasing number of exported items to below 0.2, and then reverses to reach 0.30 for firms exporting more than 100 items.

In summary, Figure 5 suggests that most Japanese manufacturing firms can be characterized as specialized trading companies or specialty international retailers, with only a portion of their exported items produced in-house. For firms exporting fewer than 30 items, the products they manufactured themselves, on average, accounted for only 20% of their total export values. Only among a small subset of firms with the largest number of exported items is the role of PI(ER) minimal, with the majority of their exports constituted with products manufactured in-house and carry-along trade items sourced from other firms.

4.2 Industries and destinations

The ratio of each trade component, such as CAT(BBVV) and TIP(ER), is likely to vary depending on the industry and its destination. Table 3, in which Japanese export data from 2014 is tabulated, confirms this conjecture. When comparing the data from Japan to that of Turkey in the study by ER, the ratio of exports by manufacturers to total exports, shown in column (2), is generally lower across all products and regions. This reflects the greater involvement of general and specialized trading companies, rather than the producers themselves, in Japan's export activities. Additionally, as predicted from Table 1, the ratios of CAT(BBVV) to ex-

ports by manufacturers in column (3), TIP(ER) to exports by manufacturers in column (4), and CAT(ER) to TIP(ER) in column (5) are all generally higher than those observed in Turkey, across all products in panel (a) and regions in panel (b). The notably higher ratio of CAT(ER) to TIP(ER) in column (5) underscores the significant role Japanese trading companies play, as they handle a large portion of PI(ER).

Table 3: Ratios of CATs by industry and destination

	(1) Share in total exports	(2) Exports by manufacturers/ total exports	(3) CAT(BBVV)/ exports by manufacturers	(4) TIP(ER)/ exports by manufacturers	(5) CAT(ER)/ TIP(ER)
(a) Products					
Food, textiles, and apparel	2.2%	31.5%	57.6%	56.1%	52.3%
Wood, paper, plastic, and rubber	5.1%	63.8%	43.5%	36.0%	68.0%
Chemicals	10.1%	51.9%	56.2%	41.0%	72.4%
Petroleum products	2.3%	43.0%	27.7%	5.7%	90.6%
Steel and nonferrous metal	10.1%	26.1%	69.0%	64.6%	57.3%
Metals and general machinery	20.4%	72.5%	66.6%	58.6%	81.1%
Electric and electronic machinery	20.2%	74.8%	76.3%	65.9%	73.0%
Vehicles	27.0%	78.3%	58.8%	17.6%	94.8%
Other products	2.6%	62.4%	72.0%	62.3%	69.6%
(b) Destination regions					
Asia and Oceania	56.4%	58.6%	65.3%	52.2%	73.2%
North America	19.9%	81.5%	61.2%	35.3%	85.5%
Europe	12.5%	72.1%	60.9%	40.5%	75.7%
Middle East and Africa	6.2%	65.1%	72.3%	26.8%	86.2%
Latin America	4.9%	63.2%	60.6%	35.7%	80.2%

Source: See Table 1.

Each ratio index varies widely across products in panel (a). To capture the general characteristics of Japanese CATs, three industries were selected based on their high export ratios to total exports (exceeding 20% in column (1)) and their status as industries where Japan has a comparative advantage, i.e. metals and general machinery, electric and electronic machinery, and vehicles. In these industries, the ratio of exports by manufacturers to total exports in column (2) exceeds 70%. One reason for the high reliance on producer-driven exports in these three industries is the nature of the differentiated goods they produce, which amplifies the benefits of conducting CATs. This is reflected in the high ratios of CAT(BBVV) to exports by manufacturers in column (3) and CAT(ER) to TIP(ER) in column (5) for these industries. In the case of vehicles, the ratio of TIP(ER) to exports by manufacturers in column (4) is notably low. Japanese automobile firms actively engage in mixed-CAT, exporting both produced and sourced products under the same item code. In this industry, the mixed-CAT ratio is as high

as 41.2%, which corresponds to the difference between the CAT(BBVV) ratio in column (3) (58.8%) and the TIP(ER) ratio in column (4) (17.6%). The differences in ratios across destination regions in panel (b) are not salient. The aforementioned characteristics are observed consistently across all regions.

5 Intrafirm and interfirm CATs

5.1 Decomposition of CATs into intrafirm and interfirm trades

Japanese export data in the previous section suggests that the ratio of CATs is relatively high in Japan under the definitions of both BBVV and ER. A small number of the largest firms account for the majority of active engagement in CAT. The extent of CATs may vary depending on the type of destination firms, particularly whether the trade is intrafirm or interfirm. In intrafirm trade, where both exporting and importing firms belong to the same MNC, any inefficiency in bargaining between sellers and buyers mitigated through coordination by the MNC headquarters, to maximize profits. This coordination may consequently increase the total value of transactions. However, it remains unclear whether intrafirm trade increases the ratio of CAT to total exports, as this ratio depends on both the exports of produced and sourced products. This section addresses this issue through an analysis of Japanese intrafirm and interfirm export data to 11 countries and regions in 2014.

Table 4 is a tabulation of the export values pertaining to 11 countries and regions, including the US and China, two major destinations for Japanese exports, across each component of BBVV's and ER's classification. The total exports to these destinations in 2014 was ¥29.46 trillion, of which ¥15.74 trillion was classified as CAT(BBVV) and ¥14.12 trillion as TIP(ER). Within TIP(ER), CAT(ER) and PI(ER) accounted for three-quarters (¥10.86 trillion) and one-quarter (¥3.27 trillion), respectively.[15]

The decomposed export values in intrafirm and interfirm trades are shown in Table 4. Of the total export value (¥29.46 trillion), approximately half (¥13.92 trillion) is attributed to intrafirm trade, and the remaining half (¥15.55 trillion) corresponds to interfirm trade. The ra-

[15] Of the total export value of ¥44.2 trillion in 2014 (see Table 1), exports to these 11 destinations accounted for approximately 67% (29.46/44.2).

Table 4: CATs in intrafirm and interfirm trades

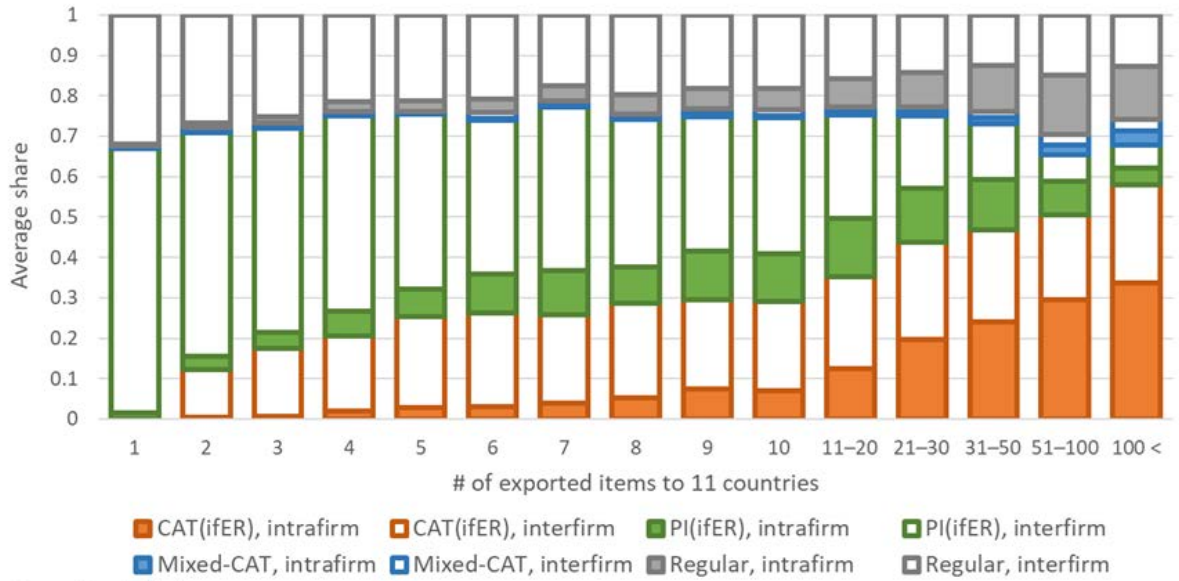
	Total	Intrafirm	Interfirm
Export	29.46	13.92	15.55
CAT(BBVV)	15.74	6.63	9.10
TIP(ER)	14.12	5.96	8.16
CAT(ER)	10.86		
CAT(ifER)	10.66	4.87	5.79
PI(ER)	3.27		
PI(ifER)	3.46	1.09	2.37

Note: The unit of values is in trillion ¥.
Source: See Table 1.

tio of CAT(BBVV) to total exports is higher in interfirm trade. It is slightly less than 60% (9.10/15.55), compared to intrafirm trade, where the ratio is slightly below 50% (6.63/13.92). Similarly, the ratio of TIP(ER) is also higher in interfirm trade. However, within TIP(ER), intrafirm trade exhibits a higher ratio of CAT(ifER) and a lower ratio of PI(ifER) to TIP(ER) compared to interfirm trade. Specifically, the ratios of CAT(ifER) and PI(ifER) to TIP(ER) for intrafirm trade are 82% (4.87/5.96) and 18% (1.09/5.96), respectively, while the corresponding ratios for interfirm trade are 71% (5.79/8.16) and 29% (2.37/8.16). The aggregated values for each component, summarized in Table 4, suggest that CAT(ifER) is more prevalent in intrafirm trade than in interfirm trade.

