Invoice Currency Choice in Intra-Firm Trade:
A Transaction-Level Analysis of Japanese Automobile Exports

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Invoice Currency Choice in Intra-Firm Trade:
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-------------------------------------   Abstract   -------------------------------------

This study empirically investigates the extent to which the choice of invoice currency differs between intra-firm and arm's length exports. We also examine whether other firm- and product-level factors affect the choice of invoice currency. This study is the first to be granted access to highly disaggregated transaction-level data on Japanese automobile exports to France. By conducting panel logit estimation, we demonstrate that importers' currency tends to be chosen in intra-firm export invoicing, which has not been rigorously shown in previous literature. Our empirical findings remain robust when introducing different types of intra-firm export variables and other conventional explanatory variables such as firm- and product market share, exchange rate volatility, a dummy for intermediate goods exports, euro-invoiced imports, labor productivity, and research and development intensity. Amid growing intra-firm trade and expanding global value chains, Japanese parent firms tend to invoice using the importer's currency, assuming the foreign exchange risk that arises from intra-firm trade; thus, exchange rate risk management is a significant consideration for Japanese parent firms.

Keywords: Invoice currency; Intra-firm trade; Japan Customs data; Market share; Export competitiveness

JEL classification: F14; F31

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1. Introduction

The choice of invoice currency has attracted considerable attention in the field of international economics. As demonstrated by Obstfeld and Rogoff (2000), when considering the impact of macroeconomic policy across countries, the choice of invoice currency (i.e., whether exporters choose the producer's currency pricing (PCP), the local currency pricing (LCP), or third-currency pricing) determines the extent of international shock transmission. As a result, optimal monetary and exchange rate policies significantly depend on firms' chosen invoice currency for exports and imports (e.g., Devereux and Engel, 2003).

Numerous research efforts have been devoted to assessing the determinants of invoice currency choice. Many recent studies have empirically analyzed how the choice of invoice currency is affected by micro and macroeconomic factors using highly disaggregated transaction-level customs data to determine invoice currency in each export/import transaction. For instance, using unpublished micro data on Canadian imports, Goldberg and Tille (2016) revealed a correlation between the size of individual transactions and invoice currency in addition to the impact of conventional macroeconomic factors such as exchange rate volatility and exchange rate regime. Devereux et al. (2017) also used Canadian data to investigate the impact of exporter's and importer's market share on the chosen invoice currency.[1] This study is the first to employ Japan Customs' transaction-level data, which have not been previously disclosed to researchers. In early 2022, the Japanese Ministry of Finance (MOF) started allowing the use of large-scale customs transaction-level data for empirical research, including detailed information on Japanese export and import transactions, on the condition of maintaining the anonymity of firms that made customs declarations in exports and/or imports. Our research group was approved for this study and granted use of the transaction-level data of exports and imports for the 2014–2020 period.

The novelty of this study is its rigorous investigation of whether invoice currency choice differs between intra-firm and arm's-length trade. We use a panel dataset constructed employing the Japanese transaction-level customs data. Although global value chains (GVCs) have become an important consideration in the empirics of international economics (e.g., Timmer et al., 2014), a limited number of studies have investigated the invoice currency choice along GVCs. For instance, motivated by recent research on GVCs, Chung (2016) and Amiti et al. (2022) considered the effect of imported intermediate inputs on exporting firms' invoice currency choice.[2] These studies demonstrated that when more intermediate inputs are imported from abroad and invoiced in foreign currencies, it is more likely for exporting firms to use foreign currencies in their exports of production goods. Such trade transactions along production chains are usually expected to be conducted via intra-firm trade between group companies; however, these studies did not clearly distinguish intra-firm trade from arm's-length trade when analyzing the effect of the invoice currency choice. Another example is Ito et al. (2018), who employed a questionnaire survey of Japanese export firms, revealing that invoice currency choice significantly differed between intra-firm and arm's-length exports. While the authors presented notable findings on Japanese firms' invoice currency choice, only 227 firms' valid responses to the questionnaire survey were included, and the

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[1] Many other examples can be cited, including Gopinath, Itskhoki, and Rigobon et al. (2010) for the US; Casas et al. (2017) and Gopinath et al. (2020) for Colombia; Hayakawa et al. (2019b) for Thailand; Chen et al. (2022) and Corsetti et al. (2022) for the UK; Montfaucon et al. (2021) for Malawi; Amiti et al. (2022) for Belgium; and Saygılı (2022) for Turkey.

[2] We also identify several studies in the literature of exchange rate pass-through (ERPT) that considered GVCs, which is closely related to invoice currency choice. Neiman (2010) empirically examined possible differences in ERPT between intra-firm and arm's-length trade using a transaction-level dataset obtained from the US Bureau of Labor Statistics, revealing that the degree of ERPT between intra-firm and arm's-length import transactions differs significantly. Rondeau and Yoshida (2023) investigated the effect of value-added contributions of exporters and importers on the degree of ERPT to Japanese imports, demonstrating that the degree of ERPT increases for industries with higher contributions from exporting countries' value-added and/or lower contributions from importing countries' value-added.

empirical results are based on pooled cross-section data representing a limited number of observations.[3]

We focus on Japanese automobile exports to France to investigate how invoice currency choice differs between intra-firm and arm's-length trade. The automobile sector is one of Japan's largest export sectors, and Japanese automobile firms have established a considerable number of overseas subsidiaries across the world, actively exporting products to these subsidiaries, and intra-firm trade has a significant role in such transactions. We choose France as the destination country because the proportion of arm's-length exports account for around 20%–30% of the trade flow, which enables us to conduct a rigorous empirical examination of possible differences in invoice currency choice between intra-firm and arm's-length exports.[4]

The identification of intra-firm trade is the key issue in this research. Invoice currency choice has not been rigorously examined because it is difficult without knowing detailed information on exporters and importers such as their names and addresses to identify whether import firms are overseas subsidiaries or independent firms without capital ties, even when we use transaction-level customs data. We matched the Japan Customs' data with external sources of overseas subsidiaries and capital relationships. Focusing on Japanese automobile exports to France, we could precisely identify the capital ties between exporters in Japan and importers in France. In the empirical analysis, we use alternative definitions of intra-firm exports considering the degree of capital ties. We present the details of this approach in Section 2.

Our empirical examination demonstrates that the euro is more likely to be chosen for intra-firm exports than arm's-length exports, implying that Japanese automobile firms tend to stabilize the euro-based export price in intra-firm exports to France, assuming all exchange rate risks that arise from euro-invoiced transactions. In arm's-length exports to France, Japanese firms prefer invoicing in yen, passing the exchange rate risk to French importers. This result remains robust to using alternative definitions of intra-firm trade. We also find that exporters tend to use the euro when the proportion of the euro in imports is high, the firms' market share in France is high or low, or when the yen is less volatile against the euro. These findings are consistent with those of previous studies such as Devereux et al. (2017). We also find that the euro is used more for exports of final goods than for intermediate goods. We interpret this result as meaning that the chosen invoice currency tends to match the destination country's currency when exported products are finally consumed. Furthermore, regarding firm characteristics, we find that labor productivity and research and development (R&D) investment, which can be considered non-price sources of export competitiveness that negatively affects the likelihood of euro-invoiced transactions. We interpret this result as meaning that exporters can offer the use of the home currency in invoicing when they hold significant bargaining power that is generated by competitiveness in the destination country.

The remainder of this paper is organized as follows. Section 2 describes the Japanese customs data and the transaction-level panel dataset constructed for this study. Section 3 presents the empirical framework and our baseline results. Section 4 checks the robustness of the empirical findings. Finally, Section 5 concludes this paper.

