Received: 17 December 2015 | Revised: 16 October 2016 | Accepted: 2 March 2017

DOI: 10.1111/jems.12211

ORIGINAL ARTICLE

WILEY Journal of Economics & Management Strategy

Should everybody be in services? The effect of servitization on manufacturing firm performance

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Abstract

The servitization of the manufacturing sector refers to the evolution of manufacturers' capabilities to offer services as complements to or substitutes for the goods that they produce. A vast literature has described these strategies and has shown that this phenomenon is widespread and growing in most developed economies. However, very little systematic evidence of the extent or consequences of servitization based on a comprehensive data set of firms exists. In this paper, we provide such evidence using exhaustive data for French manufacturing firms between 1997 and 2007. We find that the vast majority of French manufacturers sell services in addition to producing goods. The shift toward services is growing steadily but at a slow pace. We also estimate the impact of servitization on firm performance. Controlling for various sources of endogeneity bias, our most conservative results show that firms that start selling services increase their profitability by 0.4%, their employment by 2.1%, and their total sales by 0.6%. For small businesses, we also find a positive impact on the production of goods. We also uncover strong heterogeneity across manufacturing industries.

There are no such thing as service industries. There are only industries whose service components are greater or less than those of other industries. Everybody is in services.

Theodore Levitt (1972)

1 | INTRODUCTION

In most developed economies, the contribution of the manufacturing sector to overall production and employment has been steadily declining for more than a century (Pilat, Cimper, Olsen, & Webb, 2006). Economic analyses based on a representation of the economy as a collection of independent sectors often view the decline of the manufacturing sector as an ineluctable shift of resources toward the services sector (Acemoglu & Guerrieri, 2008; Baumol, 1967; Ngai & Pissarides, 2007). However, this representation as well as the ensuing industrial policies neglect the fact that the boundary between manufacturing and services is very blurry, a fact underlined decades ago by Stigler (1956): "There exists no authoritative consensus on either the boundaries or the classification of the service industries."[1] One form the deeper integration of the production of goods and services takes is the increasing offer of services by manufacturing firms. This phenomenon is referred to as servitization. We can trace the term servitization to Vandermerwe and Rada (1988), who defined it as "the increased offering of fuller market packages or 'bundles' of customer focused combinations of goods, services, support, self-service and knowledge in order to add value to core product offerings."[2]

Servitization is not a recent phenomenon and has been identified and documented since the 1980s; it is also observed in both developed and developing economies (Neely, Benedittini, & Visnjic, 2011). However, little systematic and robust evidence of the impact of servitization on firm performance exists, and this question remains controversial. Prior research has shown that most of the expected benefits of servitization (in terms of higher revenues or higher profitability, for instance) does not materialize in many cases. This is called the "service paradox" (Gebauer, Fleisch, & Friedli, 2005).[3] Furthermore, most of the available empirical evidence is based on firm-level case studies or limited samples of relatively large firms. These approaches have the advantage of allowing in-depth analysis of the business strategies and channels through which servitization operates. However, they lack the general validity that would allow inferences to be drawn from their results. In this paper, we use an exhaustive data set of French manufacturing firms over the period 1997–2007 and perform two analyses. First, we document the extent and evolution of the servitization of the French manufacturing sector. Second, we examine how firm profit margins, employment, sales of goods, and total sales are affected by the decision by the firm to start selling services. We now describe some of the empirical literature and outline how our paper contributes to existing research on servitization and firm performance.

Using data from the OSIRIS database, Neely (2008) finds that firms offering services have higher profit rates than pure manufacturers, although this premium declines with the number of services offered. Using data on 477 publicly listed manufacturing companies, Fang, Palmatier, and Steenkamp (2008) find a U-shaped relationship between services as a share of total sales and firm market value. Benedettini, Swink, and Neely (2013) analyze the characteristics of approximately 200 large manufacturing firms and find a negative correlation between the number of services offered by firms and their survival probability after controlling for firm age and size. Examining 414 firms from the engineering industry in Germany, Eggert, Hogreve, Ulaga, and Muenkhoff (2011) link product innovation and servitization to firm profitability. They find that when combined with product innovation, offering services that support the product leads to higher profitability. Taking a very different approach, Bernard, Smeets, and Warzynski (2014) exploit detailed Danish firm-level data and focus on firms that switch industries from manufacturing to services. They show that these firms are relatively small but highly productive, import intensive, and rapidly growing. The switching of these firms out of the manufacturing sector accounts for one-half of the decline in Danish manufacturing employment between 1994 and 2007. The work closest to ours in terms of data and methodology is the analysis provided by Suarez, Cusumano, and Kahl (2013). The authors look at the effect of servitization on operating profits using a sample of slightly fewer than 400 firms in the prepackaged software products industry and find a convex relationship between the share of services of total sales and overall operating margins. Their study covers a longer period than ours (1990–2006), but it is limited to one industry. We depart from several features of their analysis. First, we use a large data set containing detailed balance sheet information for more than 50,000 servitized and nonservitized French manufacturing firms over the 1997–2007 period. A key feature of our database is that it provides information on sales (to third parties) of goods and services separately. It also includes a large proportion of micro and small businesses from all manufacturing industries. This allows us to assess how the impact of servitization varies by industry and firm size. We are able to quantify the evolution of the servitization of French manufacturing over the course of a decade and to show how firm performance correlates with the decision to shift toward services while addressing a number of endogeneity concerns. Second, we focus our analysis on the shift toward services rather than on the increase in the share of services of total sales. Indeed, our results indicate that firm performance is mainly affected by the decision to engage in the provision of services rather than by their importance to total sales. Third, we do not restrict our analysis to the impact of servitization on profitability but consider several measures of firm performance.

Our contribution is twofold. First, we exploit our comprehensive database to document the extent of servitization in the French manufacturing sector. We show that in all French manufacturing industries, the share of services of total sales has increased substantially between 1997 and 2007. This increase is driven by two components: faster growth among servitized firms and a tendency for each firm to increase the share of services of total sales. Second, we assess the effect of engaging in services sales on four indicators of firm performance: profit margins, sales of goods, total sales, and employment. The link between servitization and employment growth or sales of goods has not yet been investigated in the literature. We explicitly tackle unobserved heterogeneity using a lagged dependent variable model and a fixed effects model. Our most conservative estimates suggest that compared to firms that produce goods only, the decision to start selling services is associated with an increase in profitability of 0.4% and an increase in the number of employees of 2.1%. We also find that these results are mostly driven by firms that employ fewer than 50 employees—firms for which servitization is also correlated with higher sales and production of goods.

In the next section, we further describe the motives behind the shift toward services among manufacturing firms. We describe the data in Section 3 and the change in servitization in French manufacturing industries in Section 4. In Section 5, we present our empirical strategy and our results. We conclude in Section 6.

2 | SERVITIZATION IN DETAIL

Servitization implies a major change in the business model of a firm, moving away from traditional product-oriented offerings toward an important role for additional services.[4] The shift toward services has important consequences for firms as it directly affects their business model, as well as the way they approach consumers (Cusumano, Kahl, & Suarez, 2015; Oliva & Kallenberg, 2003; Reinartz & Ulaga, 2008). A natural question to ask is why manufacturing firms would engage in the provision of services? The literature on servitization and firm performance has identified several channels through which manufacturing firms can benefit. This literature is surveyed in Baines, Lightfoot, Benedettini, and Kay (2009), and here, we only describe the most relevant mechanisms.[5] One of the expected benefits of moving toward services is the restoration (or maintenance) of firm competitiveness in both local and global markets. Breinlich, Soderbery, and Wright (2014) show that manufacturing firms in the United Kingdom responded to the decrease in tariffs between 19997 and 2007 by increasing their share of services of total sales. Wise and Baumgartner (1999) argue that "downstream [service] markets offer important benefits besides large new sources of revenue. They tend to have higher margins and to require fewer assets than product manufacturing. And because they tend to provide steady service-revenue streams, they're often countercyclical. Clearly, in manufacturing today, the real money lies downstream, not in the production function." Servitization can also enable firms to differentiate their products from those of their competitors (Baines et al., 2009; Gebauer, Gustafsson, & Witell, 2011), increase customer loyalty (Baines & Lightfoot, 2013), and increase market values (Fang et al., 2008) or increase profitability (Neely, 2008; Suarez, Cusumano, and Kahl, 2013; Visnjic, Wiengarten, & Neely, 2016). In a report for the European Commission, Baglin and Malleret (2004) interviewed representatives from a sample of 67 European firms, 24 of which are located in France. The authors report that the two main objectives behind the decision to start supplying services were increasing customer loyalty and differentiating their offerings from those of their competitors. When asked about the main benefits reaped from servitization, 28% of the firms answered increased customer loyalty, 16% reported higher sales, and 14% reported an enhanced corporate image.

The range of services that can be offered by manufacturing firms is quite large. It spans from delivery services to leasing, customization of the product, installation, maintenance, updates, and financing facilitation. Neely et al. (2011) find that the four services most offered by firms are system and solution services, design and development, maintenance and support, and retail and distribution services. Examples of manufacturing firms selling services are numerous, ranging from small businesses offering repair and after-sales services to Rolls-Royce, which made "power by the hour'—a package of support services for aircraft engines—a core element of its strategy.[6] Other examples include Alstom, which offers a package called "TrainLife Services" to rail operators, provides a range of customized services (e.g., maintenance, support for managerial and technical operations); Apple, whose strategy is to offer to consumers an ecosystem combining physical devices with online services[7]; and IBM, which decided at the beginning of the 1990s to transform the old hardware company into a firm focusing mainly on software and services.

These examples illustrate that services can be either complements to the good produced by the firm (as in the Rolls-Royce or Apple cases) or substitutes (as in the case of IBM). In their paper, Cusumano et al. (2015) further distinguish among complements that are "smoothing services" whose purpose is to ease the purchase of the product (financing, insurance, basic training) and "adapting services" whose purpose is to alter the good to the specific needs of customers (i.e., customization). Whereas smoothing services can easily be standardized, adapting services are highly differentiated as "the knowledge required to provide the service is difficult to separate from detailed knowledge of the product itself." For services that substitute the purchase of goods, they emphasize that "customers are purchasing not a product with services (adaptive or smoothing), but rather they are purchasing a service instead of the product." Unfortunately, our data do not provide information on the kind of service sold by firms (or on the type of good produced), and we cannot explicitly distinguish between services that are complements to or substitutes for the good(s) they produce. However, our empirical analysis shows that starting to sell services is correlated with higher sales of goods at firms with less than 50 employees, which we interpret as a sign of complementarity between the goods and services at the firm level.

