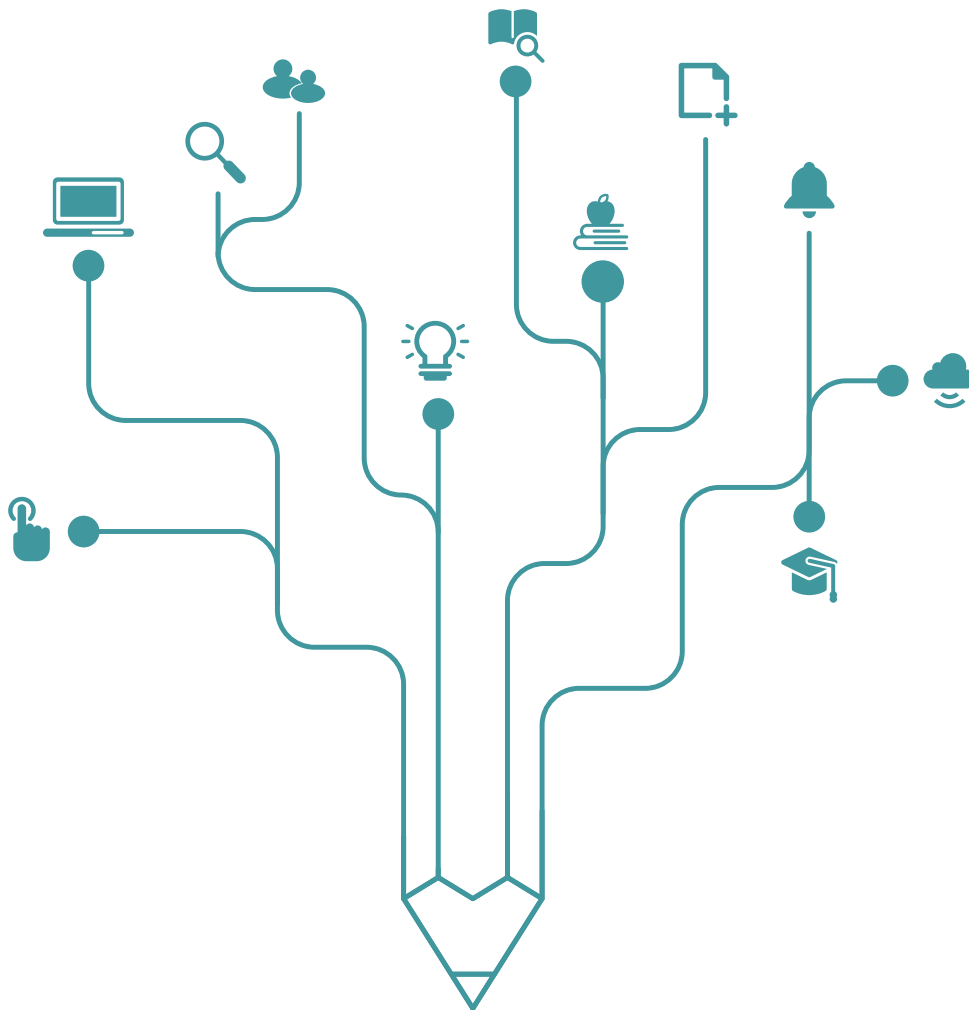# What Determines In-house Service Activities within Manufacturing Firms?: Micro Evidence from Korea

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What Determines In-house Service Activities Within Manufacturing Firms?

Micro Evidence from Korea

Siwook Lee[1]

This paper explores the pattern and determinants of the servicification of Korean manufacturing over the period 2006-2018. We first compute the net contribution of in-house provision of services to manufacturing value added, using data from an employee-level labour survey. We compare this result with domestic and foreign outsourcing to examine the relationship between these different modes of servicification. More importantly, based on an extensive establishment-level panel dataset, this paper empirically investigates the key determinants of in-house service activities within manufacturing firms.

Our analysis suggests that the net contribution of in-house service activities to manufacturing value added was around 18.6~22.5% between 2009 and 2018. At the industry-level, in-house service activities are positively correlated with domestic outsourcing, but negatively correlated with foreign outsourcing. Our regression results indicate that companies with higher export intensities, wider networks of overseas subsidiaries or those located in the Seoul metropolitan area engage in more in-house service activities, while having domestic subsidiaries have no statistically significant effect on in-house service activities. Finally, in contrast to the industry-level results, using firm-level data we find no clear relationship between domestic outsourcing and in-house service activities.

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I.   Introduction

The global economy has witnessed unprecedentedly rapid tertiarisation over the past several decades. Tertiarisation refers to the structural shift of industry structure and employment from the primary and manufacturing sectors to the service sector. Such a shift towards services is often understood as a distinctive characteristic of advanced economies, but the service sector in developing countries has also significantly expanded in recent years. As a matter of fact, in middle-income developing economies, services as a share of GDP increased by about 8.9 percentage points from 1997 to 2017, exceeding the 4.8 percentage points increase in services in high-income countries over the same period.

In the economics literature, tertiarisation has been examined mostly from the perspective of deindustrialization. This strand of research analyses the causes of the long-term decline in manufacturing employment in advanced economies and its impacts on economic growth and income distribution (Rowthorn and Ramaswamy, 1997). Deindustrialization is connected with various socio-economic factors, including rising demand for income-elastic services, unbalanced productivity growth between manufacturing and services, the expansion of global value chains and offshoring, ICT development, aging populations, and the increased participation of women in labour markets (Clark, 1940; Fisher, 1939; Baumol, 1967; Krugman, 1996; Autor et al., 2013). Recently several studies have focused on the so-called 'premature deindustrialization' phenomenon in developing countries and its implications for economic development (Rodrik, 2016).

At the same time, there is a growing tendency to look at the structural shift towards services from the angle of the servicification of manufacturing. Servicification describes manufacturers' expanded use of service inputs in the production process and/or their increased sale of services bundled with their key products (Lodefalk, 2013; Miroudot and Cadestin, 2017). Service inputs can be outsourced externally, to domestic or foreign firms, or produced in-house by manufacturers themselves.

While there is an extensive body of research on service outsourcing in manufacturing, the literature on in-house provision of services is relatively scarce. This asymmetry stems from the relative unavailability of the data required for quantitative analysis of in-house provision of services. In-depth analysis of outsourcing activities can readily be undertaken by exploring business surveys at the micro level or input-output tables at the industry level, but unfortunately it is not the case for in-house service activities. Although manufacturers increasingly engage in service-related tasks, the value added from in-house service activities is attributed to manufacturing GDP in official statistics, such as national accounts and input-output tables. Furthermore, establishment-level or enterprise-level surveys usually do not contain separate information on in-house provision of services.

Given these circumstances, one alternative approach to analysing in-house service

activities is to examine the employment and wage structures of manufacturing firms (Miroudot and Cadestin, 2017). There is strong evidence that the proportion of service-related workers within the manufacturing sector has steadily risen in advanced countries (Pilat and Wölfl, 2005). These workers engage in service tasks such as R&D, design, management, marketing, and sales, which are intermediate inputs in the production process.

Against this backdrop, this paper explores the pattern and determinants of the servicification of Korean manufacturing over the period 2006-2019. Korea is an interesting case for this purpose, because its manufacturing sector still makes up a relatively high share of GDP compared to other OECD countries, whereas manufacturing as a share of employment has rapidly converged to OECD averages (See Figure 1). At the same time, the share of service-related workers within manufacturing firms has risen in recent years. From 2011 to 2018, this share increased from 48.4% to 51.5%, mostly stemming from to an increase in R&D professionals and administration clerks. Meanwhile, the proportion of production workers decreased by 6.4 percentage points over the same period.

This paper fills a gap in the literature in the following way: we first compute the net contribution of in-house provision of services to total manufacturing value added, based on an employee-level labour survey and national account statistics. Then, by combining these results with estimates of domestic and foreign service outsourcing from the OECD's TiVA (Trade in Value Added) dataset, we investigate the relationships among these different modes of servicification in manufacturing. Finally and most importantly, this paper empirically investigates the key determinants of in-house service activities, employing an extensive firm-level panel dataset on Korean manufacturing. Here 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. As far as we know, few studies, if any, have systematically examined the determinants of in-house provision of services, especially using comprehensive establishment-level data like ours.

The results of our analysis suggest that the overall contribution of in-house service activities to manufacturing value added was around 18.6~24.0% between 2006 and 2018. We also find that the overall contribution of intermediate services to manufacturing exports was around 45~49% over the period 2009-2015. Our data indicate that in-house service activities apparently have a substitute relationship with foreign outsourcing, while they are positively correlated with the intensity of domestic outsourcing.

As for the determinants of in-house service activities, our estimation results reveal that companies with high export intensities, wider networks of overseas subsidiaries, or that are located in the Seoul metropolitan area tend to engage in a higher level of in-house service activities. On the other hand, the presence of domestic subsidiaries does not have a significant effect on in-house service activities. Finally, we show that there is no clear relationship between domestic outsourcing and in-house service activities within manufacturing firms.

