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Servicification of Japanese Manufacturing Firms and its Impact on Corporate Performance in the Export Market[1]

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Abstract

This study revisit the impact of the servicification of Japanese manufacturing firms in terms of firm-level performance in export markets, using Japanese firm-level panel data set from 2009 to 2019. We constructed two measures of firm-level servificiation: in-house service production and bought-in service input, which is service input procured from external providers. We then examine its impact on corporate performance in export markets, measured by the Global Value Chain participation dummy, namely, the two-way trader dummy and the export intensity. Unlike previous studies, we examine various measures of service outsourcing and estimate the Correlated Random effects model, which enables us to control for unobserved individual fixed effects. We find that bought-in service input, especially service outsourcing, significantly impacts GVC participation and export intensity, and that this effect is more pronounced for high-tech industries.

Keywords: Servicification, Global Value Chain, Export intensity
JEL classification: F14, L60

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1. Introduction

Recent international trade literature has focused on global manufacturing firms that procure intermediate goods from overseas and exported products, i.e., firms engaged in the global value chain (GVC). Within the sequence of the value chain, the manufacturing process, which is located in the middle, is a low value-added process compared to the beginning and the end of the producition process, i.e., research and development (R&D), marketing, sales, and distribution. Consequently, global manufacturing firms increase service inputs such as R&D, design, and sales distribution as inputs, and create added value for their products. This trend is called "servicification" by manufacturing firms. Services play diverse roles throughout a product's life cycle, serving as intermediary inputs for R&D, design, marketing, distribution, and after-sales services. Servicification represents a strategic approach adopted by manufacturing firms engaged in the GVC, enabling them to differentiate their products, mitigate the risks of imitation and substitution, and enhance market penetration and long-term sustainability. Hence, integrating services within manufacturing constitutes a notable characteristic of global manufacturing enterprises.

Numerous studies have examined the composition of value-added trade, uncovering a significant increase in the value of indirect trade involving services embedded within traded goods. For instance, Francois et al. (2015) document the patterns of services embodied in goods trade based on value-added analysis utilizing global input-output tables. Their findings indicate that exports from high-income nations exhibit a greater reliance on services. Figure 1 presents the value added of the service sector in Japan's manufacturing gross export, calculated by the Ministry of Economy, Trade and Industry (2022) based on the OECD's TiVA database. It gradually increased from 25% in 1995 to 27% in 2015. Among various sub-sectors, while "wholesale and retail trade" and "transportation" are the most significant contributors, these sectors have declined in recent years.

In contrast, the shares of "other business services," including "professional, scientific, and technical activities" and "administrative and support service activities," have shown growth. This trend corresponds with the global expansion of professional services such as research and development (R&D) and legal services. These findings imply that trade-related activities, encompassing R&D, consulting, and legal, financial, and accounting services, are increasingly significant for Japan's manufacturing exports, contributing to the advancement of product sophistication and competitiveness.

== Figure 1 ==

Several studies examine the impact of servicification on a firm's decision to export and its performance. Lodefalk (2014) investigate the relationship between service inputs and export intensity using a panel dataset of Swedish firms from 2001 to 2007. His study considers two components of service inputs: the in-house service production and the externally procured services. Applying a fractional logit model, this study finds that service inputs positively impact a firm's export capabilities. Specifically, increasing the proportion of services integrated into in-house production is associated with higher average export intensity. Furthermore, a greater procurement of services is linked to increased export intensity, particularly for firms operating in specific industries.

Reddy et al. (2021) examine the impact of servicification on the participation of Indian manufacturing firms in global value chains (GVCs). They utilize the Indian firm-level panel data set from 2001 to 2018 and define the servicification index as a sum of expenditure of R&D, outsourced professional jobs, communication expenditure, and selling and distribution expenses. By estimating the probit model, manufacturing firms that incorporate service inputs in their production processes are more likely to engage in GVCs. Additionally, servicification promotes GVC participation among small and medium-sized enterprises (SMEs), and GVC has a positive impact for firms in less technology-intensive industries. These findings emphasize the importance of servicification as a critical factor in fostering GVC participation for firms.

Other related studies examine the causes and consequences of the servicification at the firm level. Chun et al. (2021) uses Korean firm-level data set and investigate whether the engagement of GVCs leads to the servicification in terms of the share of service worker within a firm. They find that Korean firms that engage in GVC tend to increase the number of regular workers in the R&D sector. And among GVC modes, FDI towards countries near home countries has a significant impact on the servicification. Using Japanese firm-level data, Matsuura (2022) compares the impact on the servicification between import competition and offshoring. He finds that the surge of imports from China has a much more pronounced effect than offshoring. Other studies focus on service sales. Bearnd and Fort (2015) and Morikawa (2016) examine service firms that do not have production workers but sell their products by outsourcing. They call these firms Factory-less goods producers. And using US or Japanese firm-level data, they find that these firms outperform others. Crozet and Milet (2017) investigate the corporate performance of French manufacturing firms that sell services. They demonstrated that firms selling services tend to perform better than pure manufacturing firms.

