

What Determines In-house Service Activities within Manufacturing Firms: Firm-level Evidence from Korea

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This study empirically investigates the key determinants of in-house service activities within manufacturing firms based on an establishment-level panel dataset from 2006 to 2019. The extent of in-house service activities is measured as the proportion of workers performing knowledge-intensive core service functions, such as R&D, design, IT, administration, and management. After controlling for unobserved heterogeneity and simultaneity by adopting the system generalized method of moments, our regression results reveal that companies with higher export intensities, wider networks of overseas subsidiaries, or those located in metropolitan areas engage in more in-house service activities than their counterpart, and that no statistically significant link exists between external outsourcing and in-house service activities. Overall, our results suggest that export activities and overseas FDI networks are key determinants of the extent of in-house service provisions within Korean manufacturing firms.

JEL Classification: L60, L23, L80, M11, F14

Keywords: Servicification, Outsourcing, Vertical Integration, Global Value Chains

I. Introduction

Over the past few decades, the global economy has experienced an increase in the importance of service activities in production and consumption areas. Services contribute greatly to an economy, through their direct contribution to total output and final demand, and indirectly through their industrial linkages with other industries, particularly manufacturing. Currently, manufacturing firms use more intensive service inputs in their production process than before and increasingly offer services to their customers, a phenomenon often referred to as the

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“servicification of manufacturing” in the related literature.

Service value-added embodied in manufacturing accounts for 40%–60% of the total manufacturing output in OECD countries (Miroudot and Cadestin, 2017). The number of workers performing service-related tasks within the manufacturing sector has grown, whereas the number of workers performing traditional production work has gradually decreased (Pilat and Wölfl, 2005; Miroudot and Cadestin, 2017). As the boundary between manufacturing and services blurs, servicification, especially related to knowledge-based services, such as R&D, design, marketing, and engineering, is emerging as a central strategy for manufacturers to differentiate their products and improve overall efficiency.

Service inputs used in the process can be outsourced externally or produced in-house by manufacturers (Table 1). A firm may outsource from specialized domestic service providers or through foreign outsourcing. It can also vertically integrate the production of services within its boundaries, either by in-house production or intra-firm transactions with affiliated firms at home or abroad. Firms’ decisions on integrating or specializing in a particular value chain have been extensively discussed in the literature since Coase’s (1937) seminal work (Williamson, 1975, 1979; Grossman and Helpman, 2002; Antras and Helpman, 2004). This research suggests that make-or-buy decisions depend on transaction costs incurred due to incomplete contracts, such as search costs to find appropriate suppliers, negotiation costs, and coordination costs.

[Table 1] Modes of Sourcing by Ownership and Location

		Ownership decision	
		Vertical Integration	Vertical Specialization
Location decision	Home	In-house production or Spin-off and intra-firm sourcing	Domestic outsourcing (Buying in from an independent domestic supplier)
	Abroad	Offshore insourcing (FDI and intra-firm trade)	Offshore outsourcing (Inter-firm/arm’s length trade)

Source: Construction based on Antras and Helpman (2004).

Depending on the firms’ cost structure and specific characteristics, they opt for different organizational structures regarding service provisions. No compelling reason indicates regarding one strategy as universally better than another. In extreme cases, manufacturers can transform into “factoryless goods producers,” whose headquarters focus their capabilities exclusively on core service functions, while their production is widely outsourced. Notable examples are Apple, Nike, and Dyson. Other multinational enterprises also have substantially expanded their in-house service provision with the accelerated pace of globalization and rapid

expansion of global value chains.¹

Although an extensive body of empirical research has investigated the outsourcing patterns of manufacturing firms², the issue of service-related vertical integration remains largely unexplored in the literature. Current empirical literature focuses on the outsourcing of material intermediate inputs, such as parts and components, without explicitly considering its linkage to in-house service provision. As aforementioned, the decisions firms make regarding material outsourcing are closely interrelated with the extent of in-house service provision.

This study fills a gap in the literature by exploring the servicification phenomenon from a unique perspective. Specifically, we empirically investigate the key determinants of in-house service activities rather than outsourcing within manufacturing firms.³ The extent of in-house service activities is measured as the proportion of workers performing knowledge-intensive core service functions.

Our empirical research is based on an extensive establishment-level panel dataset of Korean manufacturing from 2006 to 2019. Korea presents an interesting case for this research because its manufacturing sector still accounts for a relatively high share of GDP compared with other OECD countries, whereas manufacturing, as a share of employment, has rapidly converged to OECD averages (Figure 1). At the same time, the share of service-related workers within manufacturing firms has increased in recent years. From 2011 to 2018, this share increased from 48.4% to 51.5%, primarily due to an increase in R&D professionals and administrative clerks (Lee and Choi, 2020). By contrast, the proportion of production workers decreased by 6.4 percentage points during the same period.

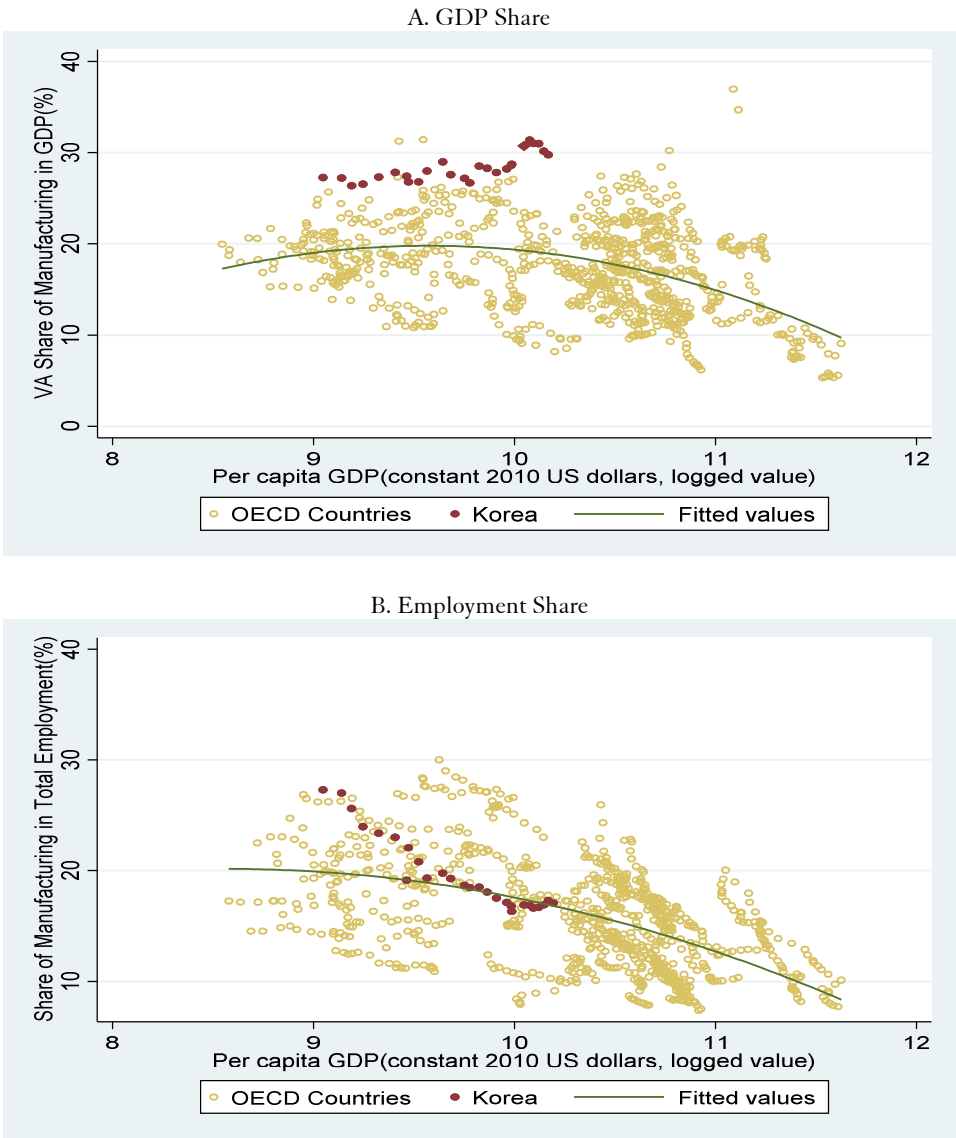
We find evidence of a complementary relationship between production outsourcing and in-house service provision, but the statistical significance of this relationship varies depending on the empirical methods applied. Our estimation results reveal that companies with higher export intensities, wider networks of overseas subsidiaries, or those located in metropolitan areas engage in more in-house service activities than their counterpart. However, the presence of domestic subsidiaries and outsourcing activities does not significantly affect in-house service activities. Our findings suggest that Korean manufacturing firms' export activities