However, this observation does not account for the specific characteristics of firms engaged in CAT. It is assumed that smaller firms engage more actively in interfirm PI(ifER) than in other types of exports, since most small firms are not multinational and, as shown in Figure 5, the share of PI(ER) is higher among firms with fewer exported items. In contrast, it is assumed that large firms are more actively involved in intrafirm CAT(ifER). These expectations are confirmed by the observations in Figure 6. This figure illustrates the average share of CAT(ifER), PI(ifER), mixed-CAT, and regular exports, with each category further divided into intrafirm and interfirm values, as proportions of total export values to 11 countries across firms in each category, in 2014. The firm categories are based on the number of exported items to each of the 11 countries. Consistent with Figure 5, the share of CAT(ifER) increases, while that of PI(ifER) decreases as the number of exported items increases. Moreover, it should be noted that within each category of CAT(ifER), PI(ifER), and regular exports, the share of intrafirm

Figure 6: Components of intrafirm and interfirm trades

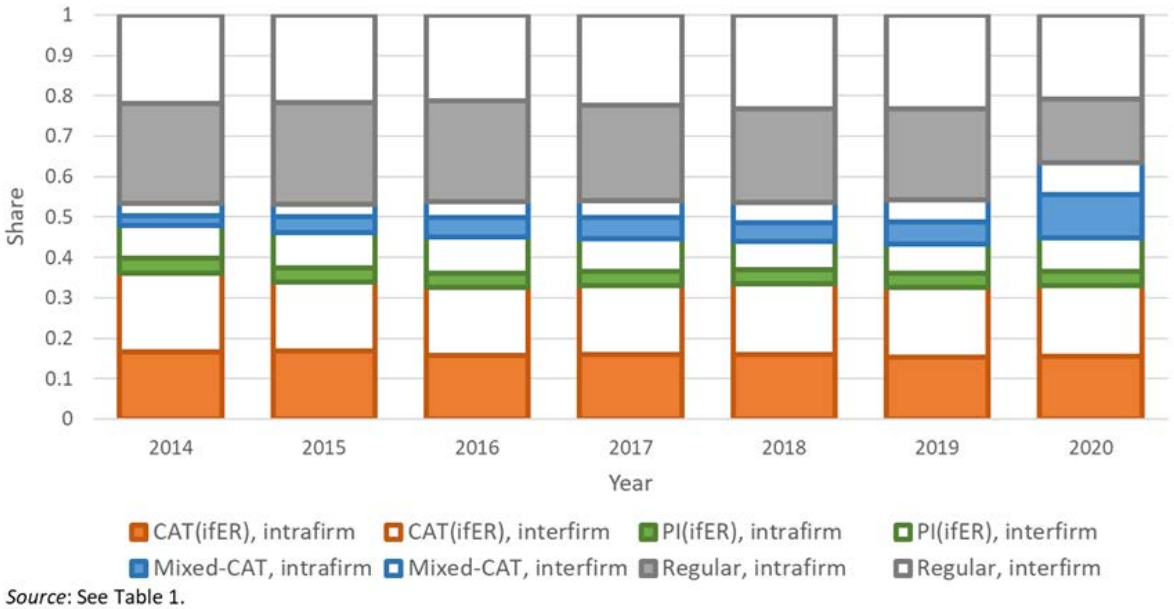


Source: See Table 1.

exports rises as the number of exported items increases. For example, the share of intrafirm CAT(ifER) surpasses that of interfirm CAT(ifER), when the number of exported items exceeds 30.

The distinct characteristics of export activities by firm size remained consistent throughout the analysis period, except in the final year, 2020. The share of each of the eight components in Figure 6, as a proportion of total export values aggregated across all firms, remained stable from 2014 to 2019, as shown in Figure 7. For example, the shares of intrafirm CAT(ifER) and interfirm CAT(ifER) remained stable at approximately 17%, throughout this period, while intrafirm and interfirm regular exports remained at around 23%. However, in 2020, the year when the COVID-19 pandemic disrupted global logistics and caused major shifts in supply and demand for traded goods, the share of intrafirm regular exports decreased, while the share of intrafirm mixed-CAT exports increased. In 2020, Japanese multinational firms reduced their production and exports of certain products, with the decline in production exceeding the decline in exports. This imbalance resulted in a reclassification of some products from regular to mixed-CAT products. Notably, the shares of components related to CAT(ifER) and PI(ifER) remained stable even in 2020, underscoring the robustness of these conservative definitions.

Figure 7: Shares of export components: 2014–2020



Source: See Table 1.

5.2 Distribution of export flows by component

BBVV suggest that demand-scope complementarities are a potential driving force behind the export of products sourced from other firms. ER have provided suggestive evidence of these complementarities by comparing the distributions of trade components. Using firm-level export flows for each product group and for each destination region, ER demonstrated that exports of sourced products are, on the average, smaller than produced exports, and that those of CAT(ER) are, on the average, lower than PI(ER). These distributions were interpreted to be a result of complementarities, based on the view that smaller exports of sourced products were rendered more profitable when exported alongside products manufactured internally. Consequently, the profitable size of CAT(ER) exports was smaller compared to PI(ER), as the latter does not, by definition, include the effect of complementarities. This subsection replicates ER's analysis using Japanese data. As the analysis produced partially different results, reasons for these differences were elucidated.

Figure 8 consists of eight panels comparing the distributions of firm-level export flows: sourced versus produced products, and PI(ER) versus CAT(ER), across four categories. These panels display histograms of Japanese exports in 2014, with the horizontal axis representing

the logarithmic values of exports and the vertical axis representing the densities.[16]

Panels (a) and (b) show figures for metal and general machinery exports, as examples of industry classifications. The shaded bars in panel (a) show that the distribution of produced products is located further to the right compared to that of sourced products which are represented by transparent bars. This provides supportive evidence for the existence of demand-scope complementarities.[17] Conversely, in panel (b), the distributions of CAT(ER) (shaded bars) and PI(ER) (transparent bars) are positioned opposite to those observed in the data from Turkey in ER's study. In Turkey, the distribution of CAT(ER) is located further to the left of PI(ER), suggesting that the smaller export values of sourced products contribute to the profit of the exporters by acting as a catalyst for the manufacturer's own export products. This difference is explained by the disparity in firm sizes between those engaging in PI(ER) and CAT(ER) in Japan. PI(ER) is predominantly observed in smaller firms with fewer export productss, with lower trade values compared to firms conducting CAT(ER), as can be confirmed in Table 2 and Figure 5. One reason why larger Japanese exporters do not actively engage in PI(ER) is the widespread presence of general and specialized trading companies, which manage PI(ER) on behalf of manufacturing firms.

As examples of destination classifications, panels (c) and (d) depict exports to Asia and Oceania. In panel (c), the distributions of sourced and produced products differ from the case studies of ER. The exports of sourced products are on the average smaller than exports of produced products in the case of Turkey versus Japan's exports to Asia and Oceania. Sourced products are exported on a relatively larger scale to Japan's aforementioned major export destinations. The distribution of sourced products represented by transparent bars, is denser in the center and sparser in the tails compared to that of the produced products represented by the shaded bars. This tendency is even more pronounced in panel (e), which shows intrafirm export flows.[18] One possible explanation for this difference between Turkey and Japan, is that Japanese multinational firms actively outsource production to domestic firms and streamline

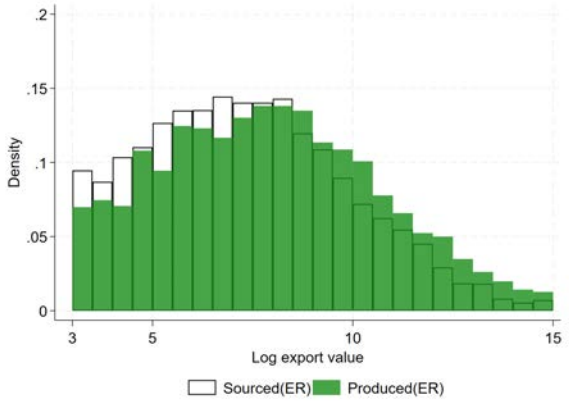
[16] In Figure 8, bars corresponding to bins with ten or fewer trade flows are omitted to protect the confidentiality of individual observation values. Consequently, the histogram's right tail is truncated.

[17] Compared to the figures in ER, the left tail of the distribution of produced products in all four panels (a), (c), (e), and (g) of Figure 8 is denser than in the case of Turkey. This likely reflects the tendency of Japanese firms to lean toward a high-mix, low-volume production.

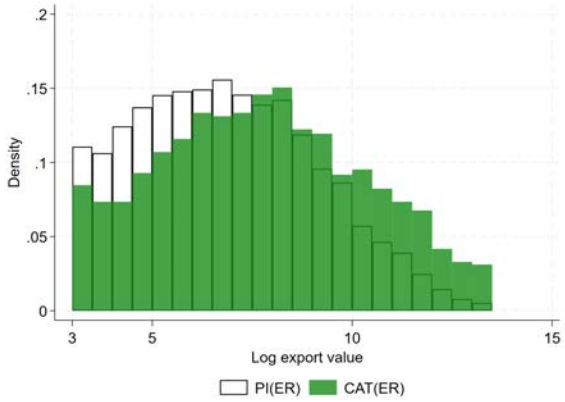
[18] To be more precise, CAT(ifER) and PI(ifER) should be used instead of CAT(ER) and PI(ER) when discussing intrafirm and interfirm exports. However, to avoid makinng it unnecessarily complicated, CAT(ER) and PI(ER) are used consistently in this subsection.

