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Heterogeneous Impact of Import Competition on Firm Organization: Evidence from Japanese firm level data (Revised)

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Heterogeneous impact of import competition on firm organization: Evidence from Japanese firm-level data[1]

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Abstract

This study empirically investigates the effect of import competition on within-firm employment reorganization using Japanese firm-level dataset covering the period of 1997–2014. Moreover, this study examines whether the import competition against low-income countries leads to a shift from a manufacturing activity to non-manufacturing activity, such as headquarters' services, wholesale, retail, or R&D. Furthermore, this study explored the heterogeneity of the impacts of import competition according to firm size. Findings reveal that competition from Chinese imports induces manufacturing firms to increase the share of service workers, particularly workers that engage in wholesale, retail, and other service activities.

Keyword: Import competition, Firm reorganization, Servitization
JEL classification: F61, L25, D22

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1. INTRODUCTION

Employment opportunities in the manufacturing sector have been declining in many high-income countries. For example, according to the Organization for Economic Co-operation and Development's Employment Outlook, as of 2015, the shares of manufacturing employment in the U.S., U.K., and Germany were 10.3%, 9.6%, and 19.3%, respectively. Japan is no exception. According to Japan's System of National Accounts (Cabinet Office of the Japanese government), the share of manufacturing employment in Japan declined from 23.1% in 1980 to 15.3% in 2015. A factor affecting this decline in manufacturing employment is a competition created by imports from emerging market countries (e.g., China). For example, Autor et al. (2013) demonstrate that 55% of the decline in U.S. manufacturing employment from 2000 to 2007 can be explained by the increase in imports from China. The increase in Chinese imports may have also caused a decline in U.S. wages and contributed to higher unemployment, increasing transfer payments through various federal and state programs.

Many studies have investigated the link between deindustrialization and import competition by focusing on the industry-level at the shift in employment from the manufacturing sector to the service sector. Meanwhile, this study sheds light on changes from manufacturing activities to service-related activities within a firm. Recently, some manufacturing firms have relocated a part of their manufacturing process to low-income countries, concentrating on R&D and product design in the home country. Other firms have shifted activities from manufacturing to services by providing user-friendly maintenance, technical support, and consulting services by monitoring their products via the internet or leveraging a global positioning system (GPS). For example, Komatsu Ltd., a construction instrument manufacturer, monitors their products through a system called KOMTRAX using GPS to provide high-quality maintenance services. Meanwhile, Rolls-Royce Holdings provide a similar service for their aircraft engine, known as "power-by-the-hour." This phenomenon is often called the servitization of manufacturing firms. The study primarily aims to explore the

factors influencing the servitization of manufacturing firms, mainly focusing on the competitive pressure generated by the surge of manufactured imports from China.

This study also examines the heterogeneity of the impact of imports on the servitization of firms. Servitization involves a non-trivial fixed cost; thus, it is challenging for small and medium enterprises to invest in or outsource production activities abroad. Providing high-quality after-sales service requires additional investment in service provision. Consequently, not all firms are capable of shifting from manufacturing to a service orientation. Besides, this paper examines the effect of offshoring on the firms' servitization. Offshoring firms may relocate part of the production process to low-income countries and concentrate on knowledge-intensive activity at home. We explore the differences in the impact on the servitization, comparing the import competition with offshoring.

Moreover, this study employs a Japanese firm-level panel dataset, covering the period of 1997–2014. Our dataset contains information about the composition of the workforce by type of activities (i.e., administrative services in headquarters, manufacturing, wholesale, and retail activities, R&D, and other services), allowing for the quantification of the servitization of firms over time. To identify the shock of competition from imports, we matched the six-digit-level plant-product data to construct a shock variable by aggregating product-level import penetration ratios with the share weight of firms' sales.

The major findings of this study can be summarized as follows. First, competition from Chinese imports induces manufacturing firms to increase the share of non-manufacturing workers, particularly workers who engage in wholesale, retail, or other services. Second, the impact of imports on the servitization of Japanese firms regarding firm size is heterogeneous; that is, larger firms have actively shifted away from manufacturing toward services in response to competition from imports. Third, offshoring and import competition exert varying levels of impact on the servitization of manufacturing firms. Offshoring firms tend to reduce the number of workers at both manufacturing and headquarter service activities, whereas firms

encountering fierce import competition shift their activities from manufacturing to service.

This study relies on two groups of earlier studies. The first group addresses the impact of competitive pressure created by imports from emerging market countries such as China on employment. For example, a series of studies by several authors (Autor et al., 2013; Autor et al., 2014; Acemoglu et al., 2016; Autor et al., 2020) revealed a significant impact on labor markets in the U.S. resulting from the surge of imports from China. Meanwhile, Dauth et al. (2014) investigated the effect of competition from imports on Germany's local labor market, comparing imports from Eastern Europe with those from China. They demonstrated that Eastern European imports exert a more prominent negative effect than Chinese imports, as an increase in capital goods exported to China mitigated the negative impact of Chinese imports.[1]

Although most previous studies have used industry-level data, firm or plant-level evidence is somewhat limited. An exception is Iacovone et al. (2013), who explored the determinants of plant closures and product churning using plant-product-level data from Mexico. They found that Chinese competition has played a significant role in the creative destruction in the Mexican manufacturing sector. In another study, Branstetter et al. (2019) used a Portuguese firm-level dataset to examine the impact of China's import shock on employment at the firm-level. Although the effect of the direct competition in Portugal is smaller and often insignificant, the indirect impact of Chinese competition through European export markets was shown to reduce employment in Portuguese export firms substantially. Our study goes a step further, investigating the impact of Chinese imports on within-firm employment reallocation, focusing on the share of non-manufacturing workers.

The second group of studies that form the basis for this research examines the

[1] Other examples include Malgouyers (2016) for France, Balsvik et al. (2015) for Norway, Dooso et al. (2014) for Spain, and Taniguchi (2018) for Japan. The first three papers from European countries report the similar pattern of impact from Chinese imports on local employment with that by Autor et al. (2013). Meanwhile, Taniguchi (2018) found that the effect of imports from China is not negative; in fact, it has a positive effect, particularly in terms of the import of intermediate goods.

characteristics of manufacturing firms that shift their primary activities from manufacturing to services. Using Danish employer–employee matched data, Bernard et al. (2017) demonstrated that the decline in manufacturing can be attributed to firms' switch from manufacturing to service and firms exiting and an overall contraction in employment. The number of workers of switching-out firms accounts for 8.6% of the total Danish manufacturing employment in 2007. Crozet and Milet (2017) used a French firm-level panel dataset to examine the effect of the servitization of manufacturing firms on performance. They focused on firms selling both products and services and found that servitization increases profitability, sales, and employment. Meanwhile, Head and Rise (2002) and Chun et al. (2018) examined the impact of foreign direct investment (FDI) on the share of non-manufacturing workers at the firm level in Japan and Korea, respectively.[2] They demonstrated that multinational enterprises—particularly those that invest in emerging Asian countries—tend to increase the share of service workers.[3] Furthermore, Chun et al. (2018) demonstrated that FDI significantly increases the share of R&D workers among service workers.