2. Data

2.1. Matching Methodology

We use Japanese customs data that was newly disclosed to conduct this research. The data contain the following information for each export and import transaction: (i) trade value (in yen), (ii) corresponding quantity

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[3] Friberg and Wilander (2008) also conducted a questionnaire survey of Swedish exporters, which provided us with useful information on firm-level Swedish export invoicing decisions; however, the study did not identify significant differences between intra-firm and arm's-length trade in the invoice currency choice. Ito et al. (2018) conducted two questionnaire surveys of Japanese listed firms in 2009 and 2013 for their empirical analysis; however, as noted previously, panel estimation was not conducted since a limited number of firms responded to the surveys twice.

[4] In fact, the proportion of arm's-length trade in this sector is extremely low for some importing countries.

(numbers and/or weight such as tons or kilograms), (iii) invoice currency, (iv) product information (Harmonized System (HS) nine-digit classification), (v) identification information for Japanese exporters and importers (ID number, name, address, and telephone number), (vi) destination or source country, (vii) trade partners' information (name and address), and (viii) transaction date, time, and other relevant details. The sample period spans from the first day of 2014 to the last day of 2020.

Although the data enable access to all transactions of all products for all partner countries, we focus on automobile exports to France to precisely identify the degree of capital ties between exporters and importers. Because we cannot directly obtain information on capital ties to differentiate intra-firm and arm's-length trade from the Japanese customs data, we identify importers with financial ties to Japanese exporters by conducting machine matching using the Python software. The machine matching was conducted based on firm-level capital relationship data provided by the Teikoku Data Bank (the original source of which is the Bureau van Dijk's Orbis database), in addition to the name and address of exporters and importers obtained from the customs data. French importers' names and addresses are submitted by Japanese exporters or customs brokers, and unfortunately, this information is not recorded in a consistent manner, and typographical errors are observed. This issue could reduce the accuracy of the machine matching procedure; therefore, for validation and accuracy, we complementarily match importers and exporters manually.

Furthermore, the Orbis database does not necessarily cover all overseas subsidiaries of Japanese auto exporters; therefore, we prepare additional lists of overseas subsidiaries from two other databases, including the database for Japanese companies expanding business abroad (Kaigai Shinshutsu Kigyo Soran), which is published by Toyo Keizai Inc. and the MarkLines Information Platform, which includes extremely detailed and comprehensive data on automobile production from countries around the world.[5] These databases are also included in our manual matching procedure, expanding the share of matches in the manual procedure, which is larger than that of the machine procedure. As long as manual matching has an important role to compensate for machine matching, dealing with all sample countries and industries is not a reasonable option.[6]

We choose to focus on Japanese automobile exporters because automobiles are one of Japan's largest export products and have a macroeconomic impact on the Japanese economy. In addition, Japanese automobile firms have established a considerable number of overseas subsidiaries across the world, which indicates the significance of intra-firm trade in the sector. To ensure a sufficient number of Japanese export firms, we chose 12 parent firms that produce completed automobiles and/or motorcycles. We also include five domestic subsidiaries in Japan that are directly owned by the above parent firms with at least a 50% ownership stake. Therefore, we examine data for 17 Japanese auto firms that export completed automobiles and motorcycles and related parts and components to France.

We choose France as the sample destination country for two reasons. First, the yen and the euro (i.e., the local currency) are predominantly used in this trade flow, and the proportion of other currencies is negligible. Doing so may render the invoice currency choice in our target trade flow more immune to the dominant currency paradigm (DCP) proposed by Gopinath et al. (2020). We are able to focus on the binary choice of invoice currency between PCP and LCP, which is theoretically simpler than including a third dominant currency such as the USD. As a comparison, panels (a) and (b) in Figure 1 illustrate the share of yen and USD in Japan's exports and imports to/from the world for all industries, respectively, revealing a significant share of USD in contrast to

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[5] In addition to the above three data sources, when necessary, we double-checked the websites of import firms to confirm our findings.

[6] For instance, in April 2014, more than 1.6 million export transactions to the world were conducted by more than 50 thousand firms. Covering all these samples is not reasonable to conduct manual matching to compensate machine matching.

our sample trade flow. One may think that we can extend the sample to other EU countries since the yen and the euro are supposed to be dominant for other EU countries. Panels (c) and (d) in Figure 1 show the share of yen, USD, and EU countries' currencies, (including the euro) in Japan's exports and imports to/from EU countries for all industries, respectively. Compared with the case for the world, the proportion of USD has been small in recent years, hovering around 12%–14% for both exports and imports; however, the USD still has a notable share, implying that the USD could be one option considered by Japanese exporters and importers in these trade flows. We subsequently focused on Japanese automobile exports to France, as only the yen and euro are used in most transactions. Our second reason for choosing this trade flow is that the share of arm's-length exports is significant, which allows us to conduct a reasonable comparison between intra-firm and arm's-length trade with a sufficient number of samples for both types of trade. As additional information, Figure 2 illustrates the sales of Japanese automakers in major destination countries obtained from the MarkLines database,[7] indicating that France is the fifth largest overseas market for Japanese automakers. Furthermore, Figure 3 presents foreign automaker's sales in France, showing that Japanese automakers have the second largest share of the French market, indicating a strong presence of Japanese automakers in France.

<div align="center">

===   Figure 1   ===
===   Figure 2   ===
===   Figure 3   ===

</div>

2.2.   Definitions of Intra-firm Exports

One challenge in identifying intra-firm and arm's-length exports is determining a definition of overseas subsidiaries based on the degree of capital ties between Japanese exporters and French importers. We consider the following five types of overseas subsidiaries, that are graphically illustrated in Figure 4, for inclusion in intra-firm exports.

Sub-1 firm: Overseas firms that are directly owned by a parent firm in Japan with at least a 10% ownership stake.

Sub-2 firm: Overseas firms that are directly owned by a Sub-1 firm with at least a 50% ownership stake.

Sub-3 firm: Overseas firms that are directly owned by a Sub-2 firm with at least a 50% ownership stake.

Sub-Sub-1 firm: Overseas firms that are directly owned by domestic subsidiaries (i.e., the parent firm's subsidiaries in Japan) with at least a 10% ownership stake.

Sub-Sub-2 firm: Overseas firms that are directly owned by a Sub-Sub-1 firm with at least a 50% ownership stake.

<div align="center">

===   Figure 4   ===

</div>

As previously noted, we consider the exports of 17 Japanese firms, including 12 parent firms and five domestic subsidiaries. We set up the four definitions of intra-firm exports as follows.

Intra-firm 1: Seventeen Japanese firms' exports to Sub-1 and Sub-2 firms.

Intra-firm 2: Seventeen Japanese firms' exports to Sub-1, Sub-2, and Sub-3 firms.

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[7] Figures 2 and 3 represent the value of sales since the MarkLines database only provides this information, whereas our empirical analysis is conducted for each transaction (not the transaction value).

Intra-firm 3: Seventeen Japanese firms' exports to Sub-1, Sub-2, Sub-Sub 1, and Sub-Sub 2 firms.

Intra-firm 4: Seventeen Japanese firms' exports to Sub-1, Sub-2, Sub-3, Sub-Sub 1, and Sub-Sub 2 firms.

The definition of intra-firm exports is narrowest in intra-firm 1 and broadest in intra-firm 4. Intra-firm 2 adds Sub-3 firms to intra-firm 1, while intra-firm 3 adds Sub-Sub 1 and Sub-Sub 2 firms to intra-firm 1 without including Sub-3 firms. In this sense, intra-firm 2 and intra-firm 3 complement one another. We obtain 114,335 export transactions for the whole sample period (2014–2020). Among these transactions, the share of intra-firm exports ranges from 73.4% to 81.2%, depending on the definition of intra-firm trade. Table 1 presents the proportion of intra-firm trade for each definition, and Figure 5 shows the share of intra-firm and arm's-length trade each year.