Figure 8: Distribution of firm-level exports

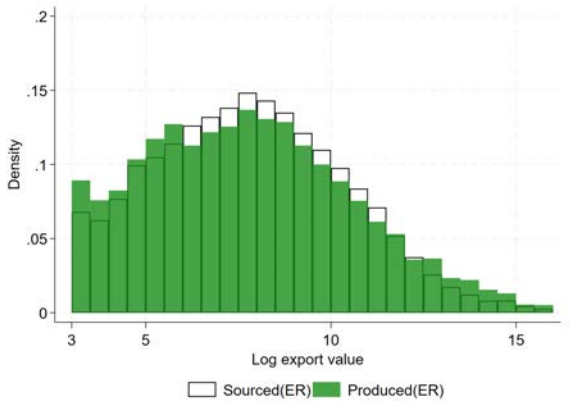
(a) Metal & general mach.: prod. vs. sourced



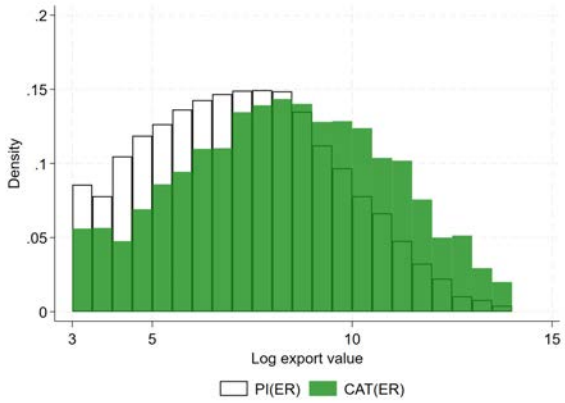
(b) Metal & general mach.: CAT(ER) vs. PI(ER)



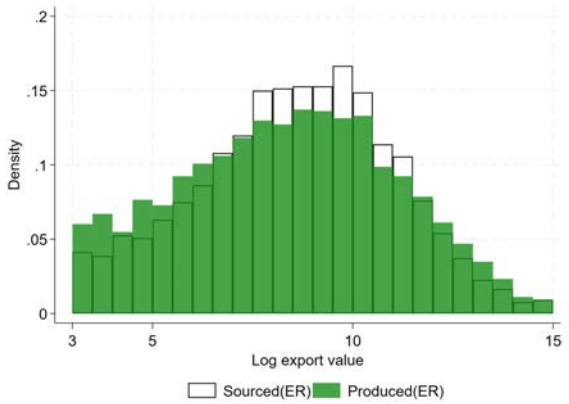
(c) Asia & Oceania: produced vs. sourced



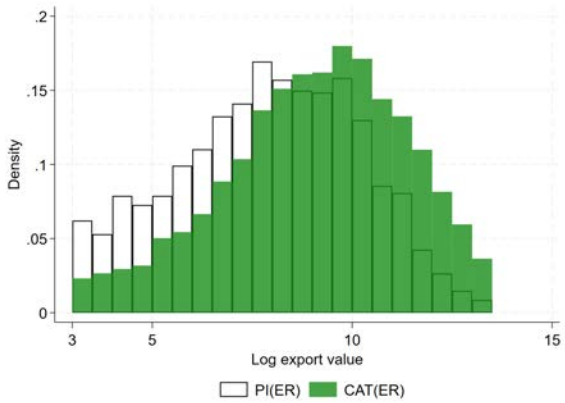
(d) Asia & Oceania: CAT(ER) vs. PI(ER)



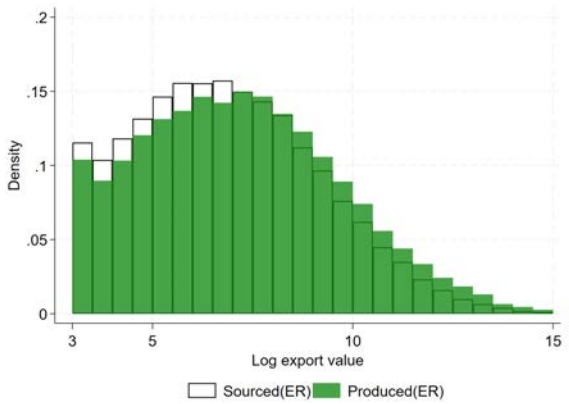
(e) Intrafirm: produced vs. sourced



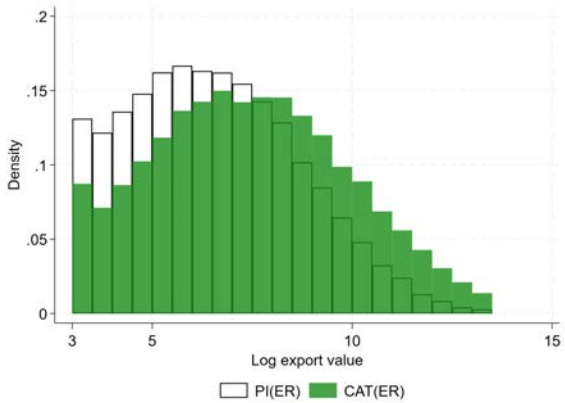
(f) Intrafirm: CAT(ER) vs. PI(ER)



(g) Interfirm: produced vs. sourced



(h) Interfirm: CAT(ER) vs. PI(ER)



their operations to focus more on management functions.[19] As a result, Japanese multinational firms are likely to export sourced products on a large scale. In panels (d) and (f), the distribution of CAT(ER) is located further to the right of PI(ER), consistent with panel (b) and differs from the case studies in ER's study. Lastly, for interfirm exports, shown in panels (g) and (f), the distribution patterns of produced and sourced products, as well as those of CAT(ER) and PI(ER), mirror the patterns observed in metal and general machinery exports.

The comparison of distributions between export flows of sourced and produced products, as well as between PI(ER) and CAT(ER), across all 16 cases—comprising nine product categories, five region categories, and two trade categories—is summarized in Table 5, with a focus on mean and median values.[20] In the Japanese case studies, a prevalent distribution pattern emerges, as observed in the cases of metal and general machinery exports and interfirm exports (panels (a), (b), (g), and (h) of Figure 8): the mean and median values of produced products are larger than those of sourced products, and similarly, the mean and median values of CAT(ER) are larger than those of PI(ER). Consequently, in most cases, the values on the right side of Table 5 are larger than those on the left for both mean and median values. The locations of PI(ER) and CAT(ER) distributions in Japan are opposite of those in Turkey. Additionally, certain cases deviate from the prevalent Japanese pattern regarding the distribution of sourced and produced products. For cases where the mean or median value of sourced products or PI(ER) exceeds the corresponding value of produced products or CAT(ER), checks indicate this in the "opposite order" column in Table 5. Two such cases were identified: the export of sourced and produced products to Asia and Oceania, and intrafirm exports of sourced and manufactured products.

The noticeable difference between the Japanese distributions of PI(ER) and CAT(ER) and those observed in Turkey and the variation in distribution patterns across Japanese cases do not necessarily suggest weaker demand-scope complementarities for Japanese products. These differences suggest that other significant, country-specific economic factors such as the scale of the trading company activities and the extent of production outsourcing influence the size of CAT.

[19] According to *The Basic Survey of Japanese Business Structure and Activities* conducted by METI, approximately 70% of Japanese manufacturing firms covered by this survey outsource production to other firms, including domestic and overseas subsidiaries and affiliated companies.

[20] Median values represent the averages of 10 observations at or near the median. Exact mean values are not reported to protect the confidentiality of individual observation values.

Table 5: Comparing mean and median of export flows

(a)	Opposite	Sourced(ER)			Produced(ER)		
Products	order	# obs.	Mean	Median	# obs.	Mean	Median
Food, textiles, and apparel		2,828	6.42	6.14	901	6.65	6.33
Wood, paper, plastic, and rubber		5,155	6.39	6.04	650	7.54	7.34
Chemicals		3,663	7.09	6.84	826	8.78	8.75
Petroleum products		659	5.78	5.44	53	8.59	7.99
Steel and nonferrous metal		4,143	6.61	6.33	206	9.07	8.98
Metals and general machinery		8,349	7.40	7.23	2,544	7.99	7.87
Electric and electronic machinery		5,369	7.05	6.69	814	8.43	8.29
Vehicles		1,516	6.55	5.94	435	8.94	8.64
Other products		3,495	6.04	5.63	602	7.68	7.43

(b)	Opposite	PI(ER)			CAT(ER)		
Products	order	# obs.	Mean	Median	# obs.	Mean	Median
Food, textiles, and apparel		1,918	6.30	6.03	1,289	6.41	6.06
Wood, paper, plastic, and rubber		3,606	5.99	5.66	2,386	6.70	6.38
Chemicals		2,530	6.68	6.38	1,859	7.54	7.31
Petroleum products		294	5.31	5.07	432	6.01	5.75
Steel and nonferrous metal		2,796	6.20	5.85	1,988	6.88	6.67
Metals and general machinery		6,862	6.90	6.75	3,501	7.93	7.77
Electric and electronic machinery		4,179	6.57	6.24	2,394	7.48	7.13
Vehicles		960	6.25	5.69	797	6.78	6.12
Other products		2,279	5.63	5.23	1,765	6.34	5.97

(c)	Opposite	Sourced(ER)			Produced(ER)		
Regions	order	# obs.	Mean	Median	# obs.	Mean	Median
Asia and Oceania	✓	11,651	7.85	7.77	5,849	7.84	7.66
North America		3,999	7.71	7.55	2,297	8.01	7.85
Europe		3,530	7.42	7.22	2,115	7.75	7.48
Middle East and Africa		1,559	6.71	6.46	980	7.45	7.12
Latin America		1,607	7.19	7.00	928	7.69	7.49

(d)	Opposite	PI(ER)			CAT(ER)		
Regions	order	# obs.	Mean	Median	# obs.	Mean	Median
Asia and Oceania		9,771	7.28	7.21	4,431	8.49	8.45
North America		2,542	6.98	6.83	1,667	8.63	8.73
Europe		2,985	6.91	6.70	1,331	8.10	7.98
Middle East and Africa		1,273	6.36	6.14	555	7.30	6.90
Latin America		1,240	6.73	6.57	589	7.80	7.68

(e)	Opposite	Sourced(ER)			Produced(ER)		
Trades	order	# obs.	Mean	Median	# obs.	Mean	Median
Intrafirm	✓	6,841	8.61	8.73	3,819	8.45	8.50
Interfirm		33,036	6.90	6.74	16,936	7.24	7.09

(f)	Opposite	PI(ER)			CAT(ER)		
Trades	order	# obs.	Mean	Median	# obs.	Mean	Median
Intrafirm		3,255	7.93	8.03	3,586	9.22	9.35
Interfirm		21,452	6.57	6.40	11,584	7.52	7.41

Note: Median values are the averages of 10 observations at or near the median.
Source: See Table 1.