The structure of this paper is as follows. Section II introduces a brief literature review

on the servicification of manufacturing. Section III discusses our estimation strategy and the results for the contribution of in-house provision of services to manufacturing. In Section IV, we present our empirical specification, data sources, and the analytic results of our analysis of the key determinants of in-house service activities. Some concluding remarks are provided in Section 5.

II.   Literature Review

As the servicification of manufacturing has spread globally, there has been an upsurge in policy and academic interest in intermediate services that are embodied in goods. While transportation, telecommunications, finance, and logistics services allow for manufacturing tasks to be dispersed internationally, knowledge-intensive services such as engineering, R&D, marketing, design, and advertising become a key factor for manufacturing productivity growth

Guerrieri and Meliciani (2005) argue that the competitiveness of the service economy depends on the manufacturing sector since manufacturing firms are intensive users of knowledge-intensive services. They show that finance, IT and business services grew faster than any other types of services in OECD countries from the mid-1970s to the early 1990s, more in terms of intermediate demand (5.1% per annum) than gross output (1.0% per annum). Miozzo and Soete (2001) convincingly argue that the heightened complexity of the production process and the coordination problems that occur in the process of introducing and applying new technologies promote servicification in manufacturing. Using OECD input-output tables, Pilat and Wölfl (2005) examine the interaction between manufacturing and services. They find that services' contribution to manufacturing has grown consistently, and by the mid-1990s accounted for about 20~25% of manufacturing value added among OECD countries. Their analysis also indicates that up to 50% of manufacturing workers are engaged in service-related tasks.

As mentioned above, there are several channels through which firms engage in servicification. On the intermediate input side, they can either outsource service inputs domestically or abroad, or produce them in-house by devoting more resources to service functions such as R&D, design, marketing, IT, administration, management, and so on. Furthermore, firms can sell services bundled with goods, a phenomenon called 'servitisation.'

Among these different modes of servicification, service outsourcing activities have been analysed intensively in the literature. According to transaction cost theory, whether certain activities are internalized within a firm or outsourced externally depends on their transaction costs (Williamson, 1975, 1979). Transaction costs comprise the search costs to find appropriate suppliers, negotiation costs, coordination costs, any costs incurred due to incomplete contracts, and so on. When transaction costs are low, a firm prefers to buy the good

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or service on the market. Otherwise, internalizing the transaction within the firm is the optimal decision. In a similar vein, Grossman and Helpman (2002) provide a theoretical framework for firms' decisions between outsourcing and in-house vertical integration. Their general equilibrium model suggests that outsourcing is more likely to occur when external producers have a great cost advantage or bargaining power and/or the competition among final producers is not intense.

From the perspective of international trade, Antras and Helpman (2004) provide a theoretical model for global outsourcing in the presence of productivity and sectoral heterogeneity. Grossman and Rossi-Hansberg (2006) also propose a similar model for global value chains, showing that foreign outsourcing can allow workers to specialize in the tasks at which they are most productive and thus increase their productivity and wages.

Given these theoretical models, much research provides empirical evidence on outsourcing. For instance, Girma and Görg (2004) investigate the determinants of outsourcing and its impact on productivity using establishment level data from the U.K. manufacturing sector. They confirm that cost savings are the key motive for service outsourcing and outsourcing intensity is positively correlated with labour productivity. Using U.S. manufacturing data, Amiti and Wei (2005) show that service outsourcing is positively correlated with labour productivity, but material outsourcing is not.[2]

On the other hand, a growing number of studies shed light on the servitisation phenomenon, i.e. integrated product-service offerings (Fang et al., 2008; Crozet and Milet, 2017; Ariu et al., 2020; Aquilante and Vendrekk-Herrero, 2019). While the servitisation of manufacturing has been studied within a variety of academic fields such as service science, operations management and service marketing, it is only recently that the economics community has begun to pay special attention to this research area.[3] Using the ORBIS database, Miroudot and Cadestin (2017) present evidence that a significant proportion of firms across countries sell services bundled with material products. Fang et al. (2008) find that the impact of service sales on firm value, measured by Tobin's q, depends on firm and industry characteristics. The impact is larger if firms surpass a certain threshold of services sales (20-30% of total sales), and if service sales are related closely to their core business. Crozet and Milet (2017) examine the effect of servitisation on firm performance in the French manufacturing sector. They show that servitizsation positively contributes to profitability, employment, total sales, and goods sales. Basing on an oligopolistic competition model, Ariu et al. (2020) show that servitised exporters outperform their non-servitised counterparts.

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[2] Olson (2006) provides an excellent survey of the empirical studies on offshore outsourcing and its productivity impacts.

[3] Please see Baines et al. (2009) for a comprehensive literature review on the servitisation of manufacturing from these fields.

Finally, the servicification of manufacturing via the increase in in-house provision of services is arguably one of the least explored research topics in the literature. The apparent reason for this scarcity is the aforementioned data availability issue. Nonetheless, there are several studies that deserve close attention. First, Pilat and Wölfl (2005) show that the share of service-related workers within the manufacturing sector has steadily risen, implying on-going servicification. On top of that, Miroudot and Cadestin (2017) examine changes in the structure of employment in the manufacturing sectors of 31 countries and find that in-house provision of services accounts for around 10-15% of manufacturing value added. And Lodefalk (2014) shows that in the Swedish case, a higher proportion of in-house service production yields higher export intensity.

III.   The Pattern of Servicification in Manufacturing

In this section, we analyse the intensity and pattern of servicification in Korean manufacturing over the period 2009-2018. Following the estimation approach suggested by Miroudot and Cadestin (2017), we first compute the net contributions of in-house service provision to manufacturing value added, using an employee-level labour survey and national account statistics. Then, we combine these results with valued added estimates of domestic and foreign service outsourcing from the OECD's TiVA dataset and investigate the overall contribution of intermediate services to Korean manufacturing exports. In addition, this paper provides new evidence about the relationships among these different modes of servicification in manufacturing.

Miroudot and Cadestin (2017) examine the value added contribution of in-house service activities in manufacturing for 31 major countries, employing a dataset on occupations built with information from labour force surveys. They first decompose manufacturing employment into core manufacturing occupations (operations and assembly) and service-related occupations that serve business support functions (R&D, design, logistics, distribution, marketing, sales, after-sale services, IT services, administration and back-office tasks). Using information on wages from labour force surveys, they calculate each service-related occupation's share of total labour compensation. They assume that capital and other factors of production are used proportionally in production, and estimate the overall contribution of in-house service activities to total manufacturing value added.

For the Korean case in particular, Miroudot and Cadestin (2017) base their estimates on the Korean Labour & Income Panel Study (KLIPS), which is a longitudinal household panel survey about labour market activities. Unfortunately, KLIPS has drawbacks for the purpose of capturing employment and wage structures in the overall manufacturing sector, as its sample consists of the members of only 5,000-12,000 households, who are surveyed on an annual basis.

Furthermore, its sampling is based on districts rather than establishments. In contrast, this paper instead extracts occupation and wage information from the Survey Report on Labor Conditions by Employment Type (SRSC hereafter). The SRSC's sample is drawn from approximately 30,000-50,000 establishments, which are surveyed on an annual basis. The sample takes into account industry composition and establishment size. The 2018 sample consisted of around 800,000 workers. In addition, unlike Miroudot and Cadestin (2017), we extract information on the total amount of value added and employee compensation for manufacturing subsectors from the Bank of Korea's national account and use these in our estimation in order to further reduce potential sample bias.

Our procedure to calculate services as a share of manufacturing value added is as follows: first, based on the Korea Standard Classification of Occupations (KSCO), we compute the total amount of employee remuneration by occupation type at the industry level using employee-level information from the SRSC. Then, by defining 'craft and related workers' and 'equipment, machine operating and assembling workers' as core manufacturing occupations and the rest – with the exception of 'skilled agricultural, forestry and fishery workers' - as service-related occupations, we calculate service-related workers' wages as a share of total wages over the period 2009-2018.[4] Finally, we multiply this share by total labour　as a share of manufacturing value added to get the net contribution of in-house service activities to manufacturing value added.

Figure 2 contains our estimation results. The net contribution of in-house service activities to manufacturing value added was around 18.6~22.5 during the period 2009-2018. It declined from 21.1% to 18.6% during the post-global crisis period from 2009 to2011, due to decreases in both service-related workers' wages as a share of total wages in the manufacturing sector and total labor compensation as a share of value added. The net contribution of in-house service activities to manufacturing value added rebounded by 2016, mainly thanks to a rise in the wages of service-related workers as a share of all manufacturing wages.