The remainder of this paper is organized into four sections. Section 2 presents the analytical framework, along with the data used and its overview. It also discusses the empirical framework. Section 3 reports the estimation results, and Section 4 concludes.

2. ANALYTICAL FRAMEWORK AND DATA OVERVIEW

2.1 Conceptual framework

How does import competition affect the servitization of manufacturing firms? Intensified import competition reduces the profitability of the manufacturing activities of firms in home

[2] Head and Rise (2002) used the data of 1,070 Japanese listed firms, examining the share of selling, general, and administrative pay in the total wage bill as a measure of the share of skilled or non-manufacturing workers. Chun et al. (2018) used firm-plant matched data in a Korean government survey. They distinguished the number employed across different types of services.

[3] Hayakawa et al. (2013) used the Japanese firm-level dataset to examine the firm-level impact of FDI on employment, comparing the impact on total and manufacturing employment and implicitly exploring the impact on servitization. Their results are broadly consistent with that of Chun et al. (2018).

countries, and some firms may reduce the number of manufacturing workers employed. The service of firms' headquarters is a fixed input to manufacturing activities; thus, the number of employed individuals at the headquarters may not be reduced in proportion to those of manufacturing activities. Consequently, firms' manufacturing worker ratio may decline.

Some firms expand the business into service-oriented areas to mitigate import competition and differentiate products' unique advantages compared to imported Chinese products.[4] Neely et al. (2011) documented that most servitized manufacturing firms offer system and solutions' maintenance, after-sales service, distribution, and retailing, as with the previously introduced examples of KOMTRAX by Komatsu and Rolls-Royce's power-by-the-hour. Such firms may increase sales and consulting staff in distribution activities or sales offices. Meanwhile, firms may increase R&D expenditure to elude growing and fierce import competition from low-income countries. Notably, recent literature offers mixed evidence on the relationship between import competition and innovation activities. This study also examines this relationship with Japanese firm-level data, investigating the changes in the share of R&D workers at the firm-level.[5]

Increases in offshoring or foreign production resulting from FDI may exert a similar effect, but with a different magnitude, on different activities.[6] As discussed in the literature on the relationship between FDI and export, FDI may not completely displace manufacturing activities in the home country if FDI has a complementary relationship with export (Blonigen, 2001; Head and Rise, 2001; Ito et al., 2020). This is because, although FDI firms may relocate labor-intensive activities to low-income countries, they may increase exports of

[4] Management literature provides anecdotal and empirical evidence that servitization enables firms to differentiate products from competitors' and increase customer loyalty (Baines et al., 2009).
[5] In fact, Bloom et al. (2016) used a European firm-level dataset to demonstrate a positive association between Chinese import competition and firm-level innovation activities. However, a recent study by Campbell and Mau (2021) asserted that the results of Bloom et al. (2016) are not robust when estimating with alternative specifications.
[6] In addition to offshoring or FDI, a foreign outsourcing may have a similar effect on the servitization. Although this effect may partially be captured by an importer status dummy, we cannot explicitly examine its impact due to data limitation. We leave this issue for future research agenda.

skill-intensive parts and components from home to investing countries. In sum, both import competition and FDI may reduce the number of firms' manufacturing employees; however, if the offshore production has a complementary relationship with domestic production, the impact of FDI may be less pronounced than that of import competition.

Regarding the impact of offshoring on the share of workers in the service activities in manufacturing firms, two opposite relationships may exist. First, as Head and Rise (2002) and Chun et al. (2018) argued, offshoring centralizes skill-intensive activities, such as knowledge generation, which increases the number of headquarter or R&D workers in their home countries. Second, according to theoretical and empirical studies on the centralization/decentralization for decision making (Aghion et al., 2014; Morikawa, 2015), increases in the offshore production may reduce the share of headquarter workers. This is because firms with a wide variety of businesses or many business units tend to enhance decentralization due to the limited central monitoring and control abilities.[7] In sum, the impact of offshoring on the share of service workers becomes positive or negative, depending on which mechanism dominates over the others.

2.2 Empirical methodology

This examination of the impact of competition from imports on servitization follows the specification of Bloom et al. (2016) and Branstetter et al. (2019) with the following equation:

$$\Delta y_{ijt} = \beta_0 + \beta_1 Z_{i0} + \beta_2 \Delta IMP_{it} + \beta_3 Offshore_{it} + \mu_{jt} + \varepsilon_{ijt}.$$

The dependent variable Δy_{it} indicates the change in the percentage of workers by type of activity for firm *i* in industry *j* in year *t*. Manufacturing, R&D, headquarters' services, and wholesale, retail, and other services constitute the activities of our focus. Z_{i0} is a vector of

[7] Morikawa (2015) examined the determinants of the size of headquarters using Japanese firm-level data. After controlling for firm characteristics, such as firm size, he revealed that diversified firms or firms with many establishments tend to have smaller headquarters functions.

firm characteristics, such as firm size and import and export status, in the initial year. We use the value in the initial year to mitigate the potential endogeneity between dependent variables and firm characteristic variables. ΔIMP_{it} and $Offshore_{it}$ represent the import competition measure and offshore intensity, respectively. μ_{jt} is the industry-year fixed effect and ε_{ijt} is the error term. We also examine the heterogeneity of the impact of import competition. Specifically, firms are divided into quartiles using the distribution of firm size in an initial period based on the number of employment. Then, we estimate the following model:

$$\Delta y_{ijt} = \beta_0 + \beta_1 Z_{i0} + \beta_2 \sum_m I_{m \in M} * \Delta IMP_{it} + \beta_3 Offshore_{it} + \mu_{jt} + \varepsilon_{ijt},$$

where I_m represents the firm-size quartile dummy variables. Corporate restructuring may occur over several years; hence, one-, three-, and five-year differences are applied.

Three comments are in order. First, following Chun et al. (2018), we defined Δy_{it}, namely, changes in the share of workers as a weighted value:

$$\Delta y_{it} = \frac{L_{it}^S}{L_{it}} \frac{L_{it}}{L_{mt}} - \frac{L_{it-s}^S}{L_{it-s}} \frac{L_{it-s}}{L_{mt-s}},$$

where L_{it}, L_{it}^S, and L_t represent the total number of employees, the number of workers in activity *S,* and the number of workers for the entire manufacturing sector all for firm *i* in year *t*, respectively. This specification is used to capture the economic significance of servitization in the manufacturing sector as a whole. The equation is estimated using weights of the number of employees in *t*-s.

Second, import competition measure, ΔIMP_{it}, is calculated as the change in Chinese import ratio weighted by firm-product-level shipment values:

$$\Delta IMP_{it} = \sum_{ij} w_{ijt-s} \frac{\Delta M_{jt}^{CH}}{X_{jt-s}}$$

where *w* is the share of a firm's product shipment value for firm *i* and product *j* in year *t-s,* M_{jt}^{CH} is the amount imported from China for a product *i* in year t and X_{jt-s} represents the corresponding domestic demand. The sum of domestic production and total imports for product *j* in year *t* is used. ΔIMP_{it} might be affected by a potential demand shock in Japan;

therefore, the identification strategy proposed by Autor et al. (2013) is applied, using the changes in the import ratio from China concerning seven high-income trading partners of China, excluding Japan, as an instrumental variable.[8]

$$\Delta IMP_{it}^{OTH} = \sum_{ij} w_{ijt-s} \frac{\Delta M_{jt}^{OTH}}{X_{jt-s}}$$

The identification strategy behind this specification is that import demand in other high-income countries is correlated with the Chinese supply shock, but import demand shocks are not correlated across high-income countries.