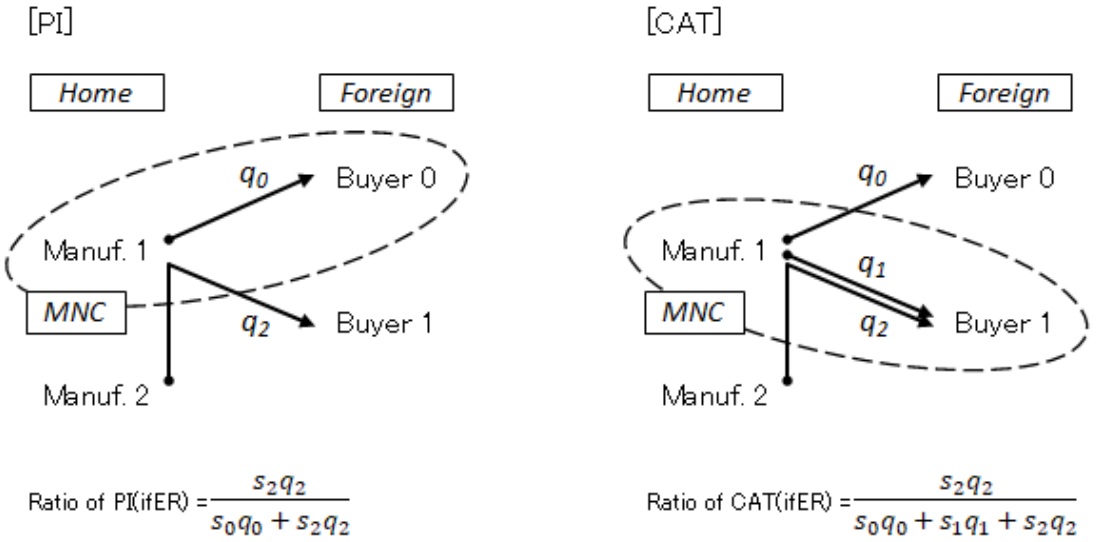
6 Empirical analysis

6.1 Theoretical background

The aggregated export data in Section 5.1 suggests that CAT(ifER) is more prevalent in intrafirm trade, whereas the ratio of PI(ifER) to total exports is higher in interfirm trade. This section explores this observation further by examining its theoretical underpinnings and conducting a detailed empirical analysis.

Firstly, this subsection will present theoretical perspectives on how the choices of the firm, between interfirm and intrafirm trade, affects their CAT(ifER) and PI(ifER), using a simple transaction structure depicted in Figure 9. Detailed arguments are provided in Appendix 2. PI(ifER) is explained first, as it has a simpler model structure, followed by CAT(ifER).

Figure 9: Flow of products



There are two countries involved: the home country from where the products originate, and the foreign country which is the destination of these products. The home country, in this instance, has two manufacturing firms: Manufacturers 1 and 2. The foreign country has two buyer firms: Buyers 0 and 1. Manufacturer 2 produces Product 2 in quantities q_2, while Manufacturer 1 acts as an intermediator for exporting it to foreign Buyer 1 at the price of s_2, earning a commission fee. Additionally, Manufacturer 1 produces Product 0 with a quantity of q_0, which is entirely sold to a foreign Buyer 0 at the price of s_0. The two products are assumed

to be perfectly differentiated. In each product market, there is one producer and one buyer, which naturally leads to an inefficiency caused by the bargaining between them. When Manufacturer 1 selects a foreign partner to form an MNC to eliminate this inefficiency and increase its profit, the natural choice is Buyer 0. This is because the marginal profit increase from a produced product is larger than that of a sourced product. The latter yields only a unit commission fee. After forming an MNC with Buyer 0, the ratio of PI(ifER) in Manufacturer 1, given by $r = s_2q_2/(s_0q_0 + s_2q_2)$, decreases as q_0 increases. This provides an intuitive explanation for the negative relationship between the ratios of intrafirm trade and PI. In this case, the ratio of PI(ifER) for Manufacturer 1 represents only interfirm PI.

In the case of CAT(ifER), a new product, Product 1, is introduced. It is produced by Manufacturer 1 and sold to Buyer 1. Since the produced product is sold to Buyer 1 alongside the sourced product, Product 2, an export of Product 2 by Manufacturer 1 transitions to CAT. In this situation, which buyer does Manufacture 1 choose as its foreign partner for forming an MNC? The natural choice is Buyer 1, as Manufacturer 1 gains additional profit from both producing Product 1 and sourcing Product 2, rather than solely exporting the produced Product 0. Therefore, the formation of Manufacturer 1's MNC increases its ratio of CAT(ifER), given by $r = s_2q_2/(s_0q_0 + s_1q_1 + s_2q_2)$ as both q_1 and q_2 increase. This explains the positive relationship between the ratios of intrafirm trade and CAT. In this particular scenario, the ratio of CAT(ifER) for Manufacturer 1 represents only intrafirm CAT.

6.2 Regression results

This subsection confirms the theoretical projection mentioned in the previous subsection through firm-destination-level export data. The characteristics of the firms were used as control variables in the regression analysis.

This dataset is from the years 2014 to 2020 and is comprised of 302,008 firm-destination observations from 21,943 firms. Since this section focuses on intrafirm exports, the analysis is limited to 11 destination countries. The four CAT indices examined are CAT(BBVV), TIP(ER), CAT(ifER), and PI(ifER), all expressed as a ratio of a firm's total exports to a specific destination. An intrafirm export ratio is defined as the ratio of a firm's intrafirm export value to a destination to its total export value to that destination. This was used as an intrafirm index

for each firm-destination observation. Other control variables include the natural logarithm of the firm's production value, firm dummies, year dummies, destination dummies, and industry dummies.[21]

Descriptive statistics for four CAT indices, the intrafirm export ratio, and the logarithm of production value are presented in Table 6.[22] The difference between the mean ratios of CAT(BBVV) and TIP(ER) to total exports (0.720 and 0.706) is the mean ratio of mixed-CAT, which is as small as 0.014. The mean ratio of TIP(ER) to total exports was then decomposed into the mean ratios of CAT(ifER) and PI(ifER) (0.153 and 0.553), based on its definition. The value of PI(ifER)/exports is 1 for more than half of the observations, suggesting that the majority of firm-destination observations represent cases where only sourced products are exported to a destination country. This type of export is primarily conducted by smaller manufacturing firms and occurs mainly in interfirm trade. In contrast, intrafirm exports are predominantly conducted by larger manufacturing firms. The number of observations with positive intrafirm export ratios is 52,064, accounting for about 17% of the total observations.

Table 6: Descriptive statistics

Variable	Mean	Std. dev.	P5	Median	P95
CAT(BBVV)/exports	0.720	0.402	0	1	1
TIP(ER)/exports	0.706	0.408	0	1	1
CAT(ifER)/exports	0.153	0.296	0	0	0.917
PI(ifER)/exports	0.553	0.495	0	1	1
Intrafirm export ratio	0.118	0.300	0	0	0.999
Ln production	8.253	1.945	5.262	8.167	11.636

Notes: The numbers of observations and firms are 302,008 and 21,943, respectively, for all variables. The number of observations with positive intrafirm export ratios is 52,064. The 5th percentile, median and 95th percentile values are the averages of 10 observations at or near the exact values.

[21] Industry dummies, representing nine industries, are assigned to firm-destination observations as follows: For each firm-destination pair during the period 2014 to 2020, the oldest observation is selected. The industry with the largest share of export values in this observation is identified and assigned as the industry dummy for all observations of the same pair. Consequently, a firm may have different industry dummies for different destinations.

[22] The 5th percentile, median, and 95th percentile values in Table 6 are calculated as the averages of 10 observations at or near the exact values. Exact values are not reported to protect the confidentiality of individual observation values.

The regression equation is as follows:

$$y_{f,d,t}^{CAT} = \beta_1(if\_ratio) + \beta_2(if\_ratio)^2 + \beta_3(ln\_prod) + FE_f + FE_d + FE_t + FE_i + \epsilon_{f,d,t},$$

where $y_{f,d,t}^{CAT}$ is each of the four CAT indices, if_ratio is the intrafirm export ratio, ln_prod is the logarithm of production value, FE_f, FE_d, FE_t, FE_i are the fixed effects of firms, destination countries, years, and industries, respectively, and $\epsilon_{f,d,t}$ is the error term. The square of if_ratio is included to observe the nonlinear effect of the intrafirm ratio on CAT indices. For example, an increase in the intrafirm ratio is expected to raise the ratio of CAT(ifER) to total exports. However, as the intrafirm ratio continues to rise, the relative size of interfirm exports (q_0 in Figure 9) decreases, causing the ratio of CAT(ifER) to approach one, at which point any further increase becomes marginal.

The results of regressing each of the four CAT indices on the intrafirm indices and other control variables are summarized in Table 7. Odd-numbered columns present results using only the intrafirm export ratio as the intrafirm index, while even-numbered columns show results using both the intrafirm ratio and its square values. Panels (a) and (b) present results using all observations and only those with positive TIP(ER), respectively. The findings in odd-numbered columns of panel (a) indicate that CAT(BBVV), TIP(ER), and CAT(ifER) are positively correlated with the intrafirm ratio, whereas PI(ifER) is negatively correlated, all with a high statistical significance. In other words, intrafirm exports are associated with a more active engagement in CAT(BBVV), TIP(ER), and CAT(ifER) while being engaged in PI(ifER) is less active compared to interfirm exports. Additionally, the results in even-numbered columns show that these relationships become marginal as the intrafirm ratio increases further. Results in panel (b), after deleting the observations without any TIP(ER), basically preserve the same patterns observed in panel (a), particularly in the ratios of CAT(ifER) and PI(ifER).