In Table 1, we report in-house service activities as a share of manufacturing value added for each manufacturing subsector. As of 2018, in-house service activities in the textile & apparel subsector made up the highest share of value added (37.1%), followed by in-house service activities in other manufacturing (33.0%), general machinery & equipment (29.9%), and transport equipment (27.0%). One interesting observation is that in-house service activities in subsectors such as chemicals and the electrical & electronics industry make a relatively low

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[4] We also re-compute service-related workers' wages as a share of all manufacturing wages by re-arranging service occupations based on a more disaggregate occupation classification, but our quantitative results remain similar. These results are available upon request.

contribution to manufacturing value added. As a matter of fact, service workers' wage share in these subsectors is still high, but overall labour compensation as a share of value added is lower than for other subsectors because the chemical, electrical and electronics subsectors are more capital-intensive. The net contribution of in-house services to manufacturing value added even declined for the electrical & electronics industry between 2011 and 2018, but our analysis indicates that this decline stemmed entirely from a decrease in the subsector's share of overall labour compensation. Meanwhile, service workers' share of wages substantially increased from 54.5% to 63.9% during the same period.[5] These results suggest that industrial characteristics and composition affect the extent of services' contribution to value added. The contribution could be low even if in-house service activities are intensive.

As depicted in Figure 3, service-related jobs have increased as a proportion of total employment in recent years. The employment shares of 'professions and related workers' and 'clerical workers' increased by 2.8 percentage points and 2.2 percentage points, respectively, over the period 2011-2018, while those of core manufacturing occupations, 'equipment, machine operating and assembling workers,' and 'craft and related workers,' significantly declined. Overall, the proportion of service-related workers in Korean manufacturing increased from 48.4% to 51.5%, mostly due to the substantial increase in administration workers and R&D professionals for ICT, engineering and bio-chemical-related tasks and back-office clerks.

On the other hand, servicification through in-house service activities is more prevalent among large rather than small or medium-sized enterprises. Our data indicate that large firms account for 65.8% of the overall contribution of in-house services to manufacturing value added. Furthermore, we observe that both service workers as a share of total employment and in-house services as a share of total value added significantly increased among large firms (See Figure 4).

Next, we combine the results of the previous analyses with estimates of the contribution of domestic and foreign service outsourcing to manufacturing value added from the OECD's TiVA (Trade in Value Added) dataset and investigate the relationships among these different modes of servicification in manufacturing. There are some policy concerns that more intense in-house service activities within the manufacturing sector may impede the proper development of the service sector. This is a plausible scenario, given that, according to transaction cost theory, depending upon transaction costs, certain activities may be internalized at the expense of external outsourcing. At the same time, in-house service activities and domestic outsourcing should are necessarily substitutes for each other. An increase in in-house provision of services

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[5] Although our analysis spans the period from 2009 to 2018, our discussion here is confined to the years 2011-2018 as the estimates for 2009 and 2010 may reflect impacts of the global financial crisis.

could boost demand for external outsourcing of supplementary service functions. Therefore, whether there is indeed a trade-off between the two is an interesting question.

The TiVA database, a useful tool for analysing global value chains, provides detailed information on supply-demand linkages across countries.[6] We use the 2018 version of its Inter-Country Input-Output (ICIO) tables to estimate the value added shares of domestic and foreign service outsourcing in total manufacturing exports.[7] The most recent data available are for the year 2015, thus our estimation is confined to the period 2009-2015.

Figure 5 reports our estimates of the value-added composition of gross manufacturing exports by source. As of 2015, domestic manufacturing accounted for about half of the total value added, followed by foreign manufacturing (12.7%), domestically-sourced services (12.6%) and foreign service outsourcing (12.4%). Service functions for wholesaling and business and professional services account for more than two-thirds of the value added for both domestic and foreign sourcing. The overall share of foreign value-added in exports decreased from 45.4% in 2011 to 35.5% in 2015.

In Figure 6, we plot our estimates of the contribution of in-house service activities, domestic outsourcing and foreign offshoring to manufacturing value added. As depicted in the figure, the overall contribution of intermediate services to manufacturing exports is around 45~49% over the period 2009-2015. Our estimates are much larger than that of Miroudot and Cadestin (2017),[8] who found that for Korean exports, services' share of value added was less than 40% in 2011, the lowest among the 31 countries compared. The difference comes from the extent of the contribution of in-house services, which they estimated it at less than 10%, while we estimated it at around 18.6% for 2011. Considering that our estimation is based on a more comprehensive labour survey, we conclude that intermediate services' contribution to Korean manufacturing accounted for about half of the total value added over the period 2009-2015.

We now examine the relationships among these different modes of servicification and report the results in Figure 6. On the left-hand side of Figure 6, we compare the value added shares of in-house service activities, domestic outsourcing and foreign offshoring for 10

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[6] Please refer to OECD(2019) for detailed information on the TiVA database and the methodology of its construction for structural GVC indicators. Nowadays, there are several software programs that allow for value added analysis using TiVA data. We used STATA's *icio* command, developed by Belotti et al. (2020), extensively for our value added estimation for domestic and foreign outsourcing.

[7] The national input-output tables do not contain information on inter-country supply-demand linkages and thus the extent of foreign service outsourcing; the ICIO tables are particularly useful in this respect. One drawback of the ICIO tables, however, is that we estimate the value added share of service outsourcing in terms of gross exports, rather than GDP.

[8] See Figure 10 in Miroudot and Cadestin (2017, p.20) for comparison.

manufacturing subsectors over the period 2009-2015. Our analysis suggests that there is a positive correlation between in-house service activities and domestic outsourcing. 'Food & beverages' and 'other manufacturing' reveal high shares for both in-house service activities and domestic outsourcing, while the 'chemicals,' and 'electrical and electronics' industries show the opposite pattern. On the other hand, there appears to be a trade-off between in-house service activities and foreign outsourcing. 'Electrical and electronic products' and 'metal products' have much more foreign outsourcing than in-house provision of services. Meanwhile, sectors like 'food & beverages,' 'wood products' and 'non-metallic products' rely less on foreign outsourcing than other sectors. Finally, we find a strong negative correlation between domestic and foreign outsourcing.

Since these results may merely reflect the different characteristics of various sectors, we also compare the three servicification modes in terms of their annual change rather than their level. As shown on the right-hand side of the figure, many of the aforementioned qualitative results are preserved even when the terms are changed. Hence, we conclude that more intense in-house service activities do not necessarily crowd out domestic outsourcing activities, but rather increase demand for domestic outsourcing of complementary service functions. On the other hand, in-house provision of services does seem to replace offshored tasks to some extent. In the next section, we further investigate these findings using establishment-level data.

IV. Determinants of In-house Services Within Manufacturing

1. Empirical Strategy

In this section, we explore the key determinants of in-house service activities, using an establishment-level panel dataset that comprises all establishments in Korea with at least 50 regular employees and more than 300 million won in capital. While little research has systematically examined the determinants of in-house provision of services, several empirical works in the literature have investigated the determinants of outsourcin. These studies generally consider labour costs, firm size, ownership structure, and export propensity as the major explanatory factors for outsourcing intensity (Diaz-Mora, 2008, 2012).

Girma and Görg (2004) present empirical evidence that cost savings are the key motive for service outsourcing in the U.K. manufacturing sector, and Holl (2004) also suggests that higher labour costs lead to an increased probability of external subcontracting. These findings are seemingly consistent with the transaction cost theory. On the other hand, there are mixed results with regard to firm size and ownership structure. If there are economies of scale and/or economies of scope in producing specific service inputs, then only companies over a certain

minimum efficiency threshold would be able to internalize the production of these inputs, while small firms would choose outsourced procurement over in-house production. However, because small firms would face relatively higher information acquisition and search costs than large ones when engaging in outsourcing, it is plausible that small firms would not be able to take advantage of outsourcing. Therefore, the overall relationship between firm size and outsourcing intensity could be ambiguous.

Similarly, existing studies have produced inconclusive results with regard to 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 networks. However, if their domestic production activities are mainly specialized in manufacturing functions such as operations and assembly within value chains, service outsourcing could remain rather low. In this paper, we consider the aforementioned factors and examine how they affect the extent of in-house service activities instead of outsourcing.

Using both firm-level and enterprise group-level data from the Swedish manufacturing sector, Lodefalk (2013) shows 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, as some service support functions can be supplied by subsidiaries within an enterprise group that specialize in services. Although this paper is based on establishment-level data, it tries to overcome the limitations of establishment-level data by utilizing information on parent companies and their subsidiaries that are included in the data.

Another important issue in the analysis is the relationship between outsourcing and in-house service activities. As discussed in Section 3, there may be complementarity or substitution between them. In the previous correlation analysis at the industry level, it appears that in-house production complements to domestic outsourcing and substitutes for foreign offshoring. In this chapter, the relationship between these factors will be re-examined empirically, this time using establishment-level data.

Based on the above discussion, this paper adopts the following estimation specification that relates in-house service activities to a broad range of firm characteristics:

$$SER_{it} \equiv \beta_0 + \beta_1 SER_{it-1} + \beta_2 OWN_{it} + \beta_3 LOC_{it} + \beta_4 OUT_{it} + \beta_5 RD_{it} + \beta_6 EX_{it}$$
$$+ \beta_7 SUBF_{it} + \beta_8 SUBD_{it} + \Omega'_{it}\psi + \Psi'_{it}\xi + D'_i\delta + T'_t\varpi + \varepsilon_{it}$$

$$\cdots\cdots\cdots\cdots\cdots (1)$$

where i represents the individual firm and t is the time period 2006-2019.