=== Table 1 ===
=== Figure 5 ===

Table 2 presents the number and share of transactions using the yen and euro. We excluded transactions with other currencies because they accounted for less than 0.1% of the total number of transactions and were omitted from our empirical investigation. The upper panel shows the number and shares in the full sample. Our sample's total number of transactions ranges from 14.8 thousand to 18.7 thousand, depending on the year. The euro share was larger than that of the yen in all sample years.

Nevertheless, the yen had a significant share each year, and the proportions of the two currencies are comparable in some sample years (i.e., in 2017 and 2020). The lower panel shows the number and share by trade type. We counted the number and calculated the share based on the four alternative classifications of intra-firm trade introduced in Table 1. A clear contrast between intra-firm and arm's length trade is evident, revealing that the euro had a dominant share in intra-firm trade, whereas the yen had a dominant share in arm's length trade, which holds for all four classifications of intra-firm trade. Notably, the local currency (i.e., the euro) is used more in intra-firm trade than in arm's length trade.

=== Table 2 ===

3. Empirical Analysis

3.1. Empirical Framework

To examine the choice of invoice currency in intra-firm trade, we estimate the following empirical equation for Japanese firm i's export transaction k of a product defined at the HS nine-digit level in year t to France:

$$y_{i,k,HS9,t} = \alpha + \beta Intra_{i,k,HS9,t} + \gamma X + \varepsilon_{i,k,HS9,t} \qquad (1),$$

$y_{i,k,HS9,t}$ is a dummy variable that takes a value of one for transactions invoiced in the euro and zero for those invoiced in the yen. As noted above, since most transactions are conducted in terms of either the euro or yen, we excluded samples with other types of invoice currency. $Intra_{i,k,HS9,t}$ is a dummy variable that takes a value of one for intra-firm export transactions and zero otherwise. We hypothesize that the euro is more likely to be chosen in intra-firm trade, implying a positive sign of β. We interchangeably use the alternative definitions of intra-firm trade shown in Table 1 to validate the robustness of the results. X is the vector of other explanatory variables. In the baseline analysis, we employ four variables in addition to the intra-firm dummy. First, we include an intermediate goods dummy $Intermediate_{HS6}$, which takes a value of one if the product in the transaction

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represents intermediate goods and zero for final goods.[8] We expect that the euro (i.e., the local currency) is more likely to be used for final goods exports, as final goods are sold to French customers in the euro when imported from Japan; thus, importers had significant motivation to invoice these final goods in the euro, indicating a negative coefficient for $Intermediate_{HS6}$. It is also expected that this variable could correlate with the intra-firm dummy, as intermediate goods might be exported to a manufacturing center of the same company group in the local market. Nevertheless, our baseline results remain unchanged when we introduce intra-firm and the intermediate goods dummies separately.[9]

Second, we consider the share of invoice currency in imports, capturing this variable ($IIS_{i,t}$) by using the natural log of the share of the number of import transactions invoiced in the euro in the total number of import transactions conducted by the firm each year. We are also allowed to use Japan's transaction-level customs import data, although our focus is on firms' export behavior. We use this import information to examine the possible effect of invoice currency share in intermediate input imports on the exporters' invoice currency decision, which has been well documented by Chung (2016).[10] Firms tend to choose the same currency for exports and imports of intermediate inputs to offset the exchange rate risk arising from export and import transactions; therefore, we expect a positive coefficient for this variable.

Third, we include the natural log of the exchange rate volatility of the yen vis-à-vis the euro in each year (Vol_t). We define this volatility as the standard deviation of the daily average exchange rate. As noted by Devereux et al. (2004), risk-averse exporters prefer the exporter's currency when the value of the currency is volatile against the importer's currency. In our context, we expect that the euro is less likely to be chosen when the yen is more volatile against the euro. In this regard, we expect a negative coefficient for Vol_t. The exchange rate data are obtained from the Pacific Exchange Rate Service from the University of British Columbia.

Fourth, we use the natural log of each firm's market share in each product category at the HS six-digit level in each year ($FirmMS_{i,HS6,t}$). The numerator of this market share variable is calculated based on the export value of the HS six-digit product from Japan to France, which is obtained from the Japanese customs data. The denominator is the total global export value, including Japan to France, calculated based on data obtained from the UN Comtrade database and Trade Statistics of Japan. Several previous studies have demonstrated that invoicing currency is related to exporters' market share. For instance, Devereux et al. (2017) showed that exporters' market share has a nonlinear impact on the choice of invoice currency using transaction-level Canadian import data, determining that small exporters are more likely to choose LCP as market share rises; however, when the market share reaches a certain threshold, increased market share makes exporters more likely to choose PCP. We construct the market share variable by dividing the total exports of each product by each exporter by the total exports of that product from the world to France. Table 3 presents the descriptive statistics of our empirical variables in the full sample and for each type of trade.

=== Table 3 ===

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[8] We regard 39, 40, and 72–90 in HS two-digit, 8706–8708 and 8714 in HS four-digit, and 870990 and 871690 in HS six-digit as intermediate goods. The other categories in 87 (HS two-digit) are considered as final goods. We exclude HS8710 (Tanks and other armoured fighting vehicles, motorized, whether or not fitted with weapons, and parts of such vehicles) and HS8715 (Baby carriages and parts thereof), as they are not relevant to this study.

[9] As an alternative interpretation of the intermediate goods dummy, this variable may capture whether the export destination is a manufacturing center or a sales center. It is more likely that the importer is a manufacturing center for intermediate goods transactions, while the importer may be a sales center in the case of final goods transactions.

[10] The impact of the import side variable on export performance has been examined in previous research. For example, using Belgian firm-product-level data, Amiti et al. (2014) showed that more import-intensive exporters have significantly lower exchange rate pass-through into their export prices, as they face offsetting exchange rate effects on their marginal costs. In the context of trade facilitation, Hayakawa et al. (2019a) documents that import processing time affects export performance using the Thai customs data.

3.2. Baseline Results

We examine how invoice currency choice in intra-firm trade differs from that in arm's-length trade. Table 4 presents our baseline results. $Intra1_{i,k,HS9,t}$ to $Intra4_{i,k,HS9,t}$ are constructed based on intra-firm 1 to intra-firm 4, respectively. All estimations are conducted using the logit model. The table presents the marginal effect for all explanatory variables. The marginal effect is evaluated using the mean value of all explanatory variables. We do not employ any fixed effects (FEs) in columns (I)–(IV), and firm, HS six-digit, and year FEs are included in columns (V)–(VIII). Including these FEs does not affect the signs of the coefficients and their significance in most cases.

=== Table 4 ===

Examining column (I), we find that $Intra1_{i,k,HS9,t}$ has a positive impact, indicating that the euro is more likely to be chosen in intra-firm trade. This implies that Japanese automobile firms tend to use the euro more in intra-firm exports to France, with the parent firm in Japan assuming all exchange rate risks arising from LCP. In arm's-length exports to France, Japanese firms prefer invoicing in yen, passing on the exchange rate risk to French importers. It is also found that $Intermediate_{HS6}$ has a negative impact, indicating that the euro is less likely to be used in exports of intermediate goods.[11] Regarding the share of the euro in imports, $IIS_{i,t}$ positively affects the likelihood of using the euro in exports; thus, Japanese automobile firms tend to choose the same invoice currency for both exports and imports to offset the exchange rate risk. Exchange rate volatility, Vol_t, has a negative impact on euro-invoiced exports from Japan to France, which is consistent with the theoretical prediction in Devereux et al. (2004) that Japanese automobile exporters prefer invoicing in yen when the yen is more volatile against the euro. $FirmMS_{i,HS6,t}$ has a positive impact, indicating that firms with a larger market share in the destination market tend to use the euro, implying that Japanese automobile exporters may invoice exports in the euro to increase market share in France. We examine the possibility that market share has a nonlinear impact in the robustness checks below (Section 4), as proposed by Devereux et al. (2017). The results remain unchanged when we employ alternative definitions of the intra-firm trade dummy, as shown in columns (II)–(IV).

