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The Servitization of French Manufacturing Firms

Matthieu Crozet and Emmanuel Milet

Highlights

- We exploit balance sheet information for a very large sample of French firms to give an account of the production of services by manufacturing firms.
- The production of services for third parties by manufacturing firms is not negligible. In 2007, services accounted for 11.4% of aggregate sales of manufacturing firms. About 83% of French manufacturers sold some services, about a third sold more services than goods.
- Between 1997 and 2007, the share of services in manufacturing total output grown slowly but steadily.

RESEARCH AND EXPERTISE
ON THE WORLD ECONOMY

Abstract

The story of deindustrialization of developed economies is now old and well-observed. In most developed countries, value added by manufacturing as a percentage of GDP has decreased continuously since the 1950's, and is now less than 15% in most OECD countries. The shift of value added and employment away from manufacturing toward services may be even deeper than suggested by data based on sectoral classification. As the complexity and diversity of firms' activities grow, the boundary between services and industries becomes increasingly elusive. This paper uses detailed balance sheet data from a very large panel of French firms to examine the production and the sales of services by manufacturing firms. Our data reveals that 83% of firms registered in manufacturing sectors provide services for third parties, and nearly one-third of these firms provide more services than goods. Additionally, we find that from 1997-2007 manufacturing firms have increased their production of services. This growing trend in ``servitization" suggests that deindustrialization, already observed on a country-scale, is also taking place within firms.

Keywords

Deindustrialisation, Servitization.

JEL

D2, L8.

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The Servitization of French Manufacturing Firms

Matthieu Crozet* and Emmanuel Milet†

Abstract

The story of deindustrialization of developed economies is now old and well-observed. In most developed countries, value added by manufacturing as a percentage of GDP has decreased continuously since the 1950's, and is now less than 15% in most OECD countries. The shift of value added and employment away from manufacturing toward services may be even deeper than suggested by data based on sectoral classification. As the complexity and diversity of firms' activities grow, the boundary between services and industries becomes increasingly elusive. This paper uses detailed balance sheet data from a very large panel of French firms to examine the production and the sales of services by manufacturing firms. Our data reveals that 83% of firms registered in manufacturing sectors provide services for third parties, and nearly one-third of these firms provide more services than goods. Additionally, we find that from 1997-2007 manufacturing firms have increased their production of services. This growing trend in "servitization" suggests that deindustrialization, already observed on a country-scale, is also taking place within firms.

1. Introduction

The fate of the manufacturing sector is not very bright in most developed economies. The share of manufacturing firms in total employment or value added has been decreasing for many years. Using data from the United Nations (the National Accounts Main Aggregate Database), we find that between 1970 and 2010 the share of the manufacturing sector in value added dropped by 10 percentage points in most OECD countries. In 2010, this share was on average less than 20%, making developed countries undoubtedly "service economies" (Fuchs, 1965).[1] Moreover, data exploited by Pilat et al. (2006) show that the share of the manufacturing sector in total employment has been decreasing for more than 200 years, suggesting that the shift toward services (and the corresponding deindustrialization of developed economies) is the result of a slow and steady trend, and seems to some extent ineluctable.

A vast literature suggests that the shift toward services is a natural consequence of the economic development process. It is for instance the main prediction of Baumol's models of unbalanced growth, which emphasize the fundamental difference in long-term productivity growth between the manufacturing and the service sectors (Baumol, 1967; Baumol

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[1] Fuchs noted that by 1960 in the United States, more than half of the workforce was employed in service sectors. "We are now a "service economy" – that is, we are the first nation in the history of the world in which more than half of the employed population is not involved in the production of food, clothing, houses, automobiles, and other tangible goods."

and Bowen, 1966). This argument has been recently revived by Acemoglu and Guerrieri (2008) and Ngai and Pissarides (2007), and discussed by Triplett and Bosworth (2003). An alternative explanation stems from the difference in the income elasticity of demand between services and goods (Kuznets, 1957, 1973; Chenery, 1960). Finally, the outsourcing strategy of firms can also help explain the decline of the manufacturing sector.[2] Nevertheless, deindustrialization remains a major concern for policy makers. It is essentially because it generates large labor market adjustment costs, and also because the relative importance of manufacturing is now so small in some countries that further shifting toward services creates uncertainty about the nature and the strength of possible engines of long-term growth.