¹ For example, Samsung electronics strengthened its R&D function by establishing "Samsung Research" as an integrated in-house research unit in 2017. The share of service task-related workers in its total employment of Samsung electronics greatly increased from 24.2% in 2006 to 53.5% in 2018 (Lee & Choi, 2020).

² See Girma and Görg (2004), Tomiura (2005), and Holl (2004) and Diaz-Mora (2008) for the manufacturing cases in the U.K., Japan, and Spain, respectively.

³ Unfortunately, our data do not allow to distinguish between domestic and cross-border outsourcing over most of our sample period. Admittedly, this is a clear limitation of our research. Beginning in 2019, the Korean Survey of Business Activities started to provide separate information on domestic and foreign outsourcing. Consequently, we must limit our investigation to the effect of "total outsourcing," which comprises domestic and foreign outsourcing in this paper.

[Figure 1] GDP and Employment Shares of the Manufacturing Sector (OECD, 1991–2018)



Source: OECD STAN Database.

and FDI networks largely determine the extent of in-house service provision. Given that export activities provide greater incentives to differentiate from the products of foreign competitors, effectively meet overseas demand, and improve productivity, exporting firms tend to strengthen their knowledge-based service functions, such as R&D, design, and marketing. In addition, firms with a wider network of foreign subsidiaries may focus their capabilities exclusively on core service functions while outsourcing their production extensively.

We assert that this research area has recently gained increased importance and relevance from academic and policy perspectives, considering disruptions in global value chains, reshoring, and rapid digital transformation. As disruptions persist in supply chains, many firms are now readjusting their business models and refocusing on strengthening their value chains' vertical integration. Digital transformation serves as another catalyst for the in-house service provision.

The remainder of this paper is organized as follows. Section II introduces a brief literature review of manufacturing servicification. Section III discusses the estimation strategy and data sources. Section IV presents our analytical results on the key determinants of in-house service activities. Concluding remarks are provided in Section V.

II. Literature Review

The servicification of manufacturing has expanded globally, leading to a surge in policy and academic interest in intermediate services embodied in goods. Although transportation, telecommunications, finance, and logistics services allow manufacturing tasks to be dispersed internationally, knowledge-intensive services, such as engineering, R&D, marketing, design, and advertising, are becoming increasingly vital for manufacturing productivity growth.

Guerrieri and Meliciani (2005) argued that the competitiveness of the service economy depends on the manufacturing sector, because manufacturing firms are heavy users of knowledge-intensive services. They showed that finance, IT, and business services experienced faster growth than any other service type in OECD countries from the mid-1970s to the early 1990s, particularly in terms of intermediate demand (5.1% per annum) than gross output (1.0% per annum). Miozzo and Soete (2001) explained that the increasing complexity of production process and coordination problems in introducing and applying new technologies promote servicification in manufacturing.

Pilat and Wölfl (2005) used OECD input-output tables to examine the relationship between manufacturing and services. They discovered that services' contribution to manufacturing had consistently grown by the mid-1990s, accounting for about 20%–25% of manufacturing value added among OECD countries. Their analysis also indicated that up to 50% of manufacturing workers are engaged in service-related tasks. Miroudot and Cadestin (2017) reported that the contribution of services to manufacturing value-added in OECD countries amounts to 40%–60% in the early 2010s.

As aforementioned, firms can engage in service through several channels. On the intermediate input side, they can outsource service inputs domestically or internationally or produce them in-house by allocating more resources to service

functions, such as R&D, design, marketing, IT, administration, and management. Furthermore, firms can sell services bundled with goods, a phenomenon called “servitization.” Crozet and Milet (2017) used French firm-level data and found that 76% of manufacturing firms sell services, and 22% sell more services than goods.

Service outsourcing activities have been intensively analyzed in the literature. Transaction cost theory suggests that the decision to internalize certain activities within a firm or outsource them externally depends on transaction costs (Williamson, 1975, 1979). These costs comprise search costs for finding suitable suppliers, negotiation costs, coordination costs, and costs resulting from incomplete contracts. When transaction costs are low, a firm prefers to buy goods or services in the market. Otherwise, internalizing the transaction within the firm is the optimal decision. Grossman and Helpman (2002) provided a theoretical framework for firms’ decisions between outsourcing and in-house vertical integration. Their general equilibrium model suggests that outsourcing is likely to occur when external producers have a great cost advantage or bargaining power, and competition among final producers is not intense.

From the perspective of international trade, Antras and Helpman (2004) developed a theoretical model for global outsourcing, considering productivity and sectoral heterogeneity. Grossman and Rossi-Hansberg (2008) proposed a similar model for global value chains, showing that foreign outsourcing can allow workers to specialize in tasks where they are most productive, thereby increasing their productivity and wages.

Given these theoretical models, numerous studies have provided empirical evidence on outsourcing. Girma and Görg (2004) investigated the determinants of outsourcing and its influence on productivity using establishment-level data from the U.K. manufacturing sector. They confirmed that cost savings are the key motive for service outsourcing, and that outsourcing intensity positively correlates with labor productivity. Amiti and Wei (2005) used U.S. manufacturing data and showed that service outsourcing positively correlates with labor productivity, but material outsourcing is not.⁴ Abramovsky and Griffith (2006) examined the influence of ICT on firms’ sourcing choices, and found that more ICT-intensive firms tend to purchase more services in the market and are more likely to purchase offshore than their less ICT-intensive counterparts.