The magnitude of the impact of all these explanatory variables is reduced by the inclusion of FEs. We examine the magnitude of the impact of the intra-firm trade dummy in the case with the FEs provided that pseudo R-squares are significantly higher in this case than in the case without the FEs. Exchange rate volatility (Vol_t) is dropped in columns (V)–(VIII) as it has a perfect correlation with the year FE. The marginal effect of $Intra1_{i,k,HS6,t}$ is 0.098 in column (V), indicating that the probability of choosing the euro is 9.8% higher in intra-firm trade than in arm's-length trade. This magnitude does not change much across alternative definitions of intra-firm trade, as shown in columns (VI)–(VIII).

4. Robustness Check

We conduct three robustness tests in this section, including (a) the nonlinear impact of firm market share and the impact of product market share, (b) alternative definitions of the invoice currency share of imports, and (c) the impact of firm productivity and R&D investment. The results of these robustness checks are presented in

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[11] It may be assumed that most trade of intermediate goods is conducted between group companies, which indicates that the intermediate goods dummy may have a positive correlation with the intra-firm trade dummy. Indeed, approximately 90% of intra-firm transactions in our dataset represent intermediate goods trade, but the results change negligibly when we exclude $Intermediate_{HS6}$ from our estimations.

Table 5, with columns (I)–(III) for presenting the results of analysis (a), columns (IV) and (V) for analysis (b), and (VI) and (VII) for analysis (c). The significant positive impact of the intra-firm trade dummy persists in all these robustness checks, while the magnitude of the marginal effect changes somewhat, validating our baseline findings.

<div align="center">===   Table 5   ===</div>

4.1. Market Share Variables

Devereux et al. (2017) asserted that firms' market share has a nonlinear impact on the choice of invoice currency. Referencing this assumption, we examine the nonlinear impact of $FirmMS_{i,HS6,t}$ by introducing its squared term $sq(FirmMS_{i,HS6,t})$. The result is shown in column (I) of Table 5, and the impact for the squared term is insignificant, while the impact of firms' market share remains significantly positive. Thus, we do not find a nonlinear impact of $FirmMS_{i,HS6,t}$ as demonstrated by Devereux et al. (2017).

We also investigate the impact of (the natural log of) of Japanese exporters' market share in total exports from the world to France for each HS6 product category ($ProductMS_{HS6,t}$), which is calculated based on the export value and the total export from the rest of the world to France obtained from the UN Comtrade database. We consider this variable to modestly capture the competitiveness of Japanese products in the French market. We use product and firm market share separately as we use the same data (i.e., product-level total exports to France) for the denominator of both measures, leading to a systematic positive correlation between the measures. Column (II) of Table 5 shows that product market share has a significant negative impact, indicating that the yen is more likely to be chosen when the exported product has competitiveness in the French market, which is consistent with Ito et al.'s (2012) findings regarding the invoicing decisions of Japanese exporters in automobile, electrical machinery, and general machinery industries. This result suggests that Japanese firms that export highly differentiated products tend to use the yen in export invoicing. Regarding nonlinearity, the squared term of this variable $sq(ProductMS_{HS6,t})$, has a significant negative impact, as shown in column (III). This indicates that the effect of product-level market competitiveness increases with products' market share, where a higher market share makes it easier for exporters to implement home currency invoicing (PCP) to avoid exchange rate risk.

4.2. The Share of the Invoice Currency in Imports

Firms may offset payments for imports and receipts from exports denominated in a foreign currency to minimize exposure to exchange rate fluctuations, as noted by Chung (2016). To examine this offsetting behavior, we employed $IIS_{i,t}$ in the baseline analysis, which is the share of euro invoicing in imports calculated based on the number of transactions. In this subsection, we use two alternative measures of import invoice share to assess robustness. First, we employ the euro invoicing share of imports, which is calculated based on the import value ($IIS\_value_{i,t}$). The invoice currency share used in high-value transactions is reflected more significantly using this definition compared with the baseline measure. The result is presented in column (IV) of Table 5. The impact of this measure is significantly positive, similar to the baseline results in column (V) of Table 4. Compared with the baseline findings, the coefficient is somewhat lower (0.034 > 0.022), indicating that the transaction-based import invoice share is more closely related to the choice of invoice currency in export transactions than the value-based import invoice share. The second alternative measure $IIS\_int_{i,t}$ is defined by the proportion of euro-based transactions of intermediate goods in firms' total imports of intermediate goods, based on the number of transactions following the baseline measure. We examine this measure considering that Japanese automakers may use imported intermediate goods to produce final or intermediate goods that are then exported abroad. Therefore, the link between this measure and the choice of invoice currency for exports may be more significant

compared to our baseline measure. The result is shown in (V) of Table 5, and we find a significantly positive impact of this measure. The magnitude is almost comparable to the baseline measure, although it is slightly larger for this alternative measure.

4.3.   Firm Productivity and R&D Investment

Numerous studies have argued that firm characteristics are important elements affecting invoice currency choice. For example, using a Belgian firm-level dataset, Amiti et al. (2022) determined that the choice of invoice currency is "an active firm-level decision" and that firms' size, exposure to imported inputs, and competitors' choice have significant impacts. We consider firm characteristics of labor productivity ($LaborProd_{i,t}$) and R&D investment ($R\&D/Sales_{i,t}$). The former variable is defined as the natural log of total sales divided by the number of employees, and the latter variable is defined as the natural log of R&D expenditure divided by total sales. We introduce these two variables separately because total sales are used to define both variables, and there is a systematic negative correlation between these two variables. Despite time-series variation, both variables are relatively stable during our sample period and have a notable high correlation with firm FE. In addition, the number of samples (especially the number of exporters) significantly decreases when we introduce detailed FEs. To avoid this issue, we define quartile dummy variables that take a value of one for each quartile of firm sales and zero otherwise and employ these dummies instead of firm FE. We also use the HS two-digit FE for product FE instead of the HS six-digit FE.

Referencing previous research, we may expect either sign of productivity.[12] Based on the model of endogenous price markup, higher productivity leads to higher price markup through improvement in product quality (e.g., Antoniades, 2015). In the flexible price equilibrium, the elasticity of the trade price becomes higher with respect to changes in production cost caused from exchange rate fluctuations when the price markup is higher. Considering the case in which a profit maximizing exporter chooses invoice currency, which replicates the flexible price allocation in the presence of price stickiness referencing Gopinath and Itskhoki (2010), productive exporters may prefer the foreign currency, implying a positive coefficient for our productivity measure. In contrast, if productivity captures the firm-level competitiveness in the destination market, productive exporters may use their own currency for trade invoicing, as Ito et al. (2013, 2018) demonstrated with a product-level analysis. Column (VI) of Table 5 reveals that the impact of $LaborProd_{i,t}$ is significantly negative, supporting the latter scenario. Furthermore, $R\&D/Sales_{i,t}$ is also interpreted as a source of firms' non-price export competitiveness. Column (VII) shows that this variable has a significantly negative impact.

5.   Concluding Remarks

Recent empirical research in international economics and finance has emphasized GVCs in which active intra-firm trade transactions between group companies are observed; however, rigorous empirical analysis regarding the choice of invoice currency in intra-firm trade is limited. The contributions of this study are two-fold. First, we rigorously examine which invoice currency is chosen and the factors related to the determination of invoice currency in intra-firm trade. Second, this study uses the highly detailed transaction-level data obtained from Japan Customs, which have not previously been accessed for empirical research. Thus, our study presents the first empirical research regarding the determinants of invoice currency in intra-firm trade using the highly disaggregated Japan Customs transaction-level data.