3 | DATA

We use firm-level information from the BRN (Bénéfice Réels Normaux) database. The database is compiled by the French fiscal authority (Direction Générale des Impôts) and provides firm information such as employment, value added, capital stock, profits, investments, industry classification, and geographic location. Of particular interest for this paper, the BRN data set reports detailed information on firm sales. Individual sales are split into three mutually exclusive categories: sales of production

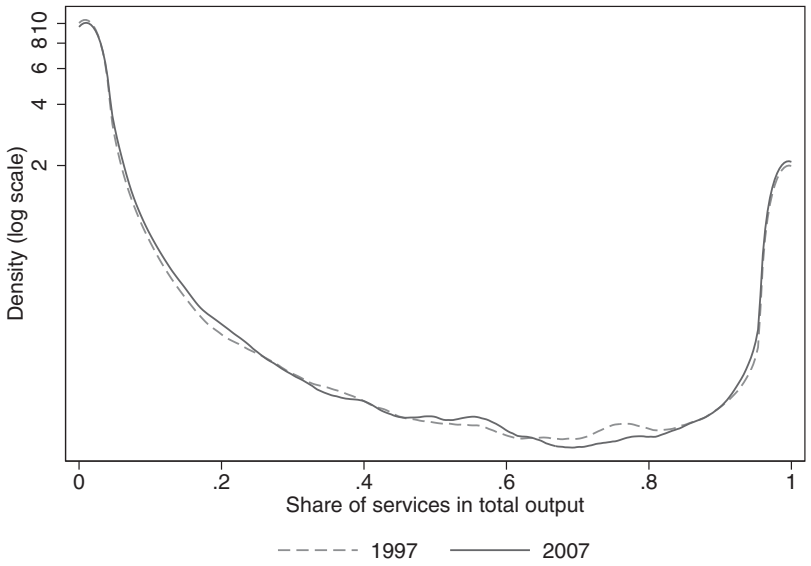

FIGURE 1 Distribution of the service intensity (share of services of production sales) for french manufacturing firms in 2007

of goods, sales of production of services, and sales of merchandise (goods purchased and sold without transformation). Note that these are sales to third parties, that is, to consumers outside of the firm.[8] It is important to note that in this paper, we are interested in the servitization of French manufacturing firms, that is, in the fact that manufacturing firms sell services to third parties. We are not interested in the production of services for own accounts. Our data cover the 1997–2007 period and provide information on 67,385 manufacturing firms. The average firm employs 55 workers and generates a turnover of 12 million.

This data set is very large, but individual data are noisy and sometimes report values that we consider highly dubious. For instance, some firms change their industry classification every year, moving from one two-digit sector to another. This complicates the design of an appropriate control group, as we want to compare firms operating in the same industry. The data set also includes a few firms that report no production, no value added, or no employment. To cope with these issues, we trim the data along several dimensions. First, we exclude firms that do not report strictly positive sales, employment, or value added. Second, we remove firms whose capital to labor ratio and value added per worker are greater than one hundred times the median ratio in their industry.[9] We are left with 44,324 manufacturing firms. In this sample, the average firm employs 61 workers and has total sales of approximately 12.6 million.

In our sample of manufacturing firms, 74.6% report selling some services. These firms account for more than 90% of the total production and employment in our sample. Among the firms that report positive sales of services, 22% report more sales of services than sales of (produced) goods, and 10% produce only services. The presence of a relatively large fraction of firms producing mainly services in a sample of manufacturing firms may be somewhat surprising. There are several explanations for this fact. Some firms may be misclassified and registered as manufacturing firms although their main activity is services. Other firms may have given up the production of goods to focus on the provision of services while keeping their original sectoral classification code. It is important to note that French firms are not automatically reclassified when their main activity changes, partly because collective labor agreements are defined at the sector level, which can make reclassification costly and cumbersome for both employers and employees. Therefore, we cannot examine manufacturing firms moving into the service sector as in Bernard et al. (2014). To grasp the extent of servitization in French manufacturing, we focus instead on the service intensity, which is defined as the share of services of total production sales. The service intensity ranges from 0 (pure goods producers) to 1 (pure services producers). In Figure 1, we present the kernel distribution of service intensity (on a log scale) for the manufacturing firms in our sample in 1997 and 2007. The striking feature of this distribution is its bimodality. This feature is present in both years and is observed in each manufacturing industry (see Fig. 2).[10]

Most of manufacturing firms are mainly goods producers (they produce and sell more goods than services). In 2007, firms with a service intensity below 50% accounted for 84% of the firms in our sample and for 90% of both value added and employment. Figure 1 also reveals that the distribution remained quite stable between 1997 and 2007.

To dig deeper into the changes in the distribution of service intensity over time, we computed a transition matrix between 1997 and 2007 (see Table A1). In this table, we retained a constant sample of firms and allocated them to bins based on their initial service intensity in 1997 and their service intensity in 2007. Firms in bin 1, for instance, are firms with a service intensity

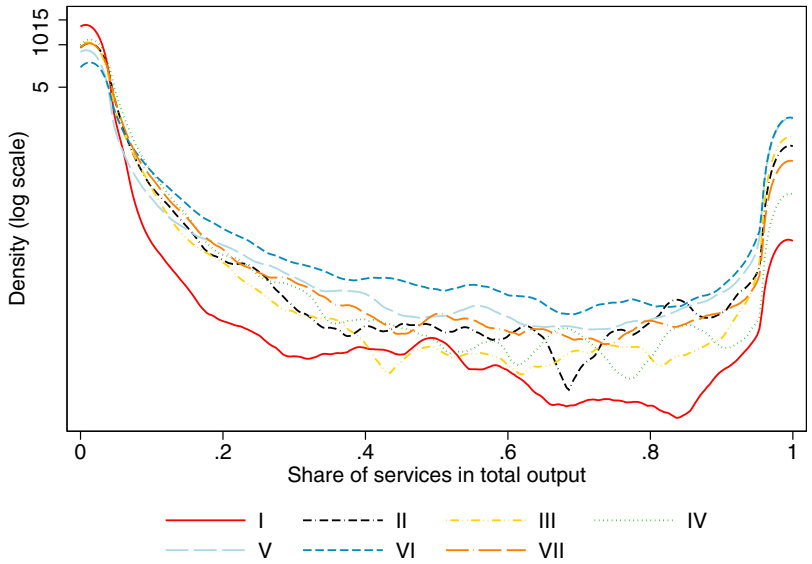

FIGURE 2 Distribution of the service intensity by industry in 2007 [Color figure can be viewed at wileyonlinelibrary.com]

Notes: We grouped industries into large sectors using the NACE Rev. 1 industry classification (indicated in parentheses). I: Manufacture of food products, beverages, and tobacco (15, 16). II: Manufacture of textiles and leather products (17, 18, 19). III: Manufacture of wood and wood products; manufacture of pulp, paper, and paper products; publishing and printing (20, 21, 22). IV: Manufacture of chemicals, chemical products, and man-made fibers; manufacture of rubber and plastic products (24, 25). V: Manufacture of other nonmetallic mineral products, basic metals, and fabricated metal products (26, 27). VI: Manufacture of machinery, electrical, optical, and transport equipment (29, 30, 31, 31, 33, 34, 35). VII: Manufacturing, n.e.c. We omitted firms in the manufacture of coke, refined petroleum products, and nuclear fuel (23), as only four firms existed in 2007.

that is strictly positive and below 10%. Consider the first row of the table: We find the share of firms that had a service intensity of exactly 0% in 1997. Adding all shares reported in this row, the table indicates that 22% of firms in our sample were not producing services in 1997. By 2007, a majority of these firms (11.98% of the total sample) remained fully specialized in the production of goods, whereas the rest (approximately 10% of the total sample) were selling some services. Among the latter, a vast majority (7.42% of the sample) had sales of services that accounted for less than 10% of their total production sales. This is a salient feature of the matrix: Most firms do not change their production mix much. Approximately 60% of firms lie on the diagonal of the table. Only 23% of firms are located above the diagonal, meaning that they substantially increased their service intensity between 1997 and 2007, and only 17% of the firms decreased their service intensity. Finally, very few firms completely changed their production mix during this period: Only 3.5% of the firms moved from a low service intensity in 1997 (below 10%) to more than 90% of services in 2007 ($0.25 + 1.30 + 0.42 + 1.57 = 3.54$).

Together, Figures 1 and 2 and Table A1 convey the following message. We encounter two distinct types of firms in the French manufacturing sector: Firms that are mainly goods producers (with a service intensity below 50%) and those that specialize in the provision of services. The distribution of these two types of firms is quite stable over time, and few firms move from one type to another.

4 | THE SERVITIZATION OF FRENCH MANUFACTURERS

This section provides an overview of the degree of servitization of French manufacturing over the decade from 1997 to 2007.

In Table 1, we present some descriptive statistics for the population of servitized and nonservitized French manufacturing firms in our sample. In the left part of the table, we show statistics for servitized and nonservitized firms, and we restrict the sample to servitized producers in the right part of the table. The first line illustrates the rapid deindustrialization of French economy. Between 1997 and 2007, the number of firms in our sample decreased by almost 11% (equivalent to an annual growth rate of −1.1%), and the number of workers employed in our sample of manufacturing firms decreased by 15% (−1.62% per year). Table 1 also shows that servitized firms are, on average, larger than pure manufacturers. In 2007, they employed 69.9 workers, on average, compared to 57.3 in the whole sample (average employment in nonservitized firms is approximately 20.3). Servitized firms are also larger in terms of turnover, they produce and sell more goods, and they are more profitable. All these differences will be studied in detail in the next section.

TABLE 1 Summary statistics

		All Firms			Servitized Firms		
		1997	**2007**	**Δ97−07**	**1997**	**2007**	**Δ97−07**
(1)	**# Firms**	31,603	28,258	−1.11	23,345	21,077	−1.02
	Share (%)				73.9	74.6	
(2)	**Employment**						
	Total (thousand)	1,905	1,618	−1.62	1,677	1,473	−1.23
	Share (%)				88	91	
	Average	60.3	57.3	−0.51	71.8	69.9	−0.28
(3)	**Turnover**						
	Total (million)	333.1	415.8	+2.24	298.7	387.6	+2.64
	Share (%)				90.2	93.2	
	Average (thousand)	10.5	14.7	+3.39	12.7	18.4	+3.69
(4)	**Production of goods**						
	Total (million)	281	334.6	+2.24	247.6	307	+2.17
	Share (%)				88.1	91.8	
	Average (thousand)	10.5	14.8	+3.39	10.6	14.6	+3.22
(5)	**Profitability**						
	Average (%)	47.48	48.5	+0.21	48.3	49.5	+0.43
(6)	**Service intensity**						
	Average (%)	17.03	18.3	+0.72	23.1	24.5	+0.62
	Median (%)	0.01	0.6	+2.63	0.03	0.3	+2.05
	Std. dev.	0.33	0.34		0.37	0.37	

Note: Δ97−07 corresponds to the annualized growth rate between 1997 and 2007.