The debate on the extent, the causes and the consequences of the deindustrialization process is implicitly based on a representation of the economy as a collection of distinct sectors. It largely ignores the complex interdependencies between sectors and the real nature of the manufacturing production. Although official statistics draw arbitrary lines between the two types of activities, a vast literature in management and marketing stresses that the frontier between manufacturing and services is quite blurry, as stated by Levitt (1972) in the following words: *"There are no such things as service industries. There are only industries whose service components are greater or less than those of other industries. Everybody is in service."* Acknowledging that the manufacturing sector is not only about the production of goods, this literature delivers another way of looking at the deindustrialization process. It is not only a relocation of employment and value added between firms and industries, but also a shift toward service activities within manufacturing firms. This literature uses the expression "servitization" of manufacturing to describe this trend.[3]

In this paper, we document the importance of the servitization of French manufacturing firms over the 1997-2007 period, by looking at their supply of services. Let us clarify one important point. We *do not* aim to assess the importance of service tasks in the production process of manufactured products, but to enlighten the importance of the production and the *sales* of services produced by firms registered in the manufacturing sector.[4] We exploit a quasi-exhaustive database providing detailed information on about 635,000 French manufacturing firms. We take advantage of a very nice feature of the data, which for each firm report the value of the production of goods and the production of services sold during the year. So far, deindustrialization has mainly been considered as a mechanism between sectors. With this information, we are able to assess the importance of an additional margin through which the deindustrialization can take place. Within the manufacturing sector, firms themselves may be deindustrializing by focusing increasingly on the production of services. One can see this as the intensive margin of deindustrialization.

[2]Firms can outsource part of their production locally, or rely on foreign suppliers. In both cases, this implies a relocation of labor toward other firms, and perhaps other sectors. Some firms may outsource most (if not all) of the production process to focus only on service activities. Apple, with its "Designed by Apple in California, assembled in China" label is a famous example of such an organization choice.

[3]The term "servitization" was first defined by Vandermerwe and Rada (1988). See **?** for a review of this literature and a detailed definition.

[4]For references on the importance of services in the production process, see Francois (1990); Francois and Woerz (2008); Jones and Kierzkowski (1988); Katouzian (1970); Markusen (1989).

A rapid overview of the data shows that the production of services by manufacturing firms is not an anecdotal phenomenon. Simple counting for the year 2007 tells us that, in our sample of French manufacturing firms, services accounted for 11.4% of aggregate sales. About 83% of French manufacturing firms sold some services, 40% sold more services than goods, and 26% did not even produce goods. The average firm-level share of services in total sales was close to 35% of the total production sold in 2007.

The existing literature on the servitization of manufacturing identifies three main reasons which encourage manufacturing firms to engage in service activities Gebauer et al. (2005). First, by producing both goods and services, firms can expect marketing advantages. The provision of services may increase the consumer's loyalty and provide a faster and more appropriate response to the consumer's needs. The service provision can also improve the firm's corporate image. Second, the production of services may offer a strategic benefit since the firm is making a product-service bundle which is harder to imitate, and perceived as less substitutable by consumers. Third, firms may expect financial benefits because services make up an additional source of revenue, and may generate higher profit margins. In some cases, services also provide more stable revenues over time. While the sale of a product can be a one-time operation for a firm, the sales of related services can be spread over time. Rolls-Royce is an example of such a successful strategy of mixing the supply of goods and services, as mentioned in The Economist (Jan. 8th, 2009): "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". Similarly, Apple's iPod/iTunes combines a physical product with online services where the customer can purchase and download music and movies. Between 2002 and 2010, Apple sold over 206 million iPods, and over one billion songs from the iTunes music store (Benedettini et al., 2010).[5]

The aim of this paper is to document the extent of the production of services by French manufacturing firms between 1997 and 2007. The main indicator of interest is the share of services in firms' production sales. We will refer to this ratio as the firm-level "service intensity". The "servitization" of French manufacturing firms is the change of this ratio over time. As already mentioned, most manufacturing firms have positive sales of services. The share of services in production sales is quite uneven across firms however. On the one hand, for two thirds of the firms, services account for less than 20% of their production sales. On the other hand, for about 30% of French manufacturing firms, services account for more than 80% of their production sales. This pattern is found in each narrowly defined manufacturing industry. A high service intensity is associated with a smaller size, a lower labor productivity or capital intensity, and lower wages on average.