Our empirical examination demonstrates that the euro is more likely to be chosen for intra-firm exports

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[12] To the best of our knowledge, no studies have directly examined the impact of productivity on the choice of invoice currency, while several studies have investigated the relationship between exchange rate pass-through and productivity (e.g., Berman et al., 2012).

from Japan to France than for arm's-length exports, implying that Japanese automobile firms tend to use the euro more so that parent firms in Japan can assume the exchange rate risks arising from euro-invoiced exports. In arm's-length exports to France, Japanese firms prefer invoicing in yen, passing the exchange rate risk to French importers. We also find that other conventional firm- and product-level factors have similar impacts on the choice of invoice currency in our dataset compared with existing studies. As another aspect of this study's novelty, we determine that labor productivity and R&D investment, which can be considered sources of non-price export competitiveness, have a negative impact on the likelihood of LCP. The impact of these firm characteristics on the choice of invoice currency has rarely been investigated in a direct manner.

Our findings offer important insights into multinational companies' exchange rate risk management, showing that Japanese parent firms may choose LCP to centrally manage the group-wide exchange rate risk arising from intra-firm trade. Therefore, as a natural consequence, firms increase LCP-based transactions as intra-firm trade expands with the widening and deepening of GVCs, making exchange rate risk management a more significant concern for Japanese parent firms. If firms are eager to reduce the exchange rate risk by using the yen, one possible approach is to improve the non-price competitiveness of export products against non-group importers. By doing so, they can offer PCP to importers to reduce the exchange rate risk, at least in arm's-length trade. Even when exported from Japanese parent firms to overseas subsidiaries, strongly competitive products enable overseas subsidiaries to have stronger negotiation power with local buyers, which may result in better group-wide exchange risk management. According to our empirical findings, improving firm productivity and expanding R&D investment are also effective.

Another interesting question is which currency is chosen in intra-firm trade between Japan and Asian countries, since USD invoicing has been observed more strongly in Asian regional trade (Ito et al., 2018). This issue is also worth investigating in the context of DCP. This research question is left for our future research.

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Table 1. Definitions of Intra-Firm Export

Definition	Scope of Intra-Firm Importers	Intra-Firm Ratio [2014–2020] [Transaction-based]
Intra-firm 1	Sub-1 and Sub-2 firms	73.4%
Intra-firm 2	Sub-1, Sub-2, and Sub-3 firms	81.0%
Intra-firm 3	Sub-1, Sub-2, Sub-Sub 1, and Sub-Sub 2 firms	73.7%
Intra-firm 4	Sub-1, Sub-2, Sub-3, Sub-Sub 1, and Sub-Sub 2 firms	81.2%

Source: Authors' calculation

Table 2. Distribution of Invoice Currency

All

Number of transactions				Share		
	Yen	Euro			Yen	Euro
2014	5,851	11,095		2014	0.345	0.655
2015	6,169	10,303		2015	0.375	0.625
2016	7,749	10,916		2016	0.415	0.585
2017	8,172	9,601		2017	0.460	0.540
2018	6,269	10,115		2018	0.383	0.617
2019	5,926	8,870		2019	0.401	0.599
2020	8,309	9,297		2020	0.472	0.528

By trade type

Intra1

Number of transactions | | | | | Share

	Intra-firm trade		Arm's-length trade			Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro		Yen	Euro	Yen	Euro
2014	2,354	10,730	3,497	365	2014	0.180	0.820	0.905	0.095
2015	2,029	9,956	4,140	347	2015	0.169	0.831	0.923	0.077
2016	3,173	10,521	4,576	395	2016	0.232	0.768	0.921	0.079
2017	2,351	9,015	5,821	586	2017	0.207	0.793	0.909	0.091
2018	2,362	9,767	3,907	348	2018	0.195	0.805	0.918	0.082
2019	2,883	8,608	3,043	262	2019	0.251	0.749	0.921	0.079
2020	4,425	8,958	3,884	339	2020	0.331	0.669	0.920	0.080

Intra2

Number of transactions | | | | | Share

	Intra-firm trade		Arm's-length trade			Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro		Yen	Euro	Yen	Euro
2014	2,558	10,731	3,293	364	2014	0.192	0.808	0.900	0.100
2015	2,549	9,964	3,620	339	2015	0.204	0.796	0.914	0.086
2016	3,902	10,522	3,847	394	2016	0.271	0.729	0.907	0.093
2017	4,202	9,016	3,970	585	2017	0.318	0.682	0.872	0.128
2018	3,762	9,769	2,507	346	2018	0.278	0.722	0.879	0.121
2019	4,495	8,617	1,431	253	2019	0.343	0.657	0.850	0.150
2020	7,011	9,015	1,298	282	2020	0.437	0.563	0.822	0.178

Intra3

Number of transactions | | | | | Share

	Intra-firm trade		Arm's-length trade			Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro		Yen	Euro	Yen	Euro
2014	2,401	10,730	3,450	365	2014	0.183	0.817	0.904	0.096
2015	2,095	9,956	4,074	347	2015	0.174	0.826	0.922	0.078
2016	3,204	10,521	4,545	395	2016	0.233	0.767	0.920	0.080
2017	2,383	9,015	5,789	586	2017	0.209	0.791	0.908	0.092
2018	2,394	9,774	3,875	341	2018	0.197	0.803	0.919	0.081
2019	2,907	8,611	3,019	259	2019	0.252	0.748	0.921	0.079
2020	4,436	8,968	3,873	329	2020	0.331	0.669	0.922	0.078

Intra4

Number of transactions | | | | | Share

	Intra-firm trade		Arm's-length trade			Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro		Yen	Euro	Yen	Euro
2014	2,605	10,731	3,246	364	2014	0.195	0.805	0.899	0.101
2015	2,615	9,964	3,554	339	2015	0.208	0.792	0.913	0.087
2016	3,933	10,522	3,816	394	2016	0.272	0.728	0.906	0.094
2017	4,234	9,016	3,938	585	2017	0.320	0.680	0.871	0.129
2018	3,794	9,776	2,475	339	2018	0.280	0.720	0.880	0.120
2019	4,519	8,620	1,407	250	2019	0.344	0.656	0.849	0.151
2020	7,022	9,025	1,287	272	2020	0.438	0.562	0.826	0.174

Source: Authors' calculation

Notes: Numbers and shares are calculated focusing on transactions invoiced in yen or euro.

Table 3. Descriptive Statistics

	All			Intra-firm trade			Arm's-length trade		
	Obs	Mean	S.D.	Obs	Mean	S.D.	Obs	Mean	S.D.
y (euro dummy)	114,364	0.614	0.487	87,133	0.775	0.417	27,231	0.097	0.296
Intra1	114,364	0.762	0.426	87,133	1.000	0.000	27,231	0.000	0.000
Intra2	114,364	0.840	0.366	87,133	1.000	0.000	27,231	0.330	0.470
Intra3	114,364	0.764	0.425	87,133	1.000	0.000	27,231	0.010	0.098
Intra4	114,364	0.843	0.364	87,133	1.000	0.000	27,231	0.339	0.474
Intermediate	114,364	0.909	0.288	87,133	0.922	0.268	27,231	0.865	0.341
IIS	114,336	-1.741	0.496	87,105	-1.620	0.464	27,231	-2.127	0.385
IIS_value	114,336	-2.009	0.816	87,105	-1.961	0.831	27,231	-2.160	0.745
IIS_int	114,309	-1.851	0.565	87,078	-1.736	0.557	27,231	-2.216	0.419
FirmMS	114,364	-6.456	2.107	87,133	-6.183	2.013	27,231	-7.330	2.161
sq(FirmMS)	114,364	46.081	29.715	87,133	42.284	27.167	27,231	58.229	33.955
ProductMS	114,364	-3.617	1.445	87,133	-3.578	1.444	27,231	-3.741	1.441
sq(ProductMS)	114,364	15.169	11.141	87,133	14.887	10.934	27,231	16.074	11.735
ERVol	114,364	1.260	0.301	87,133	1.250	0.296	27,231	1.291	0.313
LaborProd	114,364	4.157	0.362	87,133	4.148	0.374	27,231	4.187	0.311
R&D/Sales	114,364	-3.164	0.243	87,133	-3.170	0.205	27,231	-3.140	0.348