Third, the offshore intensity, $Offshore_{it}$, is defined as the ratio of the intra-firm import to the total cost for firm *i* in year *t*.[9] This variable is also considered endogenous variable; thus, we use the intermediate goods export supply to developed countries (*IGES*) as an instrument, following Hummels et al. (2013). To calculate *IGES*, we first calculate changes in the world export supply to high-income countries excluding Japan at sector-level (ΔWES_{kt}) and aggregated at sector-level using an input coefficient α_{jk} obtained from Japan's input–output table. Then, firm-level *IGES* is calculated by aggregating it with the weight by firm-product-level shipment values.

$$IGES_{it} = \sum_{ij} w_{ijt-s} \sum_{j} \alpha_{jk} \Delta WES_{kt}$$

This variable may correlate with the offshore intensity but is uncorrelated with the within-firm share of workers by activities.

2.3 Data source and construction procedure

This study combines two datasets. The first consists of firm-level data acquired from the Basic Survey of Japanese Business Structure and Activities (BSJBSA) compiled by Japan's Ministry

[8] As high-income countries, we use the same country set established in Autor et al. (2013), namely, Australia, Denmark, Finland, Germany, New Zealand, Spain, and Switzerland.

[9] Instead of the offshore intensity, as a robustness checks, we also use the size of sales by foreign manufacturing subsidiary. For details, see appendix B.

of Economy, Trade, and Industry (METI). This survey began in 1991 and has been conducted annually since 1994, covering mining; manufacturing; wholesale and retail; electricity, gas, and water suppliers; information and communication; and other service-based industries. This study focuses on manufacturing firms at the beginning of the sample period and examine the within-firm shift from manufacturing to service.[10] The BSJBSA provides a statistical overview of Japanese corporations and insights into the diversification and globalization of corporate activities and R&D strategies for Japanese firms. Variables, such as sales, costs, debt, assets, profits, employment, trade, and R&D, are available. The number of employees is categorized according to activities, including headquarters' service, manufacturing, wholesale, retail, R&D, and other activities.[11] As discussed in the introduction, these firm-level data span 1997–2014.

Some strengths of this survey include its coverage and reliability. The survey is mandatory for all firms with more than 50 employees and capital of more than 30 million yen in target industries. One disadvantage in using this survey is that firms with fewer than 50 employees or with a capital of less than 30 million yen are not included. Notably, no information is presented regarding the kinds of products companies export or import. Moreover, no information is available on the destination or source country of exports and imports because BSJBSA data cannot be matched with custom trade data.

The second dataset is the Census of Manufacture (METI), also called COM.[12] This dataset covers all manufacturing establishments located in Japan, providing plant-level information on manufacturers' location, number of employees, the value of its tangible assets, and the value of its shipments, identified per product at a six-digit level identifier. For this study,

[10] In BSJBSA, the industry classification is assigned based on the main activity referring to where the largest revenue come from. It means those service firms that also engages in a small amount of manufacturing activities at the beginning of the sample period are not included. We confirmed that the results do not change even when we include service firms with a small amount of manufacturing activities.
[11] The term "headquarters' service" includes management, strategy, administration, international, information technology, and R&D. Sales departments are included in wholesale and retail activities.
[12] The data for 2011 were collected from the "Economic Census for Business Activities" (Ministry of Internal Affairs and Communications) in place of COM. We complement the data of 2011 with the 2012 Economic Census for Business Activities.

plant-product-level data are aggregated at the firm level from COM and then matched with the BSJBSA. COM and BSJBSA have no official matching table; therefore, the two datasets are matched in reference to the firm name, phone number, zip code, and address.

For the data used to compute the import ratio, Harmonized System (HS) nine-digit-level import data are obtained from Japan's trade statistics (Ministry of Finance). HS nine-digit import data over the period 1997–2014 are reconciled using Ito and Aoyagi's (2019) concordance table. The concorded HS nine-digit import data are then matched with the six-digit COM product code using the concordance table developed by Baek et al. (2021).[13] Data on product-level exports to other high-income countries are obtained from the CEPII BACI database. The input–output tables are provided by the Ministry of Internal Affairs and Communications.

Firm characteristics variables in the initial year include logged number of employees (*Size*), a dummy variable for multi-plant firms (*Mplant*), the firm's age (*Firm age*), the lagged capital-labor ratio (*K-L ratio*), the R&D to sales ratio (*R&D intensity*), and a dummy variable for multi-product firms (*Mproduct*). The export and import status is also controlled at the firm level (*Exporter* and *Importer* dummies). The variable for intra-firm import, which is used for offshore intensity, is the import from the majority owned foreign subsidiaries. Online Appendix Tables A1 and A2 present the basic statistics of these variables and their correlations.

2.4 Data overview

Table 1 presents the shares of manufacturing and service workers. Columns (3)–(7) compare the percentage of manufacturing employees by firm size. Findings reveal that although the percentage of manufacturing workers does not vary much, it decreases as firm size increases. For example, for firms with fewer than 100 employees, the average share was 65.2% in 2014,

[13] The concordance table between COM's six-digit commodity data and HS nine-digit trade data was developed and provided by Baek et al. (2021).

whereas for firms with 3,000 or more employees, the average share was 49.7%. Furthermore, the absolute value of the changes in the share of manufacturing workers is larger for large firms, whereas the shares for smaller firms do not change over the sample period. The percentage decreased by 6.7% for larger firms with 3,000 or more employees. This suggests heterogeneity in the degree of servitization concerning firm size.

The trends in non-manufacturing worker share differ by service activity. As shown in Panel (B) of Table 1, the percentage of non-manufacturing workers is divided according to types of activities: R&D, headquarters' service, wholesale and retail, and other service activities.[14] Activities that increase the percentage of these workers include R&D and other service activities. In contrast, the share of headquarters workers has declined by 2.1%.

== Table 1 ==

The number of offshoring firms and the share of worker by activities according to the offshoring status is presented in Panels (A) and (B) of Table 2, respectively. Panel (A) shows that the number of offshoring firms has increased from 1105 to 1850 between 1997 and 2014. Offshore intensity refers to the mean value of the ratio of intra-firm import to the total cost for firms with non-zero intra-firm imports. It increases from 7.7% to 12% during our sample period. We compare the share of workers by activities between offshoring and non-offshoring firms in Panel (B). Offshoring firms tend to have a smaller share of manufacturing workers and a higher share in headquarters and R&D. However, no systematic differences seem to occur in the changes in the share of workers by activities.