A closer examination of the results reveals that the coefficients of the intrafirm export ratio for CAT(BBVV)/exports and TIP(ER)/exports are nearly identical. This is because of the relatively small value of mixed-CAT among Japanese firms, which makes the mean values of CAT(BBVV)/exports and TIP(ER)/exports similar. For example, in panel (a) of Table 7, the coefficients are 0.056 in column (1) and 0.055 in column (3), respectively. Since TIP(ER) is the sum of CAT(ifER) and PI(ifER), their coefficients in Table 7 exhibit the same relationship. The

Table 7: Regression results

(a) All observations

Dep. var.:	(1) CAT(BBVV)/ exports	(2) CAT(BBVV)/ exports	(3) TIP(ER)/ exports	(4) TIP(ER)/ export	(5) CAT(ifER)/ exports	(6) CAT(ifER)/ exports	(7) PI(ifER)/ exports	(8) PI(ifER)/ exports
Intrafirm ratio	0.056^{***}	0.096^{***}	0.055^{***}	0.098^{***}	0.110^{***}	0.202^{***}	-0.054^{***}	-0.104^{***}
	(0.005)	(0.025)	(0.006)	(0.024)	(0.005)	(0.017)	(0.006)	(0.013)
Sq. of intrafirm ratio		-0.042		-0.045^{*}		-0.097^{***}		0.052^{***}
		(0.024)		(0.024)		(0.016)		(0.015)
Ln production	-0.027^{***}	-0.027^{***}	-0.015^{***}	-0.015^{***}	0.013^{***}	0.013^{***}	-0.028^{***}	-0.028^{***}
	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
R^2	0.652	0.652	0.660	0.660	0.384	0.385	0.633	0.633

(b) Observations with positive TIP(ER)

Dep. var.:	(1) CAT(BBVV)/ exports	(2) CAT(BBVV)/ exports	(3) TIP(ER)/ exports	(4) TIP(ER)/ export	(5) CAT(ifER)/ exports	(6) CAT(ifER)/ exports	(7) PI(ifER)/ exports	(8) PI(ifER)/ exports
Intrafirm ratio	0.012^{***}	-0.011	0.009^{**}	-0.018	0.091^{***}	0.139^{***}	-0.082^{***}	-0.157^{***}
	(0.002)	(0.010)	(0.003)	(0.011)	(0.005)	(0.010)	(0.005)	(0.014)
Sq. of intrafirm ratio		0.024^{*}		0.028^{*}		-0.051^{***}		0.079^{***}
		(0.012)		(0.013)		(0.009)		(0.016)
Ln production	-0.022^{***}	-0.022^{***}	-0.016^{***}	-0.016^{***}	0.014^{***}	0.014^{***}	-0.030^{***}	-0.030^{***}
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
R^2	0.601	0.601	0.614	0.614	0.403	0.403	0.608	0.608

Notes: Firm, industry, destination, and year fixed effects are included. Figures in parentheses are robust standard errors clustered at the industry level. The numbers of observations and firms are 298,136 and 18,071, respectively, for panel (a) and 258,039 and 16,539 for panel (b). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

coefficient of TIP(ER)/exports in column (3) (0.055) is the sum of those for CAT(ifER)/exports in column (5) (0.110) and PI(ifER)/exports in column (7) (-0.054). These patterns are consistent in even-numbered columns and in panel (b) as well.

Background explanations on how forming an MNC changes the export volume from Japanese firms to foreign subsidiaries suggest that both sourced and produced products increase similarly. This is because the elimination of bargaining inefficiency enhances their trading volume to an equal degree. Table 8 provides supporting evidence for this inference. In the regression equation, the dependent variables are replaced with the export values of intrafirm CAT(ifER), PI(ifER), and manufactured products, all expressed in natural logarithms. Observations with zero export values have been excluded. The estimated coefficient of the intrafirm ratio is similar across all three cases, suggesting that an increase in the ratio of intrafirm trade enhances all three intrafirm components to a similar extent.[23]

The same regression model is applied to the components of intrafirm exports in Table 8 for

[23]The positive coefficient of the intrafirm ratio in intrafirm PI(ifER) appears to contradict the results in Table 7. Assuming other factors remain constant, this positive coefficient arises because the dependent variable considers only the intrafirm exports of a firm, which naturally increase as the firm raises its share of intrafirm exports.

Table 8: Changes in export values

Dep. var.:	(1) Ln intrafirm CAT(ifER)	(2) Ln intrafirm PI(ifER)	(3) Ln intrafirm produced
Intrafirm ratio	2.681^{***}	2.739^{***}	2.956^{***}
	(0.144)	(0.127)	(0.153)
Ln production	0.081^{***}	-0.017	0.232^{***}
	(0.022)	(0.043)	(0.029)
Observations	$25,776$	$23,527$	$27,604$
R^2	0.668	0.691	0.690

Notes: Firm, industry, destination, and year fixed effects are included. Figures in parentheses are robust standard errors clustered at the industry level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

an investigation on whether these components exhibit distinct relationships with the intrafirm ratio. The results for the components of intrafirm CAT(ifER) and PI(ifER) are tabulated in Panels (a) and (b) of Table 9.

The results after categorizing observations by buyer's industries are tabulated in Columns (1) to (3). These are intrafirm exports to wholesale and retail subsidiaries, intrafirm exports to manufacturing subsidiaries, and intrafirm exports to the other industries, all expressed in natural logarithm terms. In panel (a), the coefficient of the intrafirm ratio is larger for exports to manufacturing subsidiaries (column (2)), suggesting that CAT(ifER) is more prevalent in MNCs that actively engage in the vertical division of labor in production between parent firms in Japan and their overseas subsidiaries. To the contrary, in panel (b), the coefficients of the intrafirm ratio for PI(ifER) are similar between exports to wholesale & retail subsidiaries and exports to manufacturing subsidiaries.

Similarly, columns (4) and (5) report the results when intrafirm CAT(ifER) and PI(ifER) are categorized based on the capital relationship between Japanese seller firms and foreign buyer subsidiaries. The coefficient of the intrafirm ratio for wholly-owned subsidiaries (column (4)) is larger than that of partically-owned subsidiaries (column (5)) in both CAT(ifER) and PI(ifER). This suggests that communication and coordination between Japanese manufacturing firms and wholly-owned foreign subsidiaries are more effective than those with partially-owned subsidiaries, thereby reducing inefficiency and increasing trade volume to a greater extent.

Table 9: Changes in export values by subsidiary groups

(a) Dependent variables: components of CAT(ifER)

Dep. var.: Ln intrafirm exports to	(1) wholesale & retail	(2) manuf.	(3) others	(4) wholly-owned	(5) partially-owned
Intrafirm ratio	1.799^{***}	2.500^{***}	2.070^{***}	2.742^{***}	2.136^{***}
	(0.154)	(0.150)	(0.238)	(0.097)	(0.163)
Ln production	-0.039	0.090	0.158	0.052	0.012
	(0.060)	(0.050)	(0.177)	(0.035)	(0.062)
Observations	$8,259$	$15,669$	$6,411$	$15,278$	$13,768$
R^2	0.633	0.657	0.521	0.622	0.596

(b) Dependent variables: components of PI(ifER)

Dep. var.: Ln intrafirm exports to	(1) wholesale & retail	(2) manuf.	(3) others	(4) wholly-owned	(5) partially-owned
Intrafirm ratio	2.714^{***}	2.548^{***}	2.190^{***}	2.813^{***}	2.450^{***}
	(0.305)	(0.142)	(0.101)	(0.139)	(0.066)
Ln production	-0.034	0.050	-0.091	0.040	-0.044
	(0.065)	(0.039)	(0.066)	(0.041)	(0.034)
Observations	$4,142$	$13,832$	$6,019$	$12,013$	$12,001$
R^2	0.740	0.713	0.674	0.714	0.691

Note: See Table 8.

7 Conclusion

Trade intermediation by producers is prevalent, but its scale and characteristics vary across countries. Japanese manufacturers engage in carry-along trade more intensively than their Belgian and Turkish counterparts. This is largely driven by the activities of large Japanese multinational firms, which outsource production to related domestic firms, streamline operations to focus on management functions, and oversee export procedures for both their own products and those sourced from related firms. In contrast, Japanese manufacturers participate less intensively in purely intermediated trade compared to Turkish firms. Purely intermediated trade is primarily conducted by small manufacturers, which often function as specialized trading companies, with a portion of their exported items produced in-house. One reason why larger Japanese manufacturing exporters do not actively engage in purely intermediated trade is the

widespread presence of general and specialized trading companies in Japan.

This study has identified a new aspect of carry-along and purely intermediated trade. There is a clear distinction between intrafirm and interfirm trades. By dividing exports into these two categories, it becomes clear that carry-along trade in a country-specific definition is more prevalent in intrafirm trade. On the other hand, purely intermediated transactions is more common in interfirm trade. These patterns remain consistent even after setting a control for firm fixed effects and other variables. The positive correlation between intrafirm trade and carry-along trade may reflect the preference of multinational firms endeavoring to maximize additional profits by internalizing transactions involving both sourced and produced products. Conversely, the negative correlation between intrafirm and purely intermediated trade likely indicates that manufactured products generate greater profits than sourced products when engaging in intrafirm trade.

The investigation of trade intermediation by producers in Japan has yielded three key insights. Firstly, it was observed that there are numerous small firms that delegate export procedures for manufacturing firms that submit customs clearance documents under their own names. This illustrates how the benefits of trade permeate to smaller domestic firms, crossing the boundaries of firms that directly manage trade processes. Secondly, while the phenomena of carry-along trade and purely intermediated are universal, the characteristics of these activities vary across countries, influenced by country-specific factors, including the relative sizes of intrafirm and interfirm trades. Carry-along trade within a country-specific definition is more likely to be strongly associated with intrafirm trade, while purely intermediated is more prominent in interfirm trade. Thirdly, the distinction between the manufacturing industry and the wholesale and retail industries is blurred. Manufacturing firms play a substantial role as intermediaries in international trade, while some wholesale and retail firms design their own products, outsource production to foreign firms, and import the finished products.

Appendix 1: Alternative definitions of CAT components

Three salient features of CATs are observed in Tables 1 and 4: (1) CAT(BBVV) accounts approximately half of the total exports by manufacturing firms, (2) the values of mixed-CAT

(CAT(BBVV) minus TIP(ER)) are small, and (3) the ratio of CAT(ifER) to TIP(ER) is higher, while the ratio of PI(ifER) to TIP(ER) is lower in intrafirm trade compared to interfirm trade. The data in this appendix confirms that these three features persist even when the alternative criteria for trade intermediations are employed.