Figure 3 better illustrates the extent of servitization across manufacturing industries using three different indicators. Panel (a) shows the proportion of manufacturing firms that produce services in 1997 and in 2007. It confirms that servitization is quite common among French manufacturing firms: Almost 75% of the firms in our sample produce some services for third parties in 2007. This figure varies substantially by sector, ranging from 55% in the food, beverage, and tobacco industry to 88% in the chemical and plastic products industry. The share of servitized firms increased in every industry between 1997 and 2007, with the exception of the mechanical and electrical equipment industry. Although a very large majority of firms are servitized in all industries, most of them sell few services. This pattern is visible in panel (b), which displays the average service intensity in each industry. In 2007, the average service intensity was 18.3% for the manufacturing sector as a whole. Again, there is some heterogeneity across manufacturing industries. For the average firm in the food, beverage, and tobacco industry, services account for 4.4% of production sales, whereas they account for 26.1% in the mineral and metal products industry.

Finally, panel (c) shows the importance of services to the total production of manufacturing industries. It reports the average service intensity weighted by the production of each firm. These figures are, on average, smaller than those in panel (b), suggesting that firms with high levels of service intensity tend to be small. In 2007, services accounted for 11.5% of the total production sales of the manufacturing sector compared to 9.5% in 1997. Services also accounted for around 3.5% of total production sales in the food, beverage, and tobacco industry and up to 16.2% of production sales in the mechanical and electrical equipment industry in 2007.

In Figure 4, we show that servitization has steadily risen over the decade. The figure displays the evolution of the weighted average service intensity between 1997 and 2007 along with the share of employment at servitized firms. We take 1997 as the reference year, so the vertical axis can be read as growth rates. The weighted average service intensity was more than 20% larger in 2007 than in 1997, and the share of employment at servitized firms grew by an average of 0.3% per year over the period.

The global trend toward services shown in Figure 4 contains two potential sources of change: a generalized shift toward services in individual firms and a composition effect due to the fact that firms with a high service intensity may grow faster than other firms. We isolate the latter source of variation by estimating the following equation:

$$Service\ Intensity_{it} = \beta_i + \delta_t + \epsilon_{it}, \tag{1}$$

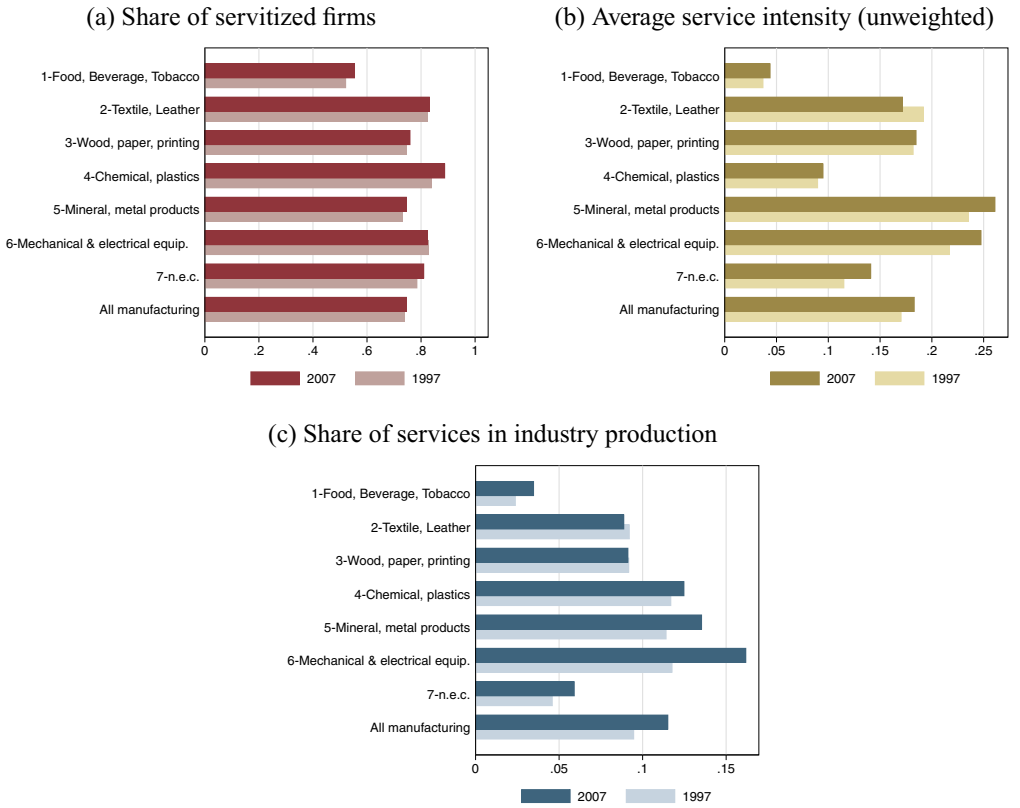

FIGURE 3 The extent of servitization in french manufacturing industries [Color figure can be viewed at wileyonlinelibrary.com]

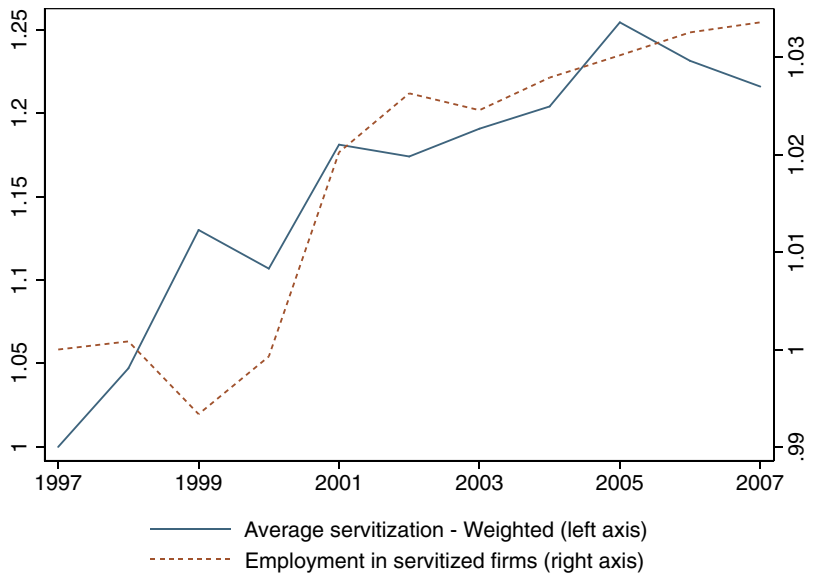

FIGURE 4 Aggregate servitization and employment: 1997–2007 [Color figure can be viewed at wileyonlinelibrary.com]

where $Service\ Intensity_{it}$ is the share of services of total sales of firm i at time t; β_i is a firm fixed effect controlling for any firm characteristic that is constant over time; δ_t is a set of year dummies; and ϵ_{it} is the error term. We omit the dummy for the year 1997 so that the estimated coefficients on the dummies δ_t measure the yearly average change in service intensity within each firm with respect to 1997. We display the results graphically in Figure 5, which plots the coefficients on the year dummies δ_t along with the 95% confidence interval. A positive (and statistically significant) coefficient means that, on average, firms have increased their service intensity with respect to their initial level in 1997. The dashed line represents an estimation with simple OLS, whereas the solid line shows the estimates obtained from a linear regression wherein observations have been weighted by

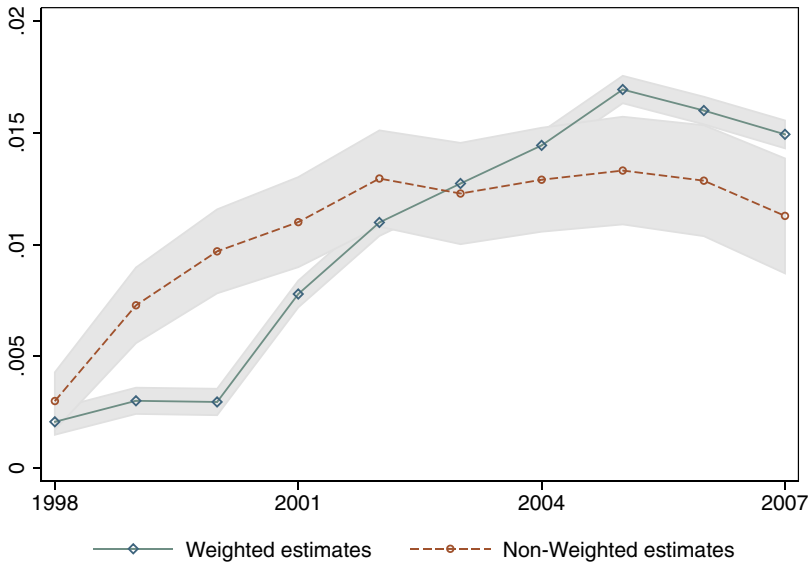

FIGURE 5 Firm-level servitization: 1997–2007 [Color figure can be viewed at wileyonlinelibrary.com]

the average employment of the firm over the period. All the coefficients are positive, statistically significant, and increase over time. This means that the growing importance of services as a share of the total production of manufacturing firms is not entirely driven by faster relative growth among servitized firms. On the contrary, each firm increased its service intensity between 1997 and 2007 by an average of 1.5 percentage points over the decade. In 1997, the (weighted) average service intensity was 4.2%. An average increase of 1.5 percentage points in each firm represents an average increase of 35% over the decade (or 3% per year).