[5]However, the provision of services can be a risky business, and the expected benefits listed above may not come to fruition. The fact that the firm's performance may be lower after engaging in servitization is known as the "service paradox" (Gebauer et al., 2005): *"most product manufacturers were confronted with the following phenomenon: extended service business leads to increased service offerings and higher costs, but not to the corresponding higher returns"*. When selling services, firms may dilute their resources so that neither business reaches the critical size required to become successful. More details and examples on the benefits and costs of the servitization can be found in Bharadwaj et al. (1993); Brax and Jonsson (2009); Fang et al. (2008); Gebauer et al. (2005); Gebauer (2008); Oliva and Kallenberg (2003); Malleret (2006); Nelly (2007); Windahl and Lakemond (2006, 2010).

Regarding the change in the service intensity of manufacturing firms, we find evidence of a significant trend of servitization over the period. The service intensity increased steadily between 1997 and 2007, in each industry. This aggregate change is mainly driven by a within-firm servitization. This increase is quite moderate, however. Very few firms radically change their production mix, either toward a specialization in the production of services, or toward the production of manufacturing products. Finally, we propose a first look into a within-firm process of deindustrialization, which contributes to the global trend of deindustrialization of the French economy, but which is absent from studies focusing on sectoral classifications rather than on the actual production of the firms. We find that taking the firms' servitization into account provides a harsher diagnosis about the deindustrialisation of the French economy. We estimate that the decline in the proportion of workers involved in the production of goods has been up to 8% higher than the usual measures of deindustrialization based on the proportion of workers employed in manufacturing firms.

The rest of the paper is organized as follows. Section 2 presents and describes the data. In Section 3, we take a first look at the extent of the service intensity of French manufacturing firms. In Section 4, we then look at the servitization of French firms between 1997 and 2007. We propose another view of the deindustrialization process in Section 5. Section 6 concludes and proposes questions for future research.

2. Data

We use firm-level information from the BRN (Bénéfice Réels Normaux) dataset. It is collected by the French fiscal authority (Direction Générale des Impôts) and provides exhaustive information on the balance sheet of French firms. It includes about 635,000 firms from the private non-financial, nonagricultural sectors. We have information on a firm's main activity (identified by a 4-digit level NACE code), employment, value added, purchase of intermediate inputs, total cost, exports of goods, production and total sales. What is of particular interest to us is the distinction between the sales of services and the sales of goods produced by the firm.[6] This distinction allows us to compute the share of services in the total production sold by each firm. This is our measure of firms' service intensity. Because of changes in the industry classification and incomplete data for the year 2002, we split our sample into two periods: 1997-2001 and 2003-2007.

Figure 1 presents a visual description of the importance of the service intensity in different industries in both periods. It reports the average share of services in the total production sold by each 2-digit industry. Unsurprisingly, services account for most of the sales in the service sectors, as well as in the wholesale and retail industries.[7] In the manufacturing industries, the share of services in the total production sold is unsurprisingly much smaller. However, the sales of services by manufacturing firms are not confined to specific industries. The service intensity ranges from 5% in food production or in the manufacturing of basic metals, to over 20% in industries such as the manufacturing of fabricated metal

[6] Total sales also include the sales of merchandise, i.e. sales of products that have been bought and sold without transformation. We discard this information as we focus on the production of the firm only.

[7] Note that we do not consider the total sales in each industry, but only the production sales. In the wholesale-retail sector, most of the revenues stem from the sales of merchandise.

products, the manufacturing of computer, electronic and optical products, or the repair and installation of machinery and equipment. Figure 1 also suggests that the manufacturing industries are selling relatively more services over time. We formally investigate this question in Section 4.