Table A1: Alternative definitions

	(a) Relabeling small-value exports as regular goods		(b) Excluding firms producing only one good	
	Intrafirm	Interfirm	Intrafirm	Interfirm
Export	13.92	15.55	12.84	12.68
CAT(BBVV)	6.62	9.09	5.84	7.00
TIP(ER)	5.95	8.13	5.17	6.31
CAT(ifER)	5.85	7.52	4.64	5.33
PI(ifER)	0.10	0.61	0.54	0.98

	(c) Aggregating items to 4-digits		(d) Excluding reexports defined by ER	
	Intrafirm	Interfirm	Intrafirm	Interfirm
Export	13.92	15.55	13.81	15.28
CAT(BBVV)	5.74	7.88	6.63	9.09
TIP(ER)	4.61	6.81	5.96	8.16
CAT(ifER)	3.89	4.97	4.67	4.70
PI(ifER)	0.72	1.83	1.29	3.46

	(e) Relabeling mixed-CAT with small-value prod. to pure-CAT		(f) Relabeling mixed-CAT with large-value prod. to regular goods	
	Intrafirm	Interfirm	Intrafirm	Interfirm
Export	13.92	15.55	13.92	15.55
CAT(BBVV)	6.63	9.10	6.60	9.01
TIP(ER)	6.11	8.33	5.96	8.16
CAT(ifER)	5.02	5.96	4.87	5.79
PI(ifER)	1.09	2.37	1.09	2.37

Note: The unit of values is trillion ¥.
Source: See Table 1.

Though the share of CAT(ifER) in TIP(ER) is very high, it may still be underestimated due to the potential underreporting of manufactured products in the production data. This underreporting may occur if employees responsible for completing the questionnaire bundled multiple items with small production values into a single entry or omitted them altogether to reduce effort. The recalculated export values after relabeling exports of ¥1 million or lower as regular products are shown in Panel (a) of Table A1. After this revision, the values of intrafirm and interfirm CAT(BBVV) and TIP(ER) decrease only marginally, compared to Table

4. However, each of their CAT(ifER) increases, while their PI(ifER) decreases significantly due to the increase in the export of produced goods and the accompanying rise in CAT(ifER). Since most of the exports classified as PI(ifER) belong to firms with a small number of exported items, and each of their export values is relatively small, the relabeling of small-value exports to regular goods significantly decreased their PI(ifER).

Similar to the case in panel (a), some firms that reported exporting only one item may have done so to bypass having to write down the details of many items in the survey. To address this possibility, panel (b) tabulated the results after excluding firms with only one export item. All figures in panel (b) are smaller than their corresponding values in Table 4. Notably, the decreases in all interfirm figures and in intrafirm PI(ifER) are significant, as many export records for these components are submitted by firms with only one exported item.

To address the possibility that there may still be some incorrect matching of produced and exported goods, panel (c) aggregates the 6-digit production and export classifications into 4-digit categories and recalculates the export values for comparison with Table 4. As a result, all figures of TIP(ER), CAT(ifER), and PI(ifER) in both intrafirm and interfirm trades are reduced almost proportionally.

ER define an exported item by a firm, as a reexport if the firm's import value of that item exceeds its export value. Although this study has already excluded export records classified as reexport by Japan Customs, panel (d) further eliminates reexports based on ER's definition and recalculates the values. While this procedure slightly increases CAT(ifER) and reduces PI(ifER) in both intrafirm and interfirm trades, the overall results remain unchanged.

Lastly, panels (e) and (f) have relabelled mixed-CAT items to other components. For mixed-CAT items, when the ratio of production value to export value for an item in a firm is less than 0.1, the item is reclassified as pure-CAT in panel (e), assuming that the production is negligible. Conversely, when the ratio exceeds 0.9, the item is reclassified as regular goods in panel (f), assuming that the difference between the produced and exported values is negligible. Similar to observations made in panel (d), these procedures slightly increase CAT(ifER) in panel (e) and decrease CAT(BBVV) in panel (f) in both intrafirm and interfirm trades, but the overall features remain constant.

Appendix 2: Theoretical explanation

Appendix 2 provides more details to the theoretical model that explains the empirical findings from Section 6, specifically regarding how TIP(ER) differs between interfirm and intrafirm exports. Using a duopoly framework, Eckel and Riezman (2020) analyzed the quantities of products and profits of firms categorized into two scenarios. Firstly, where two sellers export their self-produced goods directly to a foreign market, referred to as "Delivery of Own Goods" or "DOG" in their terminology, and secondly, where one seller delegates the export task to the other, resulting in the latter exporting both goods; these are referred to as "CAT". Based on this, the model developed in this appendix extends the framework of Eckel and Riezman (2020). The dimension of intrafirm and interfirm trades between home seller firms and a foreign buyer firm were incorporated into the equation, while certain aspects of the original setup were simplified.

A.2.1 Purely intermediated

In this subsection, PI(ifER) is defined first, as it has a simpler model structure. This is followed by a definition of CAT(ifER).

There are two countries involved: home and foreign. The home country has two manufacturing firms, Manufacturers 1 and 2, while the foreign country has two buyer firms, Buyers 0 and 1. Manufacturer 2 produces Product 2 with a quantity q_2, which is all purchased by foreign Buyer 1 at a price of s_2, which is then distributed in a foreign market with a liner demand function, $p_2 = a_2 - bq_2$, where p_2 is the price of Product 2 for foreign consumers. Parameter a_2 can be interpreted as a measure of the quality of the product, with a larger value indicating a higher quality. Parameter b measures the size of the foreign market, where larger values indicates a smaller market. Manufacturer 1 may act as an intermediator for exporting Product 2 on behalf of Manufacturer 2. Additionally, Manufacturer 1 produces Product 0 with a quantity q_0, which is entirely sold to foreign Buyer 0 at a price s_0. Since the two products are assumed to be perfectly differentiated, the equilibrium in the market for Product 2 is determined independently of the market for Product 0. Therefore, q_0 and s_0 are treated as a given in the subsequent analysis. Figure 9 in Section 6.1 summarizes the flow of the products.

The profit of Manufacturer 2 from Product 2 is $\pi_{M2} = (s_2 - c_2 - t_2)q_2$, where c_2 is the

fixed marginal cost of producing Product 2, and t_2 is the fixed per-unit export cost. The export cost t_2 reflects in-house paperwork and transportation costs associated with selling the product in a foreign market, which differ between sellers. It is assumed that Manufacturer 1 has a lower handling cost for international transactions, $t_2 = t_2^1$, due to its experienced in-house human resources and well-established systems for international trade, compared to Manufacturer 2's higher cost, $t_2 = t_2^2$. When Manufacturer 2 delegates the export task to Manufacturer 1, Manufacturer 1 charges a per-unit commission fee of $t_2^{1'}$, where $t_2^1 < t_2^{1'} < t_2^2$, to Manufacturer 2 and earns a profit of $\pi_{M1} = (t_2^{1'} - t_2^1)q_2$. Under this arrangement, the profit of Manufacturer 2 is $\pi_{M2} = (s_2 - c_2 - t_2^{1'})q_2$, while the profit of Buyer 1 from Product 2 is $\pi_B = (p_2 - s_2)q_2$.

Three cases are analyzed step by step to examine the effects of transitioning from DOG to PI and subsequently from interfirm to intrafirm trade. In the first case, the two manufacturers and the buyer operate as independent firms, with Manufacturer 2 selling its product directly and non-cooperatively to Buyer 1. The flow of the product in this case is not depicted in Figure 9. In the second instance, Manufacturer 2 delegates the export of Product 2 to Manufacturer 1, the seller with lower trading costs, and pays the commission fee. In this scenario, the export of Product 2 is categorized as an interfirm PI, managed by Manufacturer 1. In the third case, Manufacturer 1 and Buyer 1 belong to the same MNC, where the export of Product 2 is implemented by intrafirm PI, where the supply of Product 2 is determined to maximize their joint profit. This analysis identifies two key benefits. Firstly, the shift from DOG to PI, from the first to the second case, reduces the trading costs of Product 2, generating additional profits for the two manufacturers and the buyer. Secondly, the shift from interfirm to intrafirm trade, from the second to the third case, allows Manufacturer 1 and Buyer 1 to collaboratively set the price and quantity of Product 2, eliminating any inefficiencies caused by the bargaining between them. Finally, after the observations and analyses are made about these effects, the incentive for Manufacturer 1 to choose Buyer 1 as a partner in forming the MNC is examined.

Case I: DOG by Manufacturer 2

Since the transaction between Manufacturer 2 and Buyer 1 is a bilateral monopoly in this case, it is assumed that q_2 and s_2 are determined through a two-stage game between the two firms. In the first stage, Manufacturer 2 sets the price s_2 for Product 2. In the second stage, Buyer 1

decides the import quantity q_2. This game is solved using backward induction, starting from Buyer 1's decision. From the profit maximization at given s_2, Buyer 1's choice of q_2 is given by

$$q_2 = \frac{a_2 - s_2}{2b}. \tag{1}$$

The decision made by Manufacturer 2 regarding s_2 is solved as a standard Nash duopoly case. Anticipating the reaction of Buyer 1, Manufacturer 2 sets s_2 to maximize its profit non-cooperatively. Manufacturer 2, which is both the producer and seller of Product 2, obtains the first-order condition for the maximization of profit, through substituting equation (1) into its profit function $\pi_{M2} = (s_2 - c_2 - t_2^2)q_2$ and differentiating it with respect to s_2. Solving this results in the following equilibrium selling price in Case I of PI, denoted as s_2^I:

$$s_2^I = \frac{a_2 + c_2 + t_2^2}{2}.$$

Using the definition of s_2^I, equilibrium outputs, q_2^I, Manufacturer 2's profit, π_{M2}^I, and Buyer 1's profit, π_B^I, in this case are

$$q_2^I = \frac{a_2 - c_2 - t_2^2}{4b},$$

$$\pi_{M2}^I = 2b(q_2^I)^2,$$

$$\pi_B^I = b(q_2^I)^2.$$

We assume that the parameters in these equations satisfy positive outputs throughout this section.