A growing number of studies have shed light on the servitization phenomenon, that is, integrated product-service offerings (Fang et al., 2008; Crozet and Milet, 2017; Ariu et al., 2020). Although the servitization of manufacturing has been explored across various academic fields, the economics community has only recently

⁴ Olson (2006) provided an excellent survey of empirical studies on offshore outsourcing and its influence on productivity.

started to pay special attention to this research area.⁵ Miroudot and Cadestin (2017) used the ORBIS database, from which they discovered that a significant proportion of firms across countries sell services bundled with material products. Fang et al. (2008) that the effects of service sales on firm value, measured by Tobin's q , depends on firm and industry characteristics. The effect is considerable if firms surpass a certain threshold of service sales (20%–30% of total sales) and if service sales closely relate to their core business. Crozet and Milet (2017) examined the effect of servitization on firm performance in the French manufacturing sector, revealing that servitization positively contributes to profitability, employment, total sales, and goods sales. On the basis of an oligopolistic competition model, Ariu et al. (2020) showed that servitized exporters outperform their non-servitized counterparts.

Finally, the servicification of manufacturing through the increased in-house service provision is arguably one of the least explored research topics in the literature, primarily due to data availability issues. However, several studies require close attention. Pilat and Wölfl (2005) showed that the share of service-related workers within the manufacturing sector has steadily increased, implying ongoing servicification. Miroudot and Cadestin (2017) examined changes in the employment structure in the manufacturing sectors of 31 countries. They found that in-house service provision accounts for approximately 10%–15% of manufacturing value added. Lodefalk (2014) explained that, in the case of Sweden, a high proportion of in-house service production yields a high export intensity.

III. Empirical Strategy

3.1. Empirical Specification

Several empirical studies have investigated the determinants of outsourcing. These studies consider labor costs, firm size, ownership structure, and export propensity as major explanatory factors for outsourcing intensity (Diaz-Mora, 2008). This study explores the key determinants of in-house service activities using an establishment-level panel dataset comprising all establishments in Korea with at least 50 regular employees and over 300 million won in capital.

Girma and Görg (2004) presented empirical evidence that cost savings are the key motive for service outsourcing in the U.K. manufacturing sector. Holl (2004) suggested that higher labor costs lead to an increased probability of external subcontracting. These findings appear to align with transaction cost theory.

⁵ See Baines et al. (2009) for a comprehensive literature review on the servitization of manufacturing from these fields.

However, mixed results exist regarding firm size and ownership structure. If economies of scale and scope are present in producing specific service inputs, then only companies above a certain minimum efficiency threshold will internalize the production of these inputs, whereas small firms will opt for outsourced procurement over in-house production. However, given that small firms will face relatively higher information acquisition and search costs than large firms when outsourcing, small firms will not benefit from outsourcing. Therefore, the overall relationship between firm size and outsourcing intensity remains ambiguous.

Similarly, existing studies have produced inconclusive results on the effect of foreign ownership on outsourcing intensity (Girma and Görg, 2004; Holl, 2004). At first glance, foreign-owned companies may be more active in outsourcing, especially offshoring, based on their global production network. However, service outsourcing may remain low if their domestic production mainly specializes in manufacturing functions, such as operations and assembly within value chains. In this study, we consider these factors and examine how they affect the extent of in-house service activities instead of outsourcing.

Lodefalk (2013) studied firm- and enterprise group-level data from the Swedish manufacturing sector. They found that a high degree of in-house service production is detected when enterprise-level data are employed. This finding illustrates that in-house service production can be underestimated when using firm-level data because subsidiaries can supply some service support functions within an enterprise group specializing in services. Although this paper is based on establishment-level data, it attempts to overcome the limitations of establishment-level data by utilizing information on parent companies and their subsidiaries included in the data.

Another important issue in the analysis is the relationship between outsourcing and in-house service activities. We expect production outsourcing to increase the intensity of in-house service activities as firms redirect their resources into service functions. However, the relationship between service outsourcing and in-house provision remains ambiguous. On the one hand, intense outsourcing of services may substitute for in-house service activities. Depending on transaction costs, certain activities may be internalized at the expense of external outsourcing. On the other hand, an increase in the in-house service provision can boost demand for the external outsourcing of supplementary service functions (Abramovsky and Griffith, 2006).

On the basis of the above discussion, this study adopts the following estimation specification, relating in-house service activities to a broad range of firm characteristics:

$$\begin{aligned}
 SER_{it} = & \beta_0 + \beta_1 OWN_{it} + \beta_2 LOC_{it} + \beta_3 OUT_{it} + \beta_4 RD_{it} + \beta_5 EX_{it} + \beta_6 SUBF_{it} \\
 & + \beta_7 SUBD_{it} + \Omega'_{it}\psi + \Psi'_{it}\xi + D'_t\delta + T'_t\varpi + \varepsilon_{it}, \quad (1)
 \end{aligned}$$

where i represents the individual firm, and t is the period from 2006 to 2019. The dependent variable SER_{it} is the extent of in-house service provision for firm i in year t , measured as the proportion of workers engaging in knowledge-intensive core service functions, such as R&D, design, IT, administration, and management out of total employment. OWN_{it} is a dummy variable for foreign ownership. LOC_{it} is a location dummy, and we assign a value of 1 to firms in the Seoul metropolitan area. OUT_{it} is the outsourcing cost, which is a proportion of the total sales. RD_{it} and EX_{it} represent the share of R&D expenditure from total sales and export intensity, respectively. $SUBF_{it}$ and $SUBD_{it}$, the number of subsidiaries abroad and at home, respectively, are also included in the estimation to overcome the limitations of establishment-level data.⁶ Ω_{it} is the vector of log-transformed variables controlling for firm size, such as the total number of regular workers, amount of total sales, and value of total assets.

In addition, Ψ_{it} is the vector of dummy variables for outsourcing activities, such as manufacturing production, distribution, cleaning services, and knowledge-intensive services. D_i is the vector of individual firm-level fixed-effect dummies for controlling unobserved firm-specific characteristics. Finally, T_t is the vector of year dummies; ψ, ξ, δ , and ϖ are vectors of coefficients; and ε_{it} is the error term.

We employ various estimators, including ordinary least squares (OLS) and least square dummy variable (LSDV) estimators. However, our preferred specification is the system generalized method of moments (system GMM hereafter), as proposed by Blundell and Bond (1998).⁷ This approach is suitable for dynamic longitudinal data with moderately persistent series. It includes the regression in differences and the regression in levels using lagged differences as instruments. By doing so, the system GMM estimator controls for potential endogeneity problems arising from unobserved heterogeneity, simultaneity, and other dynamic endogeneity sources. Selecting the appropriate lag length for the instruments is critical in system GMM estimation. We adopt Roodman's (2007) approach to restrict the number of lags to a maximum of medium length and then check the robustness of the results by varying the lag length. Thus, we restrict the lagged instruments to a maximum of six, but our regression results remain robust when using instruments with approximately three to five lags.

3.2. Data Source and Description

We obtain our data from the Survey of Business Activities, which were collected

⁶ We initially included information on the parent company in the regression analysis; however, given that the statistical significance of the estimated coefficient was low, we excluded it from our main estimation specification.

⁷ See Blundell and Bonds (1998) for detailed information on the system GMM estimator.

by the Korea National Statistical Office (Statistics Korea). This comprehensive longitudinal dataset encompasses all establishments in Korea that have a minimum of 50 regular employees and a capital exceeding 300 million won.⁸ It contains establishment-level information, including the number of workers, legal status, asset structure, financial information, domestic sales, exports, information on parent and affiliated companies, intra-firm trade, R&D, and outsourcing activities. The period for our analysis is 2006–2019. Table 2 reports the descriptive statistics of the key variables in our estimation.