Figure 1 – Share of Services in Production Sold

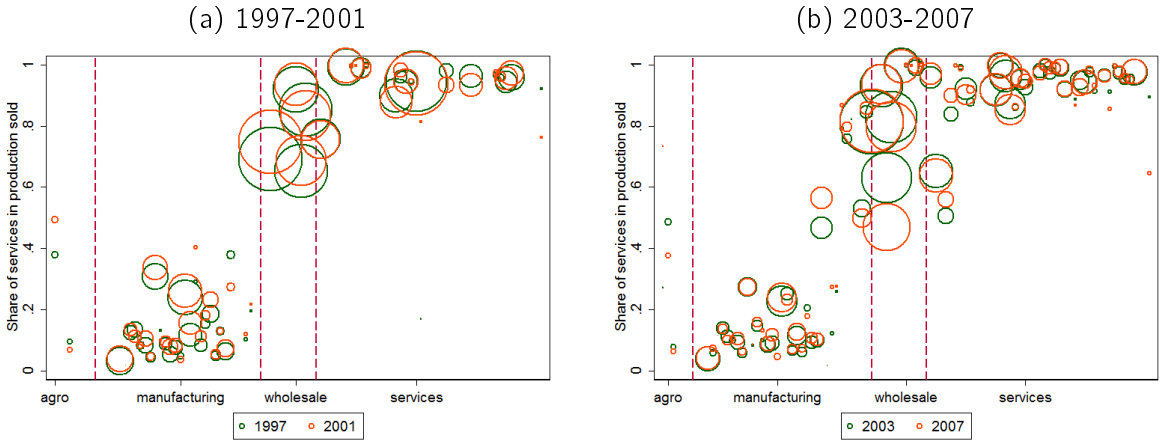


Table 1 – Number of Firms, Employment and Value Added in Manufacturing

	1997	2001	Δ	2003	2007	Δ
Number of Firms	68,634	65,078	-1.3%	55,847	50,721	-2.4%
	(0.21)	(0.19)		(0.16)	(0.14)	
Employment (thousands)	3,136	3,120	-0.1%	2,738	2,438	-2.9%
	(0.34)	(0.30)		(0.28)	(0.23)	
Value Added (thousands)	198,650	212,379	+1.7%	194,455	194,730	0%
	(0.39)	(0.35)		(0.32)	(0.27)	

Δ = Annualized growth rate. Share of manufacturing in our total sample of firms in parenthesis.
Sources: BRN database, authors' calculations.

In the rest of the paper, we focus on manufacturing firms only, i.e. the ones reporting a manufacturing NACE code as their main activity. Table 1 gives detailed information on the change in the number of firms, employment and value added in the manufacturing sector during the two periods. Our sample consists of 68,634 manufacturing firms in 1997, which represent 21% of the firms in the full sample. Table 1 also shows the extent of the deindustrialization of the French economy. Between 1997 and 2001, the number of manufacturing firms decreased by 1.3% on average each year. In 2001, the manufacturing sector accounted for 19% of the firm population. This decline was more pronounced between 2003 and 2007, when the number of manufacturing firms decreased on average by 2.4% per year. The figures for employment also reveal the shrinking importance of the manufacturing sector in terms of jobs. During the first period, the number of jobs in manufacturing remained quite stable despite a 1.3% yearly decrease in the number of firms. In the second period however, employment decreased by almost 3% per year. By 2007, the workers employed in the manufacturing sector accounted for 23% of the workforce in

the whole BRN database. Figures for employment and the firm population suggest that the manufacturing sector declined in both absolute and relative terms. Nevertheless, the manufacturing sector benefitted from positive growth in terms of value added. In the first period, value added grew by 1.7% on average, while growth was much more limited – although still positive – in the second period. In relative terms however, the contribution of the manufacturing sector to total value added declined by about 5 percentage points in both periods. In 2007, the manufacturing sector accounted for 27% of the total value added reported in the BRN database.