Although these previous studies provide insightful findings, our study revisits the

impact of servicification on a firm's internationalization, shedding light on several new aspects. First, Our Japanese firm-level data set, the Basic Survey of Japanese Business and Activities, provides detailed information on the externally procured services, especially on service outsourcing. We construct two servicification measures, the in-house service production and the externally procured service, namely, the bought-in service input. We also examine what kind of service outsourcing is effective for firms to succeed in their foreign business. Second, we utilize the Correlate Random Effects model to consider the unobserved individual fixed effects in the non-linear model, which are ignored in previous studies. We demonstrate that ignoring unobserved individual fixed effects leads to unbiased estimators, and we obtained some different results against previous studies.

This study also related to the extensive literature on export or GVC participation at the firm level. Starting from pioneering papers by Bernard and Jensen (1995, 1999), the early studies focus on the link between productivity and the decision to export both in theoretical and empirical perspectives (e.g., Melitz, 2003, International Study Group on Exports and Productivity, 2008, Wagner, 2012). Recent studies investigate the determinants of GVC participation at the firm-level. Firm-level GVC participation is often measured by the two-way trader dummy variable that takes one if firms simultaneously engage in export and import. Examples include Lu et al. (2018) and Minetti et al. (2019), which focus on productivity and financial constraint. According to a recent study by Urata and Baek (2022), the number of Japanese firms participating in GVCs is gradually increasing, and it also reports that firms' participation in GVCs promotes higher firm productivity.

Major findings in this paper are as follows; Our empirical analysis demonstrates that in-house service production and the bought-in service input positively correlate with the firm performance in the export market, measured by the GVC participation dummy and the export intensity. However, once unobserved firm fixed effects are controlled. In-house service production becomes insignificant, and only the coefficient of bought-in service remains significant. We also find that bought-in service input, especially service outsourcing has significant impact on GVC participations and export intensity. And this effect is more pronounce for high-tech industries.

The rest of this paper is organized as follows. The next section explains the conceptual framework, the data source and present the data overview. And Estimation results are reported in section 3. Last, section 4 concludes in this study.

2.1 Conceptual framework

We modeled the decision to participate in the GVC or the export intensity as a function of firm characteristics, e.g., a measure of servicifications, firm size, and productivity. Existing studies estimate the probit model, pooled OLS, or fractional logit model with firm-level panel data. However, these specifications are problematic when individual unobserved fixed effects correlate with covariates, leading to biased estimators. Since it is impossible to include individual fixed effects in a non-liner model, such as logit or probit, we use the alternative approach, the correlated random effects (CRE) model proposed by Wooldridge (2010). Suppose that an outcome variable y_{it} is a function of covariates X_{it}, unobserved individual effects c_i, and error term ϵ_{it} as follows:

$$y_{it} = f(X_{it} + c_i + \epsilon_{it}). \quad (1)$$

If the function *f* is linear, we can control c_i with individual fixed effects. However, individual fixed effects cannot be included in a non-linear model such as logit or probit. In the CRE model, individual unobserved effects are assumed to be correlated with the average level of covariates $\bar{X}_\iota$ as in the following equation:

$$c_i = \eta \bar{X}_\iota + \gamma_i,$$

where γ_i is assumed to be uncorrelated with $\bar{X}_\iota$. Substituting this equation into equation (1) gives

$$y_{it} = f(X_{it} + \eta \bar{X}_\iota + \gamma_i + \epsilon_{it}). \quad (2)$$

Since γ_i is the unobserved individual effect but not correlated with X_{it}, individual fixed effects that correlated with X_{it} can be controlled by including $\bar{X}_\iota$ and we can obtain an unbiased estimator of covariates by estimating the random effect model with equation (2).

Specifically, the equation to be estimated is as follows.

$$Prob(GVC_{it}) = f(\beta Service_{it} + \gamma X_{it} + \eta \bar{Z}_\iota + \epsilon_{it}) \quad (3)$$

$$Ex\_Int_{it} = \beta Service_{it} + \beta_2 BI\_Serv_{it} + \gamma X_{it} + \eta \bar{Z}_\iota + \epsilon_{it} \quad (4)$$

where GVC_{it} and Ex_Int_{it} are the GVC dummy and the export intensity for firm *i* in year *t*. GVC dummy variable takes one if firms engaged in export and import simultaneously. And the export intensity is defined as the share of export in total sales. $Service_{it}$ is the measure of service input. X_{it} and $\bar{Z}_\iota$ are variables for other firm characteristics and the firm-specific time averages for all time-variant covariates. We estimate equation (3) with the random effect probit model. For equation (4), since the dependent variable has many zeros, we estimate it by the random effect Poisson model. We also control year and industry-fixed effects.

2.2 Data source

The data utilized in our study is derived from the Basic Survey of Japanese Business Structure and Activities (BSJBSA) administered by METI, Japan. Initiated in

1991, this survey has been conducted annually since 1994. It encompasses various sectors, including Mining, Manufacturing, Wholesale and Retail, Electricity, Gas and Water Supply, Information, and Communication, as well as several other service industries. The BSJBSA provides a comprehensive representation of Japanese corporate firms, offering valuable insights into their diversification, globalization, and R&D strategies. Notably, it contains a wide array of variables such as sales, costs, debt, assets, profits, employment, trade, and R&D activities. Additionally, the number of employees is categorized based on different functions, such as headquarters services, manufacturing, wholesale and retail, R&D, and other activities.[2] We use this firm-level data for manufacturing industries for 2009–2019 because this survey has started to collect detailed information on the outsourcing and service trade since 2009.