[Table 2] Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
Share of Core Service Workers (%)	28.23	20.44	0.04	100	1.32	4.72
Foreign Ownership (Foreign=1)	0.12	0.33	0	1	2.32	6.4
Location (Metropolitan=1)	0.54	0.5	0	1	−0.15	1.02
Outsource Costs/Total Sales (%)	8.18	27.34	0	5,420	118.48	20,840.18
R&D Expenses/Total Sales (%)	2.14	21.34	0	4,442	163.83	31,049.29
Exports/Total Sales (%)	18.19	26.16	0	100	1.56	4.45
Number of Foreign Subsidiaries	0.74	2.21	0	77	11.07	233.3
Number of Domestic Subsidiaries	0.57	1.54	0	43	6.33	75.37
Number of Regular Workers (logged)	4.94	0.85	0.69	11.6	1.72	8.06
Total Sales (logged)	5.77	0.8	−4.88	10.1	0.14	5.22
Total Assets (logged)	5.71	0.85	−2.68	10.9	−0.03	4.08
Production Outsource (Dummy)	0.48	0.5	0	1	0.09	1.01
Distribution Outsourcing (Dummy)	0.41	0.49	0	1	0.35	1.12
Cleaning Outsourcing (Dummy)	0.36	0.48	0	1	0.59	1.35
KIS Outsourcing (Dummy)	0.02	0.15	0	1	6.52	43.45
Other Outsourcing (Dummy)	0.02	0.14	0	1	6.68	45.56

As for employment, the Survey of Business Activities contains the number of establishments’ regular and irregular workers. Regular workers are classified according to task type, services, manufacturing, and other functions. The number of regular workers for each function is further divided into those working at an establishment’s headquarters and those working outside of it. In addition, service-related workers outside headquarters are divided into those engaging in sales, distribution/delivery, R&D, construction, and other services. In this study, the extent of in-house service activities is measured as the proportion of workers engaging in knowledge-intensive core service functions, such as R&D, design, IT, administration, and management, as a share of total employment. Therefore, we select two types of service task as knowledge-intensive core service functions in the data: core service-related workers at headquarters and R&D professionals working

⁸ It also covers smaller establishments in the service sector that have fewer than 50 regular employees, but more than 1 billion won in capital.

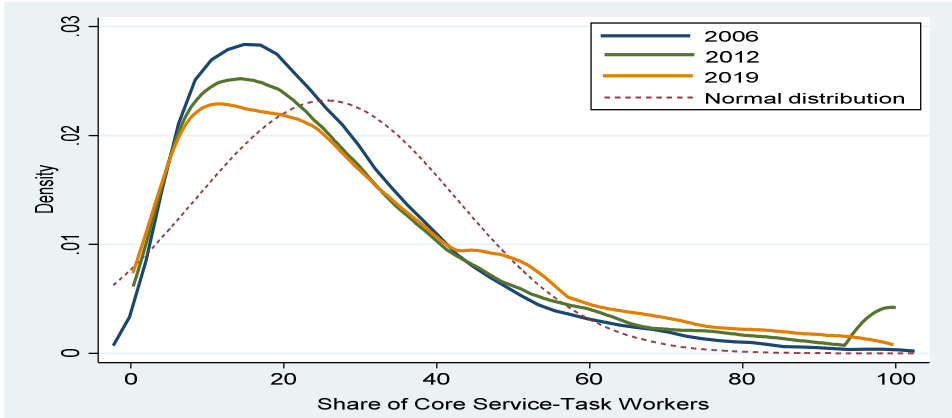
outside headquarters.

Firms with a foreign equity share of 10% or more are regarded as foreign investment companies. As for subsidiaries, the data contain the number of domestic and foreign subsidiaries and related companies and their annual investment. In the analysis, subsidiary-related explanatory variables are constructed using the number of domestic and foreign subsidiaries and related companies.⁹ Finally, the data reflect whether outsourcing is used for functions such as production, information processing, design/planning, marketing, R&D, logistics, cleaning, personnel management, accounting, education/training, and welfare. Particularly, we consider information processing, design/planning, marketing, and R&D to be knowledge-intensive.

IV. Empirical Results

Figure 2 presents firms' distributions of the share of core service task workers in total employment for 2006, 2012, and 2019 based on kernel density estimation.¹⁰ The figure shows that the distributions are right-skewed, with a mean of 28.2% for the entire period from 2006 to 2019. Over time, the proportion of companies in which core service task workers make up more than 40% of all employees is gradually increasing.

[Figure 2] Share of Core Service Task Workers: 2002, 2012, and 2019



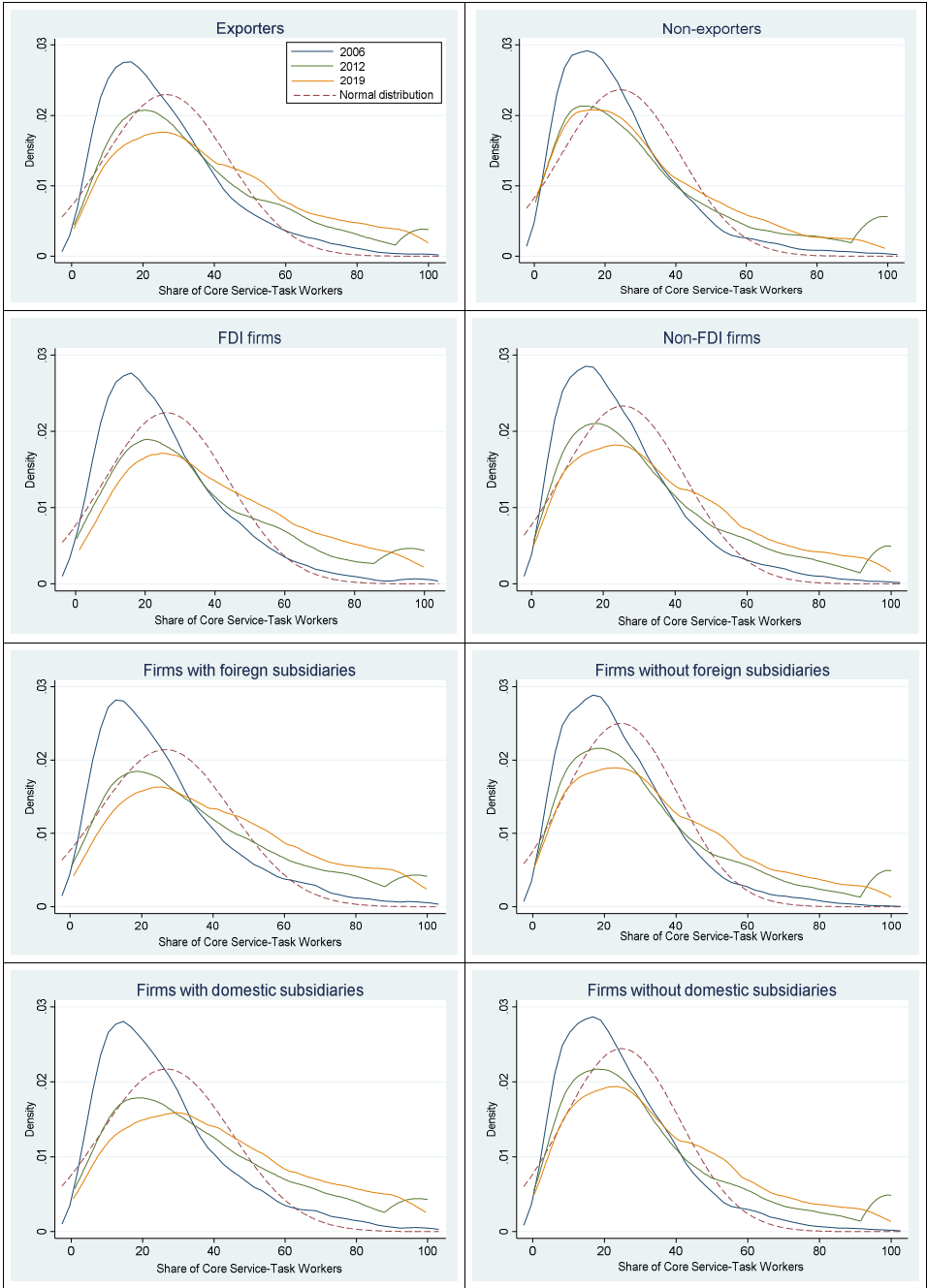
Source: Author's construction based on estimation results.