The dependent variable, SER_{it}, is the extent of in-house provision of services for a 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 for foreign ownership. LOC_{it} is a location dummy, and we assign a value of 1 to firms located in the Seoul metropolitan area. OUT_{it} is outsourcing costs as a proportion of total sales. RD_{it} and EX_{it} represent the share of R&D expenditures out of total sales and export intensity, respectively. $SUBF_{it}$ and $SUBD_{it}$ - the number of subsidiaries at home and abroad, respectively - are also included in the estimation to overcome the limitations of the establishment-level data.[9] Ω_{it} is the vector of log-transformed variables controlling for firm size, such as the total number of regular workers, the amount of total sales and the value of total assets.

In addition, Ψ_{it} is the vector of dummy variables for outsourcing activities such as manufacturing production, distribution, cleaning services, knowledge-intensive services and others. D_i is the vector of individual firm-level fixed effect dummies to control for 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.

While we employ several different estimator, such as the ordinary least squares (OLS hereafter) and the least square dummy variable (LSDV hereafter) estimator, our preferred specification is the system generalized method of moments (System GMM hereafter) à la Blundell and Bond (1998).[10] It is suitable for longitudinal data like ours with a moderately persistent series. More importantly, the system GMM estimator controls for potential endogeneity problems from unobserved heterogeneity, reverse causality, simultaneity and other sources of dynamic endogeneity. For instance, Lodefalk (2014) claims that in-house service production contributes to increased export intensity. On the other hand, it is also plausible that more active export activities can serve as an incentive for companies to specialize in core value chains and to outsource other support functions. Therefore, the causal relationship between the two are ambiguous a priori, and require a careful estimation controlling for reverse causality. A similar logic applies to other determinants of servicification in our estimation.

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[9] We initially included information on the parent company in the regression analysis, but as the statistical significance of the estimated coefficient was quite low, we excluded it from our main estimation specification.

[10] Please see Blundell and Bonds (1998) for detailed information on the system GMM estimator.

2. Data Description

Our data source is the Survey of Business Activities collected by the Korea National Statistical Office (Statistics Korea). It is a comprehensive longitudinal dataset for all establishments in Korea with at least 50 regular employees and more than 300 million won in capital.[11] It contains establishment-level information, including 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, among many others. The time span for our analysis is the periods 2006-2019.

As for employment, the Survey of Business Activities contains the number of establishments' regular workers and irregular workers. Regular workers are classified by type of task, into service functions, manufacturing functions and other functions. The number of regular workers for each function is further decomposed into those working at an establishment's headquarters and those working outside of it. On top of that, service-related workers working outside the headquarters are divided into those engaging in sales, distribution/delivery, R&D, construction, and other services respectively. In this paper, 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 choose two types of service tasks as knowledge-intensive core service functions in the data: core service-related workers at headquarters and R&D professionals working outside of the headquarters.

To construct a dummy for foreign ownership, firms with a foreign equity share of 10% or more are regarded as foreign investment companies. The Seoul metropolitan area includes Seoul, Incheon and Kyonggi province. As for subsidiaries, the data contain the number of domestic and foreign subsidiaries and related companies, and the amount of annual investment in them. In the analysis, subsidiary-related explanatory variables are constructed using the number of domestic and foreign subsidiaries and related companies. 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, welfare, etc.[12] Among these functions, we consider information processing, design/planning, marketing, and R&D to be knowledge-intensive services. In Table 2, we

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

[12] Unfortunately, the Survey of Business Activities does not separate domestic and foreign outsourcing. It began to differentiate the two in the 2019 survey.

report descriptive statistics for the key variables in our estimation. Table 3 shows outsourcing activities by firm size as of 2019. The most common outsourced tasks are consigned production, distribution/delivery and cleaning/security services. On the other hand, the proportion of companies outsourcing knowledge-intensive services is very low, which is more evident as the size of the company shrinks.

In Figure 6, we present the distributions of core service-task workers as a share of all workers the years 2006, 2012 and 2019.[13] As depicted in the figure, the distributions are right-skewed, with a mean of 28.2% for the entire period from 2006 to 2019. Over time, it can be observed that the proportion of companies in which core service-task workers make up more than 50% of all employees is gradually increasing. In Figure 7, we present trends in the share of core service-task workers, R&D intensity and outsourcing costs as a share of total sales for the top three largest companies in the sample.[14] Figure 7 confirms that all three of these firms saw a substantial increase in the share of core service workers, especially R&D professionals. Meanwhile, there is little sign that they are engaging in more outsourcing. Hence, it seems apparent that much of these firms' servicification consists of in-house service activities.

3. Empirical Results

Table 4 contains our estimation results for the entire sample. Columns 1 through 3 present the OLS results, Column 4 for the LSDV results, and Column 5 for the system GMM estimation results, respectively. In case of the system GMM estimation, we check the validity of the instruments used in the analysis by employing the Hansen test. In addition, since the validity of the instruments also requires the absence of second-order serial correlation in the error terms, we adopt the Arellano and Bond autocorrelation test. As reported in Table 4, our test results confirm the validity of the instruments in our estimation.

Except for some of the outsourcing-related variables, estimates for most of the explanatory variables in the estimation show statistical significance. Firs, we find a positive

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[13] We use the Epanechnikov kernel density function to estimate these distributions.

[14] Firm A - the largest company with more than 100 thousand regular workers - is a multinational electronics corporation with 22 domestic subsidiaries and 55 subsidiaries abroad. It accounts for 8.1% of the total sales and 17.8% of the total exports in the whole sample for 2018. Firm B and Firm C are world-renowned automotive and electronics manufacturers, respectively. These three firms together account for 5.2% of the regular workers, 8.1% of the total sales and 24.1% of the total exports in the whole sample.

impact of foreign ownership on in-house provision of services using OLS and LSDV estimations. However, the estimated coefficient for foreign ownership is statistically non-significant using the system GMM estimation. However, we find that this result is sensitive to the model specification. When we include R&D and export dummies instead of their intensities in the system GMM regression, the estimated coefficient for foreign ownership turns out to be positive and statistically significant at the 5 percent level.

Firms located in the Seoul metropolitan area tend to exhibit a high intensity of in-house service activities. This result is robust regardless of the estimation method. Specifically, for these firms, the proportion of core service-task workers in total employment is about 2.3~3.8 percentage points higher than for firms located elsewhere. On the other hand, we find mixed results on outsourcing intensity, measured using outsourcing costs as a proportion of total sales. For the OLS and LSDV approaches, our results indicate a positive effect of outsourcing intensity on in-house service activities, which may imply that in-house provision of services and outsourcing are complementary. However, the GMM results are exactly opposite; a higher outsourcing intensity is linked to less in-house service activity. Given that the system GMM estimator is our preferred estimation approach since it controls for potential endogeneity bias, we conclude that, contrary to our industry-level evidence, we cannot find a complementary relationship between in-house provision of services and outsourcing once other firm-specific characteristics are controlled in estimation.

The system GMM estimation results also show that export intensity is a statistically significant determinant of in-house service activities, while the estimated coefficient for R&D intensity is also positive but with little statistical significance. As mentioned above, if we replace the R&D intensity variable with the R&D dummy, then we find a statistically significant impact of R&D on in-house service activities. Specifically, our estimation indicates that firms engaging in R&D activities have, on average, 2.9 percentage point higher proportion of core service-task workers than other firms. We find that the existence of foreign affiliates substantially contributes to increased in-house provision of services, suggesting that the decision to engage in in-house provision of services is closely linked to global value chains. Meanwhile, firms' networks of domestic subsidiaries have little impact on the extent of their in-house service activities.

As discussed in the previous section, the existing literature provides mixed results as to whether firm size is a determinant of outsourcing activities. Our results suggest that the effect of firm size depends on the choice of variables; in our analysis, several variables such as number of workers, sales, and assets are included as proxies for firm size. When the number of workers is used as a proxy for firm size, it appears that the larger the firm size, the less intense the in-house service activities. On the other hand, in terms of sales or assets, it turns out that firm size is positively related to in-house service activities. Finally, none of the estimated coefficients for outsourcing-related variables are statistically significant in the system GMM estimation. Hence, in contrast to our industry-level results, we cannot find any clear

relationship between domestic outsourcing and in-house service activities using firm-level data.

We perform a robustness test of the regression results by excluding those variables which do not have significant effect on the dependent variables and confirm that both the qualitative and quantitative results remain robust. As mentioned above, we run the regressions by replacing R&D and export intensities with dummy variables and find that our results are largely preserved. Finally, we also construct a balanced panel of firms that survived the entire sample period and re-run the regression. The estimation results for the balanced panel is presented in Table 5. As shown in the table, no substantial changes are detected. For the balanced panel, R&D intensity emerge as a key determinant of in-house service activities, while the impact of export intensity is now statistically nonsignificant.