5 | SERVITIZATION AND MANUFACTURING FIRM PERFORMANCE

In this section, we analyze the interaction between servitization and firm performance. The following two subsections address two questions: Do servitized firms outperform pure manufacturers, and do firms that shift toward services improve their performance? We retain four indicators of performance: profitability (which we proxy by EBITDA—Earnings Before Interest, Taxes, Depreciation, and Amortization—divided by value added),[11] employment, total sales, and the production sales of goods.[12]

5.1 | Servitization premia

We provide evidence of the magnitude of the performance gap between servitized and nonservitized firms. To assess the differences between the two groups of firms precisely, we have to remove possible composition effects and compare firms in the same year and industry. This is done by estimating the following equation:

$$Performance_{i,t} = \sum_{k=0}^{k=99} \theta_{]k;k+1]} d_{]k;k+1],i,t-1} + Employment_{i,t-1} + \delta_{j,t} + \epsilon_{i,t}, \tag{2}$$

where $Performance_{i,t}$ is a variable characterizing the performance of firm i in year t: firm i's profitability (as a percentage), (log) employment, (log) turnover, and (log) sales of goods at time t. $\delta_{j,t}$ is a two-digit industry × year dummy, and $\epsilon_{i,t}$ is the error term. The dummies $d_{]k;k+1],i,t-1}$ are defined as follows:

$$d_{]k;k+1],i,t-1} = \begin{cases} 1 & \text{if } k < \text{Service Intensity}_{i,t-1} \leq k+1, k \in [0\%; 99\%] \\ 0 & \text{otherwise.} \end{cases}$$

Each of the 100 dummy variables $d_{]k;k+1],i,t-1}$ takes the value 1 if the service intensity of firm i lies in the interval $]k; k+1]$, where k varies from 0% to 99%. The coefficients $\theta_{]k;k+1]}$ are estimated taking the performance of nonservitized firms as the reference group. They are interpreted as the average performance gap (i.e., the "premium") between pure manufacturers and firms with a given service intensity within the same year and industry. Because profitability, turnover, and total sales of goods are likely to be correlated with firm size, we control for lagged employment in those regressions.[13]

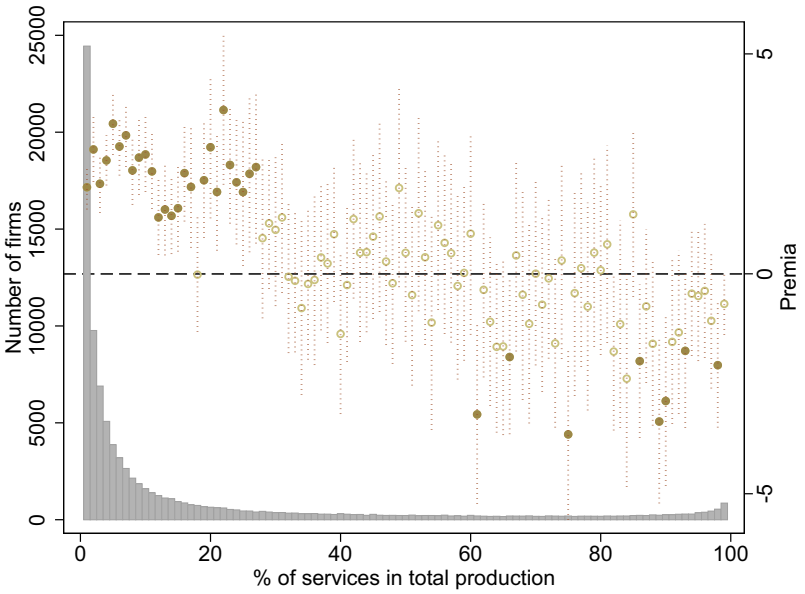

FIGURE 6 Relative profitability of servitized firms [Color figure can be viewed at wileyonlinelibrary.com]

The results are presented in Figures 6 and 7. We graphically report the coefficients $\theta_{]k;k+1]}$ along with the 95% confidence interval. Dark/plain circles represent significant coefficients whereas light/hollow circles represent coefficients that are not statistically different from zero at the 95% level. In addition, we report the histogram of the distribution of firms for each level of service intensity. In Figure 6, we display the profitability premia of being servitized. These premia are positive and statistically significant for firms with a service intensity below 30%, becoming not statistically different from zero for higher values of service intensity. When significant, the premia are quite stable over the range of service intensity. Compared to pure goods producers, servitized firms with a service intensity below 30% exhibit profitability 2.1 percentage points higher than that of nonservitized firms of comparable size in their industry. In 2007, the average profit rate was 47.4%. An increase of 2.1 percentage points is equivalent to a 5% increase. The coefficients $\theta_{]k;k+1]}$ become nonsignificant for firms with service intensities greater than 30%. It is noteworthy that, as shown by the histogram, approximately 80% of the firms in our sample have a service intensity below 30% (this share decreases to 74% when we exclude firms that do not produce services). The small number of observations at high levels of service intensity explains the lack of significance of the estimated premia. It also implies that any estimate of the average impact of moving from a pure goods producer to a service provider is going to be driven by firms with low service intensities.

Panel (a) of Figure 7 shows the premia in terms of employment. The estimated coefficients $\theta_{]k;k+1]}$ are all positive and statistically significant for levels of service intensity below 30%. Their magnitudes decline steadily up to this threshold. The premia then become negative and alternate between significant and nonsignificant, thus casting doubt on their overall significance at levels of services intensity greater than 30%. Below 30%, the average premium varies between 0.07 and 0.6, with an average of 0.3. In panel (b), we show how (the log of) turnover of servitized firms compares with that of pure manufacturers. The results appear similar to those in panel (a). The estimated coefficients are positive and significant for levels of service intensity below 30%. On average, servitized firms with a service intensity below 30% generate approximately 10% more revenue than do nonservitized firms. At higher levels of service intensity, the premia become negative and statistically significant, with an average premium of approximately −0.14. In panel (c), we consider the sales of goods. The estimated coefficients $\theta_{]k;k+1]}$ are positive and significant for levels of service intensity below 10%. They become negative and statistically significant above this level of service intensity. On average, firms with a service intensity below 10% sell 4% more goods than pure goods producers. Recall that most of the servitized firms in our sample have service intensities below 10%. Those firms account for 74% of the firms in our sample and for more than 65% of servitized firms. The unambiguous negative trend of the premia shown in panel (c) indicates a dual relationship between the production of services and the production of goods. The positive premia estimated for the first bins of service intensity indicate that the provision of services is complementary to the production of goods when services account for a small share of total firm production. For the (relatively few) firms that have quite high service intensity, however, the production of services appears to be a substitute for the production of goods.

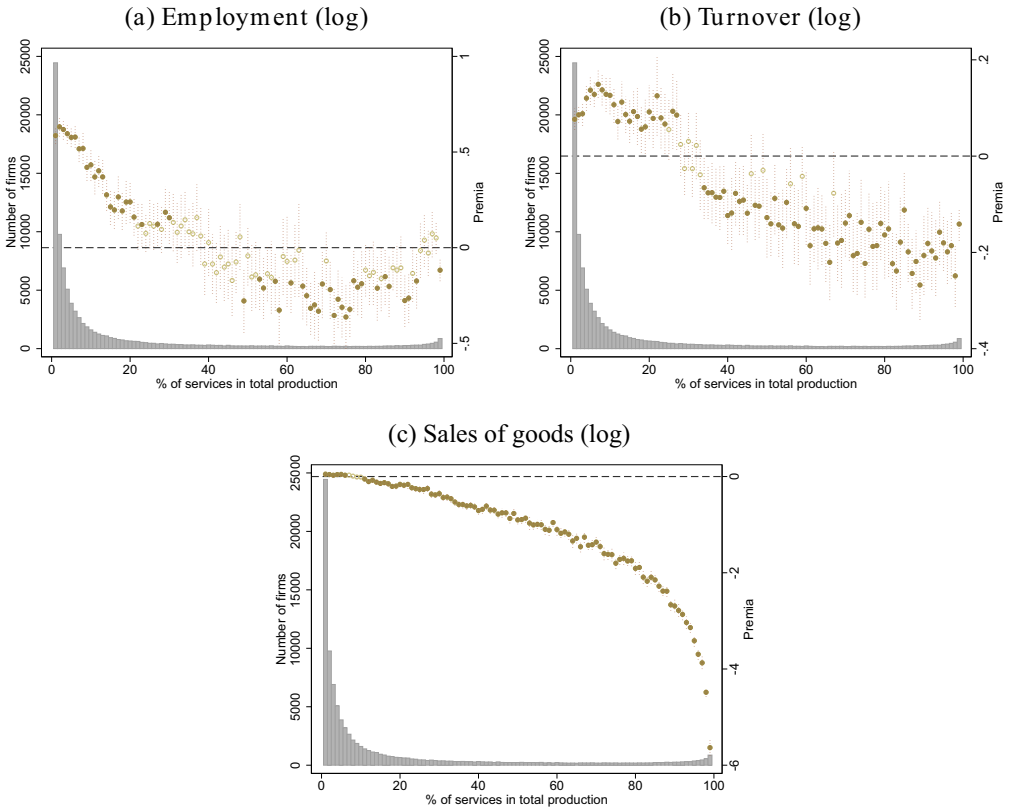

FIGURE 7 Relative performance of servitized firms (employment, turnover, and sales of goods) [Color figure can be viewed at wileyonlinelibrary.com]

5.2 | Econometric analysis of the link between servitization and firm performance

The premia reported in Figures 6 and 7 deliver three key messages. First, it seems that the population of French manufacturing firms can be divided into three distinct groups: pure manufacturers who do not produce services, servitized firms that mainly produce goods (with a share of services of total production roughly below 30%), and firms that mainly produce services. Besides the importance of services to their total production, the firms in these three groups also differ in terms of size and profitability. In 2007, approximately 25% of the firms belong to the first group, 56% to the second, and less than 19% to the third. Second, for a large majority of manufacturing firms, servitization is associated with better performance compared to nonservitized firms. As long as the production of services represents a small share of total production, servitized manufacturers are larger (in terms of employment and production) and more profitable. Third, with the exception of the production of goods, differences in service intensity within the two groups of servitized firms does not influence the premia much. In particular, selling services is associated with better performance, even when they represent a small share of firm sales.

Building on these observations, our empirical analysis of the impact of servitization on firm performance will concentrate on the decision to start selling services rather than on changes in service intensity. It seems that the decision to produce services is what really matter for firms, whereas the decision to sell more or fewer services has an ambiguous impact on firm performance. It is noteworthy that by doing so, firms for which services represents a large share of total output contribute only marginally to the econometric identification, because most of them report strictly positive production of services each year. Our econometric analysis is therefore based on a more precise and consistent sample of firms that are (by a very large proportion) mainly producers of goods.[14]

The premia shown above are simple OLS estimates and suffer from patent endogeneity problems. Our first concern is that some confounding factors could be simultaneously correlated with both the decision to start selling services and firm performance. The decision to start selling services may be motivated or influenced by changes in firm environments (e.g., changes in competition pressure, technological changes, evolution of public regulations, improvement of transport, and telecommunication infrastructures). The decision may also depend on unobserved firm-level characteristics, such as manager ability and past experiences. Failing to control for these confounding factors can seriously bias estimates.