⁹ The first two years of our sample do not contain the information on foreign subsidiaries. Given that the number of subsidiaries does not change considerably in a short period of time, the figures for 2008 are used to proxy for the two years to avoid a decrease in the number of samples. In a similar logic, the 2019 R&D figure is proxied by that of the previous year. For a robustness check, we include the regression analysis confined to the sample of 2008 to 2018 in Table 6.

¹⁰ We use the Epanechnikov kernel density function to estimate these distributions.

In Figure 3, we present the changes in the intensity of core service task workers for different subgroups.

[Figure 3] Share of Core Service Task Workers by Group: 2006, 2012, and 2019

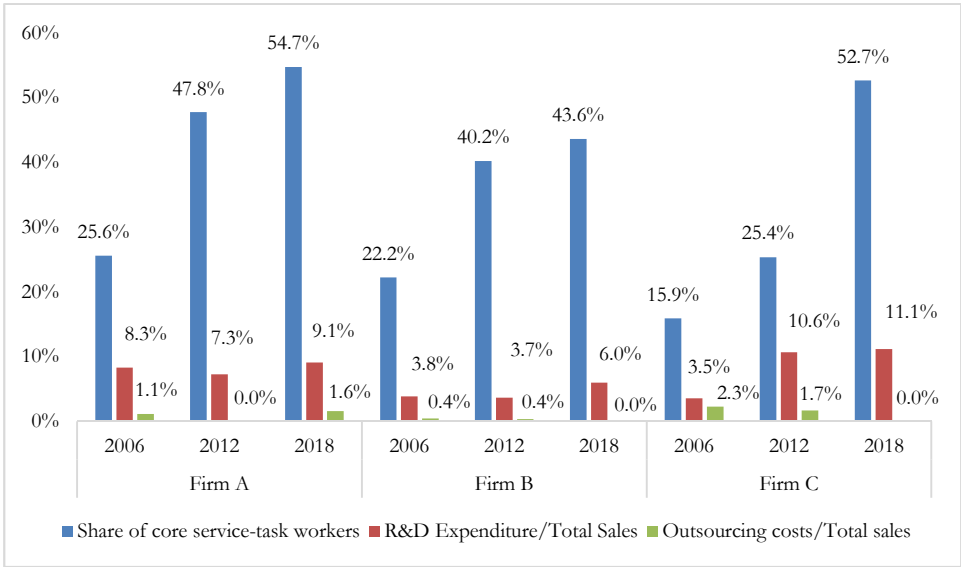


Source: Author's construction based on estimation results.

The exporter group underwent a more significant shift in the proportion of core service task workers compared to the non-exporter group. In 2006, the distributions for both groups were quite similar; however, by 2019, exporters had higher mean (30.2% versus 25.8%) and median values (25.2% versus 21.1%) than non-exporters. The distribution of the former group shows higher variance but lower skewness than the latter. Conversely, we found no consistent differences in the evolution pattern of the share of core service task workers between FDI and non-FDI firms. Similar observations emerge when we compare firms with foreign or domestic subsidiaries; however, those with subsidiaries tend to show a slightly higher density of firms with a share of 40% or more core service task workers.

Figure 4 presents the trends in the share of core service task workers, R&D intensity, and outsourcing costs for the three largest companies in terms of total sales from the sample. Firm A, the largest company with over 100 thousand regular workers, is a multinational electronics corporation with 22 domestic subsidiaries and 55 subsidiaries abroad. It accounts for 8.1% of total sales and 17.8% of total exports in the entire sample for 2018. Firms B and C are world-renowned manufacturers of automotive and electronics, respectively. Together, the three firms account for 5.2% of regular workers, 8.1% of total sales, and 24.1% of total exports in the sample. We confirm that all three firms experienced a substantial increase in the share of core service workers, especially R&D professionals. At the same time, little evidence shows that they are engaging in outsourcing. Thus, we can deduce that many of these firms' services are in-house services.

[Figure 4] Intensities of In-house Services, R&D, and Outsourcing (Top 3 Firms)



Source: Author's calculation.

Table 3 shows outsourcing activities by firm size as of 2019. The most common outsourced tasks include consigned production, distribution/delivery, and cleaning/security services. The proportion of companies outsourcing knowledge-intensive services is extremely low, which becomes even more evident as the company size decreases. Generally, the larger the company is, the higher the proportion of companies that utilize outsourcing will be. However, even for companies with more than 1,000 regular workers, the proportion of firms outsourcing core services, such as R&D, design, marketing, accounting, and personnel management, is less than 25%, except for ICT outsourcing (37.4%).

[Table 3] Outsourcing Activities by Firm Size (2019)