== Table 2 ==

[14] R&D workers in this table include headquarters workers who engage in R&D activities and those who work for independent R&D establishments. Note that the category of headquarter workers in Column (2) and that in Tables 5 and 6 contains employees who engage in R&D activity in the firm's headquarters. As a robustness check, we calculate the share of headquarters workers excluding R&D workers and confirm the results do not change so much.

Table 3 presents the share of workers according to types of activities by industry, revealing that the level and trend of the servitization of Japanese firms have substantial heterogeneity across sectors. The shares of manufacturing workers as of 2014 are high for transport equipment (74.9%), primary metal (73.4%), and pulp and paper (69.8%) firms, whereas coal and petroleum firms had the lowest percentage of manufacturing workers among manufacturing industries (at 43.5%). Regarding changes in the share of an industry's manufacturing workers, the share of manufacturing workers in electric machinery, textile, and coal and petroleum industries decreased by 4.9%, 2.8%, and 2.4%, respectively. Moreover, the percentage of non-manufacturing workers is analyzed based on four different activities. The textile and coal and petroleum industries increased the share of workers in wholesale and retail activities (+2%), whereas the chemical and electrical machinery industries increased the share of workers in other service activities by 3.2% and 4%, respectively.

== Table 3 ==

3. EMPIRICAL RESULTS

3.1 Main results

This section reviews the estimation results. Columns (1)–(3) in Table 4 present the results for changes in manufacturing worker shares. Each column delineates one-, three-, and five-year differences, respectively. The coefficients for Chinese imports are all negative. As the differences are calculated over a longer period, the absolute value of the import coefficient increases, and the coefficient becomes significant when five-year lags are assumed. These results imply that organizational reforms take time to occur. In contrast, the coefficient of the offshoring intensity is not significant. To interpret the coefficients of firm characteristics, we must take caution, even though an initial value of firm characteristics is used to mitigate endogenous bias. Larger firms (*non-trading firms*) reveal a tendency to increase (*decrease*) the

share of manufacturing workers.

Columns (4)–(9) estimate the model using the growth rate in the total number of workers and of manufacturing workers as dependent variables, again calculating one-, three-, and five-year differences. In contrast to the case of the share of manufacturing workers, the coefficients of import competition become positive or negative and insignificant in most cases. However, the coefficient for the growth rate in the number of manufacturing workers is significant considering the 5-year lag. The fact that import competition has no significant impact on the overall number of workers at the firm-level may imply that increases in service workers may offset the negative impact on manufacturing workers. The impact of offshoring becomes negative and significant on the 5-year growth rate of total worker and manufacturing workers. These results may imply that offshore production reduces the number of workers both at manufacturing activities and non-manufacturing activities. Based on these results, the following analysis focuses on the 5-year differences.

== Table 4 ==

Table 5 breaks non-manufacturing activities down into four sub-sections. Two results are noteworthy. First, across the four sub-sections, competition from Chinese imports has a significant positive effect on the percentage of wholesale and retail, and other service workers.[15] Second, although the coefficient for offshoring intensity is negative for the share of headquarter workers, the coefficient for wholesale and retail is positive and significant. The former result is consistent with the theory of centralization/decentralization of decision making and empirical findings from Morikawa (2015); as the cost of central monitoring and control increases along with increases in the offshore production, firms have an incentive to enhance

[15] The types of activities included in the BSJBSA questionnaire vary by year. Among activities outside headquarters' service, only manufacturing and wholesale and retail are available throughout the sample period, preventing the delineation of other service activities.

decentralization and reduce the number of headquarter workers.

== Table 5 ==

Next, to explore the heterogeneous impact of competition from imports on servitization concerning size, firm size quartile dummies are constructed in terms of employment in an initial period and interaction terms with the import ratio are introduced. Results are reported in Table 6. For the manufacturing worker ratio, import competition has a significant impact only for firms in the largest quartile. The same pattern is revealed in the share of wholesale and retail and other workers. These results suggest that servitization caused by globalization is more pronounced for larger firms.

== Table 6 ==

Next, several robustness checks are conducted. First, following Dauth et al. (2014), we included the share of exports from Japan to China as an additional control variable. Table 7 presents the results. The coefficients for the shares of exports to China are significantly positive for the growth rate for the number of manufacturing employees; however, the major results are confirmed as unchanged. Second, to control for increases in the number of temporary workers (*tmp worker ratio*), the share of temporary workers is included as additional independent variables. In Japan, because of deregulation regarding the use of temporary workers in the manufacturing sector in 2004, the number of temporary workers has substantially increased. The number of temporary workers has been available in the BSJBSA data only since 2000; therefore, the estimation results are restricted to the period 2001–2014. As presented in Column (4) of Table 7, we confirmed that the coefficient of the temporary worker ratio is significant, but this impact does not affect existing other results.

== Table 7 ==

4. CONCLUSION

The impact of rising imports from low-income countries, such as China, on manufacturing sectors has attracted the attention of policymakers and academic researchers. Recent studies

(e.g., Autor et al., 2013) have emphasized that imports from China to the U.S. and European countries harm local employment. In contrast to previous studies, this paper empirically investigates the effect of competition from imports on within-firm employment reorganizations, rather than industry-level employment, by using a Japanese firm-level dataset. We found that although the competition from Chinese imports reduces the number of manufacturing workers, it increases the share of service workers, particularly workers engaged in wholesale, retail, and other service activities.

Furthermore, the impact of competition from imports on the servitization of Japanese firms is heterogeneous concerning firm size. Larger firms have actively shifted their activities from manufacturing to services in response to competition from imports. We also found that an offshore production has a different impact on import competition. Offshoring firms tend to reduce the number of workers at both manufacturing and headquarter service activities, whereas firms encountering fierce import competition shift activities to wholesale, retail, and other service activities.

Although this study provides new evidence on the impact of competition from imports, it also offers various avenues for future research. First, a complementary relationship may exist between certain manufacturing and specific service activities. Exploring which type of manufacturing activity is most compatible with the servitization of firms might be an interesting research topic. Second, how the servitization of manufacturing firms affects the geographical distribution of manufacturing facilities and service establishments is another issue worthy of study. For example, are service activities conducted by manufacturing firms operated in a city or close to an existing production site? This issue might be important for policymakers concerned about the hollowing out of local industries.

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Table 1 The share of manufacturing and non-manufacturing workers

Panel (A) The number of employees and the share of manufacturing workers

	(1)	(2)	(3)	(4)	(5)
	Share of manufacturing workers				
	Average	Firm size in terms of # of emp			
		50-99	100-999	1000-2999	3000-
1997	65.8%	67.4%	66.0%	56.2%	56.4%
2002	65.9%	68.4%	65.8%	52.5%	49.9%
2007	66.9%	68.0%	67.4%	58.9%	54.2%
2014	65.3%	67.8%	65.2%	55.2%	49.7%

Panel (B) The share of non-manufacturing workers

	(1)	(2)	(3)	(4)
	R&D	HQ	Wholesale & retail	Other services
1997	3.5%	15.1%	13.9%	4.5%
2002	3.9%	13.5%	14.6%	5.2%
2007	4.0%	13.3%	12.7%	6.3%
2014	3.8%	13.0%	13.8%	7.0%

Source: Author's calculation based on BSJBSA.