V. Summary and Conclusion

In this paper, we examine the pattern and determinants of the servicification of Korean manufacturing over the period 2006-18. Our main findings are as follows: first, our results indicate that the net contribution of in-house service activities to manufacturing value added was around 18.6~22.5 percent between 2009 and 2018. The overall contribution of intermediate services to manufacturing exports was around 45~49% over the period 2009-2015. Second, in-house service activities at the industry level are positively related to domestic outsourcing, but negatively related to foreign outsourcing. This finding may suggest that the increase in in-house provision of services by manufacturers could be an effective way to reduce the extent of foreign outsourcing while helping to increase the outsourcing demand for domestic services. Unfortunately, however, in the establish-level regression analysis, we do not find any clear relationship between domestic outsourcing and in-house service activities.

Third, as for determinants of in-house service activities, our estimation results reveal that companies with high export intensity, wider networks of overseas subsidiaries, or that are located in the Seoul metropolitan area tend to engage in a higher level of in-house service activities. On the other hand, the presence of domestic subsidiaries does not have a significant effect on in-house service activities. Last but not least, servicification within the Korean manufacturing sector has been mainly centred on large-scale companies with a high export share. On the other hand, servicification remains limited among small and medium enterprises. This implies that the government needs to provide active policy support to help small and medium-sized companies increase service utilization and/or production, in order to improve the competitiveness of the overall economy.

The servicification of manufacturing is driven by various economic factors such as the spread of labour-saving technologies in manufacturing, the expansion of global value chains and ICT development. The advent of the Fourth Industrial Revolution and the recent COVID-

19 outbreak are expected to further accelerate such trends by breaking down the boundaries between manufacturing and services. Few studies, if any, have systematically examined the determinants of in-house provision of services, especially using comprehensive establishment-level data like ours. One of the obvious reasons for this is the paucity of relevant data. Therefore, much more effort is needed to construct both micro- and industry-level data containing detailed information on in-house service activities. Finally, as a future research agenda, empirical research on the impact of in-house service activities on firm performance would be promising.

References

Amiti, M. and S.J. Wei (2005), "Service outsourcing, productivity and employment: Evidence from the United States" IMF Working Papers No.2005/238.

Antras, P. and E. Helpman (2004), "Global Sourcing," Journal of Political Economy, Vol.112(3), pp.552-580.

Aquilante, T. and F. Vendrell-Herrero (2019), "Bundling and Exporting: Evidence from German SMEs", Staff Working Paper No. 781, Bank of England.

Ariu, A. et al. (2020), "One Way to the Top: How Services Boost the Demand for Goods," *Journal of International Economics*, Vol.123(1), pp.1-17.

Autor, D.H. et al.(2013), "The China syndrome: local labor market effects of import competition in the United States," *American Economic Review,* Vo.103 (6), pp.2121–2168.

Baines, T.S. et al.(2009), "The Servitization of Manufacturing: A Review of Literature and Reflection on Future Challenges," *Journal of Manufacturing Technology Management*, Vol. 20(5), pp. 547-567.

Baldwin, R. et al. (2015), "Unveiling the Evolving Sources of Value Added in Exports," Joint Research Program Series No.161.

Baumol, W.J (1967), "Macroeconomics of Unbalanced Growth: the Anatomy of Urban Crisis," *American Economic Review,* Vol.57(3), pp. 415-426.

Belotti, F, A. Borin and M. Mancini (2020), "ICIO: Economic Analysis with Inter-Country Input Output Tables in Stata," World Bank Policy Research Working Paper No. 9156.

Blundell, R. and Bond, S. (1998), "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," Journal of Econometrics, 87, pp.115–43.

Cadestin, C. and S. Miroudot(2020), "Services Exported Together with Goods,"OECD Trade Policy Papers, No. 236, OECD Publishing, Paris.

Clark, C.(1940), The Conditions of Economic Progress, London: Macmillan.

Crozet, M. and E. Milet (2017), "Should Everybody be in Services? The Effect of Servitization on Manufacturing Firm Performance," *Journal of Economics and Management Strategy* Vol.26, pp.820-841.

Diaz-Mora, C. (2008), "What Factors Determine the Outsourcing Intensity? A Dynamic Panel Data Approach for Manufacturing Industries," *Applied Economics* 40, pp.2509-21.

Fang, E. et al. (2008), "Effect of Service Transition Strategies on Firm Value," *Journal of Marketing*, Vol.72, pp.1-14.

Fisher, A. (1939), "Primary, Secondary and Tertiary Production," *Economic Record*, Vol. 15,

pp.24-38.

Girma, S. and H. Görg (2004), "Outsourcing, Foreign Ownership and Productivity: Evidence from UK Establishment Level Data," *Review of International Economics*, Vol. 12(5), pp.817-832.

Grossman, G.M. and E. Helpman (2002), "Integration versus Outsourcing in Industry Equilibrium," *The Quarterly Journal of Economics*, Vol. 117(1), pp.85–120.

Grossman, G. and E. Rossi-Hansberg (2008), "Trading tasks: A simple theory of offshoring", *American Economic Review*, Vol. 98(5), pp. 1978-1997.

Guerrieri, P. and V. Meliciani (2005), "Technology and International Competitiveness: the Interdependence between Manufacturing and Producer Services, *Structural Change and Economic Dynamics*, vol. 16(4), pp. 489-502.

Heuser, C. and A. Mattoo (2017), "Services Trade and Global Value Chains," Policy Research Working Paper 8126, World Bank Group.

Holl, A. (2004), "Production subcontracting and location: panel data evidence from Spanish manufacturing firms," TRP Working Paper 146, University of Sheffield.

Lodefalk, M. (2013), "Servicification of manufacturing - evidence from Sweden," *International Journal of Economics and Business Research*, Vol.6(1), pp.87-113.

Lodefalk, M. (2014), "The role of services for manufacturing firm exports", *Review of World Economics*, Vol. 150(1), pp. 59-82

Miozzo, M. and L. Soete (2001), "Internationalization of services: A Technological Perspective," *Technological Forecasting and Social Change*, No.67(2-3), pp.159-185.

Miroudot, S. and C. Cadestin (2017), "Services in Global Value Chains: From Inputs to Value-Creating Activities,"OECD Trade Policy Papers, No. 197, OECD Publishing, Paris.

National Board of Trade (2012), "Everybody is in Services: the Impact of Servicification in Manufacturing on Trade and Trade Policy," National Board of Trade, Sweden.

OECD(2014), "Global Value Chains: Challenges, Opportunities, and Implications for Policy," Report prepared for submission to the G20 Trade Ministers Meeting Sydney, Australia.

Olsen, K.B. (2006), "Productivity Impacts of Offshoring and Outsourcing: A Review," OECD Science, Technology and Industry Working Papers 2006/01.

Pilat, D. and A. Wölfl (2005), "Measuring the Interaction between Manufacturing and Services," STI Working Paper Series 2005/5, OECD.

Rodrik, D. (2016), "Premature Deindustrialization," *Journal of Economic Growth*, Vol. 21(1), pp. 1–33.

Rowthorn R.E. and R. Ramaswamy (1997), "Deindustrialization: Its Causes and Implications", IMF Working Paper No. 97/42, International Monetary Fund.

Rowthorn R.E. and R. Ramaswamy (1999), "Growth, Trade and Deindustrialization," IMF Staff Paper Vol 46, No.1, International Monetary Fund.

Thangavelu, S.M. et al.(2018), "Servicification in global value chains: Comparative analysis of selected Asian countries with OECD,"*the World Economy*, Vol.41(11), pp.3045-3070.

Timmer, M., B. Los, R. Stehrer and G. de Vries(2016), "An Anatomy of the Global Trade Slowdown based on the WIOD 2016 release", Groningen Growth and Development Centre Research Memorandum 162, University of Groningen, November.

Williamson, O. (1975), Markets and Hierarchies: Analysis and Antitrust Implications, Macmillan, New York.

Williamson, O. (1979), "Transaction-cost economics: The governance of contractual relations," *Journal of Law and Economics*, 22, pp.233–261.

WTO(2019), World Trade Report 2019, WTO, Geneva.