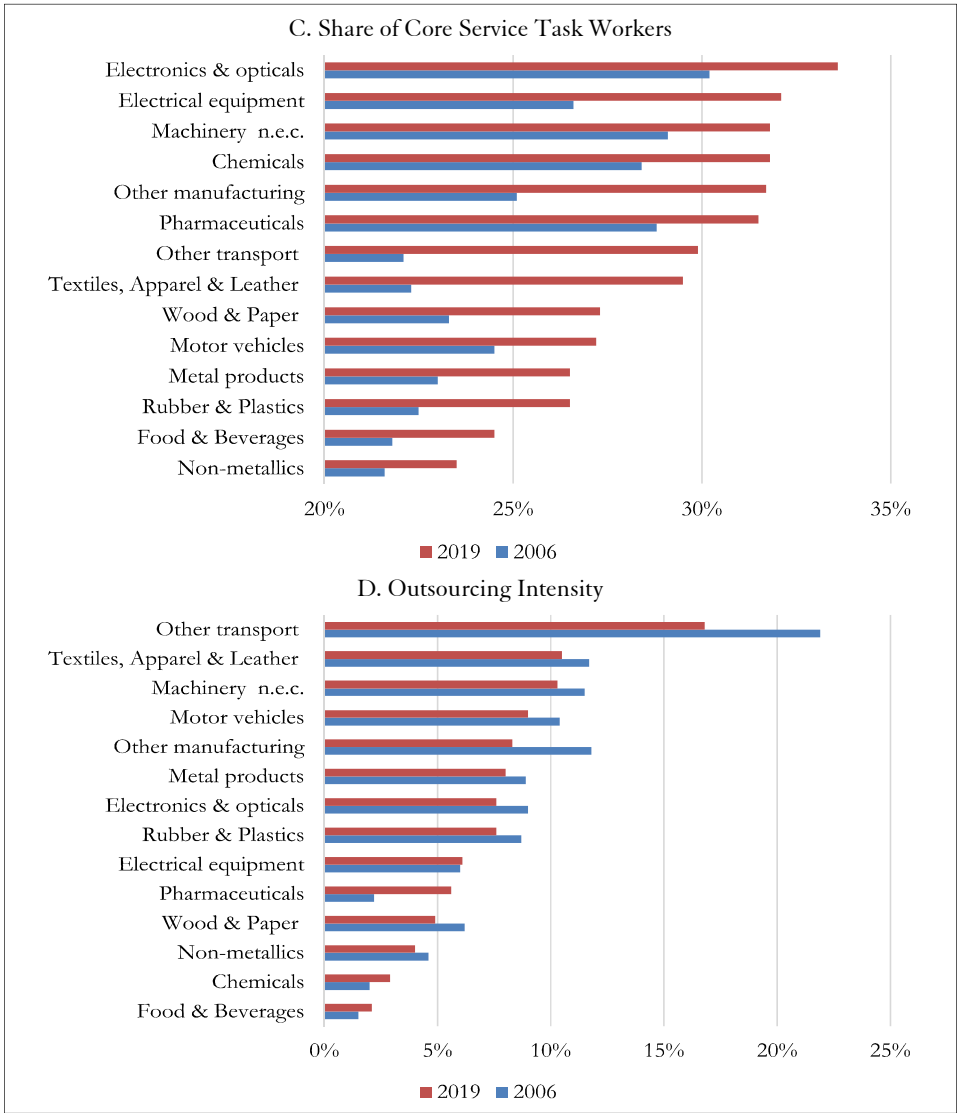
	No more than 100 workers	101–300 workers	301–500 workers	501–1,000 workers	More than 1,000 workers
No Outsourcing	23.2%	15.6%	12.4%	8.6%	4.4%
Production	47.2%	51.4%	55.3%	56.8%	59.3%
Distribution	38.7%	46.1%	50.8%	55.1%	64.8%
Cleaning/security	33.3%	45.2%	58.1%	63.4%	76.9%
Finance/Accounting	17.1%	12.3%	8.9%	11.3%	17.0%
ICT	4.4%	6.6%	12.9%	15.8%	37.4%
Design/Planning	4.1%	4.7%	7.9%	7.2%	18.1%
Marketing	1.4%	2.2%	4.3%	7.5%	22.0%
R&D	5.8%	7.8%	12.7%	11.3%	22.0%
Personnel management	5.3%	6.4%	4.8%	5.8%	11.0%
Training	8.1%	10.6%	9.9%	15.8%	25.8%
Welfare	3.0%	3.4%	4.6%	5.1%	15.9%
Others	2.6%	2.5%	1.5%	2.1%	1.6%

Finally, Figure 5 depicts the change in the industry sector's share of core service task workers and outsourcing intensity from 2006 to 2019. Outsourcing intensity is measured as the ratio of total outsourcing expenses to total sales values. From the figure, the share of core service task workers increased in all the industrial sectors over the sample period. As of 2019, this share was the highest in the electronics and optics sector, followed by electrical equipment, machinery, and chemicals. It is relatively low in industries such as non-metallics, food and beverages, and rubber and plastics; however, even in these industries, it increased significantly during the sample period.

Overall, we find that in-house service activities within manufacturing firms expanded from 2006 to 2019, whereas outsourcing did not expand significantly. Conversely, except for the pharmaceutical industry, outsourcing intensity stagnated or decreased in all industries during this period. Other transport equipment and manufacturing industries showed the largest decrease in outsourcing intensity, whereas the proportion of outsourcing expenses in total sales generally increased or

decreased by 1–1.5 percentage points in other industries.

[Figure 5] Share of Core Service Task Workers versus Outsourcing Intensity



Note: Outsourcing intensity is measured as the ratio of total outsourcing expenses to total sales.
Source: Author's calculation.

Table 4 presents the estimation results for the sample. Columns 1–3 present the OLS results, Column 4 shows the LSDV results¹¹, and Column 5 shows the system

¹¹ Time-invariant variables, such as foreign ownership and location, are not removed in the regression, because some firms experienced changes in ownership or location of headquarters over the sample period.

GMM estimation results. As shown in Table 5, the test statistics generally confirm the validity of the instruments used in our estimation. In the case of system GMM estimation, we check the validity of the instruments used in the analysis by employing the Hansen test. In addition, given that the validity of the instruments also requires the absence of second-order serial correlation in the error terms, we adopt the Arellano–Bond autocorrelation test.

The estimated coefficients for the explanatory variables generally show statistical significance in OLS and LSDV estimations. Initially, we observe a positive influence of foreign ownership on in-house service provision using OLS and LSDV estimations. However, the estimated coefficient for foreign ownership is statistically insignificant when using the system GMM estimation. However, this result is sensitive to model specifications. When we include R&D and export dummies instead of their intensities in the system GMM regression, the estimated coefficient for foreign ownership becomes positive and statistically significant at the 5% level.

Firms in the Seoul metropolitan area tend to engage in high-intensity in-house service activities, a result that is robust across estimation methods. Specifically, these firms have a 2.3–3.8 percentage point higher proportion of core service task workers in total employment compared with firms in other locations. However, we find mixed results for outsourcing intensity, measured by outsourcing costs as a proportion of total sales. For OLS and LSDV approaches, our results indicate a positive effect of outsourcing intensity on in-house service activities, implying that in-house service provision and outsourcing are complementary. However, given that the system GMM estimator is our preferred estimation approach because it controls for potential endogeneity bias, we conclude that no clear relationship exists between in-house service provision and outsourcing once other firm-specific characteristics are controlled for in the estimation.

The system GMM estimation results also show that export intensity is a statistically significant determinant of in-house service activities, whereas the estimated coefficient for R&D intensity is positive but with little statistical significance. As aforementioned, replacing the R&D intensity variable with the R&D dummy results in a statistically significant effect of R&D on in-house service activities. Specifically, our estimation indicates that firms engaging in R&D activities have, on average, a 2.9 percentage point higher share of core service task workers than other firms.

We find that foreign affiliates substantially contribute to the increased in-house service provision, suggesting a close link between the decision to engage in in-house service provision and global value chains. Firms' networks of domestic subsidiaries have little influence on the extent of their in-house service activities.