Table 2 Offshoring and the servitization of the firm

Panel (A) Number of offshoring firms and offshore intensity

	No. of firms		Offshare
Offshoring	No	Yes	intensity
1997	11,613	1,105	7.69%
2014	10,179	1,850	12.07%

Panel (B) The share of worker by activities

	Manufacturing		R&D		HQ	
Offshoring	No	Yes	No	Yes	No	Yes
1997	66.4%	59.4%	3.2%	6.4%	14.9%	17.1%
2014	66.4%	59.2%	3.3%	6.7%	12.6%	15.5%

	Wholesale & Retail		Other services	
Offshoring	No	Yes	No	Yes
1997	13.6%	17.2%	4.6%	4.1%
2014	13.5%	15.4%	6.9%	7.8%

Source: Author's calculation based on BSJBSA.

Table 3 The share of manufacturing and non-manufacturing workers by industry.

	Manufacturing			R&D			HQ		
	a) 1997	b) 2014	b)-a)	a) 1997	b) 2014	b)-a)	a) 1997	b) 2014	b)-a)
Food	61.1%	63.3%	2.2%	2.0%	2.5%	0.4%	12.5%	10.8%	-1.8%
Textile	70.4%	67.6%	-2.8%	1.7%	2.0%	0.3%	12.4%	11.4%	-1.0%
Pulp and Paper	69.3%	69.8%	0.6%	1.3%	1.3%	0.1%	12.7%	10.8%	-1.9%
Chemical	53.4%	54.8%	1.4%	9.4%	9.5%	0.1%	18.5%	16.0%	-2.4%
Coal and petroleum	46.0%	43.5%	-2.4%	4.4%	4.6%	0.2%	15.5%	14.3%	-1.2%
Non-metal mineral products	63.4%	61.4%	-2.0%	2.4%	2.4%	0.0%	14.2%	11.9%	-2.2%
Primary metal	74.2%	73.4%	-0.8%	1.4%	1.4%	0.0%	13.7%	11.1%	-2.6%
Metal products	63.9%	64.9%	1.0%	2.2%	2.3%	0.1%	16.0%	12.4%	-3.6%
Machinery	63.5%	62.8%	-0.8%	5.0%	5.6%	0.6%	17.8%	15.6%	-2.3%
Electric Machinery	70.3%	65.4%	-4.9%	5.1%	5.9%	0.8%	15.9%	15.2%	-0.6%
Transport equipment	74.4%	74.9%	0.5%	3.6%	3.9%	0.3%	15.9%	13.4%	-2.4%
Other manufacturing	66.2%	66.4%	0.2%	1.9%	2.2%	0.3%	14.1%	11.6%	-2.5%

	Wholesale & retail			Other service		
	a) 1997	b) 2014	b)-a)	a) 1997	b) 2014	b)-a)
Food	20.0%	17.8%	-2.2%	6.0%	7.7%	1.7%
Textile	13.0%	15.3%	2.3%	3.9%	5.3%	1.4%
Pulp and Paper	14.2%	14.5%	0.3%	3.6%	4.7%	1.1%
Chemical	20.6%	17.9%	-2.8%	3.4%	6.5%	3.2%
Coal and petroleum	18.0%	20.3%	2.2%	17.4%	19.4%	2.0%
Non-metal mineral products	14.5%	16.1%	1.6%	7.3%	9.9%	2.6%
Primary metal	9.2%	10.4%	1.1%	2.7%	5.0%	2.3%
Metal products	15.4%	16.6%	1.3%	4.6%	5.9%	1.3%
Machinery	14.0%	14.0%	0.0%	4.1%	7.2%	3.0%
Electric Machinery	9.6%	10.9%	1.4%	3.7%	7.7%	4.0%
Transport equipment	4.6%	4.8%	0.2%	4.6%	6.1%	1.5%
Other manufacturing	14.8%	14.4%	-0.4%	4.7%	7.2%	2.5%

Source: Author's calculation based on BSJBSA.

Table 4 Estimation results: Manufacturing worker share, the growth rate of employment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$\Delta MFG\ worker\ share$			$\Delta\ln(Emp)$			$\Delta\ln(MFG\ Emp)$		
VARIABLES	1 year lag	3 year lag	5 year lag	1 year lag	3 year lag	5 year lag	1 year lag	3 year lag	5 year lag
ΔIMR	-0.0185	-0.0405	-0.885*	-0.183	-0.257	0.0390	-0.183	-0.463	-0.562**
	(0.0845)	(0.0848)	(0.459)	(0.177)	(0.180)	(0.148)	(0.198)	(0.281)	(0.222)
Offshore	-0.254	0.0908	-4.455	-0.534	-3.732	-0.866*	0.0710	-3.197	-2.011*
	(0.443)	(1.427)	(2.840)	(0.945)	(2.504)	(0.479)	(0.777)	(2.156)	(1.059)
Size	-0.0106**	-0.0151***	-0.0705**	-0.00624***	-0.0200***	-0.0218***	-0.00513***	-0.0406**	-0.0326***
	(0.00508)	(0.00300)	(0.0286)	(0.00133)	(0.00403)	(0.00413)	(0.00132)	(0.0169)	(0.00569)
Mplant	0.000306	-0.00723**	0.0171	-0.00946***	-0.0207***	-0.0128***	-0.00192*	0.00918	-0.0334***
	(0.00187)	(0.00283)	(0.0107)	(0.00141)	(0.00512)	(0.00425)	(0.00109)	(0.00799)	(0.00477)
Firm Age	-3.70e-05	-0.000221*	-0.000332	-8.53e-05	-0.000336	-0.000373**	-7.46e-05	-0.000218	-0.000358**
	(3.01e-05)	(0.000126)	(0.000224)	(6.40e-05)	(0.000208)	(0.000174)	(5.34e-05)	(0.000164)	(0.000166)
K-L ratio	-6.99e-05	0.0109***	-0.00103	0.00403***	0.0144***	0.0185***	0.00363***	0.000146	0.0219***
	(0.000760)	(0.00177)	(0.00439)	(0.000829)	(0.00218)	(0.00244)	(0.000618)	(0.00245)	(0.00354)
R&D intensity	-0.219	0.252***	-1.570	-0.00413	0.0751	0.417***	0.0674***	-0.796	0.141
	(0.144)	(0.0512)	(1.017)	(0.0397)	(0.0924)	(0.100)	(0.0165)	(0.493)	(0.110)
Mproduct	-0.000271	-0.0100**	-0.00416	-0.00459**	-0.0172**	-0.0177***	-0.00379**	-0.00409	-0.0201**
	(0.00103)	(0.00384)	(0.0107)	(0.00204)	(0.00793)	(0.00512)	(0.00164)	(0.00819)	(0.00755)
Export dummy	0.00410	-0.000305	0.0408**	0.00636	0.0326	0.00413	-2.52e-05	0.0311	0.0116
	(0.00487)	(0.0115)	(0.0183)	(0.00840)	(0.0209)	(0.00643)	(0.00651)	(0.0200)	(0.00793)
Import dummy	0.00980	-0.00598	0.147*	0.0120	0.0900	0.0192	-0.00267	0.102	0.0425
	(0.0120)	(0.0382)	(0.0832)	(0.0264)	(0.0629)	(0.0157)	(0.0219)	(0.0674)	(0.0313)
First stage									
ΔIMR^{oth}	0.249***	0.390***	0.324***	0.249***	0.390***	0.324***	0.249***	0.390***	0.324***
	(0.0600)	(0.0851)	(0.0550)	(0.0600)	(0.0852)	(0.0550)	(0.0598)	(0.0851)	(0.0551)
IGES	0.0423***	0.146**	0.120***	0.0423***	0.148**	0.120***	0.123***	0.146**	0.119***
	(0.00700)	(0.0712)	(0.0228)	(0.00700)	(0.0729)	(0.0228)	(0.0431)	(0.0712)	(0.0228)
First stage F test stat									
ΔIMR^{oth}	9.286	12.61	17.55	9.286	12.61	17.55	12.25	12.61	17.51
IGES	18.98	2.166	14.80	18.98	2.128	14.80	4.398	2.166	14.79
Observations	150,664	117,379	96,397	150,664	117,331	96,397	150,664	117,379	96,371