The second concern is reverse causality induced by self-selection. Do firms decide to sell services because they have good performance or do they have better performance because they also sell services to their consumers? The bias may occur in both directions. On the one hand, servitization may be a selective process whereby only the highest performing firms find it profitable to sell services. This mechanism will be observed, for instance, if firms have to invest in and allocate some managerial resources to start selling services. These investments may not be affordable to firms with low profits or strong financial constraints. They may also be nonprofitable for firms with low competitiveness because the potential commercial gain they expect from selling services may not compensate for the fixed investment cost. In this case, the OLS estimates would be biased upward. On the other hand, a negative relationship between *ex ante* firm performance and the decision to start selling services may also exist. When facing a negative shock, firms may try to restore their market shares and profits by shifting their production toward services in order to generate additional revenues and/or to add value to the good they sell. If the decision to start selling services is a defensive strategy for declining firms, we would expect the OLS estimates to be biased downward.[15]

To tackle these endogeneity issues, we control for unobserved confounding factors that may simultaneously influence the decision to sell services and firm performance. The traditional method to address unobserved variables is to use firm-level fixed effects in a difference-in-differences approach. This is not the most appropriate method in our case. Difference-in-differences estimators are based on the assumption that the most relevant unobserved confounding factors are time invariant, which may not be true here. It is very likely that firms that decide to sell services have recently experienced some specific shock: a negative shock that reduced their profitability, a positive shock that provided them with the resources needed to invest in a new activity, or simply a change in their management team or ownership structure that may have influenced their strategies and performance in some undetermined way.[16] In this case, the most appropriate econometric strategy is to estimate a lagged dependent variable model in which all relevant omitted variables (including those that are time varying) are controlled for by the lags of the dependent variable. Compared to a fixed effects model, a lagged dependent variable model offers better control for self-selection and the ensuing reverse causality bias. In addition, we introduce year × industry fixed effects to capture unobserved determinants that may influence performance in a given year and 2-digit industry (e.g., changes in technology, regulations, infrastructures, competitive environment).[17]

Equations (3) and (4) represent the fixed effect and lagged dependent variable models that we estimate:

$$Performance_{i,t} = \alpha_0 \mathbb{1}(serv_{i,t-1}) + \chi_{i,t-1} + \eta_i + \delta_{j,t} + \epsilon_{i,t}; \tag{3}$$

$$Performance_{i,t} = \alpha_1 \mathbb{1}(serv_{i,t-1}) + \sum_{k=1}^{\#Lags} \gamma_k Performance_{i,t-k} + \chi_{i,t-1} + \delta_{j,t} + \varepsilon_{i,t}. \tag{4}$$

$Performance_{i,t}$ measures the performance of firm i in year t (i.e., profitability, employment, turnover, or production of goods); $\mathbb{1}(serv_{i,t-1})$ is a dummy variable taking the value one if the firm i sells services at $t-1$ and zero otherwise; $\chi_{i,t-1}$ is a vector of control variables, which are all lagged by one period to avoid simultaneity issues; $\delta_{j,t}$ is a set of year × two-digit industry fixed effects; η_i in equation (3) is a set of firm fixed effects; $\epsilon_{i,t}$ and $\varepsilon_{i,t}$ are the error terms. As the accuracy of the parameter estimates tends to increase with the number of lags of the dependent variable (Wilkins, 2015), our preferred specification includes three lags (i.e., $\#Lags = 3$ in equation (4)).[18] The coefficients of interest, α_0 and α_1, measure the conditional correlation between servitization and firm performance.

5.3 | Baseline econometric results

5.3.1 | Profitability

We begin our presentation of the econometric results by examining how servitization correlates with firm profitability. The benchmark results are shown in Table 2. Columns (1) and (2) use a simple OLS estimator and do not control for omitted variables or unobserved heterogeneity. Columns (3) and (4) tackle this bias using a linear model with fixed effects, and in columns (5) and (6), we use a lagged dependent variable model.

The first two columns produce very similar results. The coefficients on the decision to start selling services are positive and highly significant. These estimates mirror the premia we presented in Figure 6[19]: compared to firms that do not shift toward services, servitized firms have profit margins approximately 3.8 percentage points higher. In the sample used for the regressions, the average profit rate is 47.4%, which implies a premium on the profit rate between 7.9% and 8.2% depending on whether we control for the number of employees, the market share (the firm sales of goods divided by the total sales of goods in the same industry) and the interaction between market share and the Herfindahl index, which captures the level of competition in the

TABLE 2 Impact of servitization on firm profitability—benchmark results

Dep. Var.: Profit$_{i,t}$	(1)	(2)	(3)	(4)	(5)	(6)
Estimator:	**OLS**	**OLS**	**FE**	**FE**	**Lag. Dep.**	**Lag. Dep.**
$\mathbb{1}(serv_{i,t-1})$	3.784*	3.884*	0.709**	0.715**	0.368*	0.375*
	(0.402)	(0.405)	(0.298)	(0.298)	(0.094)	(0.095)
Ln Employment$_{i,t-1}$	−0.171	−0.566**	−3.589*	−3.656*	0.083**	0.058
	(0.174)	(0.226)	(0.307)	(0.301)	(0.035)	(0.039)
Ln MkShare$_{i,t-1}$		13.881**		7.858**		1.056
		(5.717)		(3.993)		(0.659)
Ln MkShare$_{i,t-1}$		−291.045*		−143.889**		−26.727***
× Herf$_{j,t-1}$		(108.894)		(70.328)		(14.573)
Profit$_{i,t-1}$					0.601*	0.601*
					(0.007)	(0.007)
Profit$_{i,t-2}$					0.182*	0.182*
					(0.008)	(0.008)
Profit$_{i,t-3}$					0.125*	0.125*
					(0.006)	(0.006)
# Obs.	37,049	37,049	37,049	37,049	37,049	37,049
R^2	0.065	0.073	0.038	0.038	0.749	0.749

Note: All regressions include industry × year fixed effects. Robust standard errors in parentheses are clustered at the firm level. Regressions in columns (3) and (4) include firm fixed effects. Columns (5) and (6) report the lagged dependent variable model estimates.
Significance levels: ***: $p < 0.1$, **: $p < 0.05$, *: $p < 0.01$.

industry.[20] In columns (3) and (4), we control for firm fixed effects in order to account for selection effects. Unsurprisingly, the point estimates decline sharply. They are approximatively five times smaller than the OLS estimates. This confirms that a large share of the premium comes from self-selection due to time-invariant unobserved characteristics. The effect of servitization remains positive but is much smaller. On average, firms moving toward servitization (i.e., $\mathbb{1}(serv_{i,t-1})$ moves from zero to one) experience an increase in their profit margin of approximately 0.7 percentage points once we account for time-invariant firm characteristics. Finally, in columns (5) and (6), we control for the lagged values of the profit rate. The effect of servitization on the profit margin is still positive and statistically significant and is more precisely estimated than in the fixed effects model. Note that the fixed effects estimates are systematically larger than those of the lagged dependent variable models. This is consistent with the bracketing properties of these two estimators, as described by Angrist and Pischke (2008). If the correct model is a lagged dependent variable model, then fixed effects will result in overestimation of a positive treatment effect. However, if the most important omitted variables are time invariant, the correct model is a fixed effects model, and the lagged dependent variable estimator will result in underestimation of the treatment effect. We argue that the correct specification in our case is the lagged dependent variable model, but it is useful to think of our estimates as the lower bounds of the true effect.

In Table A2, we test the robustness of our benchmark results to alternative firm samples. In our benchmark regression (Table 2), we exclude firms that always sold services or that stopped selling services over the period. We focused on the subsample of firms that either never sold services or that started to sell services. In line (1) of Table A2, we exclude all firm that produced services in year $t - 2$. In other words, we use a sharper definition of the treatment. We exclude from the sample all treated firms once they have been treated (i.e., once they have started to produce services), and we estimate the impact of shifting toward services in the year after the shift but not in the following years. In line (2), we add to our benchmark sample the firms that stopped producing services, and in line (3), we replicate our benchmark regression using the sample of firms that are always observed in our database (i.e., we exclude firms that appeared or disappeared from the sample between 1997 and 2007). We confirm that there is a positive relationship between servitization and firm profitability.

5.3.2 | Employment, turnover, and production of goods

We now turn to the relationship between servitization and alternative indicators of firm performance. We reestimate equations (3) and (4) using level of employment, turnover, and production of goods as alternative dependent variables. The results are shown in Table 3. We only report the estimated coefficients on the decision to start selling services, that is, the estimates of α_0 and α_1 from equations (3) and (4). The results confirm the positive correlation between servitization and firm performance. Once

TABLE 3 Impact of servitization on firm employment, turnover, and production of goods

Estimator		*Dep. Var.*	$\mathbb{1}(serv_{i,t-1})$	(Std. Err.)	# Obs.	R^2
(1a)	FE	Employment	0.042*	(0.009)	37,049	0.020
(2a)	FE	Turnover	0.029*	(0.009)	37,049	0.140
(3a)	FE	Prod. goods	−0.074*	(0.024)	35,182	0.079
(1b)	Lag. Dep.	Employment	0.021*	(0.003)	37,049	0.967
(2b)	Lag. Dep.	Turnover	0.006**	(0.003)	37,049	0.971
(3b)	Lag. Dep.	Prod. goods	0.002	(0.004)	35,182	0.964

Note: All regressions include industry × year fixed effects. Robust standard errors in parentheses are clustered at the firm level. Regressions in lines (1a), (2a), and (3a) include firm fixed effects. Regressions in lines (1b), (2b), and (3b) include 3-year lagged dependent variables. Regressions in lines (2a), (3a), (2b), and (3b) control for the 1-year lagged employment level.
Significance levels: ***: $p < 0.1$, **: $p < 0.05$, *: $p < 0.01$.

again, the fixed effects estimates are a bit larger than those of the lagged dependent model, which implies that the estimates from the lagged dependent variable model should be seen as conservative lower bound estimates.[21] As for profitability, we find a significant, positive correlation between servitization and firm outcomes. Because each dependent variable is in logarithmic form, the magnitude of the estimated effect of starting to produce services is given by the exponent of the point estimate minus one. We find that, on average and relative to pure manufacturers, firms that start producing services have between 2.1% and 4.2% more employees and between 0.6% and 3% higher turnover. The point estimate for the production of goods is negative in the fixed effects specification and not statistically different from zero in the lagged dependent variable specification. Given the bracketing properties of the two estimators, we cannot conclusively say anything about the true effect of servitization on goods production.