As discussed earlier, existing literature provides mixed results on whether firm size is a determinant of outsourcing activities. Our results suggest that the effect of firm size depends on the choice of size variables. In our analysis, several variables,

[Table 4] Estimation Results I (Whole Sample)

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) LSDV	(5) System GMM
Foreign Ownership	1.442*** (0.405)	1.525*** (0.406)	1.589*** (0.404)	1.050*** (0.391)	0.317 (0.404)
Metropolitan Region	3.701*** (0.274)	3.719*** (0.275)	3.682*** (0.274)	2.573*** (0.268)	2.492*** (0.486)
Outsource Costs/Sales	0.022* (0.011)	0.022* (0.012)	0.019* (0.010)	0.012* (0.007)	-0.182 (0.135)
R&D Expenses/Sales	0.081* (0.045)	0.081* (0.045)	0.081* (0.045)	0.067* (0.035)	0.327 (0.213)
Exports/Sales	0.043*** (0.005)	0.043*** (0.005)	0.042*** (0.005)	0.025*** (0.005)	0.025*** (0.006)
Foreign Subsidiaries	0.628*** (0.078)	0.629*** (0.077)	0.621*** (0.077)	0.502*** (0.066)	0.458*** (0.100)
Domestic Subsidiaries	0.025 (0.100)	0.040 (0.100)	0.056 (0.100)	0.142 (0.093)	-0.043 (0.085)
No. of Workers (logged)	-5.808*** (0.189)	-5.820*** (0.189)	-5.918*** (0.190)	-6.035*** (0.184)	-4.523*** (0.697)
Total Sales (logged)	1.380*** (0.279)	1.327*** (0.279)	1.272*** (0.277)	1.966*** (0.261)	1.399*** (0.337)
Assets (logged)	2.997*** (0.245)	2.868*** (0.252)	2.839*** (0.251)	2.944*** (0.240)	2.006*** (0.377)
Production Outsourcing			1.608*** (0.234)	0.987*** (0.223)	0.302 (0.955)
Distribution Outsourcing			-0.121 (0.239)	0.151 (0.230)	-0.086 (0.803)
Cleaning Outsourcing			0.622** (0.242)	0.405* (0.232)	-0.230 (1.527)
KIS Outsourcing			0.749 (0.596)	0.419 (0.587)	13.052 (8.544)
Other Outsourcing			-0.062 (0.742)	0.269 (0.709)	3.228 (2.799)
Lagged Dependent Variable					0.262* (0.143)
Observations	78,883	78,883	78,883	78,883	68,865
R-squared	0.078	0.082	0.083	0.117	
Firm FE	NO	NO	NO	YES	YES
Year FE	NO	YES	YES	YES	YES
Arellano-Bond Test: AR(1)					0.000
Arellano-Bond Test: AR(2)					0.590
Hansen Test					0.100
Sargan Test					0.141

Note: Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

such as the number of workers, sales amount, and assets amount, are included as proxies for firm size. When the number of workers is used as a proxy for firm size, larger firms exhibit less intense in-house service activities than their counterparts. However, in terms of sales or assets, firm size is positively related to in-house service activities.

Finally, we find evidence suggesting a complementary relationship between production outsourcing and in-house service provision. However, the statistical significance of this estimate also varies depending on the empirical method. In the system GMM estimation, none of the estimated coefficients for the outsourcing-related variables were statistically significant. Possible explanations for these results are as follows. First, the outsourcing variables are simply dummy variables used to determine whether to outsource. Given that they do not contain information on the actual size or scope of outsourcing, these variables do not properly reflect the relationship between outsourcing and in-house services.

Second, as previously mentioned, the relationship between service outsourcing and in-house provision can be ambiguous. Although intense outsourcing of services may substitute in-house service activities, an increase in in-house service provision can also increase the demand for external outsourcing of supplementary service functions.

Third, as shown in Table 3, the proportion of Korean manufacturers that outsource is relatively low. Furthermore, the outsourcing intensity stagnated or decreased for most industries over the sample period (Figure 5). Therefore, outsourcing may not be the main factor affecting the intensity of in-house service activities among Korean manufacturing firms.

We perform various robustness checks for the regression results. Initially, we confirm that qualitative and quantitative results remain robust even when we exclude some variables that do not have a significant effect on the dependent variable. In addition, as mentioned earlier, we run regressions by replacing R&D and export intensities with dummy variables and find that our results still remain.

We also create a balanced panel of firms that remained throughout the entire sample period and conducted the regression analysis again. Table 5 lists the estimation results for this balanced panel. From the table, no substantial changes are observed. For the balanced panel, R&D intensity stands out as a key determinant of in-house service activities, whereas the influence of export intensity becomes statistically insignificant.

Finally, we perform several more system GMM estimations, as shown in Table 6. First, we replace our dependent variable with the share of all service-related workers instead of that of core service task workers. As shown in Column 1, the estimated coefficients for foreign ownership and domestic subsidiaries are positive and statistically significant at the 1% level. This finding suggests that the effects of these variables differ depending on the scope of in-house service provisions. Second,

[Table 5] Estimation Results II (Balanced Panel Sample)

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) LSDV	(5) System GMM
Foreign Ownership	1.362*** (0.492)	1.448*** (0.493)	1.503*** (0.490)	0.970** (0.474)	0.978 (0.603)
Metropolitan Region	2.204*** (0.387)	2.220*** (0.388)	2.222*** (0.386)	1.631*** (0.379)	1.841*** (0.469)
Outsource Costs/Sales	0.019 (0.014)	0.019 (0.014)	0.017 (0.013)	0.010 (0.008)	-0.200 (0.191)
R&D Expenses/Sales	0.785*** (0.144)	0.786*** (0.145)	0.780*** (0.144)	0.625*** (0.124)	0.384*** (0.110)
Exports/Sales	0.029*** (0.007)	0.030*** (0.007)	0.029*** (0.007)	0.018*** (0.006)	0.020 (0.016)
Foreign Subsidiaries	0.590*** (0.093)	0.590*** (0.093)	0.581*** (0.093)	0.491*** (0.079)	0.471*** (0.110)
Domestic Subsidiaries	-0.120 (0.110)	-0.103 (0.110)	-0.086 (0.110)	0.013 (0.105)	-0.126 (0.110)
No. of Workers (logged)	-5.368*** (0.262)	-5.404*** (0.263)	-5.525*** (0.262)	-5.750*** (0.257)	-3.512*** (0.821)
Total Sales (logged)	2.636*** (0.437)	2.608*** (0.439)	2.526*** (0.437)	3.017*** (0.417)	1.982*** (0.438)
Assets (logged)	1.243*** (0.362)	1.110*** (0.376)	1.117*** (0.373)	1.423*** (0.367)	1.547*** (0.430)
Production Outsourcing			1.655*** (0.318)	1.072*** (0.307)	-0.350 (2.017)
Distribution Outsourcing			0.307 (0.323)	0.279 (0.313)	-2.018 (1.638)
Cleaning Outsourcing			0.719** (0.317)	0.509* (0.306)	-6.987** (2.982)
KIS Outsourcing			0.362 (0.793)	0.053 (0.784)	-12.705 (8.733)
Other Outsourcing			0.050 (0.987)	0.292 (0.953)	-0.835 (6.364)
Lagged Dependent Variable					0.239 (0.170)
Observations	39,452	39,452	39,452	39,452	36,600
R-squared	0.083	0.086	0.088	0.120	
Firm FE	NO	NO	NO	YES	YES
Year FE	NO	YES	YES	YES	YES
Arellano-Bond Test: AR(1)					0.001
Arellano-Bond Test: AR(2)					0.917
Hansen Test					0.213
Sargan Test					0.730