Note: Robust standard errors in parentheses clustered at the two-digit industry classification. Two-digit industry-year fixed effects are included. "***," "**," and "*" indicate the statistical significance at 1%, 5%, and 10%, respectively.

Table 5 Estimation results: Non-manufacturing activities

VARIABLES	(1) HQ	(2) R&D	(3) Wholesale &retail	(4) Other services
ΔIMR	-0.120	0.258	0.281**	0.411*
	(0.108)	(0.353)	(0.112)	(0.220)
Offshore	-1.342***	-0.117	0.680**	4.713
	(0.385)	(0.419)	(0.259)	(2.889)
Size	-0.00409	0.0279**	-0.01000*	0.0609**
	(0.00614)	(0.0120)	(0.00559)	(0.0218)
Mplant	0.00848**	-0.0124	0.00783***	-0.0207**
	(0.00400)	(0.00835)	(0.00153)	(0.00831)
Firm Age	-0.000105	8.88e-06	3.30e-05	0.000379
	(7.11e-05)	(2.40e-05)	(3.50e-05)	(0.000246)
K-L ratio	-0.00125	-3.50e-05	-0.000354	0.00238
	(0.00137)	(0.00113)	(0.00119)	(0.00348)
R&D intensity	-0.0278	0.561	0.202**	0.941
	(0.161)	(0.409)	(0.0841)	(0.683)
Mproduct	-0.00128	-0.00232	0.00349	0.00329
	(0.00321)	(0.00181)	(0.00226)	(0.0113)
Export dummy	0.0135***	0.00165	-0.00825**	-0.0433**
	(0.00415)	(0.00277)	(0.00348)	(0.0189)
Import dummy	0.0332**	-0.0134	-0.0177**	-0.139*
	(0.0140)	(0.0224)	(0.00775)	(0.0778)
First stage				
ΔIMR^{oth}	0.324***	0.324***	0.324***	0.324***
	(0.0550)	(0.0550)	(0.0550)	(0.0550)
IGES	0.120***	0.120***	0.120***	0.120***
	(0.0228)	(0.0228)	(0.0228)	(0.0228)
Frist stage F test				
ΔIMR^{oth}	17.55	17.55	17.55	17.55
IGES	14.80	14.80	14.80	14.80
Observations	96,397	96,397	96,397	96,397

Note: Robust standard errors in parentheses clustered at the two-digit industry classification. Two-digit industry-year fixed effects are included. "***," "**," and "*" indicate the statistical significance at 1%, 5%, and 10%, respectively.

Table 6 Heterogeneous impact of import competition

VARIABLES	(1) MFG	(2) HQ	(3) R&D	(4) Wholesale &retail	(5) Other services
$\Delta IMR \times first\ size\ qurtile$	-0.0477	-0.0377	-0.0356	0.00752	0.113
	(0.118)	(0.0244)	(0.0402)	(0.0305)	(0.111)
$\Delta IMR \times second\ size\ qurtile$	-0.159	-0.0203	0.0316	-0.00475	0.152
	(0.174)	(0.0444)	(0.0359)	(0.0427)	(0.187)
$\Delta IMR \times third\ size\ qurtile$	-0.112	0.0721	-0.00250	0.0222	0.0197
	(0.170)	(0.0884)	(0.0320)	(0.0552)	(0.184)
$\Delta IMR \times forth\ size\ qurtile$	-2.486*	-0.211	0.800	0.793**	1.104**
	(1.400)	(0.233)	(1.102)	(0.344)	(0.451)
$Offshore$	-4.580	-0.852**	-0.0602	0.591**	4.900
	(3.000)	(0.360)	(0.446)	(0.228)	(3.057)
Observations	96,397	96,397	96,397	96,397	96,397

Note: Robust standard errors in parentheses clustered at the two-digit industry classification. Firm controls and two-digit industry-year fixed effects are included. "***," "**," and "*" indicate the statistical significance at 1%, 5%, and 10%, respectively. Full results are presented in Online Appendix A3.

Table 7 Robustness checks

	(1) $\Delta MFG\ worker\ share$	(2) $\Delta \ln(Emp)$	(3) $\Delta \ln(MFG\ Emp)$	(4) $\Delta MFG\ worker\ share$
ΔIMR	-0.902*	0.0290	-0.597**	-0.522**
	(0.484)	(0.152)	(0.244)	(0.219)
ΔEXR	0.176	0.104	0.363***	
	(0.183)	(0.0714)	(0.118)	
Offshore	-4.446	-0.861*	-1.993*	-2.020
	(2.836)	(0.477)	(1.044)	(1.761)
Temp worker ratio				0.0292**
				(0.0131)
Size	-0.0703**	-0.0217***	-0.0322***	-0.0374*
	(0.0285)	(0.00414)	(0.00569)	(0.0195)
Mplant	0.0169	-0.0129***	-0.0337***	0.00625
	(0.0107)	(0.00428)	(0.00483)	(0.00589)
Firm Age	-0.000331	-0.000372**	-0.000355**	-0.000277
	(0.000223)	(0.000173)	(0.000164)	(0.000206)
K-L ratio	-0.000867	0.0186***	0.0222***	0.00153
	(0.00442)	(0.00243)	(0.00357)	(0.00399)
R&D intensity	-1.574	0.415***	0.133	-0.718
	(1.020)	(0.0998)	(0.111)	(0.473)
Mproduct	-0.00424	-0.0177***	-0.0203**	0.00284
	(0.0106)	(0.00513)	(0.00756)	(0.00666)
Export dummy	0.0401**	0.00372	0.0102	0.0218
	(0.0182)	(0.00638)	(0.00800)	(0.0219)
Import dummy	0.147*	0.0192	0.0426	0.0659
	(0.0831)	(0.0156)	(0.0309)	(0.0578)
First stage				
ΔIMR^{oth}	0.319***	0.319***	0.319***	0.331***
	(0.0569)	(0.0569)	(0.0570)	(0.124)
ΔEXR^{oth}	0.488***	0.488***	0.488***	
	(0.0777)	(0.0777)	(0.0777)	
IGES	0.119***	0.119***	0.119***	0.135***
	(0.0229)	(0.0229)	(0.0230)	(0.0520)
Frist stage F test				
ΔIMR^{oth}	31.50	31.50	31.41	3.645
ΔEXR^{oth}	15.61	15.61	15.62	
IGES	9.862	9.862	9.851	
Observations	96,397	96,397	96,371	40,819

Note: Robust standard errors in parentheses clustered at the two-digit industry classification. Two-digit industry-year fixed effects are included. "***," "**," and "*" indicate the statistical significance at 1%, 5%, and 10%, respectively.