Case II: PI by Manufacturer 1

In the second case of PI, the task of exporting Product 2 on behalf of Manufacturer 2, is delegated to Manufacturer 1. Although the transaction of Product 2 between the two manufacturers is a bilateral monopoly, following in on Eckel and Riezman (2020), it is assumed that there is no inefficiency of bargaining between the two manufacturers. Similar to the game setting of first case, q_2 and s_2 are determined through a two-stage non-cooperative game between Manufacturer 1 and Buyer 1. Buyer 1's choice of q_2 is the same as equation (1). The combined profit function on the manufacturer's side is: $\pi_M = \pi_{M1} + \pi_{M2} = (s_2 - c_2 - t_2^{1'})q_2 + (t_2^{1'} - t_2^1)q_2 =$

$(s_2 - c_2 - t_2^1)q_2$. The manufacturers maximize this profit with respect to s_2. Applying the same procedure as in the first case yields the corresponding outcomes, denoted as *II* in the superscript of each result:

$$s_2^{II} = \frac{a_2 + c_2 + t_2^1}{2},$$

$$q_2^{II} = \frac{a_2 - c_2 - t_2^1}{4b},$$

$$\pi_M^{II} = 2b(q_2^{II})^2,$$

$$\pi_B^{II} = b(q_2^{II})^2.$$

Since $q_2^I < q_2^{II}$, the joint profit of Manufacturers 1 and 2 and the buyer's profit are higher in this case. Manufacturer 2 has the incentive to delegate the export task to Manufacturer 1, and Buyer 1 benefits from this arrangement, due to the reduction in trading costs.

Case III: Intrafirm PI

In the third case, Manufacturer 1 and Buyer 1 are part of the same MNC, and the MNC decides q_2 to maximize their combined profit $\pi_{MB} = \pi_M + \pi_B = (s_2 - c_2 - t_2^1)q_2 + (p_2 - s_2)q_2 = (p_2 - c_2 - t_2^1)q_2$.[24] Maximizing π_{MB} with respect to q_2 yields the equilibrium output in this case, q_2^{III}, and then the profit, π_{MB}^{III}, as follows:

$$q_2^{III} = \frac{a_2 - c_2 - t_2^1}{2b},$$

$$\pi_{MB}^{III} = b(q_2^{III})^2.$$

Since the quantity of Product 2 doubles when shifting from interfirm to intrafirm exports ($q_2^{III} = 2q_2^{II}$), it is evident that $\pi_M^{II} + \pi_B^{II} < \pi_{MB}^{III}$. Specifically,

$$\pi_{MB}^{III} - \pi_M^{II} - \pi_B^{II} = \frac{(a_2 - c_2 - t_2^1)^2}{16b}. \tag{2}$$

This indicates that the joint profit of the two manufacturers and the buyer is higher in Case III, demonstrating the benefit of eliminating inefficiencies caused by the bargaining process

[24]The assumption of no bargaining inefficiency between the two manufacturers remains valid. Consequently, Manufacturer 2 is treated as a de facto part of the MNC, even though this is not explicitly assumed.

between the seller and the buyer.

It is worth noting that the price of Product 2 for foreign consumers in this case, p_2^{III}, becomes equal to s_2^{II}. Therefore, the change in quantity from q_2^{II} to q_2^{III} indicates the change in the total export value, assuming that Manufacturer 1 registers p_2^{III} as the unit value of Product 2, s_2^{III}, in the customs clearance system. This study assumes that firms register s_2 as the unit value price, and in Case III, $s_2^{III} = p_2^{III}$.

The choice of MNC partner

The third case considers the scenario where Manufacturer 1 chooses Buyer 1 as its MNC partner. Does Manufacturer 1 have an incentive to choose Buyer 1 instead of Buyer 0 to maximize their profits? The theoretical analysis suggests that if the market conditions for Products 0 and 1 are similar, selecting Buyer 0 as the partner yields a larger joint profit for Manufacturer 1 and Buyer 0, as Manufacturer 1 retains the producer profit.

In this setting, the ratio of PI(ifER) to total exports is defined as $r = s_2q_2/(s_0q_0 + s_2q_2)$. If Manufacturer 1 selects Buyer 0 as the MNC partner, q_0 doubles, and this results in a reduction in the ratio r. All else being equal, home manufacturing firms with larger values of intrafirm exports tend to have the lower ratio. This theoretical projection aligns with the empirical results.

A.2.2 Carry-along trade

In this subsection, the model used to explain PI(ifER) is extended to include an additional product. This will be referred to as Product 1 from Manufacturer 1. This extension is necessary for studying CAT. Manufacturer 1 produce a q_1 quantity of Product 1, which is entirely purchased by foreign Buyer 1 at a price of s_1. The profit from this transaction for Manufacturer 1 is $\pi_{M1} = (s_1 - c_1 - t_1)q_1$, where c_1 and t_1 are the fixed marginal costs of producing Product 1 and exporting it, respectively. Product 1 is always assumed to be exported by Manufacturer 1, and as a result, t_1 will remain a constant.

Buyer 1 then distributes Product 1 in a foreign market with a linear demand function $p_i = a_i - bq_i - b\theta q_j$, where $i, j \in 1, 2$ and $i \neq j$. The profit of Buyer 1 from two products is $\pi_B = \Sigma_{i=1,2}(p_i - s_i)q_i$. The parameter $\theta \in (-1, 1)$ represents the degree of product differentiation between the two products. When $0 < \theta < 1$, the products are imperfectly differentiated and can

be partially substituted, with a larger θ indicating less differentiation and higher substitutability. When $\theta = 0$, the products are perfectly differentiated and thus cannot be substituted. When $-1 < \theta < 0$, the products are complements, meaning an increase in demand for one enhances the demand for the other.[25] Since the selling price of one product, s_i, influences the price of the other product, s_j, exporting both products through a single seller, rather than two separate sellers, allows the seller to internalize the demand linkages. This creates an additional benefit, which will be further explained later.

As in the case of PI, three cases were analyzed to observe the effects of changing from DOG to CAT and subsequently from interfirm to intrafirm trade, as outlined below:

Case I: DOGs by Manufacturers 1 and 2

This is the case where two home manufacturers and a foreign buyer all belong to different firms, and manufacturers export their products directly and non-cooperatively to the buyer. Note that the DOG flow of Product 2 to Buyer 1 is not depicted in Figure 9. The structure of the game and the method for solving it are the same as those in Case I of PI. The quantity chosen by Manufacturer i is derived as

$$q_i = \frac{(a_i - s_i) - \theta(a_j - s_j)}{2b(1 - \theta^2)}. \tag{3}$$

Taking into account the reactions of Buyer 1, as expressed in equation (3), each manufacturer differentiates its profit function $\pi_{Mi} = (s_i - c_i - t_i)q_i$ with respect to s_i to obtain the first-order condition $d\pi_{Mi}/ds_i = 0$, yielding the equation $s_i = \{(a_i + c_i + t_i) - \theta(a_j - s_j)\}/2$. Solving two equations produces the following equilibrium selling price in Case I, s_i^I:

$$s_i^I = \frac{2(a_i + c_i + t_i) - \theta^2 a_i - \theta(a_j - c_j - t_j)}{4 - \theta^2},$$

[25] Eckel and Riezman (2020) examine the case where the marginal export cost of products increases under CAT and demonstrate that even in that case, CAT increases the joint profit of manufacturers when θ is close to 1 or -1. While this finding is meaningful, the present study does not consider increasing marginal transportation cost of a CAT product, focusing instead on the comparison between interfirm and intrafirm exports.

where $t_2 = t_2^2$. Using the definition of s_i^I, equilibrium outputs, q_i^I, the Manufacturer i's profit, π_{Mi}^I, and Buyer 1's profit, π_B^I, in Case I are

$$q_i^I = \frac{(2-\theta^2)(a_i - c_i - t_i) - \theta(a_j - c_j - t_j)}{2b(1-\theta^2)(4-\theta^2)},$$

$$\pi_{Mi}^I = 2b(1-\theta^2)(q_i^I)^2,$$

$$\pi_B^I = b\{\Sigma_{i=1,2}(q_i^I)^2 + 2\theta q_1^I q_2^I\}.$$

Case II: CAT by Manufacturer 1

The second case, examines the scenario where Manufacturer 2 delegates the task of exporting Product 2 to Manufacturer 1, assuming there is no inefficiency in bargaining between the two manufacturers, as in the Case II of PI. The joint profit function of the two manufacturers is $\pi_M = \pi_{M1} + \pi_{M2}$, where $t_2 = t_2^1$. As before, Manufacturer 1 and Buyer 1 will engage in the same two-stage game, so Buyer 1's choice of q_i is the same as equation (3). When Manufacturer 1 maximizes their joint profit with Manufacturer 2, the two first-order conditions, $d\pi_M/ds_1 = 0$ and $d\pi_M/ds_2 = 0$, yield the following equilibrium selling prices in Case II, s_i^{II}:

$$s_i^{II} = \frac{a_i + c_i + t_i}{2},$$

where $t_2 = t_2^1$. Substituting the definition of s_i^{II}, the equilibrium outputs, q_i^{II}, the joint profit of Manufacturers 1 and 2, π_M^{II}, and Buyer 1's profit, π_B^{II}, in Case II are:

$$q_i^{II} = \frac{(a_i - c_i - t_i) - \theta(a_j - c_j - t_j)}{4b(1-\theta^2)},$$

$$\pi_M^{II} = \Sigma_{i=1,2}\frac{a_i - c_i - t_i}{2}q_i^{II},$$

$$\pi_B^{II} = b\{\Sigma_{i=1,2}(q_i^{II})^2 + 2\theta q_1^{II} q_2^{II}\}.$$

To confirm the incentive for the two manufacturers to internalize demand linkages, $\pi_M^{II} - \Sigma_{i=1,2}\pi_{Mi}^I$ is calculated, resulting in the following equation:

$$\pi_M^{II} - \Sigma_{i=1,2}\pi_{Mi}^I = \frac{\theta^2}{8b(1-\theta^2)(4-\theta^2)^2}\Lambda_1,$$

where

$$\Lambda_1 = \Sigma_{i=1,2}(4-3\theta^2)(a_i - c_i - t_i)^2 - 2\theta^3(a_1 - c_1 - t_1)(a_2 - c_2 - t_2)$$

$$> \{(a_1 - c_1 - t_1) - (a_2 - c_2 - t_2)\}^2 \geq 0.$$

This value is positive, which demonstrates the internalizing effect of a single seller conducting the export of two products.[26]