3. Service Intensity of French Manufacturing Firms

3.1. Who Is Servitized?

Figure 2 – Distribution of the Share of Services in Production

(a) Manufacturing (b) Selected Industries

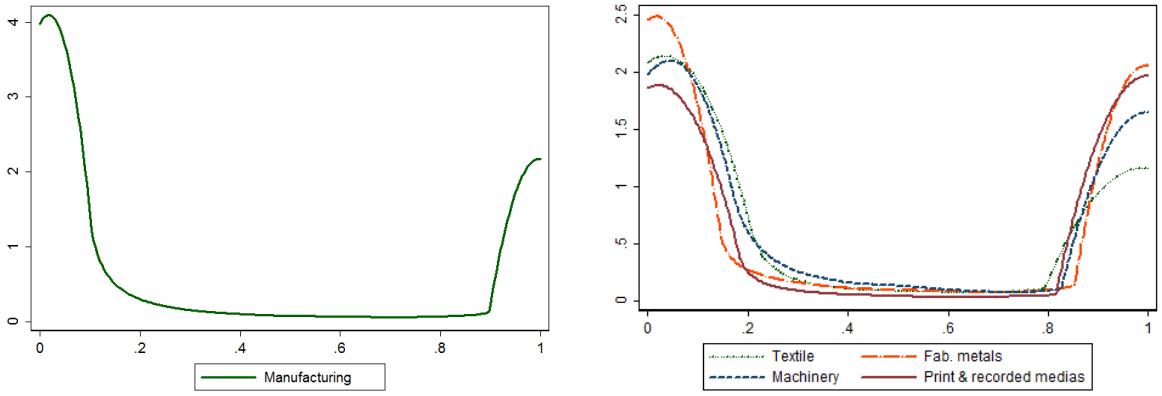


Figure 2 presents the distribution of service intensity across manufacturing firms in 2007. Panel (a) shows the distribution for all manufacturing firms, and panel (b) presents the distribution for a subset of industries. The distribution of service intensity across firms is clearly bimodal, with peaks at both ends of the distribution. The left peak is quite expected and can be easily explained. It merely reflects the fact that most manufacturing firms sell little or no services at all. About two thirds of manufacturing firms have less than 20% of their production sales in services. The distribution then approaches zero as the service intensity increases. This monotonic trend breaks at about 90%, where we encounter the second peak. 30% of French manufacturing firms are gathered in this second part of the distribution. This bimodal shape is found in each manufacturing industry. Panel (b) of Figure 2 shows the distribution of service intensity in four different manufacturing industries: Textile, Metal Products, Machinery and Printing and Recorded Media. All these industries exhibit a very similar distribution.[8] Firms which have a very high service intensity are probably firms that have outsourced most of the production of goods to focus on the provision of services. They may also have progressively increased the sales of services that are linked to the goods they produce, but have remained registered

[8]Figure 2 uses the 2-digit industry classification. The bimodal shape remains intact whether we look at 3-digit or 4-digit industries.

in the manufacturing sector.[9] Table 2 provides additional information on the firms that constitute the second peak of the distribution. For each 2-digit manufacturing industry, it describes the share of firms with at least 50% of their production sales in services. Their corresponding share in industry employment and value added is shown in the last two columns of the table. Across the different industries, the share of highly servitized firms ranges from 50% (Other transport equipment) to less than 15% (Food production). However, these firms represent a much smaller share of employment and value added in their industry. Taken altogether, they make up as much as a third of the firms in the manufacturing sector, but only 14% of the employment and 12% of the value added. This pattern is constant across industries and quite stable over time.

Table 2 – Share of Firms With at Least 50% of Services in Production Sales, in 2007

Industry	Nb Firms	Nb Firms (%)	L (%)	VA (%)
Other transport equipment	269	51.34	9.05	5.63
Recorded Media	2,012	49.81	31.37	30.79
Fabricated metal products	4,910	43.92	27.23	25.24
Machinery	1,703	41.46	14.48	11.9
Computer, electronic products	673	39.82	14.68	12.88
Motor vehicles	408	37.81	7.63	6.7
Other manufacturing	860	36.75	15.63	13.14
Furniture	703	35.85	11.41	11.54
Wearing Apparel	510	34.91	23.49	24.79
Textiles	550	34.9	22.87	18.26
Coke, petroleum	19	33.93	25.22	4.29
Electrical equipment	412	32.16	5.42	4.03
Leather	155	31.63	22.73	14.31
Other non-metallic mineral products	646	27.42	10.97	7.65
Wood products	546	22.11	12.61	11.37
Pharmaceutical products	63	21.72	18.64	19.98
Beverage	152	20.13	5.2	3.55
Tobacco	1	20	3.97	0.16
Paper products	204	19.63	6.92	7.28
Chemical products	266	18.95	13.95	30.77
Plastic products	477	16.33	6.15	6.04
Basic metals	95	14.91	4.15	4.29
Food Products	1,036	14.67	9.31	7.48
Total	16,670	32.86	14.01	12.64

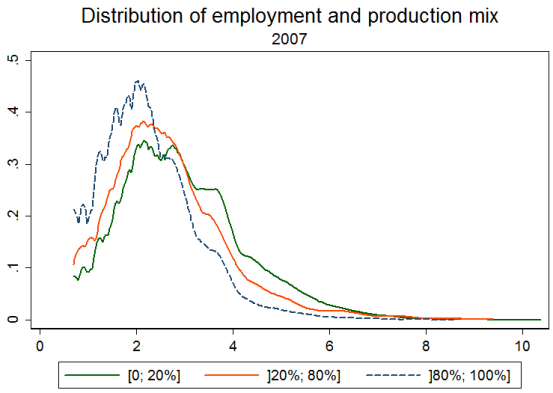
3.2. Firm-Level Determinants of Service Intensity