One notable strength of the BSJBSA survey lies in its extensive coverage and reliability. It is mandatory for all firms operating within the target industries with more than 50 employees and capital exceeding 30 million yen. However, it is essential to acknowledge certain limitations associated with this survey. Specifically, it does not encompass specific service industries like Finance, Insurance, Transportation, Education, and Medical Services. Moreover, small-scale enterprises with fewer than 50 employees or capital below 30 million yen are excluded from the survey's scope. Furthermore, due to the inability to align the BSJBSA data with customs trade data, we cannot ascertain the specific products being exported or imported by the firms under analysis.

Regarding the measure of the service input, we utilize two measures of the service input, following Lodefalk (2014). The first is the indicator for in-house services production (*In_Serv*). It corresponds to the expenditure incurred by a company for the production of "services" within its operations. This indicator includes the labor costs of non-manufacturing employees in a manufacturing company and the company's expenditures on research and development (R&D). The labor cost of non-manufacturing employees is derived by multiplying the number of employees in this sector by the average wage at the firm level.

The other indicator is the Bought-in services (*BI_serv*), which refers to the expenses incurred by a company for purchasing "services" from external suppliers. Specifically, it includes costs related to packaging and transportation, information processing and communications, outsourced services, outsourced R&D, as well as service imports. Both indicators are normalized by dividing them by the total costs, also known as operating expenses.

[2] "Headquarter service" includes management, strategy, administration, international, information technology, and R&D. A sales department is covered by "Wholesale and retail" activities.

We also employed qualitative questions regarding outsourced services. We constructed dummy variables to indicate whether firms outsource "Research/Marketing" and "Design/Product development" or not. Furthermore, we created additional dummy variables for both indicators to differentiate between outsourcing to domestic companies and outsourcing to foreign businesses.

As variables for firm characteristics, we include the number of workers (*log(Labor*)), capital-labor ratio (*log(K-L ratio)*), the foreign capital share (*Capital_FR*), and Total Factor Productivity (*log(TFP)*). All independent variable are taken one year lag. To estimate TFP, we employ the Wooldridge (2009) modification of the Levinsohn and Petrin methodology to estimate total factor productivity. This modified approach accounts for potential co-linearity issues that may arise in the first stage of the Levinsohn and Petrin (2003) estimator. To derive the variables necessary for TFP estimation, we construct the following measures: real gross output is computed by deflating sales using the output deflator, while intermediate inputs are calculated by deflating the cost of materials utilizing the input deflator. Labor input is measured by the total number of employees, and capital stock is determined based on the value of fixed tangible assets. All output and input deflators utilized in this study are sourced from the System of National Accounts provided by the Cabinet Office of the Japanese government. The basic statistics and the correlation matrix of variables we used are presented in Table A1 and A2.

2.3 Data overview

Table 1 shows the mean value of the service input indicators and compares the In-house service index and the bought-in service index between 2009 and 2019 and between high-tech and low-tech industries. Overall, the In-house service share is higher than the Bought-in service share (8.5% and 3.7% in 2009, respectively), but a comparison between 2009 and 2019 shows an increasing trend for the Bought-in service, while the In-House service has a slightly decreasing trend. For In-House service, the ratio is higher in high-tech industries, while in Bought-in service, the ratio is higher in low-tech industries.

Table 2 presents the percentage of firms that outsource "research and marketing" and "design and product development," both of which increased from 3.3% to 6.3% and from 3.6% to 5.1%, respectively. A comparison of high-tech and low-tech industries shows a higher percentage of high-tech industries in "research and marketing" and a higher percentage of low-tech industries in "design and product development. Panel B also examines the percentage of firms outsourcing "research and marketing" and "design and product development" overseas, but the percentages are quite small, 0.6% for "research and marketing" and 0.2% for "design and product development" in 2009. Regarding

changes over time, the percentage remained unchanged in "Design/Product Development," but doubled in "Research/Marketing." As for differences between industries, the percentage of companies outsourcing overseas is higher in the high-tech industries.

== Table 1 &Table 2 ==

3. Estimation results

Table 3 shows the baseline results. The results in columns (1) and (4) are the estimation results of the logit and Poisson models, which do not account for unobserved individual effects; in these specifications, the coefficients of In-house service and Bought-in service are positive and significant. Columns (2) and (5) are the results of Correlated Random Effect models that control the mean value of time-varying factors. The results show that the coefficient for in-house service is positive but loses statistical significance once we consider the presence of an unobserved individual effect. The coefficient for the Bought-in service remains positive and statistically significant, indicating that it still affects the probability of participation in GVCs and the export ratio, even after accounting for unobserved individual effects. Thus, it can be seen that not considering unobserved individual effects changes the conclusions. In columns (3) and (6), we use the GVC dummy and the export ratio defined with export/import with related parties, namely majority-owned foreign subsidiaries. We also find the coefficient of Bought-in service is statistically significant.