Source: Authors' calculation

Table 4. Baseline Results

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Intra1	0.344 **				0.098 **			
	(0.004)				(0.002)			
Intra2		0.288 **				0.090 **		
		(0.006)				(0.002)		
Intra3			0.344 **				0.099 **	
			(0.004)				(0.002)	
Intra4				0.288 **				0.091 **
				(0.006)				(0.002)
Intermediate	-0.296 **	-0.357 **	-0.297 **	-0.358 **	-0.124 **	-0.136 **	-0.124 **	-0.136 **
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)	(0.010)
IIS	0.275 **	0.393 **	0.277 **	0.394 **	0.034 **	0.034 **	0.033 **	0.033 **
	(0.003)	(0.003)	(0.003)	(0.003)	(0.007)	(0.007)	(0.006)	(0.007)
FirmMS	0.018 **	0.017 **	0.018 **	0.018 **	0.009 **	0.008 **	0.009 **	0.008 **
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ERVol	-0.009 **	-0.017 **	-0.008 **	-0.017 **				
	(0.003)	(0.003)	(0.003)	(0.003)				
Firm FE	NO	NO	NO	NO	YES	YES	YES	YES
Year FE	NO	NO	NO	NO	YES	YES	YES	YES
Product FE	NO	NO	NO	NO	YES	YES	YES	YES
Obs.	114,335	114,335	114,335	114,335	108,131	108,131	108,131	108,131
Pseudo R2	0.457	0.385	0.456	0.384	0.872	0.854	0.873	0.854

Notes: The dependent variable is a dummy which takes a value of one if the transaction is invoiced in the euro and zero otherwise. The logit model and robust standard errors are used in all estimations. ** indicates a 1% level of significance. Columns (I)–(IV) exclude fixed effects (FEs), while we employ the firm, year, and HS six-digit product FEs in the remaining columns.

Table 5. Robustness Check

|	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Intra1	0.098 **	0.099 **	0.099 **	0.099 **	0.099 **	0.259 **	0.264 **
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.006)	(0.006)
Intermediate	-0.124 **	-0.167 **	-0.174 **	-0.125 **	-0.126 **	-0.103 **	-0.183 **
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.002)	(0.003)
IIS	0.034 **	0.028 **	0.025 **			0.007 *	0.090 **
	(0.007)	(0.007)	(0.007)			(0.003)	(0.004)
IIS_value				0.022 **			
				(0.002)			
IIS_intermediate_num					0.035 **		
					(0.005)		
FirmMS	0.009 **			0.009 **	0.009 **	0.008 **	-0.001
	(0.002)			(0.001)	(0.001)	(0.000)	(0.001)
sq(FirmMS)	0.000						
	(0.000)						
ProductMS		-0.013 **	-0.031 **				
		(0.001)	(0.003)				
sq(ProductMS)			-0.002 **				
			(0.000)				
LaborProd						-0.605 **	
						(0.007)	
R&D/Sales							-0.112 **
							(0.006)
Firm FE	YES	YES	YES	YES	YES	Quartile	Quartile
Year FE	YES	YES	YES	YES	YES	YES	YES
Product FE	YES	YES	YES	YES	YES	HS2	HS2
Obs.	108,131	108,131	108,131	108,131	108,131	110,060	110,060
Pseudo R2	0.872	0.869	0.869	0.872	0.872	0.752	0.671

Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in the euro and zero otherwise. The logit model and robust standard errors are used in all estimations. ** indicates a 1% level of significance. Firm, year, and HS six-digit product fixed effects (FEs) are introduced in columns (I)–(V). In columns (VI) and (VII), we use dummy variables that take a value of one for each quartile of firm sales and zero otherwise (i.e., quartile FEs) in addition to year and HS two-digit product FEs. The squared term coefficient for firm MS in column (I) is −0.00000856.

Figure 1. Invoice Currency Choice in Japanese Trade with the World and EU Countries
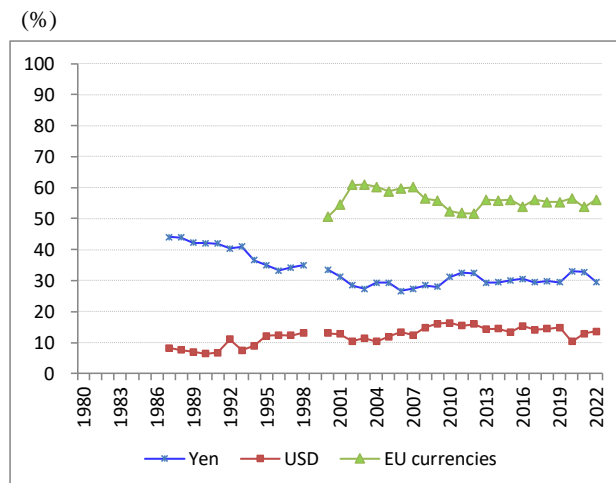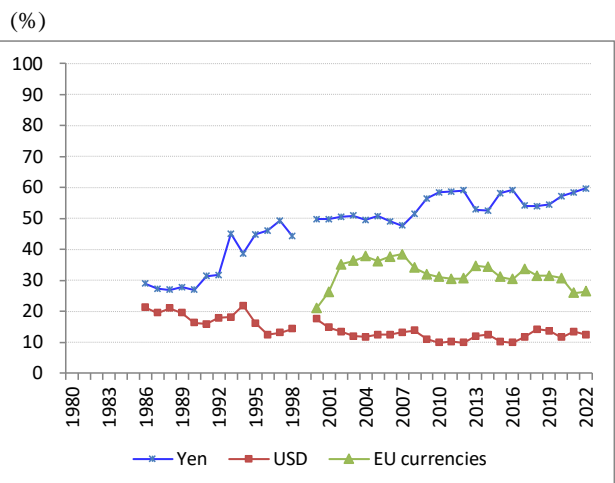
(a) Japanese Exports to the World
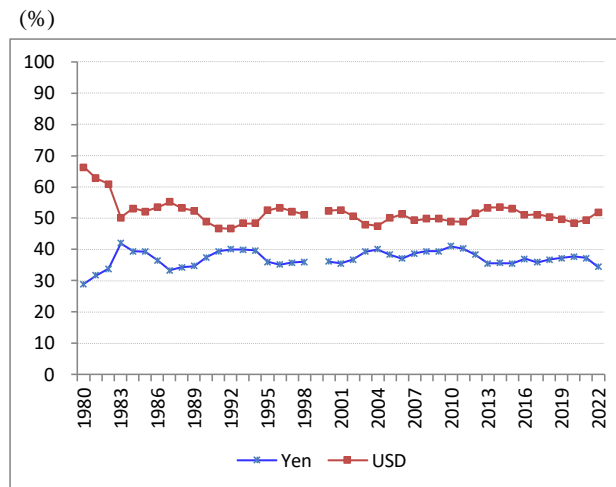
(b) Japanese Imports from the World
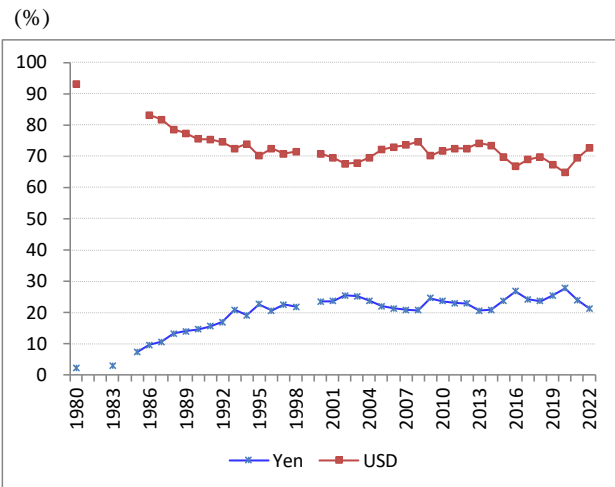
(c) Japanese Exports to EU Countries