5.4 | Extensions

All the econometric results shown above point in the same direction. They confirm that servitization is correlated with higher performance among manufacturing firms, at least in terms of profitability. These econometric results contrast with many case studies that highlight the difficulties companies experience in reaping the benefits of a servitization strategy (Gebauer et al., 2005; Martinez, Bastl, Kingston, & Evans, 2010). However, our estimates are average effects, which may hide heterogeneity by industry or firm type. In this section, we evaluate the consequence of starting to sell services for long-run performance, and we replicate our baseline estimation using an alternative sample of firms. These more detailed results indicate that the link between servitization and firm performance is much less systematic than suggested by our benchmark regressions.

5.4.1 | Long-run effects

As emphasized in the literature, selling services is associated with long-term investments with consumers, and the benefits of servitization may take time to materialize. Our baseline specification considered firm performance in the year that a move toward services takes place. Thus, our results may miss some of the long-run effects of servitization. In the following table, we present the results for how firm performance is affected by the move toward services at $t + 1$, $t + 2$, and $t + 3$ using our preferred and most conservative specification, equation (4).[22]

The results indicate that the benefits of servitization in terms of firm profitability occur over time. Our benchmark results indicate that in the year after a shift toward services, servitized firms increase their profit rate by 0.37 percentage points compared to pure manufacturers (see Table 2). Table 4 shows that most of the benefits from servitization are observed up to 1 year after starting to sell services. In line (1), the point estimate is approximately two-thirds of that observed in the year the firm switches toward services, as reported in columns (5) and (6) of Table 2. The correlation between servitization and firm profitability 3 or 4 years after starting to sell services remains positive but is nonsignificant. The correlation with employment also declines over time but is more persistent. Even 4 years after engaging in servitization, firms employ more workers than pure manufacturers. The correlations with turnover and with the production of goods is either nonsignificant or very small and imprecisely estimated, mirroring the results presented in the previous table. Taken together, these results suggest that the supply of services does not necessarily support the production of goods over the long run. Servitization seems to be mainly a strategy that leads firms to focus on their most profitable activities and/or to differentiate their products further in order to charge higher margins.

TABLE 4 Impact of servitization on firm performance—long-run effects

Dep. Var.		$\mathbb{1}(serv_{i,t-1})$	(Std. Err.)	# Obs.	R^2
(1)	$\text{Profit}_{i,t+1}$	0.215**	(0.098)	37,049	0.75
(2)	$\text{Profit}_{i,t+2}$	0.109	(0.109)	37,049	0.75
(3)	$\text{Profit}_{i,t+3}$	0.091	(0.122)	30,202	0.75
(4)	$\ln(\text{Emp.})_{i,t+1}$	0.016*	(0.003)	37,049	0.97
(5)	$\ln(\text{Emp.})_{i,t+2}$	0.011*	(0.004)	37,049	0.97
(6)	$\ln(\text{Emp.})_{i,t+3}$	0.008**	(0.004)	30,202	0.97
(7)	$\ln(\text{Turnover})_{i,t+1}$	0.004	(0.003)	37,049	0.97
(8)	$\ln(\text{Turnover})_{i,t+2}$	0.000	(0.004)	37,049	0.97
(9)	$\ln(\text{Turnover})_{i,t+3}$	−0.001	(0.004)	30,202	0.97
(10)	$\ln(\text{Prod. goods})_{i,t+1}$	0.009**	(0.004)	35,089	0.96
(11)	$\ln(\text{Prod. goods})_{i,t+2}$	0.007	(0.005)	35,089	0.96
(12)	$\ln(\text{Prod. goods})_{i,t+3}$	0.009***	(0.005)	28,502	0.97

Note: Lagged dependent variable models with three lags, controlling for lagged employment (except for lines 4–6) and industry × year fixed effects. Column (std. err.) reports robust standard errors clustered by firm.
Significance levels: ***: $p < 0.1$, **: $p < 0.05$, *: $p < 0.01$.

TABLE 5 Impact of servitization on firm profitability, employment, turnover, and production of goods—by firm size

Dep. Var.		$\mathbb{1}(serv_{i,t-1})$	(std. err.)	# Obs.	R^2	Firm Size Category
(1)	Profitability	0.306*	(0.159)	20,160	0.73	Micro (1–10)
(2)	Profitability	0.357*	(0.132)	13,650	0.77	Small (11–50)
(3)	Profitability	0.077	(0.253)	3,239	0.75	Large (>50)
(4)	Employment	0.015*	(0.005)	20,160	0.84	Micro (1–10)
(5)	Employment	0.024*	(0.004)	13,650	0.87	Small (11–50)
(6)	Employment	0.011***	(0.006)	3,239	0.97	Large (>50)
(7)	Turnover	0.001	(0.005)	20,160	0.89	Micro (1–10)
(8)	Turnover	0.013*	(0.005)	13,650	0.92	Small (11–50)
(9)	Turnover	−0.006	(0.008)	3,239	0.97	Large (>50)
(10)	Prod. goods	−0.013***	(0.007)	19,051	0.89	Micro (1–10)
(11)	Prod. goods	0.017*	(0.006)	12,876	0.90	Small (11–50)
(12)	Prod. goods	−0.018***	(0.011)	3,162	0.96	Large (>50)

Note: Lagged dependent variable models with three lags, controlling for lagged employment (except in lines 4–6) and industry × year fixed effects. Column (std. err.) reports robust standard errors clustered by firm.
Significance levels: ***: $p < 0.1$, **: $p < 0.05$, *: $p < 0.01$.

5.4.2 | Results by firm size

In Table 5, we examine whether the link with servitization differs by firm size. We report the point estimates on $\mathbb{1}(serv_{i,t-1})$ for samples of micro, small, and medium and large firms, as defined by the European Commission.[23] For each of the four performance measures, we find that the baseline results are driven by micro and small businesses, that is, by firms with fewer than 50 employees. The point estimates on either performance measure for these type of firms are very similar to those shown in Tables 2 and 3. Starting to sell services also increases employment and turnover, whereas the impacts on the production of goods are more mixed. The correlation is negative, although not precisely estimated, for micro firms and positive for small enterprises. Regarding large firms, the results show a positive correlation between servitization and employment, although it is smaller than in the baseline results and less precisely estimated, whereas the correlation with the sales of goods appears to be negative and statistically significant only at the 10% level. In large firms, the shift toward services appears to be correlated with a simultaneous shift away from the production of goods. The overall lack of significance may be due to the relatively small number of firms in this category (especially of firms starting to sell services), which reduces the precision of the estimates. This pattern may also indicate that firms that have managed to grow without needing to produce services perform particularly well in the production of goods.

TABLE 6 Impact of servitization—by sector

	$\mathbb{1}(serv_{i,t-1})$	(Std. Err.)	# Obs.	R^2
1—Food, Beverage, Tobacco				
Profitability	0.549*	(0.191)	10,539	0.81
Ln Employment	0.018*	(0.008)	10,539	0.95
Ln Turnover	0.001	(0.007)	10,539	0.97
Ln Prod. Goods	−0.000	(0.007)	10,491	0.97
2—Textile, Leather				
Profitability	−0.526	0.516)	1,316	0.81
Ln Employment	0.021	(0.015)	1,316	0.96
Ln Turnover	−0.011	(0.019)	1,316	0.95
Ln Prod. Goods	−0.025	(0.025)	1,273	0.94
3—Wood, Paper, Printing				
Profitability	0.206	(0.224)	5,301	0.71
Ln Employment	0.027*	(0.008)	5,301	0.96
Ln Turnover	0.012	(0.008)	5,301	0.96
Ln Prod. Goods	−0.001	(0.010)	4,914	0.95
4—Chemicals, Plastics				
Profitability	−0.083	(0.414)	1,559	0.74
Ln Employment	0.039*	(0.011)	1,559	0.98
Ln Turnover	0.009	(0.014)	1,559	0.98
Ln Prod. Goods	0.005	(0.014)	1,549	0.98
5—Mineral, Metal Products				
Profitability	0.355**	(0.168)	11,341	0.70
Ln Employment	0.016*	(0.004)	11,341	0.96
Ln Turnover	0.009	(0.006)	11,341	0.96
Ln Prod. Goods	−0.001	(0.008)	11,341	0.94
6—Machinery, Electrical Equip.				
Profitability	0.894*	(0.272)	4,845	0.70
Ln Employment	0.015**	(0.006)	4,845	0.98
Ln Turnover	0.004	(0.009)	4,845	0.98
Ln Prod. Goods	−0.004	(0.011)	4,469	0.97
7—Manufacturing, n.e.c.				
Profitability	0.054	(0.381)	2,148	0.69
Ln Employment	0.031*	(0.012)	2,148	0.97
Ln Turnover	0.015	(0.013)	2,148	0.97
Ln Prod. Goods	0.017	(0.015)	2,009	0.96

Note: Lagged dependent variable model with three lags, controlling for lagged employment and industry × year fixed effects. Robust standard errors are clustered at the industry × year level.
Significance levels: ***: $p < 0.1$, **: $p < 0.05$, *: $p < 0.01$.

5.4.3 | Results by industry

The move toward supplying services to consumers is very likely to depend on the characteristics of the product being sold or on the type of competition prevailing in an industry. In Crozet and Milet (2017), we use the same data set to show that servitization is more widespread in industries that produce heterogeneous goods.[24] Fang et al. (2008) provide evidence that adding a service to the core product of the firm leads to higher market value, especially in industries with overall low growth and high sales volatility. In a widely cited article, Teece (1986) argues that services "do not loom large" in the early stages of an industry. This influenced the vision that services are beneficial when firms enjoy a well-established base of customers and when differentiation of the product becomes increasingly challenging. To show how the link between servitization and firm performance differs by

sector, we assigned each firm in our sample to a broadly defined sector and estimated equation (4) for each sector separately.[25] The results are reported in Table 6.