[Table 1] Contribution of In-house Service Activities by Sector

	VA share of in-house service activities			Wage share of service-related workers			VA share of labor compensation		
	2011 (A)	2018 (B)	B-A	2011 (A)	2018 (B)	B-A	2011 (A)	2018 (B)	B-A
Food & Beverage	21.7%	22.2%	0.5%p	42.4%	41.9%	-0.5%p	51.3%	52.9%	1.6%p
Textiles & Apparel	31.5%	37.1%	5.6%p	63.4%	67.3%	3.9%p	49.7%	55.1%	5.4%p
Wood products	20.8%	20.1%	-0.7%p	43.3%	42.7%	-0.6%p	48.1%	47.1%	-1.0%p
Chemicals	12.9%	16.4%	3.5%p	52.6%	53.4%	0.8%p	24.6%	30.7%	6.1%p
Non-metallic products	17.3%	18.2%	0.9%p	41.3%	41.9%	0.6%p	41.9%	43.4%	1.5%p
Metal products	14.9%	19.9%	5.0%p	39.2%	45.7%	6.5%p	38.0%	43.5%	5.5%p
General Machinery/equipment	28.1%	29.9%	1.8%p	56.9%	57.8%	0.9%p	49.4%	51.8%	2.4%p
Electrical/Electronic products	17.8%	17.2%	-0.6%p	54.5%	63.9%	9.4%p	32.7%	26.9%	-5.8%p
Transport equipment	21.0%	27.0%	6.0%p	41.0%	49.6%	8.6%p	51.2%	54.4%	3.2%p
Other manufacturing	25.0%	33.0%	8.0%p	41.5%	52.2%	10.7%p	60.3%	63.3%	3.0%p
Total	18.6%	21.0%	2.4%p	48.5%	54.5%	6.0%p	38.3%	38.6%	0.3%p

Source: Author's calculations based on SRSC and national account.

[Table 2] Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
Share of Core Service Workers (%)	28.23	20.44	.04	100	1.32	4.72
Foreign Ownership (Foreign=1)	.12	.33	0	1	2.32	6.4
Location (Metropolitan=1)	.54	.5	0	1	-.15	1.02
Outsource Costs/Total Sales (%)	8.18	27.34	0	5420	118.48	20840.18
R&D Expenses/Total Sales (%)	2.14	21.34	0	4442	163.83	31049.29
Exports/Total Sales (%)	18.19	26.16	0	100	1.56	4.45
Number of Foreign Subsidiaries	.74	2.21	0	77	11.07	233.3
Number of Domestic Subsidiaries	.57	1.54	0	43	6.33	75.37
Number of Regular Workers (logged)	4.94	.85	.69	11.6	1.72	8.06
Total Sales (logged)	5.77	.8	-4.88	10.1	.14	5.22
Total Assets (logged)	5.71	.85	-2.68	10.9	-.03	4.08
Production Outsource (Dummy)	.48	.5	0	1	.09	1.01
Distribution Outsourcing (Dummy)	.41	.49	0	1	.35	1.12
Cleaning Outsourcing (Dummy)	.36	.48	0	1	.59	1.35
KIS Outsourcing (Dummy)	.02	.15	0	1	6.52	43.45
Other Outsourcing (Dummy)	.02	.14	0	1	6.68	45.56

[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%

[Table 4] Estimation Results I (Whole Sample)

| VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) LSDV	(5) System GMM
Foreign Ownership	1.343***	1.410***	1.469***	0.936**	0.017
	(0.402)	(0.402)	(0.401)	(0.387)	(0.393)
Metropolitan Region	3.821***	3.843***	3.805***	2.691***	2.284***
	(0.268)	(0.269)	(0.268)	(0.264)	(0.430)
Outsource Costs/Sales	0.024**	0.024**	0.021*	0.014*	-0.296**
	(0.012)	(0.012)	(0.011)	(0.007)	(0.142)
R&D Expenses/Sales	0.045**	0.045**	0.044**	0.038***	0.091
	(0.019)	(0.019)	(0.019)	(0.015)	(0.085)
Exports/Sales	0.045***	0.045***	0.044***	0.026***	0.030***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)
Foreign Subsidiaries	0.591***	0.584***	0.576***	0.463***	0.365***
	(0.074)	(0.074)	(0.074)	(0.066)	(0.086)
Domestic Subsidiaries	-0.036	-0.038	-0.022	0.058	-0.068
	(0.103)	(0.103)	(0.103)	(0.097)	(0.083)
No. of Workers (logged)	-5.606***	-5.605***	-5.706***	-5.840***	-4.004***
	(0.178)	(0.178)	(0.179)	(0.174)	(0.610)
Total Sales (logged)	1.305***	1.245***	1.188***	1.897***	0.389
	(0.248)	(0.248)	(0.247)	(0.242)	(0.453)
Assets (logged)	3.135***	3.034***	3.004***	3.110***	2.480***
	(0.226)	(0.233)	(0.232)	(0.227)	(0.500)
Production Outsourcing			1.597***	0.971***	0.837
			(0.232)	(0.220)	(0.988)
Distribution Outsourcing			-0.110	0.170	0.073
			(0.236)	(0.227)	(0.800)
Cleaning Outsourcing			0.652***	0.417*	-0.642
			(0.239)	(0.229)	(1.569)
KIS Outsourcing			0.743	0.411	14.166
			(0.596)	(0.587)	(8.946)
Other Outsourcing			-0.060	0.268	3.553
			(0.733)	(0.700)	(2.840)
Lagged dependent variable					0.369***
					(0.121)
Observations	80,493	80,493	80,493	80,493	69,471
R-squared	0.077	0.080	0.082	0.116	
Country 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)					0.130
Hansen Test					0.127
Sargan Test					0.444

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

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

| VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) LSDV	(5) System GMM
Foreign Ownership	1.268***	1.335***	1.390***	0.859*	0.919
	(0.491)	(0.492)	(0.489)	(0.473)	(0.598)
Metropolitan Region	2.237***	2.247***	2.250***	1.658***	1.851***
	(0.387)	(0.388)	(0.386)	(0.379)	(0.471)
Outsource Costs/Sales	0.019	0.019	0.017	0.010	-0.201
	(0.014)	(0.014)	(0.013)	(0.008)	(0.191)
R&D Expense/Sales	0.789***	0.790***	0.783***	0.628***	0.385***
	(0.144)	(0.145)	(0.145)	(0.124)	(0.110)
Exports/Sales	0.031***	0.031***	0.031***	0.019***	0.021
	(0.007)	(0.007)	(0.007)	(0.006)	(0.016)
Foreign Subsidiaries	0.555***	0.554***	0.544***	0.453***	0.412***
	(0.088)	(0.089)	(0.089)	(0.079)	(0.103)
Domestic Subsidiaries	-0.177	-0.167	-0.150	-0.046	-0.136
	(0.113)	(0.113)	(0.113)	(0.109)	(0.106)
No. of Workers (logged)	-5.192***	-5.221***	-5.343***	-5.572***	-3.384***
	(0.247)	(0.249)	(0.249)	(0.246)	(0.798)
Total Sales (logged)	2.646***	2.615***	2.531***	3.016***	1.989***
	(0.438)	(0.439)	(0.437)	(0.417)	(0.439)
Assets (logged)	1.253***	1.168***	1.176***	1.497***	1.578***
	(0.361)	(0.373)	(0.371)	(0.365)	(0.434)
Production Outsourcing			1.658***	1.072***	-0.340
			(0.318)	(0.307)	(2.016)
Distribution Outsourcing			0.317	0.290	-2.019
			(0.323)	(0.313)	(1.638)
Cleaning Outsourcing			0.719**	0.509*	-6.983**
			(0.317)	(0.306)	(2.983)
KIS Outsourcing			0.341	0.035	-12.695
			(0.793)	(0.784)	(8.738)
Other Outsourcing			0.042	0.282	-0.826
			(0.990)	(0.955)	(6.363)
Lagged dependent variable					0.240
					(0.170)
Observations	39,452	39,452	39,452	39,452	36,600
R-squared	0.082	0.085	0.087	0.119	
Country 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)					0.913
Hansen Test					0.214
Sargan Test					0.734