== Table 3 ==

In Table 4, we slightly modified the servification indicators to check the robustness. Column (1) contains the baseline results from Column (2) of Table 3 for comparison. Column (2) is an indicator that considers the labor costs of headquarters function employees for In-house service, but the coefficient remains insignificant. Column (3) decomposes In-house service into “labor costs for In-house service sector workers” and “in-house R&D costs,” but again, none of these were significant. This result contradicts previous studies such as Reddy (2021), which found that internal R&D expenditures are an essential factor. But, this may be because the previous studies do not consider unobserved individual effects. In Column (4), we use the Bought-in service measure restricted to domestic service procurement, excluding service outsourcing from foreign countries and service import. But the results remain unchanged. And in Column (5), the

Bought-in service index is decomposed into R&D outsourcing and others. The coefficients of both variables are positive and significant. And we also find the coefficient on R&D outsourcing is a larger value. The results for the export ratio were generally similar, but no significant results were obtained for outsourcing R&D in the Bought-in services.

== Table 4 ==

Since the BSJBSA has qualitative questions on the specifics of service outsourcing, we examine what type of service outsourcing is vital for GVC participation and export intensity. We focus on "research and marketing" and "design and product planning." The results are shown in Table 5. We find that "design and product planning" was important for participation in GVC. When outsourcing was decomposed into domestic and overseas, it was found that outsourcing to the domestic market positively impacted the probability of participation in GVCs. On the other hand, outsourcing for "research and marketing" was significant in estimating the export ratio.

== Table 5 ==

Finally, we investigate whether the impact of the servicification differs between low-tech and high-tech industries. High-tech industries includes Chemical, Phamathetical, Machinery, Electronic parts and devices, Electrical Machinery, Information and Communication equipment, and Transportation equipment. Others are regarded as low-tech industries. The results are presented in Table 6. In-house service was not statistically significant, while bought-in service was only significant in the high-tech industry. This result suggests that the importance of servicification in expanding into foreign markets varies by industry and is particularly important in the high-tech industry.

== Table 6 ==

4. Discussion

We conducted a few additional estimations. First, one may be concerned our estimated coefficients may suffer from the potential endogeneity bias; Firms that start oversea business extensively use the external service or increase thier in-house service production. We use the control function approach to address the endogeneity concern following Chun et al. (2021). As instruments, we use the industry average servicification

measures, which are also used in Reddy et al. (2021). Firms in the same industry may make similar service expenditures. However, participation in GVCs and the expansion in export market are firm-specific and are not conditional on servicing other firms in the same industry. Therefore, this variable is exogenous and serves as a reasonable operating variable. The results are presented in Table A3 and we found that the results do not qualitatively change even when we consider the endogeneity of the servicification measures.

Second, one may be interested in why the in-house service production is not significant for oversea business expansion. As pointed out in Table 3, the different results from previous studies are due to differences in estimation methods. But how should we interpret these results? One possibility is that in-house services may contribute to the integration of in-house product sales and service sales, namely, the servitization of output, rather than the expansion of overseas business. Servitization is a phenomenon in which manufacturing firms expand into service fields that are complementary to their products. It is possible that firms promoting such servitization are increasing in-house services. To confirm this relationship, we use the ratio of service sales to total sales of manufacturing firms as the dependent variable and examine the link with the two servicification measures. The results are presented in Table A4. While Column (1) estimate the model with CRE poission model, Column (2) uses the CRE tobit model to accont for the fact that the share of service sales ranges from 0 to 1. In both cases, the coefficient on the in-house service indicator as well as the Bought-in service measure is positive and significant. This result suggests that manufacturing firms use in-house service inputs to service their output.

Third, if firms export higher quality products to developed countries than to developing countries, then exports to developed countries would require more service inputs. Francois et al. (2015) also found a higher dependence on services in the case of exports to developed countries. We use the export and import values by regions (Asia, Europe, and North America), construct the two-way trading dummy and the export intensity by region, and check whether the impact of the servicification differs across regions. The results are shown in Table A5. The coefficients of the Bouth-in service are positive and significant for both exports to Asia and exports to developed countries. This is probably because Japanese firms are engaged in vertical fragmentation with Asian countries, and they export high-quality goods not only for Europe and the U.S. but also for Asian countries. Looking at the marginal effects, there is not much difference between them. In contrast, the coefficients of the export intensity for both regions become insignificant.

5. Conclusion

This study examines the impact of the servicification of Japanese manufacturing firms in terms of firm-level performance in the export market, using the data of Japanese manufacturing firms from 2009 to 2019. We constructed two measures of firm-level servificiation: in-house service production and bought-in service input, which is the service input procured from external providers. And we then examine its impact on the Global Value Chain participation, which is measured by a two-way trader dummy and the export intensity. Unlike previous studies, we estimate the Correlated Random effects model, enabling us to control unobserved individual fixed effects.

Our empirical analysis demonstrates that both in-house and bought-in service input positively correlates with the firm performance in the export market, which is measured by the GVC participation dummy and the export intensity. However, once unobserved firm fixed effects are controlled. In-house service production becomes insignificant, and only the coefficient of bought-in service remains significant. We also find that bought-in service input, especially service outsourcing has a significant impact on GVC participation and export intensity. And this effect is more pronounced for high-tech industries.