Appendix Table A1 Basic Statistics

	Mean	S.D.	p1	p99
$\Delta share$: *MFG*	-0.02	0.64	-0.82	0.53
$\Delta share$: *HQ*	0.00	0.28	-0.32	0.36
$\Delta share$: *HQ* (excl. *R&D*)	0.00	0.24	-0.25	0.28
$\Delta share$: *R&D*	0.01	0.37	-0.20	0.26
$\Delta share$: *Wholesale & Retail*	0.00	0.30	-0.44	0.38
$\Delta share$: *Other service*	0.02	0.58	-0.42	0.70
$\Delta \ln(Emp)$	-0.02	0.27	-0.78	0.74
$\Delta \ln(MFG\ Emp)$	-0.05	0.44	-1.40	1.13
Size	5.38	1.05	3.99	8.82
Mplant	0.50	0.50	0.00	1.00
Firm Age	45.57	31.68	5.00	91.00
K-L ratio	1.97	0.94	-0.93	4.11
R&D intensity	0.01	0.02	0.00	0.10
Mproduct	0.60	0.49	0.00	1.00
Export dummy	0.31	0.46	0.00	1.00
Import dummy	0.25	0.43	0.00	1.00
ΔIMR	0.01	0.04	-0.02	0.10
Offshore	0.01	0.05	0.00	0.27

Appendix Table A2 Correlation Matrix

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]
$\Delta share$: *MFG*	1.000																	
$\Delta share$: *HQ*	0.088	1.000																
$\Delta share$: *HQ* (excl. *R&D*)	0.169	0.859	1.000															
$\Delta share$: *R&D*	-0.479	-0.172	-0.380	1.000														
$\Delta share$: *Wholesale & Retail*	-0.224	-0.213	-0.199	0.019	1.000													
$\Delta share$: *Other service*	-0.744	-0.229	-0.251	0.034	-0.202	1.000												
$\Delta \ln(Emp)$	0.021	-0.045	-0.041	-0.016	0.003	0.002	1.000											
$\Delta \ln(MFG\ Emp)$	0.196	-0.060	-0.039	-0.071	-0.095	-0.104	0.632	1.000										
Size	-0.131	-0.016	-0.037	0.079	-0.024	0.120	-0.087	-0.096	1.000									
Mplant	-0.034	0.006	0.001	0.012	0.002	0.027	-0.053	-0.065	0.359	1.000								
Firm Age	-0.024	-0.005	-0.010	0.011	-0.002	0.024	-0.039	-0.025	0.154	0.105	1.000							
K-L ratio	-0.022	-0.009	-0.011	0.010	-0.005	0.024	0.046	0.032	0.166	0.131	0.117	1.000						
R&D intensity	-0.083	-0.006	-0.020	0.049	0.009	0.064	0.017	-0.017	0.299	0.083	0.061	0.100	1.000					
Mproduct	-0.026	-0.001	-0.005	0.014	-0.001	0.022	-0.038	-0.034	0.223	0.149	0.089	0.067	0.077	1.000				
Export dummy	-0.039	-0.002	-0.009	0.024	-0.007	0.035	-0.020	-0.033	0.332	0.141	0.101	0.111	0.298	0.130	1.000			
Import dummy	-0.024	-0.005	-0.008	0.010	-0.006	0.026	-0.023	-0.036	0.297	0.113	0.073	0.101	0.236	0.111	0.557	1.000		
ΔIMR	-0.018	-0.003	0.002	0.010	0.002	0.012	-0.009	-0.018	0.011	-0.016	-0.006	-0.032	0.017	0.020	0.017	0.023	1.000	
Offshore	-0.006	0.013	0.011	-0.001	-0.001	0.002	-0.021	-0.036	0.111	0.041	0.000	0.022	0.083	0.022	0.197	0.263	0.001	1.000

Appendix Table A3 Full results of Table 6

	(1) MFG	(2) HQ	(3) R&D	(4) Wholesale &retail	(5) Other services
$\Delta IMR \times first\ size\ qurtile$	-0.0477	-0.0377	-0.0356	0.00752	0.113
	(0.118)	(0.0244)	(0.0402)	(0.0305)	(0.111)
$\Delta IMR \times second\ size\ qurtile$	-0.159	-0.0203	0.0316	-0.00475	0.152
	(0.174)	(0.0444)	(0.0359)	(0.0427)	(0.187)
$\Delta IMR \times third\ size\ qurtile$	-0.112	0.0721	-0.00250	0.0222	0.0197
	(0.170)	(0.0884)	(0.0320)	(0.0552)	(0.184)
$\Delta IMR \times forth\ size\ qurtile$	-2.486*	-0.211	0.800	0.793**	1.104**
	(1.400)	(0.233)	(1.102)	(0.344)	(0.451)
Offshore	-4.580	-0.852**	-0.0602	0.591**	4.900
	(3.000)	(0.360)	(0.446)	(0.228)	(3.057)
Second size qurtile dummy	0.0124***	0.000927	-0.00224*	-0.000340	-0.0107**
	(0.00388)	(0.00101)	(0.00125)	(0.000602)	(0.00390)
Third size qurtile dummy	0.0211***	0.00142	-0.00546*	-0.00159	-0.0155***
	(0.00661)	(0.00149)	(0.00279)	(0.000982)	(0.00513)
Forth size qurtile dummy	0.000317	0.00326	0.00522	-0.0219***	0.0131
	(0.0149)	(0.00495)	(0.00847)	(0.00740)	(0.0114)
Mplant	-0.0202**	0.00308	0.00156	0.00556***	0.01000
	(0.00775)	(0.00294)	(0.00496)	(0.00139)	(0.00601)
Firm Age	-0.000522	-0.000114	8.19e-05	1.12e-05	0.000543
	(0.000327)	(7.28e-05)	(7.24e-05)	(3.64e-05)	(0.000329)
K-L ratio	-0.00637	-0.00178*	0.00200**	-0.000794	0.00695*
	(0.00410)	(0.000941)	(0.000928)	(0.00119)	(0.00357)
R&D intensity	-2.076	-0.206	0.756	0.152*	1.374
	(1.273)	(0.142)	(0.514)	(0.0882)	(0.915)
Mproduct	-0.0219**	-0.00275	0.00440	0.00212	0.0181*
	(0.00938)	(0.00210)	(0.00277)	(0.00224)	(0.00986)
Export dummy	0.0200	0.00613***	0.00937*	-0.00906**	-0.0265
	(0.0220)	(0.00204)	(0.00521)	(0.00347)	(0.0215)
Import dummy	0.133	0.0210	-0.00830	-0.0166**	-0.129
	(0.0888)	(0.0134)	(0.0225)	(0.00700)	(0.0839)
First stage					
$\Delta IMR \times first\ size\ qurtile$	0.298***	0.298***	0.298***	0.298***	0.298***
	(0.0725)	(0.0725)	(0.0725)	(0.0725)	(0.0725)
$\Delta IMR \times second\ size\ qurtile$	0.303***	0.303***	0.303***	0.303***	0.303***
	(0.116)	(0.116)	(0.116)	(0.116)	(0.116)
$\Delta IMR \times third\ size\ qurtile$	0.308***	0.308***	0.308***	0.308***	0.308***
	(0.0528)	(0.0528)	(0.0528)	(0.0528)	(0.0528)
$\Delta IMR \times forth\ size\ qurtile$	0.417**	0.417**	0.417**	0.417**	0.417**
	(0.178)	(0.178)	(0.178)	(0.178)	(0.178)
IGES	0.120***	0.120***	0.120***	0.120***	0.120***
	(0.0228)	(0.0228)	(0.0228)	(0.0228)	(0.0228)
First stage F test					
$\Delta IMR \times first\ size\ qurtile$	8.533	8.533	8.533	8.533	8.533
$\Delta IMR \times second\ size\ qurtile$	32.35	32.35	32.35	32.35	32.35
$\Delta IMR \times third\ size\ qurtile$	26.23	26.23	26.23	26.23	26.23
$\Delta IMR \times forth\ size\ qurtile$	14.28	14.28	14.28	14.28	14.28
IGES	7.169	7.169	7.169	7.169	7.169
Observations	96,397	96,397	96,397	96,397	96,397