Case III: Intrafirm CAT

In the third case, Manufacturer 1 and Buyer 1 belong to the same MNC, and the MNC determines q_i to maximize $\pi_{MB} = \pi_M + \pi_B = \Sigma_{i=1,2}(p_i - c_i - t_i)q_i$. The first-order condition $d\pi_{MB}/dq_i = 0$ produces the equation $2b(q_i + \theta q_j) = a_i - c_i - t_i$. Solving two equations produces the following equilibrium outputs, q_i^{III}, and the total profit, π_{MB}^{III}, in Case III are:

$$q_i^{III} = \frac{(a_i - c_i - t_i) - \theta(a_j - c_j - t_j)}{2b(1-\theta^2)},$$

$$\pi_{MB}^{III} = b\{\Sigma_{i=1,2}(q_i^{III})^2 + 2\theta q_1^{III} q_2^{III}\}.$$

By comparing q_i^{II} and q_i^{III}, it is evident that $q_i^{III} = 2q_i^{II}$. This suggests that the quantity of each product doubles when shifting from interfirm to intrafirm exports, as in the cases of PI. To confirm the incentive for shifting to intrafirm trade and eliminating the inefficiency of bargaining, $d\pi_{MNC\_11} = \pi_{MB}^{III} - \pi_M^{II} - \pi_B^{II}$ is calculated, yielding the following equation:

$$d\pi_{MNC\_11} = \frac{1}{16b(1-\theta^2)}\Lambda_2, \tag{4}$$

where

$$\Lambda_2 = \Sigma_{i=1,2}(a_i - c_i - t_i)^2 - 2\theta(a_1 - c_1 - t_1)(a_2 - c_2 - t_2)$$

$$> \{(a_1 - c_1 - t_1) - (a_2 - c_2 - t_2)\}^2 \geq 0.$$

This value is positive, indicating the resolution of bargaining inefficiency. Equation (4) repre-

[26] For the change of q_i from Cases I to II, $q_i^{II} - q_i^I = \{\theta^2(a_i - c_i - t_i) + \theta(\theta^2 - 2)(a_j - c_j - t_j)\}/4b(1-\theta^2)(4-\theta^2)$. This indicates that q_i increases by shifting from Case I to Case II when $\theta < 0$, meaning that the two goods are complements. When $\theta = 0$, indicating that there is no demand linkage to internalize by maximizing the joint profit of the two manufacturers, q_i is the same in both cases. Additionally, q_i increases even in the case of $\theta > 0$ when $(a_i - c_i - t_i) > (a_j - c_j - t_j)$ and θ is close to 1.

sents the additional benefit gained by Manufacturer 1 and Buyer 1 from forming an MNC.

As in the situation with PI, the price of Product i for foreign consumers, p_i^{III}, equals s_i^{II}. Therefore, doubling the quantity from q_i^{II} to q_i^{III} results in doubling the total export value of Product i.

Choosing an MNC partner

Assume that the market conditions for Products 0 and 1 are similar. Which buyer—Buyer 0 or Buyer 1—brings a larger additional profit to Manufacturer 1 as its MNC partner? The additional profit from forming an MNC with Buyer 0, denoted as $d\pi_{MNC\_10}$, is calculated as $d\pi_{MNC\_10} = (a_0 - c_0 - t_0)^2/16b$ from equation (2). When $(a_0 - c_0 - t_0) = (a_1 - c_1 - t_1)$, $d\pi_{MNC\_11}$ denoted in equation (4) is larger than $d\pi_{MNC\_10}$ by

$$d\pi_{MNC\_11} - d\pi_{MNC\_10} = \frac{\{\theta(a_1 - c_1 - t_1) - (a_2 - c_2 - t_2)\}^2}{16b(1 - \theta^2)} > 0.$$

This result indicates that, even after allocating a portion of the additional profit to Manufacturer 2, forming an MNC with Buyer 1 could potentially bring greater profit to Manufacturer 1 than forming an MNC with Buyer 0. This highlights the benefit of internalizing demand linkages between produced and sourced products in the case of an MNC formed with Buyer 1.

The ratio of CAT(ifER) to total exports, given by $r = s_2q_2/(s_0q_0+s_1q_1+s_2q_2)$, is compared between the interfirm export case (Case II) and the intrafirm export case (Case III). As in PI, q_o and s_i remain constant in both cases. Thus, an increase in q_1 and q_2 raises the ratio. However, the ratio of CAT(ifER) does not differ significantly between interfirm and intrafirm trade when q_1 and q_2 increase proportionally, as indicated by the theoretical analysis, and the export value of Product 0 by Manufacturer 1, s_0q_0, is relatively small. When Manufacturer 1 communicates the characteristics of the sourced Product 2 to Buyer 1 more effectively than those of the produced Product 1 through in-house communication, the formation of an MNC between Manufacturer 1 and Buyer 1 increases the product-specific parameter a_2. This, in turn, would result in a higher rate of increase in s_2q_2 compared to s_1q_1, leading to an increase in the ratio $r = s_2q_2/(s_0q_0 + s_1q_1 + s_2q_2)$, regardless of the value of s_0q_0. This is one possible explanation for the empirical analysis results discussed in Section 6.

The argument regarding the motivation to form an MNC is applicable to the case where Manufacturer 1 exports a sourced product (e.g., Product 3) in addition to the produced product (Product 0) to Buyer 0. To simplify the analysis, assume that θ is common and $(a_0 - c_0 - t_0) = (a_1 - c_1 - t_1)$. From equation (4), the additional profit from forming an MNC with Buyer 0 with the sourced product q_3, denoted as $d\pi_{MNC\_10'}$, is

$$d\pi_{MNC\_10'} = \frac{\Sigma_{i=1,3}(a_i - c_i - t_i)^2 - 2\theta(a_1 - c_1 - t_1)(a_3 - c_3 - t_3)}{16b(1-\theta^2)}. \tag{5}$$

The difference between $d\pi_{MNC\_11}$ in equation (4) and $d\pi_{MNC\_10'}$ in equation (5) is then calculated as:

$$d\pi_{MNC\_11} - d\pi_{MNC\_10'} = b(1-\theta^2)\{(q_2^{II})^2 - (q_3^{II})^2\}.$$

This is positive as long as $q_2^{II} > q_3^{II}$, indicating that a larger quantity of sourced products results in higher profits when forming an MNC.

When $q_0 = q_1$ and $q_2 > q_3$ in the stage of Case II, Manufacturer 1 chooses Buyer 1 as its MNC partner. In this case, both the manufactured product q_1 and the sourced product q_2 double in quantity in Case III. As a result, the ratio of CAT(ifER) to total exports, $r = (s_2q_2 + s_3q_3)/(s_0q_0 + s_1q_1 + s_2q_2 + s_3q_3)$, increases. This occurs because $s_2q_2/(s_1q_1 + s_2q_2)$ is larger than $s_3q_3/(s_0q_0 + s_3q_3)$. Although this example incorporates some additional assumptions, it suggests that the ratio of CAT(ifER) to total exports tends to rise when an exporting manufacturer selects its partner buyer to maximize joint profit. The positive relationship between intrafirm trade and the ratio of CAT(ifER), as identified in the empirical analysis in Section 6.2, can be interpreted as the result of exporters' rational choices in selecting MNC partners.

References

Abreha, K. G., V. Smeets, and F. Warzynski (2020). Coping with the crisis and export diversification. *The World Economy 43*(5), 1452–1481.

Antràs, P. (2003). Firms, contracts, and trade structure. *The Quarterly Journal of Economics 118*(4), 1375–1418.

Arnarson, B. T. (2020). The superstar and the followers: Intra-firm product complementarity in international trade. *Journal of Economic Behavior and Organization 177*, 277–304.

Baek, Y., K. Hayakawa, K. Tsubota, S. Urata, and K. Yamanouchi (2021). Tariff pass-through in wholesaling: Evidence from firm-level data in Japan. *Journal of the Japanese and International Economies 62*, 101164.

Bernard, A. B., E. J. Blanchard, I. Van Beveren, and H. Vandenbussche (2019). Carry-along trade. *Review of Economic Studies 86*(2), 526–563.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2018). Global firms. *Journal of Economic Literature 56*(2), 565–619.

Chun, H., J. Hur, Y. G. Kim, and H. U. Kwon (2017). Cross-border vertical integration and intra-firm trade: New evidence from Korean and Japanese firm-level data. *Asian Economic Papers 16*(2), 126–139.

Corcos, G., D. M. Irac, G. Mion, and T. Verdier (2013). The determinants of intrafirm trade: Evidence from French firms. *Review of Economics and Statistics 95*(3), 825–838.

Di Nino, V. (2015). The phenomenal CAT: Firms clawing the goods of others. *Occasional papers, Bank of Italy 281*.

Eckel, C. and R. Riezman (2020). CATs and DOGs. *Journal of International Economics 126*, 103338.

Egger, P. and T. Seidel (2013). Corporate taxes and intra-firm trade. *European Economic Review 63*, 225–242.

Erbahar, A. and V. Rebeyrol (2023). Trade intermediation by producers. *Journal of International Economics 140*, 103693.

Ito, K., M. Endoh, N. Jinji, T. Matsuura, T. Okubo, and A. Sasahara (2025). Margins, concentration, and the performance of firms in international trade: Evidence from Japanese customs data. *Journal of the Japanese and International Economies 75*, 101340.

Matsuura, T., B. Ito, and E. Tomiura (2023). Intrafirm trade, input–output linkage, and contractual frictions: evidence from Japanese affiliate-level data. *Review of World Economics 159*(1), 133–152.

Mayer, T. and G. I. P. Ottaviano (2008). The happy few: The internationalisation of European firms. *Intereconomics 43*(3), 135–148.

Ramondo, N., V. Rappoport, and K. J. Ruhl (2016). Intrafirm trade and vertical fragmentation in U.S. multinational corporations. *Journal of International Economics 98*, 51–59.

Ruhl, K. J. (2015). How well is US intrafirm trade measured? *American Economic Review 105*(5), 524–529.

van den Berg, M., A. Boutorat, and A.-P. Alberda (2019). Dissecting carry-along trade: What's in the bundle? *Centraal Bureau voor de Statistiek Discussion Paper*.