The evidence that the bought-in service plays an important role in the GVC participation or the export expansion leads to a policy implication. Since service providers are concentrated in urban areas, access to service providers is challenging for regional companies. Table A6 shows the number of business offices of information processing services and professional/technical service providers by prefecture, which are obtained from the Economic Census as of 2016. It indicates that 20-40% of them are located in Tokyo, Saitama, Chiba, and Kanagawa. According to a survey conducted by the Japan Chamber of Commerce and Industry (2022) on the promotion of oversea business by small and medium enterprises, regional companies have difficulties accessing overseas business consulting services providers. Regional trading companies are expected to provide the services to regional firms. But, due to a lack of expertise in trade practices, marketing, logistics, and communication with foreign firms, regional companies are not satisfied with the services of regional trading companies. Therefore, it is important to ensure local firms have access to the service providers they need to expand their overseas businesses.

Although this paper provides interesting insights, there seems to be various avenue for future research. For example, to what extent does an increase in service inputs affect the quality of exported goods, and does it have a more significant effect on exports to

developed countries or developing countries? Furthermore, there are two possible effects of an increase in export intensity: an increase in the number of export destinations and an increase in the value of exports per destination country. More comprehensive data using firm-level trade transaction data are needed to clarify these issues.

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Figure 1 The contribution of service to manufacturing gross export

Source: White paper on international trade 2022 (Ministry of Economy, Trade and Industry)

Table 1 Servicification Intensity

In-House Service input			
	Total	Low Tech	High Tech
2009	0.085	0.075	0.096
2019	0.078	0.069	0.087

Bought-in Service input			
	Total	Low Tech	High Tech
2009	0.037	0.043	0.031
2019	0.041	0.048	0.035

Source: Author's calculation based on BSJBSA (METI)

Table 2 Share of firms that engage in service outsourcing

Service outsourcing in Research/Marketing				Design/Product Development		
	Total	Low Tech	High Tech	Total	Low Tech	High Tech
2009	3.3%	2.7%	3.9%	3.6%	4.4%	2.8%
2019	6.3%	5.4%	7.2%	5.1%	6.6%	3.8%
Service outsourcing to oversea suppliers						
Research/Marketing				Design/Product Development		
	Total	Low Tech	High Tech	Total	Low Tech	High Tech
2009	0.6%	0.3%	0.8%	0.2%	0.1%	0.2%
2019	1.2%	0.7%	1.7%	0.2%	0.1%	0.2%

Source: Author's calculation based on BSJBSA (METI)

Table 3 Baseline results

Dependent variable	(1) *GVC dummy*	(2) *GVC dummy*	(3) *GVC dummy w related party*	(4) *Ex Int*	(5) *Ex Int*	(6) *Ex Int w related party*
In_Serv $_{t-1}$	0.595***	0.000360	0.0118	1.534***	0.0761	0.202
	(0.0454)	(0.0162)	(0.0137)	(0.262)	(0.0781)	(0.147)
Bi_Serv $_{t-1}$	0.234***	0.0665***	0.0495*	0.429**	0.218**	0.0334
	(0.0565)	(0.0201)	(0.0268)	(0.176)	(0.106)	(0.168)
log(Labor $_{t-1}$*)*	0.0889***	0.0299***	0.0252***	0.299***	0.0700	0.183**
	(0.00360)	(0.00536)	(0.00619)	(0.0173)	(0.0462)	(0.0802)
log(K-L ratio $_{t-1}$*)*	0.0255***	0.00176	-0.000870	0.229***	0.0327	0.0518
	(0.00290)	(0.00240)	(0.00225)	(0.0210)	(0.0214)	(0.0357)
log(TFP $_{t-1}$*)*	0.0568***	0.00379	0.00536	0.480***	0.185***	0.194**
	(0.0128)	(0.00548)	(0.0124)	(0.0615)	(0.0407)	(0.0875)
Capital FR $_{t-1}$	0.00248***	6.00e-05	0.000196	0.0103***	-0.000862	0.00160
	(0.000219)	(0.000169)	(0.000170)	(0.000869)	(0.000829)	(0.00149)
Method	Probit	CRE probit	CRE probit	Poisson	CRE poisson	CRE poisson
Mean of time variant covariates	No	Yes	Yes	No	Yes	Yes
Observations	121,758	121,758	121,758	121,758	121,758	121,758
Number of firmid		16,039	16,039	16,039	16,039	16,039

Note: The coefficinets from Column (1) through (3) are marginal effect. Robust standard errors are in parentheses. ***, **, and * represents the statistically significant at 1%, 5% and 10%, respectively. Industry FE and Year FE are included but not reported.