Again, this table conveys a more complex message about the link between servitization and firm performance than suggested by the baseline results. At first glance, this table seems to confirm the baseline results, as most estimates are positive and statistically significant when firm performance is measured by profitability or employment (of the 14 estimates corresponding to these two performance measures, nine are positive and statistically significant, and five are not significant). Servitization is also not correlated with higher turnover or higher production of goods in any of the seven broad sectors. The coefficients are, on average, very small and not statistically different from zero. However, the results differ substantially across sectors and reveal both the complexity and the diversity of the servitization strategies discussed in the literature. We can identify three patterns:

1. Servitization is positively correlated with both higher profitability and employment as in the agri-food (1), mineral and metal products (5), and machinery, electrical, optical, and transport equipment (6) sectors. In all these sectors, the correlations between servitization and profitability are higher than in the baseline estimates, ranging from 0.35 in the mineral and metal product sector to almost 0.9 in the machinery, electrical, optical, and transport equipment sectors. The correlation between servitization and employment is slightly smaller but not statistically different from the baseline estimates in Table 3.
2. Servitization is positively correlated with higher employment only. This pattern is observed in three of the broad industrial sectors: wood, paper and printing (2), chemicals and plastics (4), and other manufacturing not elsewhere classified (7). The correlation is larger in the last two sectors but remains quite small overall.
3. Servitization is not correlated with firm performance. This is the case for the textile and leather sector (2).

6 | CONCLUSION

Servitization is growing everywhere, yet empirical evidence of its impact on firm performance remains scarce (Baines & Lightfoot, 2013). We help fill this gap by documenting the extent and evolution of servitization in the French manufacturing sector between 1997 and 2007 using a large data set of more than 50,000 servitized and nonservitized firms. We first documented that the vast majority of French manufacturing firms report positive sales of services. The share of servitized firms in the population of French manufacturers increased slightly during the 1997–2007 period. More importantly, we find that the share of services of total production sales increased in almost all industries, and on average, each French manufacturing firms increased its service intensity. We show that servitized firms are more profitable, employ more workers, and have higher total sales than nonservitized firms. For the vast majority of firms in our sample, these premia depend only on the decision to start selling services and not on the share of services of total sales. Building on this result, we adopt a microeconometric approach to assess how engaging in the production of services correlates with firm performance. According to our most conservative estimates, firms that start selling services increase their profitability by 8% to 8.5% and increase the size of their workforce by 0.2% to 0.4%. We also find that these results are mostly driven by micro and small businesses employing less than 50 employees. For these firms, servitization is also correlated with higher sales and production of goods. Moving toward the provision of services is certainly costly for firms, as it implies deep modification of their business models. Our findings suggest that, on average, the benefits reaped from servitization outweigh its costs, at least for small businesses. Finally, we uncover considerable heterogeneity across manufacturing sectors. The gains from servitization for French firms are highest for agri-food, minerals and metals, and machinery and electrical equipment.

From an academic perspective, several interesting questions that are beyond the scope of this paper are raised. Firms that complement their products with services have shifted toward a new business model. They now provide a mix of goods and services and rather than only tangible products. This raises the question of how to define the production functions of such firms and calls into question the definition and proper calculation of the total factor productivity of these firms. Measures of productivity relate physical output to input use, and quantifying service output and service quality constitutes a severe challenge.[26]

From an economic policy side, this paper raises the question of the relevance of a unique industry classification based on the main activity of firms. How should firms that produce as many goods as services be classified? This is an important issue as most economic policies are based on such classifications. Failing to consider the dual nature of manufacturing production may result in nonoptimal policies (Lodefalk, 2017). The same logic applies, for instance, to trade negotiations (including those taking place at the World Trade Organization) where trade in goods and trade in services are typically negotiated separately. Although negotiations to liberalize trade in goods traditionally address tariff reductions and reduction in nontariff barriers, a crucial aspect of the negotiations to liberalize services is market access. Manufacturing firms offering goods and services benefit from tariff

reductions, but also from enhanced market access for their service. Our paper shows that there is some complementarity between goods and services, and policies that ignore this complementarity may be inefficient.

NOTES

[1] See Fuchs (1968) for similar views of the distinction between manufacturing and services.

[2] Since then, several alternative definitions have been proposed, but they all emphasize the role of additional services offered by manufacturers. Desmet and van Looy (2013) define servitization as "a trend in which manufacturing firms adopt more and more service components in their offerings"; Robinson, Clarke-Hill, and Clarkson (2002) define it as "an integrated bundle consisting of both the goods and the services."

[3] The authors describe it as follows: "Most product manufacturers are confronted with the following phenomenon: Companies which invest heavily in extending their service business, increase their service offerings and incur higher costs, but this does not result in the expected correspondingly higher returns. Because of increasing costs and a lack of corresponding returns, the growth in service revenue fails to meet its intended objectives. We term this phenomenon the 'service paradox' in manufacturing companies."

[4] The change in business model induced by servitization is related to the shift from a "product-dominant" logic to a "service-dominant" logic (Vargo & Lusch, 2004).

[5] Servitization has fostered research in several communities: service marketing, service management, operation management, and product-service systems. Lightfoot, Baines, and Smart (2013) surveys the relevant literature in each field.

[6] "Rolls-Royce earns its keep not just by making world-class engines, but by selling "power by the hour"—a complex of services and manufacturing that keeps its customers' engines burning. If it did not sell services, Rolls-Royce could not earn enough money from selling engines," The Economist (January 8, 2009).

[7] Between 2002 and 2010, Apple sold over 206 million iPods and over one billion songs through the iTunes Music Store (Benedettini, Clegg, Kafouros, & Neely, 2010).

[8] The data set does not provide information on the type of service sold by firms. Note that for firms that belong to a group, they can be sales to other affiliates or to subsidiaries of the group.

[9] Firms may report such extreme values of these ratios for two reasons. The first obvious reason is misreporting; the second is related to how firms manage their capital. Consider the following example: For tax purposes, a firm may decide to create an entity whose only purpose is to own its real estate assets. In this setting, the first firm is producing goods and employing workers but appears to have little or no capital. The second firm, which is entirely linked to the first, has a (potentially large) capital stock with few (if any) workers. Depending on how the boundaries of the firms are defined, we are left with two apparently distinct entities with capital to labor ratios that do not reflect the activities of the firm.

[10] Our database covers 21 two-digit industries. In the econometric analyses presented in Sections 4 and 5, we systematically control for two-digit industry fixed effects. However, to facilitate the exposition, we group the two-digit industries into seven broad categories.

[11] EBITDA is a proxy for a firm's current operating profitability (as well as cash flow). We divide it by value added in order to compare firm of different size and from different industries. This measure is commonly used in the literature to assess firm performance (Suarez et al., 2013; Visnjic et al., 2016). Value added is calculated as total revenues nets of intermediate consumption and directly available in the BRN data set.

[12] We do not consider sales of products that are bought and sold without transformation by the firm. See Bernard and Fort (2017) for a description of "factoryless goods producers," that is, firms that do not produce the goods they sell themselves but that are involved in the design and coordination of their production.

[13] The premia are very similar when we do not control for employment.

[14] In unreported regressions, we also examine how changes in the share of services of total sales affect firm performance. The estimations produce fragile and nonrobust results. These estimates, which confirm the ambiguity of the evidence reported in the existing literature, are partly driven by the fact that such econometric analysis gives great importance to the evolution of the performance of firms that drastically changed their business models, moving from very low shares of services to very large shares.

[15] Breinlich et al. (2014) provide empirical evidence in favor of such a defensive strategy. They show that increasing competition pressure resulting from lower European manufacturing tariffs caused British firms to shift into the provision of services and out of the production of goods.

[16] The literature has emphasized the role of organizational changes in successful transitions to services. When moving into services, firms often need to change their organizational structures and business models. These changes are costly, and firms may fail to implement them successfully, thus leading to the previously described "service paradox." Bowen, Siehl, and Schneider (1989) argue that managers in manufacturing companies are often reluctant to adopt service-specific values, as these values contradict traditional manufacturing goals and practices, such as standardization and efficiency. Gebauer and Fleisch (2007) argue that "managers are highly risk-averse when it comes to replacing their traditional product-oriented values with service-oriented values," a point also raised in Mathieu (2001) and Eggert et al. (2011).

[17] Other unobserved factors that can lead to reserve causality may also exist. A bias may persist if firms start selling services because they anticipate changes in their performance. For instance, firms innovating in products may also decide to sell services with them. To identify a causal link between servitization and firm performance, we need a suitable instrumental variable, that is, a measure correlated with the decision to start selling services but uncorrelated with the dependent variable. This is not an easy task given the data at hand, as any information on the firm balance sheet is very likely to be correlated with its performance. Nevertheless, in the Appendix, we propose an instrumental variable strategy that aims at addressing potential reverse causality bias.

[18] Our results are robust to the use of only one or two lags.

[19] The results shown in Figure 7 are slightly different because they are based on sample of observations that is not restricted by the use of a lagged variable or a precise control group.

[20] We do not include the Herfindahl index on its own because it is fully captured by the industry × year fixed effect.

[21] We also checked the robustness of these results to the use of alternative models, samples of firms and control groups. All unreported estimates corroborate those shown in Table 3. They are available upon request.

[22] Because of data limitations, we cannot estimate the impact of servitization over a longer period.

[23] Firms are classified according to their average number of employees over the observation period. Micro firms have no more than 10 employees. Small firms have between 11 and 50 employees, and large firms have more than 50 employees.

[24] We use the firm-level exports of goods from French customs data and Rauch (1999)'s classification to distinguish between differentiated and homogeneous goods. We find a positive log-linear relationship between the average share of services of the industry's output and the share of differentiated products in this industry. This argument is in line with Anderson, Fornell, and Rust (1997), who argue that firm performance depends on the degree of product heterogeneity. In their paper, they link measures of productivity to customer satisfaction (which takes into account the standardization versus the customization quality of the product).

[25] All regressions include two-digit industry × year fixed effects. Recall that we do not have information on the attributes of the products firms produce. Only the firm industry classification is available.

[26] In some service sectors, the quantity of service provided can be approximated by the quantity of goods necessary for the provision of the service. For instance, van Ark, Monnikhof, & Mulder (1999) compute a measure of productivity in the transport, communication, and distribution sectors in Canada, France, Germany, the Netherlands, and the United States. Quantities in the transport sector are measured by the number of passengers or tons per kilometers. In the communication sector, they use the number of mail delivered by postal services and the number of calls or access lines. For the distribution sector, they use the gross margins of wholesale and retail establishments.

[27] The French territory is divided into more than 36,500 cities with an average surface area of only 14.9 km^2. This high level of administrative fragmentation makes our measure of distance between firms quite precise and offers substantial variation in the instrument across firms.

[28] We also performed robustness analyses with an alternative instrument: the share of servitized firms in the same industry located in the same or surrounding départements (France is divided into 95 départements). The (unreported) results are very close to those reported here.