Note: Robust standard errors in parentheses clustered at the two-digit industry classification. Firm controls and two-digit industry-year fixed effects are included. "***," "**," and "*" indicate the statistical significance at 1%, 5%, and 10%, respectively.

Appendix B Different measure of offshoring

Instead of the offshoring intensity, we also use the size of sales of foreign manufacturing subsidiaries as a proxy for the size of overseas production. Specifically, we use the total sales of overseas manufacturing subsidiaries (*ln* (foreign sales)), which is obtained from Basic Survey on Overseas Business Activities (BSOBA) by METI. We match it with the firm-level data from BSJBSA. We take log for the sum of foreign subsidiary sales plus one. One may be concerned that this variable may be endogenous and thus, its coefficient may suffer from endogeneity bias. The objective of this exercise is to confirm the robustness of the results related to import competition.

Estimation results, which are corresponding to Table 4, are presented in Appendix Table B1. Different from the offshore intensity, the size of sales of foreign manufacturing subsidiaries has negative and significant coefficient in the case of the share of manufacturing worker and the growth rate of total worker. However, looking at the coefficient of the import competition, its size become larger as the differences are calculated over a longer period. These results are broadly consistent with our baseline results.

Appendix Table B1 Estimation results with the size of the oversea production

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$\Delta MFG\ worker\ share$			$\Delta\ln(Emp)$			$\Delta\ln(MFG\ Emp)$		
VARIABLES	1 year lag	3 year lag	5 year lag	1 year lag	3 year lag	5 year lag	1 year lag	3 year lag	5 year lag
ΔIMR	-0.00860	-0.460*	-0.867**	-0.186	-0.0391	0.0761	-0.148	-0.238	-0.504**
	(0.0883)	(0.248)	(0.405)	(0.200)	(0.0880)	(0.143)	(0.166)	(0.161)	(0.230)
Size	-0.00840*	-0.0324**	-0.0546**	-0.00558***	-0.0166***	-0.0246***	-0.00684***	-0.0230***	-0.0343***
	(0.00421)	(0.0133)	(0.0215)	(0.000812)	(0.00274)	(0.00442)	(0.00101)	(0.00343)	(0.00637)
Mplant	0.000288	0.00701	0.0138	-0.00190*	-0.00717**	-0.0135***	-0.00964***	-0.0233***	-0.0369***
	(0.00166)	(0.00659)	(0.00939)	(0.00104)	(0.00266)	(0.00432)	(0.00125)	(0.00331)	(0.00510)
Firm Age	-1.89e-05	-6.02e-05	-0.000118	-7.94e-05*	-0.000229**	-0.000345**	-6.25e-05*	-0.000185**	-0.000289*
	(1.37e-05)	(5.15e-05)	(0.000114)	(3.98e-05)	(0.000104)	(0.000166)	(3.25e-05)	(8.51e-05)	(0.000140)
K-L ratio	0.000252	0.000898	0.000210	0.00356***	0.0107***	0.0180***	0.00383***	0.0132***	0.0222***
	(0.000609)	(0.00246)	(0.00417)	(0.000405)	(0.00150)	(0.00265)	(0.000692)	(0.00208)	(0.00397)
R&D intensity	-0.202	-0.717	-1.427	0.0638***	0.242***	0.402***	-0.00142	0.0884	0.138
	(0.135)	(0.462)	(0.941)	(0.0172)	(0.0473)	(0.0890)	(0.0364)	(0.0560)	(0.0886)
Mproduct	0.000205	0.00284	0.00442	-0.00393***	-0.0103***	-0.0167***	-0.00379**	-0.00955**	-0.0152*
	(0.000808)	(0.00234)	(0.00346)	(0.000796)	(0.00278)	(0.00524)	(0.00138)	(0.00411)	(0.00744)
Export dummy	0.00399**	0.0135*	0.0240**	0.000133	-0.000757	-0.00308	0.00174	0.00245	-0.000246
	(0.00177)	(0.00655)	(0.00959)	(0.00101)	(0.00258)	(0.00481)	(0.00134)	(0.00296)	(0.00636)
Import dummy	0.00397	0.0220	0.0396	-0.000965	-0.00441	-0.00543	-0.00317	-0.0105**	-0.0124*
	(0.00381)	(0.0152)	(0.0307)	(0.00129)	(0.00295)	(0.00455)	(0.00206)	(0.00428)	(0.00649)
ln(Foregin sales)	-0.00260**	-0.0108***	-0.0186***	0.000558***	0.00161**	0.00222***	7.96e-05	0.000293	0.000550
	(0.00116)	(0.00300)	(0.00533)	(0.000176)	(0.000607)	(0.000776)	(0.000354)	(0.000944)	(0.00128)
First stage									
ΔIMR^{oth}	0.249***	0.393***	0.322***	0.249***	0.393***	0.322***	0.249***	0.393***	0.323***
	(0.0600)	(0.0846)	(0.0550)	(0.0600)	(0.0846)	(0.0550)	(0.0600)	(0.0847)	(0.0551)
Frist stage F test	17.22	21.58	34.43	17.22	21.58	34.43	17.22	21.60	34.41
Observations	150,701	117,409	97,655	150,701	117,409	97,655	150,701	117,361	97,621

Note: Robust standard errors in parentheses clustered at two-digit industry classification. Two-digit industry-year fixed effects are included. "***", "**" and "*" indicates the statistical significance at 1%, 5% and 10%, respectively.