Table 4 Results with alternative definitions of servicification indicators

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable	*GVC dummy*						*Ex_Int*					
In_Serv $_{t-1}$	0.000158	0.000255	0.000301	0.000459	0.000270	0.000633	0.0719	0.0774	0.0744	0.0734	0.0773	0.0784
	(0.0152)	(0.0161)	(0.0159)	(0.0150)	(0.0161)	(0.0170)	(0.0790)	(0.0784)	(0.0788)	(0.0786)	(0.0784)	(0.0781)
Bi_Serv $_{t-1}$	0.108***	0.111***	0.109***	0.105***	0.111***	0.107***	0.673***	0.581***	0.624***	0.673***	0.573***	0.599***
(excl. service outsourcing)	(0.0330)	(0.0393)	(0.0324)	(0.0341)	(0.0372)	(0.0315)	(0.161)	(0.152)	(0.155)	(0.165)	(0.151)	(0.156)
Serv outsourcing dummy	0.00592						0.0498**					
(*Research/Marketing*)	(0.00426)						(0.0219)					
Serv outsourcing dummy		0.00789*						0.00584				
(*Design/Product Development*)		(0.00452)						(0.0277)				
Serv outsourcing dummy (Dom)			0.00621						0.0425*			
(*Research/Marketing*)			(0.00438)						(0.0233)			
Serv outsourcing dummy (For)				-0.00167						0.0712**		
(*Research/Marketing*)				(0.00852)						(0.0351)		
Serv outsourcing dummy (Dom)					0.00803*						0.0117	
(*Design/Product Development*)					(0.00455)						(0.0286)	
Serv outsourcing dummy (For)						-0.0202						-0.0412
(*Design/Product Development*)						(0.0177)						(0.0702)
Observations	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758
Number of firmid	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039

Note: The models are estimated by CRE. The coefficinets from Column (1) through (5) are marginal effect. Robust standard errors are in parentheses. ***, **, and * represents the statistically significant at 1%, 5% and 10%, respectively. Other covariates and their mean are included. Industry FE and Year FE are included but not reported.

Table 5 Results with service outsourcing dummies (Marginal effect)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable	*GVC dummy*						*Ex_Int*					
In_Serv $_{t-1}$	0.000158	0.000255	0.000301	0.00856	0.00466	0.0112	0.0719	0.0774	0.0744	0.0734	0.0773	0.0784
	(0.0152)	(0.0161)	(0.0159)	(0.280)	(0.278)	(0.302)	(0.0790)	(0.0784)	(0.0788)	(0.0786)	(0.0784)	(0.0781)
In_Serv $_{t-1}$	0.108***	0.111***	0.109***	1.957***	1.917***	1.894***	0.673***	0.581***	0.624***	0.673***	0.573***	0.599***
(excl. service outsourcing)	(0.0330)	(0.0393)	(0.0324)	(0.571)	(0.552)	(0.559)	(0.161)	(0.152)	(0.155)	(0.165)	(0.151)	(0.156)
Serv outsourcing dummy	0.00592						0.0498**					
(*Research/Marketing*)	(0.00426)						(0.0219)					
Serv outsourcing dummy		0.00789*						0.00584				
(*Design/Product Development*)		(0.00452)						(0.0277)				
Serv outsourcing dummy (Dom)			0.00621						0.0425*			
(*Research/Marketing*)			(0.00438)						(0.0233)			
Serv outsourcing dummy (For)				-0.0312						0.0712**		
(*Research/Marketing*)				(0.159)						(0.0351)		
Serv outsourcing dummy (Dom)					0.139*						0.0117	
(*Design/Product Development*)					(0.0809)						(0.0286)	
Serv outsourcing dummy (For)						-0.359						-0.0412
(*Design/Product Development*)						(0.314)						(0.0702)
Observations	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758	121,758
Number of firmid	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039	16,039

Note: The models are estimated by CRE. The coefficinets from Column (1) through (6) are marginal effect. Robust standard errors are in parentheses. ***, **, and * represents the statistically significant at 1%, 5% and 10%, respectively. Other covariates and their mean are included. Industry FE and Year FE are included but not reported.

Table 6 Estimation results by industris

	(1)	(2)	(3)	(4)
Dependent variable	*GVC dummy*		*Ex_int*	
In_Serv $_{t-1}$	0.0121	-0.00349	0.215	6.63e-05
	(0.0185)	(0.0356)	(0.193)	(0.0867)
Bi_Serv $_{t-1}$	0.0404	0.103***	0.103	0.297**
	(0.0290)	(0.0367)	(0.295)	(0.144)
log(Labor $_{t-1}$*)*	0.0183**	0.0479***	0.121	0.0593
	(0.00791)	(0.00950)	(0.0954)	(0.0527)
log(K-L ratio $_{t-1}$*)*	0.00363	0.00193	0.0150	0.0377
	(0.00378)	(0.00407)	(0.0405)	(0.0254)
log(TFP $_{t-1}$*)*	0.0223**	-0.00775	0.353***	0.139***
	(0.00874)	(0.0146)	(0.116)	(0.0445)
Capital FR $_{t-1}$	5.54e-05	2.78e-05	-0.00283	-0.000470
	(0.000246)	(0.000181)	(0.00185)	(0.000961)
Observations	56,593	65,165	56,593	65,165
Number of firmid	8,101	8,772	8,101	8,772

Note: The models are estimated by CRE. The coefficinets in Column (1) and (2) are marginal effect. Robust standard errors are in parentheses. ***, **, and * represents the statistically significant at 1%, 5% and 10%, respectively. The means of covariates are included. Industry FE and Year FE are included but not reported.