We now examine the characteristics of manufacturing firms with different service intensities. We classify firms into three categories: firms with a low service intensity (less

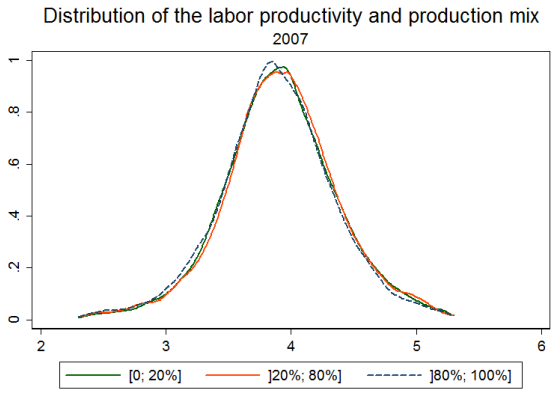
[9] It is important to notice that, in France, firms are not systematically reclassified when their main activity changes over time. This is partly due to the fact that collective labor agreements are defined at the sectoral level, which makes the reclassification very costly and cumbersome for employers and employees.

Figure 3 – Firm Performance and Service Intensity in 2007

(a) Employment



(b) Labor productivity



than 20% of services in total production sold), firms with an intermediate intensity (between 20% and 80%), and highly servitized firms (over 80%). In Figure 3, we look at the distribution of employment, labor productivity, export sales and profit rates for these three categories of firms. Panel (a) shows a clear negative relationship between a firm's service intensity and its number of employees. Firms with low service intensity are larger on average than firms with intermediate or high intensities. Regarding labor productivity (measured as value added per worker), shown in panel (b) of Figure 3, the differences are much smaller. Table 3 shows more detailed and robust evidence on the relationships between firms' service intensity and firms' characteristics. The regression reported in Column (1) shows that, controlling for industry×year fixed effects, a higher service intensity is associated with a smaller number of workers, lower labor productivity, lower capital intensity and lower wages. These results are confirmed by those reported in the last column of Table 3, where we retain firms that are continuously observed in our sample between 1997 and 2007. In Column (2), the sample of firms is restricted to those which primarily produce manufactured goods (we thus eliminate all firms in the right-hand peak of the bimodal distribution shown in Figure 2). For these firms, a higher service intensity is still associated with a smaller size and smaller capital intensity, but with higher average wages. These econometric results suggest that the production of services by manufacturing firms is on average less capital-intensive and more skill-intensive than the production of goods.

4. The Servitization of French Manufacturing: 1997-2007

In this section, we look at the servitization of French manufacturing firms, i.e. at how the service intensity of manufacturing firms has changed over time. In Figure 4, we look at the aggregate servitization between 1997 and 2001, and between 2003 and 2007. The plain line denotes the manufacturing sector as a whole, and the dashed lines represent selected industries. Between 1997 and 2001, the aggregate service intensity of manufacturing firms increased by more than 10%, going up from 10.8% in 1997 to 12% four years later. This is equivalent to a 2.8% average yearly growth rate over the period.[10] This

[10]The simple (unweighted) average of the share of services in production sold across all firms in the manufacturing sector produces much higher shares. The unweighted share was 36.5% in 1997, and 38% in 2001. This means that small firms increased their service intensity more than larger ones.

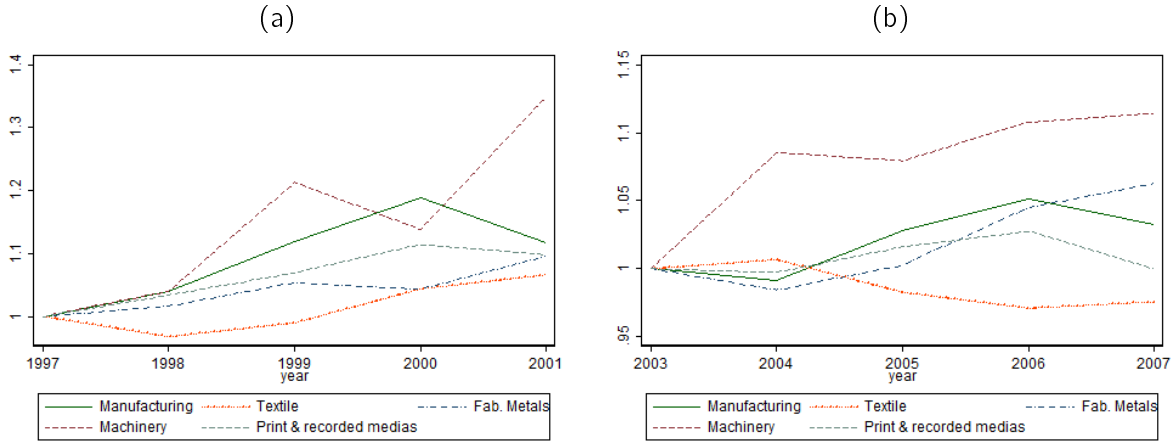
Table 3 – Firm-Level Determinants of Service Intensity