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

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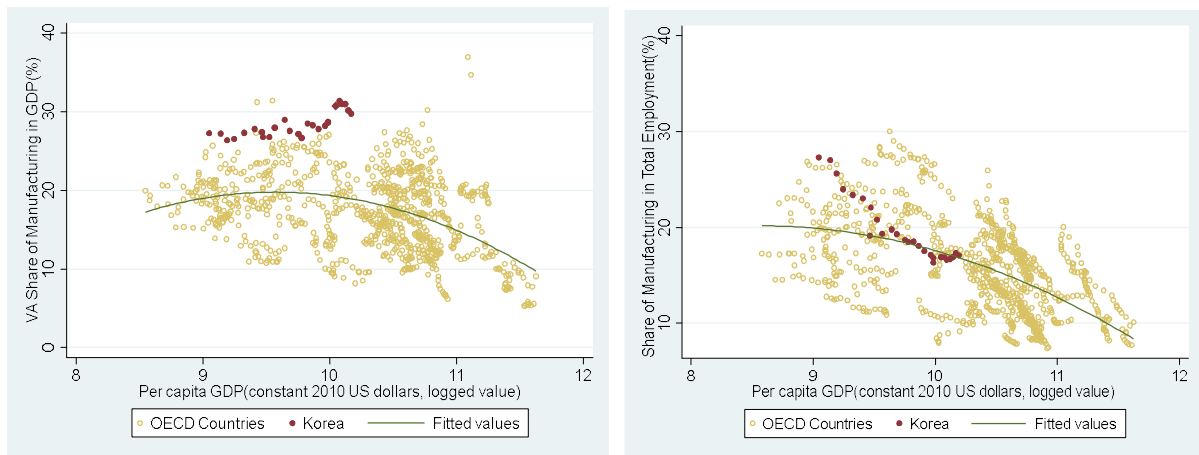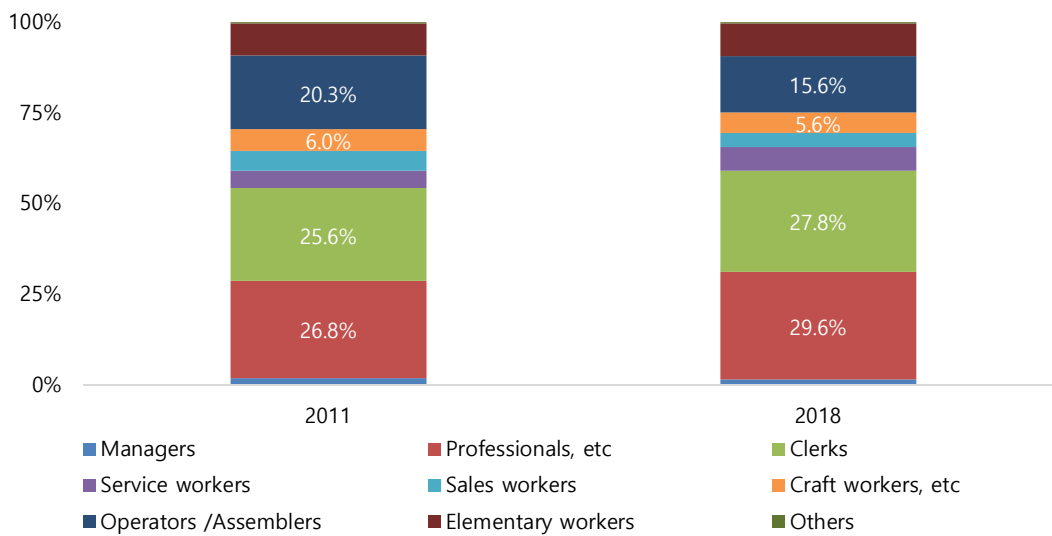

Source: OECD STAN Database

[Figure 2] Contribution of In-house Service Activities to Manufacturing Value added
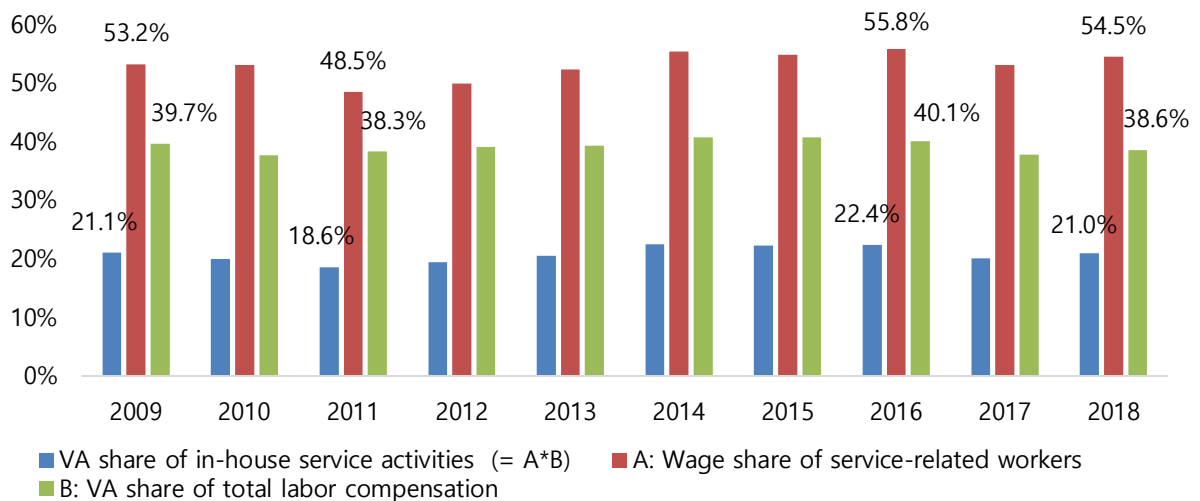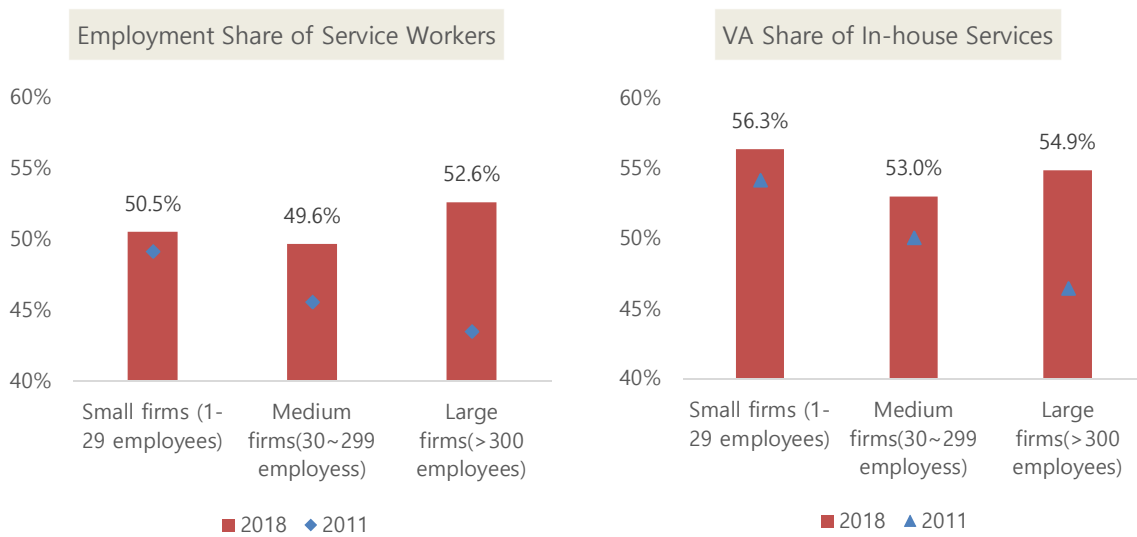

Source: Author's calculations based on SRSC and national account.

[Figure 3] Occupational Composition of Korean Manufacturing: 2011 vs 2018
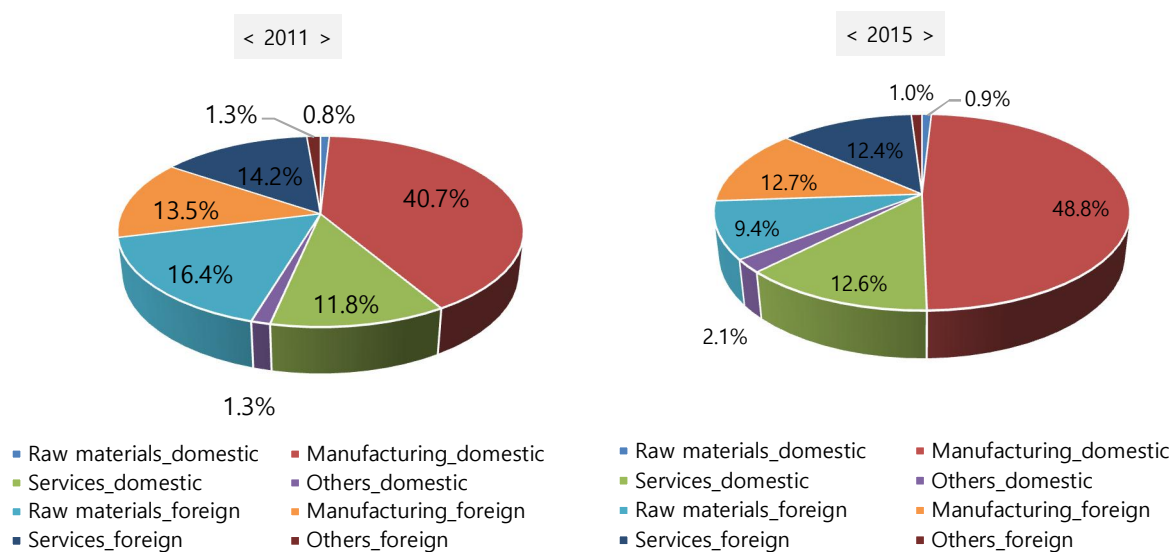

Source: Author's calculations based on SRSC and national account.

**[Figure 4]** Contribution of In-house Service Activities by Firm Size

Source: Author's calculations based on SRSC and national account.

**[Figure 5]** The Value Added Composition of Gross Exports by Source

< 2011 >

< 2015 >

1.3%   0.8%
14.2%
13.5%
16.4%
11.8%
1.3%
40.7%

1.0%   0.9%
12.4%
12.7%
9.4%
2.1%
12.6%
48.8%

- Raw materials_domestic
- Services_domestic
- Raw materials_foreign
- Services_foreign

- Manufacturing_domestic
- Others_domestic
- Manufacturing_foreign
- Others_foreign

- Raw materials_domestic
- Services_domestic
- Raw materials_foreign
- Services_foreign

- Manufacturing_domestic
- Others_domestic
- Manufacturing_foreign
- Others_foreign

Source: Author's calculations based on the TiVA database.