Appendix

Table A1 The Basic Statistics

	N	Mean	SD	p25	p75
Two-way dummy	121758	0.251	0.433	0.000	1.000
Export Intensity	121758	0.058	0.147	0.000	0.027
In_Serv $_{t-1}$	121758	0.047	0.067	0.003	0.066
Bi_Serv $_{t-1}$	121758	0.037	0.050	0.011	0.048
log(Labor $_{t-1}$*)*	121758	5.152	0.882	4.466	5.645
log(K-L ratio $_{t-1}$*)*	121758	1.888	1.061	1.423	2.517
log(TFP $_{t-1}$*)*	121758	0.161	0.419	-0.037	0.425
Capital FR $_{t-1}$	121758	2.385	12.574	0.000	0.000

Table A2 The Correlation Matrix

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
[1]	*Two-way dummy*	1.000							
[2]	*Export Intensity*	0.444	1.000						
[3]	*In_Serv* $_{t-1}$	0.160	0.113	1.000					
[4]	*Bi_Serv* $_{t-1}$	0.028	0.006	0.067	1.000				
[5]	*log(Labor* $_{t-1}$*)*	0.249	0.185	0.123	0.091	1.000			
[6]	*log(K-L ratio* $_{t-1}$*)*	0.064	0.079	-0.068	0.082	0.089	1.000		
[7]	*log(TFP* $_{t-1}$*)*	-0.051	-0.007	-0.063	0.052	0.167	-0.023	1.000	
[8]	*Capital FR* $_{t-1}$	0.152	0.166	0.053	0.043	0.138	0.038	-0.023	1.000

Table A3 Control Function Approach

	(1)	(2)
Dependent variable	GVC dummy	*Ex_int*
In_Serv $_{t-1}$	-0.000481	0.0857
	(0.0157)	(0.0771)
Bi_Serv $_{t-1}$	0.0617***	0.182*
	(0.0226)	(0.109)
log(Labor $_{t-1}$*)*	0.0327***	0.0623
	(0.00680)	(0.0464)
log(K-L ratio $_{t-1}$*)*	0.00188	0.0304
	(0.00264)	(0.0215)
log(TFP $_{t-1}$*)*	0.00517	0.190***
	(0.00726)	(0.0409)
Capital FR $_{t-1}$	7.19e-05	-0.000934
	(0.000215)	(0.000830)
Control Variables	Yes	Yes
Observations	121,265	121,265
Number of firmid	15,996	15,996

Note: This table presents the second-stage regression results after controlling residulas calculated from the first stage estimation with instrument variables. The coefficinets in Column (1) are marginal effect. Robust standard errors in parentheses. ***, **, and * represents the statistical significant at 1%, 5% and 10%, respectively. Insutry average In_Serv_{t-1} and Bi_Serv_{t-1} are used as instruments. The means of covariates are included. Industry FE and Year FE are included but not reported.

Table A4 The impact on the share of service in total sales

	(1) RE poisson	(2) RE Tobit
In_Serv $_{t-1}$	0.224***	0.0401***
	(0.0641)	(0.00805)
Bi_Serv $_{t-1}$	0.152**	0.0299***
	(0.0652)	(0.00930)
log(Labor $_{t-1}$*)*	0.0389	0.0100***
	(0.0399)	(0.00261)
log(K-L ratio $_{t-1}$*)*	0.0163	0.00395***
	(0.0163)	(0.00129)
log(TFP $_{t-1}$*)*	-0.0128	0.00151
	(0.0455)	(0.00328)
Capital FR $_{t-1}$	-0.000891	-0.000140*
	(0.000928)	(7.82e-05)
Observations	121,758	121,758
Number of firmid	16,039	16,039

Note: Robust standard errors in parentheses. ***, **, and * represents the statistical significant at 1%, 5% and 10%, respectively. The means of covariates are included. Industry FE and Year FE are included but not reported.

Table A5 Disaggregation by regions

	(1)	(2)	(3)	(4)
	Twoway trading dummy		Export intensity	
	Asia	Europe and North America	Asia	Europe and North America
In_Serv $_{t-1}$	0.00850	0.00116	0.0922	0.0380
	(0.0126)	(0.00782)	(0.100)	(0.0890)
Bi_Serv $_{t-1}$	0.0595***	0.0402***	0.119	0.176
	(0.0209)	(0.0151)	(0.124)	(0.168)
log(Labor $_{t-1}$*)*	0.0386***	0.0136***	0.112*	0.0594
	(0.00566)	(0.00409)	(0.0586)	(0.0842)
log(K-L ratio $_{t-1}$*)*	7.16e-05	0.00408*	0.0369	0.0545*
	(0.00248)	(0.00220)	(0.0278)	(0.0297)
log(TFP $_{t-1}$*)*	0.0103*	0.00598	0.181***	0.205***
	(0.00600)	(0.00420)	(0.0499)	(0.0692)
Capital FR $_{t-1}$	-3.51e-05	0.000108	-0.000857	-0.00198
	(0.000164)	(9.74e-05)	(0.00118)	(0.00122)
Observations	121,758	121,758	121,758	121,758
Number of firmid	16,039	16,039	16,039	16,039

Note: Estimated by the correlated random effect model. Robust standard errors in parentheses. ***, **, and * represents the statistical significant at 1%, 5% and 10%, respectively. The means of covariates are included. Industry FE and Year FE are included but not reported.