Note: Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[Table 6] Estimation Results III (System GMM)

VARIABLES	Whole Sample			Balanced Panel Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Ownership	1.509*** (0.537)	0.143 (0.432)	0.102 (0.395)	2.729** (1.168)	0.848 (1.018)	1.299 (1.072)
Metropolitan Region	6.421*** (1.164)	2.278*** (0.405)	2.108*** (0.443)	5.130*** (1.667)	1.433** (0.580)	1.631** (0.686)
Outsource Costs/Sales	0.013 (0.157)	−0.310* (0.159)	−0.261** (0.132)	−0.259 (0.213)	−0.417* (0.215)	−0.439** (0.220)
R&D Expenses/Sales	0.126 (0.159)	0.178*** (0.064)	0.413* (0.235)	0.342*** (0.126)	0.342*** (0.112)	0.338*** (0.111)
Exports/Sales	−0.006 (0.006)		0.024*** (0.006)	−0.016 (0.017)		0.025 (0.018)
Intra Exports/Sales		−0.000 (0.012)			−0.018 (0.019)	
Intra Imports/Purchases		0.019* (0.010)			0.003 (0.015)	
Foreign Subsidiaries	0.411*** (0.129)	0.501*** (0.102)	0.394*** (0.089)	0.262* (0.154)	0.503*** (0.162)	0.438** (0.178)
Domestic Subsidiaries	0.343*** (0.129)	−0.079 (0.084)	−0.048 (0.084)	0.241 (0.174)	−0.228 (0.143)	−0.188 (0.157)
No. of Workers (logged)	−1.425** * (0.354)	−4.326** * (0.629)	−4.213** * (0.641)	0.467 (1.111)	−2.995** (1.412)	−2.646 (1.680)
Total Sales (logged)	1.652*** (0.429)	0.948*** (0.274)	1.366*** (0.355)	2.339*** (0.789)	2.025*** (0.651)	2.418*** (0.791)
Assets (logged)	2.331*** (0.449)	2.071*** (0.356)	1.824*** (0.352)	2.567** (1.085)	1.534* (0.925)	1.919** (0.904)
Production Outsourcing	0.748 (1.106)	0.962 (1.049)	0.753 (0.973)	4.936** (2.026)	1.675 (2.156)	2.220 (2.315)
Distribution Outsourcing	1.230 (0.977)	0.382 (0.847)	0.013 (0.809)	−5.702 (8.896)	−11.616 (7.649)	−11.571 (8.752)
Cleaning Outsourcing	−3.715** (1.673)	−0.328 (1.533)	−0.491 (1.570)	−21.124 (13.598)	−4.667 (12.526)	−12.167 (13.807)
KIS Outsourcing	−0.627 (9.856)	19.189* (9.924)	15.183* (9.110)	−5.304 (13.897)	−22.913 (16.617)	−22.988 (17.893)
Other Outsourcing	57.186* (33.902)	4.407 (2.935)	3.452 (2.873)	−2.659 (48.913)	−38.202 (55.948)	−50.404 (57.896)
Lagged Dependent Variable	0.235 (0.151)	0.309*** (0.119)	0.352*** (0.125)	0.320 (0.235)	0.326 (0.206)	0.306 (0.234)
Observations	68,865	65,722	63,913	36,600	35,203	33,748
Arellano–Bond Test: AR(1)	0.000107	7.70e-05	3.59e-07	0.0111	0.0574	0.0643
Arellano–Bond Test: AR(2)	0.873	0.333	0.186	0.783	0.621	0.816
Hansen Test	0.184	0.0990	0.117	0.333	0.365	0.465
Sargan Test	0.127	0.222	0.285	0.321	0.892	0.935

instead of the overall export intensity, we include the intensity of intra-firm trade in our estimation. We confirm that the overall export intensity plays a more decisive factor for in-house service activities than in-firm trade intensity. Column 3 reports the system GMM estimations for 2008–2018. The qualitative results do not change significantly when we confine the estimation to the subsample period.

V. Concluding Remarks

In this study, we examine the factors that determine the intensity of in-house service activities within manufacturing firms based on an establishment-level panel dataset from 2006 to 2019. After controlling for unobserved heterogeneity and simultaneity, our regression results show that companies with high export intensities or wide networks of overseas subsidiaries engage in in-house service activities. This finding indicates that export activities and FDI networks play a crucial role in determining the level of in-house service provisions within Korean manufacturing firms. As export activities offer increased incentives to differentiate from the products of foreign competitors, effectively meet overseas demand, and improve productivity, exporting firms tend to strengthen their knowledge-based service functions, such as R&D, design, and marketing. In addition, firms with a wide network of foreign subsidiaries may focus their capabilities exclusively on core service functions while outsourcing production extensively.

However, we cannot find a statistically significant link between service outsourcing and in-house service activities. Several potential reasons for this are as follows. First, this relationship may be empirically ambiguous. Although increased service outsourcing may substitute in-house service activities, an increase in in-house service provision can stimulate demand for the external outsourcing of supplementary service functions. Alternatively, outsourcing may not be the main factor affecting the intensity of in-house service activities within Korean manufacturing firms. Outsourcing intensity is relatively low and stagnated over the sample period.

The servicification of manufacturing is driven by various economic factors, such as the spread of labor-saving technologies in manufacturing, the expansion of global value chains, and ICT development. The emergence of the Fourth Industrial Revolution and the rapid rate of digital transformation are expected to further accelerate these trends by dissolving the barriers between manufacturing and services. In addition, with recent disruptions in global value chains, firms are now readjusting their business models and refocusing on strengthening the vertical integration of their value chains. As a result, servicification issues will become increasingly important and relevant from academic and policy perspectives.

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기업 미시자료를 이용한 제조업체 내 서비스 활동 결정요인 분석

이 시 욱*

초 록 본 논문은 2006-19년 기간을 대상으로 사업체 수준의 패널자료를 이용하여 제조업체 내부에서 이루어지는 서비스 생산활동의 결정요인에 대해 분석하고 있다. 제조업체 내 서비스 생산활동 집약도는 전체 상용근로자 대비 R&D, 디자인, IT, 경영 등 지식집약적 핵심 서비스 업무에 종사하는 근로자의 비중으로 측정한다. 시스템 일반화적률법(system GMM)을 적용해 내생성문제를 제어한 실증분석 결과에 의하면, 수출집약도가 높을수록, 해외 자회사의 네트워크가 클수록, 그리고 수도권에 입지한 기업일수록 기업 내 서비스 생산활동의 집약도가 높은 것으로 나타난다. 반면, 국내 소재 자회사 네트워크와 기업 내 서비스 생산활동의 집약도 간에는 특별한 연관성이 발견되지 않는다. 아울러, 기업의 생산 및 서비스 외주와 기업 내부의 서비스 생산활동 간에도 통계적으로 유의한 대체 혹은 보완 관계가 나타나지 않는 것으로 분석된다. 본 논문의 분석결과는 수출 및 해외투자 활동이 한국 제조업체 내 서비스화를 진전시키는 주요 요인임을 시사한다.

핵심 주제어: 제조업의 서비스화, 외주, 수직적 통합, 글로벌 가치사슬

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