[Figure 6] The Value Added Share of Services in Manufacturing by Source

22.3%
12.4%
12.6%

- Domestic Outsourcing
- Foreign Outsourcing
- In-house Provision
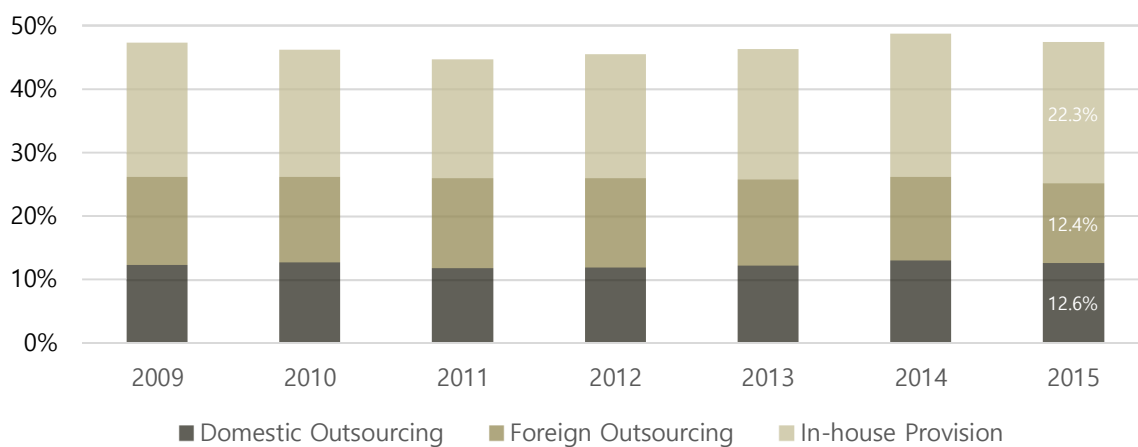
Source: Author's estimations based on SRSC, national account statistics and the TiVA database.

[Figure 6] Relationship Between In-house Services, Domestic and Foreign Outsourcing
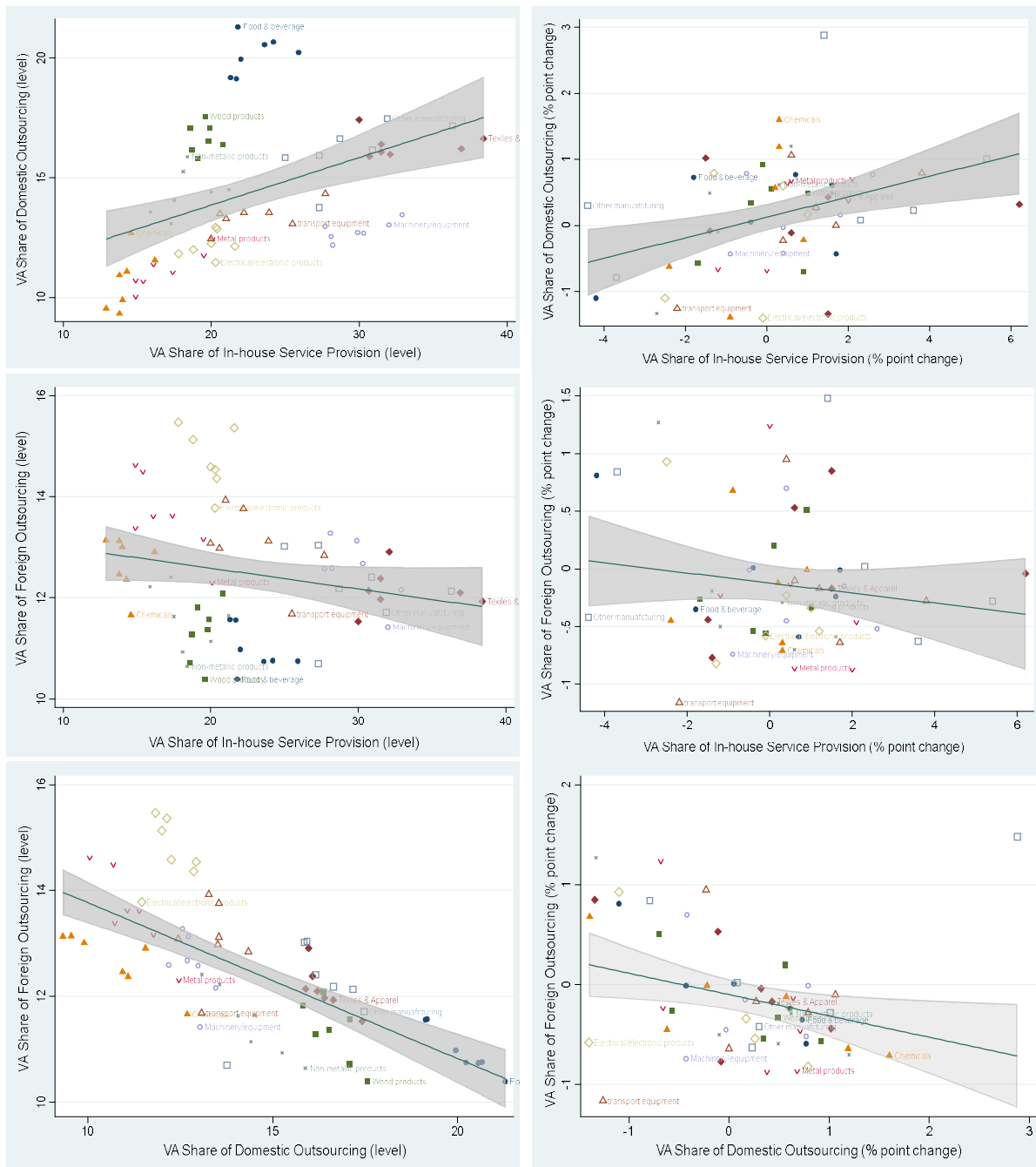
Source: Author′s construction based on estimation results

[Figure 6] Distribution of Core Service-task Workers as a Proportion of Total Employment
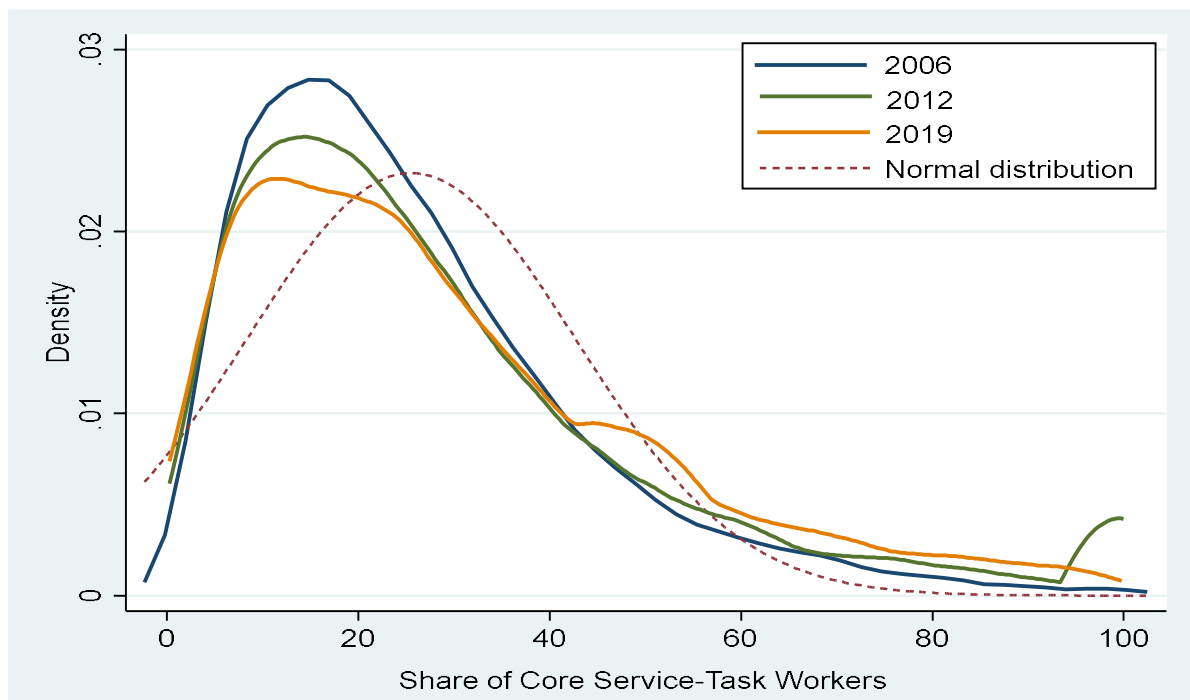
[Figure 7] The Intensities of In-house Service Activities, R&D and Outsourcing (Top 3 firms)