Table A6 Regiona distribution of service providers in Japan

	391 COMPUTER PROGRAMMING AND OTHER SOFTWARE SERVICES	392 DATA PROCESSING AND INFORMATION SERVICES	71 SCIENTIFIC AND DEVELOPMENT RESEARCH INSTITUTES	72 PROFESSIONAL SERVICES, N.E.C.	73 ADVERTISING	74 TECHNICAL SERVICES, N.E.C.
Hokkaido	3.2%	3.7%	6.1%	3.3%	3.7%	4.5%
Aomori	0.4%	0.6%	1.5%	0.7%	0.7%	1.0%
Iwate	0.6%	0.5%	0.7%	0.7%	0.7%	1.1%
Miyagi	1.7%	1.4%	2.4%	1.6%	2.3%	2.1%
Akita	0.4%	0.4%	0.4%	0.7%	0.7%	0.9%
Yamagata	0.5%	0.5%	0.3%	0.8%	0.6%	1.0%
Fukushima	0.8%	1.0%	1.1%	1.3%	1.6%	1.7%
Ibaraki	1.5%	1.7%	5.1%	1.5%	1.0%	2.4%
Tochigi	0.8%	0.9%	1.2%	1.4%	1.1%	1.7%
Gunma	1.1%	1.0%	1.2%	1.5%	1.2%	1.7%
Saitama	2.8%	4.0%	3.2%	3.8%	2.2%	4.2%
Chiba	2.4%	3.1%	4.0%	2.8%	1.7%	3.5%
Tokyo	29.8%	27.7%	22.8%	19.4%	26.0%	11.3%
Kanagawa	7.7%	6.1%	7.4%	5.4%	3.7%	6.0%
Niigata	1.4%	1.6%	0.8%	1.6%	1.1%	2.1%
Toyama	0.6%	0.7%	0.8%	0.9%	0.9%	0.9%
Ishikawa	1.0%	1.0%	0.7%	1.0%	1.0%	1.2%
Fukui	0.6%	0.5%	0.6%	0.7%	0.7%	0.8%
Yamanashi	0.5%	0.5%	0.4%	0.6%	0.4%	0.8%
Nagano	1.6%	1.3%	2.0%	1.9%	1.7%	2.1%
Gifu	0.8%	1.0%	1.1%	1.7%	1.2%	1.8%
Shizuoka	2.3%	2.1%	2.6%	3.0%	3.0%	3.4%
Aichi	6.5%	5.9%	5.5%	6.7%	7.0%	5.8%
Mie	0.7%	0.9%	0.8%	1.1%	1.1%	1.4%
Shiga	0.5%	0.6%	1.0%	0.8%	0.4%	1.1%
Kyoto	1.3%	1.4%	2.9%	2.1%	1.5%	1.6%
Osaka	9.8%	9.4%	6.9%	9.2%	9.4%	6.1%
Hyogo	2.8%	2.8%	3.1%	3.8%	2.2%	3.7%
Nara	0.3%	0.5%	0.6%	0.6%	0.4%	0.8%
Wakayama	0.3%	0.6%	0.5%	0.6%	0.4%	0.8%
Tottori	0.3%	0.5%	0.7%	0.4%	0.6%	0.5%
Shimane	0.4%	0.5%	0.9%	0.5%	0.6%	0.8%
Okayama	1.1%	1.5%	0.5%	1.3%	1.4%	1.5%
Hiroshima	2.1%	2.4%	1.6%	2.4%	2.9%	2.6%
Yamaguchi	0.6%	0.7%	0.6%	0.9%	0.9%	1.1%
Tokushima	0.3%	0.3%	0.0%	0.6%	0.5%	0.7%
Kagawa	0.6%	0.7%	0.6%	0.8%	1.0%	0.9%
Ehime	0.8%	0.9%	0.3%	1.0%	0.7%	1.3%
Kochi	0.3%	0.4%	0.5%	0.5%	0.3%	0.6%
Fukuoka	4.7%	3.7%	2.2%	4.0%	5.5%	4.1%
Saga	0.2%	0.5%	0.3%	0.5%	0.5%	0.6%
Nagasaki	0.5%	0.7%	0.6%	0.7%	0.8%	1.3%
Kumamoto	0.8%	1.1%	0.7%	1.3%	1.1%	1.5%
Oita	0.5%	0.6%	0.2%	0.8%	0.9%	1.0%
Miyazaki	0.4%	0.6%	0.3%	0.8%	0.6%	1.1%
Kagoshima	0.6%	0.8%	0.8%	1.2%	1.0%	1.6%
Okinawa	0.9%	1.0%	1.3%	0.9%	0.9%	1.4%
# of Establishment	19359	5232	2374	91052	6814	76720

Source: 2016 Economic Census for Business Activity (Ministry of Internal Affair, Communications, and Ministry of Economy, Trade, and Industry)