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How to cite this article: Crozet M., Milet E. Should everybody be in services? The effect of servitization on manufacturing firm performance. *J Econ Manage Strat*. 2017;00:1–22. https://doi.org/10.1111/jems.12211

APPENDIX A

A.1 Transition matrix

TABLE A1 Transition matrix—change in service intensity between 1997 and 2007

from\to	0%	bin1	bin2	bin3	bin4	bin5	bin6	bin7	bin8	bin9	bin10	100%
0%	**11.98**	**7.42**	0.40	0.17	0.11	0.06	0.05	0.05	0.05	0.04	**0.25**	**1.30**
bin1	**5.89**	**39.49**	2.78	0.82	0.40	0.17	0.15	0.10	0.06	0.08	**0.42**	**1.57**
bin2	0.23	1.79	**1.17**	0.47	0.18	0.12	0.05	0.04	0.01	0.04	0.03	0.24
bin3	0.09	0.63	0.45	**0.42**	0.20	0.14	0.07	0.03	0.02	0.03	0.05	0.13
bin4	0.04	0.26	0.13	0.21	**0.19**	0.12	0.11	0.07	0.02	0.01	0.05	0.13
bin5	0.03	0.13	0.07	0.11	0.13	**0.18**	0.08	0.07	0.07	0.01	0.04	0.09
bin6	0.01	0.11	0.03	0.06	0.05	0.11	**0.12**	0.08	0.04	0.04	0.07	0.08
bin7	0.01	0.06	0.03	0.04	0.04	0.05	0.08	**0.10**	0.08	0.08	0.05	0.10
bin8	0.02	0.08	0.01	0.02	0.03	0.03	0.04	0.05	**0.12**	0.09	0.12	0.16
bin9	0.02	0.07	0.01	0.01	0.01	0.02	0.03	0.04	0.08	**0.14**	0.23	0.20
bin10	**0.08**	**0.31**	0.06	0.02	0.02	0.03	0.03	0.05	0.08	0.13	**2.36**	**1.96**
100%	**0.83**	**1.38**	0.22	0.18	0.12	0.12	0.14	0.13	0.13	0.15	**1.63**	**3.81**

Note: Constant sample of 29,909 firms. Lines refer to the service intensity in 1997, whereas columns refer to the service intensity in 2007. Bins are defined as 10% intervals of service intensity. Firms in bin5 have a service intensity between 40% and 50%. The first and last columns (0% and 100%) refer to firms that produced either only goods or only services, respectively, in 2007.

A.2 Alternative samples

TABLE A2 Impact of servitization on firm profitability—alternative samples

					Samples		
	$\mathbb{1}(serv_{i,t-1})$	(Std. Err.)	# Obs.	R^2	Starts Only	With Stops	All Years
(1)	0.634*	(0.221)	28,170	0.75	✓		
(2)	0.288*	(0.059)	78,597	0.74		✓	
(3)	0.460*	(0.062)	116,968	0.75			✓
(4)	0.905**	(0.276)	17,808	0.75	✓		✓
(5)	0.227*	(0.068)	55,984	0.74		✓	✓

Note: Lagged dependent variable model with three lags, controlling for lagged employment and industry × year fixed effects. Column (std. err.) reports robust standard errors clustered by firm. Line (1) uses the sample of firms that were not producing services at $t-2$. Line (2) includes all firms except those that always produce services. Line (3) replicates the benchmark regressions shown in column (6) of Table 2 for a panel of firms active from 1997 to 2007. Lines (4) and (5) replicate the regressions shown in lines (1) and (2), respectively, for a panel of firms active from 1997 to 2007.

Significance levels: ***: $p < 0.1$; **: $p < 0.05$; *: $p < 0.01$.

A.3 Instrumental variable strategy

We now present an instrumental variable approach to address reverse causality between servitization and firm performance. We propose an instrument based on the assumption that management practice spillovers exist across firms. We argue that firms observe and imitate their competitors and are more likely to start selling services if comparable firms in the neighborhood already do so. A vast empirical literature has shown that scanning the external environment to obtain information about competitors' practices is a determinant of management innovation at the firm level. Audretsch and Feldman (1996) use this type of logic to assess how innovation is spread across firms that are geographically clustered. They argue that "Although the cost of transmitting information may be invariant to distance, presumably the cost of transmitting knowledge rises with distance. That is, proximity and location matter." The same argument is proposed by Fu (2012) regarding the diffusion of managerial practices from multinational enterprises to local firms in the United Kingdom. McEvily and Zaheer (1999) argue that firms are more likely to acquire competitive capabilities when they are embedded in a dense network. Mol and Birkinshaw (2009) talk about the "reference group" a firm belongs to and how this influences its management innovation choices. We follow this literature to define our instrument. For each firm i at time t in our database, we compute the number of servitized firms in its industry and the decile of size (measured as the average number of workers over the period) weighted by the geographic distance to firm i. The distance between firms is the geodesic distance between the cities in which the two headquarters are located.[27] Distance is used to proxy for the likelihood that a firm can observe and copy another (McEvily & Zaheer, 1999). For firms located in the same city, we use a measure of the internal distance of the city equal to $(2/3)\sqrt{A/\pi}$, where A is the area of the city in km^2 (Mayer & Zignago, 2011). Hence, our instrument varies by year, two-digit industry, city, and firm size decile.[28] We lag the instrument by two periods, as our endogenous variable is the decision to sell services at $t-1$. Our first-stage regression is the following:

$$\mathbb{1}(serv_{i,t-1}) = \gamma IV_{i,t-2} + \sum_{k=1}^{\#Lags} \eta_k Performance_{i,t-k} + \mu_{j,t} + \varepsilon_{i,t}, \tag{A.1}$$

where $\mathbb{1}(serv_{i,t-1})$ is the decision by firm i to start selling services at time $t-1$, $Performance_{i,t-k}$ is the lagged performance of firms (as in our preferred baseline regression, we use three lags: #Lags = 3). $\mu_{j,t}$ is a set of industry × year fixed effects, and $\varepsilon_{i,t}$ is the error term. Our instrumental variable, $IV_{i,t-2}$, is defined as follows:

$$IV_{i,t-2} = \frac{1}{distance_{i,i'}} \sum_{i'} \mathbb{1}serv_{i',t-2} \times \mathbb{1}Size_{i,i'} \times \mathbb{1}Industry_{i,i'}. \tag{A.2}$$

$\mathbb{1}serv_{i',t-2}$ is a dummy variable taking the value one if firm i' is a servitized firm at time $t-2$. $\mathbb{1}Size_{i,i'}$ takes the value one if firms i and i' are in the same size decile, and $\mathbb{1}Industry_{i,i'}$ takes the value one if they belong to the same industry. $\sum_{i'} \mathbb{1}serv_{i',t-2} \times \mathbb{1}Size_{i,i'} \times \mathbb{1}Industry_{i,i'}$ is therefore the number of firms fulfilling these three requirements. We weigh this number by the distance in thousands of kilometers between firm i and i'. We expect a positive correlation between $\text{IV}_{i,t-2}$ and $\mathbb{1}(serv_{i,t-1})$. Note that we lag our instrumental variable one period with respect to the endogenous variable $\mathbb{1}(serv_{i,t-1})$.

A legitimate concern about the instrument is that it may be directly correlated with firm performance, which would violate the exclusion restriction and thus the validity of our instrument. Indeed, if selling services influence the competitiveness of firms, then changing the number of service suppliers in the neighborhood of a firm is very likely to alter the competition pressure it faces and thereby its performance. In this case, the exclusion restriction is not verified, and no inference can be drawn from the empirical results. Our empirical strategy addresses this issue in two ways. First, our instrument is lagged by two periods with respect to the dependent variable, $Performance_{i,t}$. This should eliminate simultaneity bias that would lead to violation of the exclusion restriction. Second, our first- and second-stage regressions control for the past performance of firms (in $t-1$ and $t-2$). Any effect of our instrumental variable on past performance is therefore captured by these lags. Because all the performance measures we are interested in (profit margins, sales of goods, employment) are continuous outcomes, it is not possible for our instrumental variable to influence the current performance of a firm without influencing its performance in $t-1$ or $t-2$, for which we explicitly control.

Finally, we need to define an appropriate control group given that our objective is to assess the impact of starting to sell services on firm performance. We compare the performance of firms that shift toward the provision of services to the performance of firms that do not (or have not yet started). In other words, we do not consider firms that sell services throughout the period. We also omit firms that stop selling services to avoid mixing the effects of shifting into services from those of shifting out of services. Given these restrictions and the large number of lags (#Lags = 3), the econometric identification relies on a sample of 6,847 individual firms. Note that our results are robust to less restrictive alternative samples. The first-stage equation is a probit regression, which predicts the probability of treatment (i.e., the probability that a firm starts selling services). Both equations (4)

TABLE A3 Impact of servitization on firm profitability employment, turnover, and production of goods—lagged dependent variable model with instrumented treatment

	Dep. Var.	ATE	(std. err.)	#Obs.	ρ (p-value)
(1)	Profitability	1.433*	(0.357)	37,049	−0.082* (0.027)
(2)	Employment	0.169*	(0.014)	37,049	−0.408* (0.041)
(3)	Turnover	0.028*	(0.009)	37,049	−0.053** (0.021)
(4)	Prod. goods	0.037*	(0.007)	35,089	−0.073* (0.012)

Note: Lagged dependent variable model with three lags, controlling for lagged employment and industry × year fixed effects. All lines report estimates by full maximum likelihood, where the treatment variable, $\mathbb{1}(serv_{i,t-1})$, is instrumented by the (2-year lagged) distance-weighted sum of servitized producers in the corresponding industry and decile of size. Column (std. err.) reports robust standard errors clustered by firm. The last column reports the value of ρ and the corresponding p-value of the Wald test of the exogeneity of the instrumented variables.
Significance levels: ***: $p < 0.1$, **: $p < 0.05$, *: $p < 0.01$.

and (A.1) are estimated simultaneously via maximum likelihood. The results are shown in Table A3. Each line reports the estimation of the causal impact of starting to supply services on firm performance. The last column reports the value of ρ and the corresponding p-value of the Wald test of the exogeneity of the instrumented variable. The test statistic is negative and significant, meaning that the baseline results are likely to suffer from downward bias. This is what we see in the third column, which reports the average treatment effects. The estimated coefficients are positive, statistically significant, and larger than in the baseline estimate. Moving toward services leads to an increase in profitability of 1.43 percentage points ($\simeq 3\%$). The impact on employment is also larger than in the baseline result. On average, employment grows by 17% after the shift toward services. This may seem very large, but the median firm in our sample employs only nine workers. Increasing the workforce by 17% is equivalent to hiring 1.5 additional workers. Engaging in services also leads to higher turnover (+2.8%) and sales of goods (+3.7%).