(d) Japanese Imports from EU Countries

Sources: Bank of Japan, *Yushutsu Shinyojo Tokei* (*Export Letter of Credit Statistics*); Ministry of International Trade and Industry (MITI), *Yushutsu Kakunin Tokei* (*Export Confirmation Statistics*); MITI, *Yushutsu Hokokusho Tukadate Doko* (*Export Currency Invoicing Report*); MITI, *Yushutsu Kessai Tsukadate Doko Chosa* (*Export Settlement Currency Invoicing*); MITI, *Yunyu Shonin Todokede Hokokusho* (*Import Approval Notification Report*); MITI, *Hokokushorei ni Motozuku Hokoku* (*Report Based on Report Guidance*); MITI, *Yunyu Hokoku Tokei* (*Import Report Statistics*); MITI, *Yunyu Hokokusho Tukadate Doko* (*Import Currency Invoicing Report*); MITI, *Yunyu Kessai Tsukadate Doko Chosa* (*Import Settlement Currency Invoicing*); website of Japan Customs.

Notes: 1999 data are not available. September data are used for 1992–1997, March data are used for 1998, and data for the second half of the year are used for 2000–2022. 1986 data are fiscal year data for Japanese imports.

Figure 2. Japanese Automakers' Sales in 10 Major Countries, Including Japan
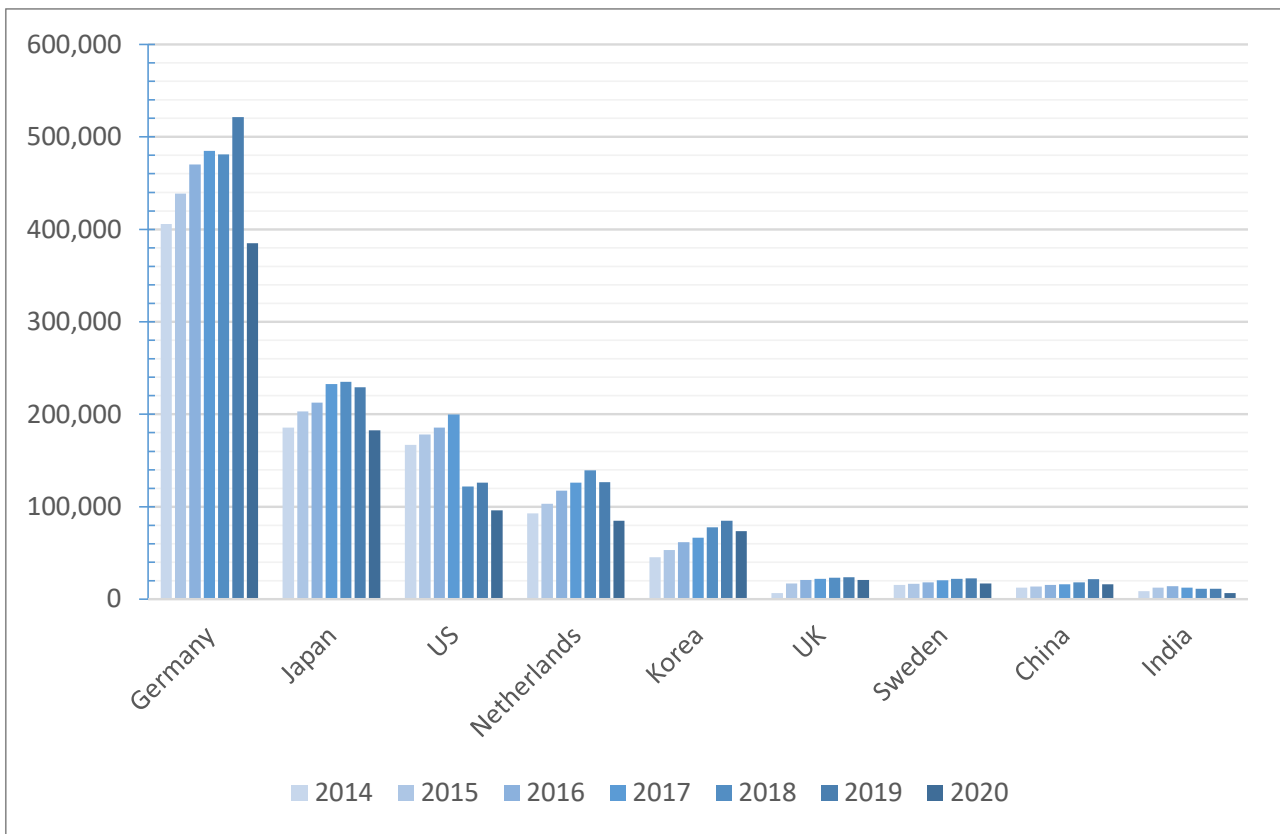
(Number of Unit)
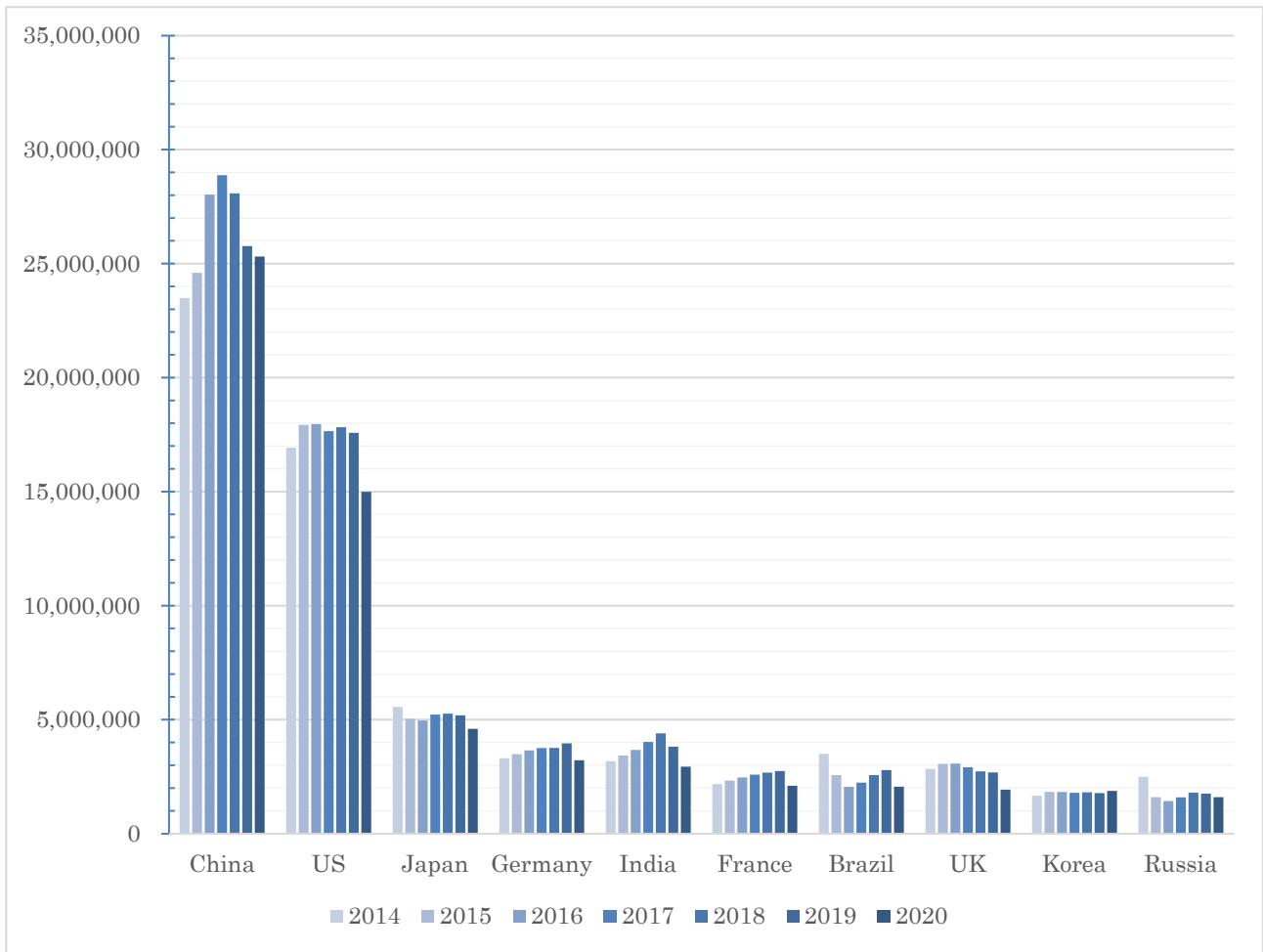
Source: MarkLines Information Platform

Notes: Automobile sales in 48 major countries, including Japan, by manufacturers' country.

Figure 3. Automobile Sales by Foreign Automakers in France

(Number of Unit)

Source: MarkLines Information Platform
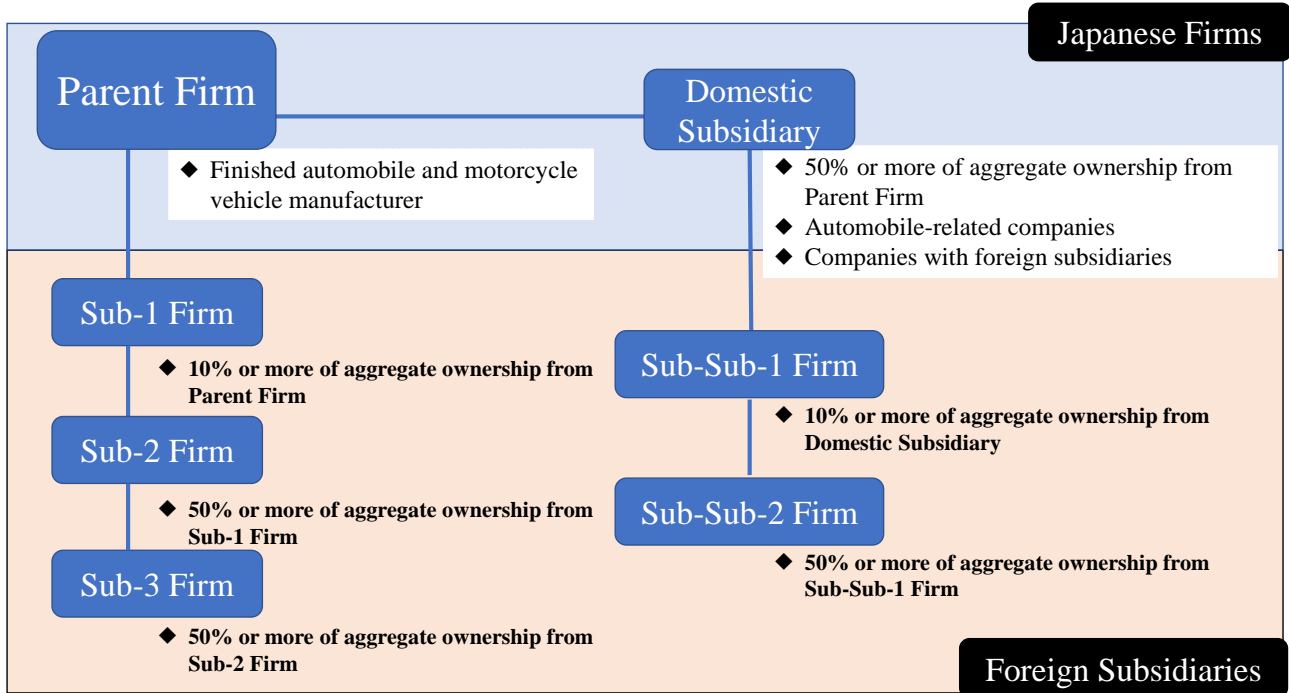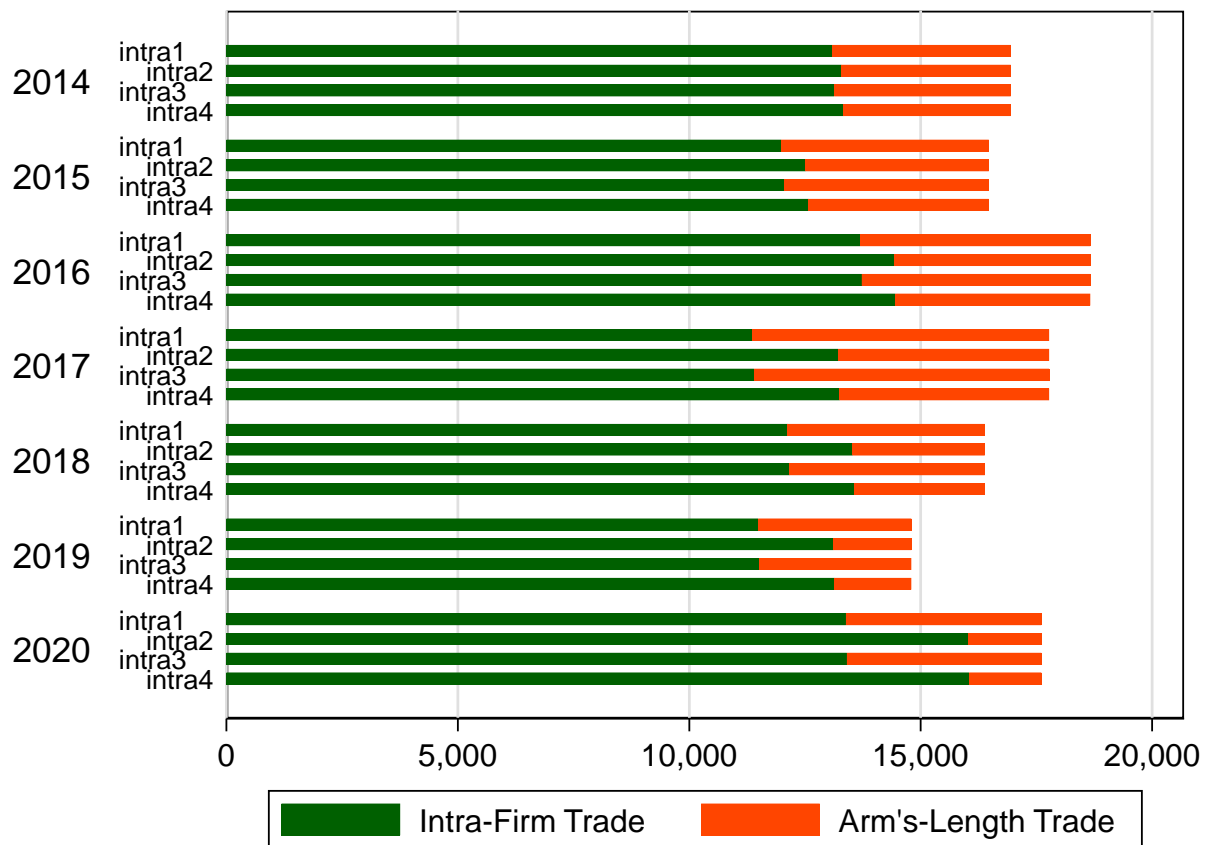
Figure 4. Definitions of Foreign Subsidiaries

Figure 5. The Share of Intra-firm and Arm's-length Exports in the Total Number of Export Transactions

Source: Authors' calculation