Dependent Variable: Firms' Share of Services in Total Production Sold			
	All Firms	Firms with Sh. Servi. < .5	Continuing firms
Ln Employment	-0.090[a]	-0.001[a]	-0.078[a]
	(0.005)	(0.000)	(0.004)
Ln Lab. prod.	-0.092[a]	-0.000	-0.100[a]
	(0.007)	(0.001)	(0.008)
Ln K/L	-0.068[a]	-0.001[b]	-0.072[a]
	(0.003)	(0.000)	(0.003)
Ln av. wage	-0.042[a]	0.004[a]	-0.024[a]
	(0.007)	(0.001)	(0.007)
Observations	605509	388964	290790

Robust standard errors in parentheses, clustered at the NACE2×year level ([b]: p<0.05, [a]: p<0.01). The sample includes manufacturing firms only. NACE2×year fixed effects included.

servitization is seen in most industries. Between 1997 and 2001, the service intensity declined by 17% in the wearing apparel, and by 25% in the manufacturing of basic metal products, but it increased by more than 30% in the fabricated machinery industry. The service intensity declined in the textile industry until 1998 but, in 2001, this industry was 6% more servitized than what it was four years earlier. The trend of service intensity is rather similar after 2003. At the beginning of the period, the aggregate share of services in production sold was 11.1% only, but it reached 11.4% four years later.

Figure 4 – The Servitization of Manufacturing: Aggregate Trends



Three margins of adjustment can explain the change in the aggregate service intensity in each manufacturing industry. The first margin is due to entries and exists of firms with different service intensities. Then, considering a constant sample of firms, aggregate changes can be decomposed into a "between-firms" margin and a "within-firms" margin. The "between-firms" margin refers to the shift of market shares between firms with different service intensities. The "within-firms" margin refers to the average changes in the share of services in firms' total output. In order to assess the importance of firm-level servitization, for each industry we decompose the changes in aggregate service intensity

into the between and the within margin for the 1997-2001 and 2003-2007 periods respectively. Here, we consider a constant sample of firms for each period, thus ignoring the first margin due to entries and exits. A standard way of decomposing an aggregate change into terms reflecting the reallocation between and within firms is as follows:

$$\Delta S_j = \sum_i \Delta Y_{i,j} \overline{S}_{i,j} + \sum_i \Delta S_{i,j} \overline{Y}_{i,j}, \quad (1)$$

Table 4 – Change in Service Intensity Between 1997 and 2001 (Percentage Point Changes)

Industry	Total Change	Within	Between
All Manufacturing	0.95	1.62	-0.67
Office machinery	17.52	19.07	-1.55
Machinery, n.e.c.	4.03	2.67	1.36
Radio, TV	4.01	5.19	-1.18
Medical, optical instruments	3.61	3.31	0.3
Electrical machinery	3.25	2.07	1.18
Publishing	2.32	2.56	-0.24
Plastic products	2.3	2.29	0.01
Wood products	1.19	0.28	0.92
Non-metallic products	1.11	0.69	0.41
Fabricated metals	1.03	1.1	-0.08
Textile	0.99	1.65	-0.66
Motor vehicles	0.93	1.66	-0.74
Manufacturing, n.e.c.	0.91	0.83	0.08
Tobacco	0.89	0.9	-0.02
Food products	0.81	0.74	0.07
Paper products	0.31	0.8	-0.5
Other transport equipment	0.09	0.9	-0.81
Basic metals	-0.03	0.18	-0.21
Chemical products	-0.24	2.71	-2.94
Leather	-0.4	-0.7	0.3
Wearing apparel	-0.51	2.18	-2.68
Petroleum	-5.13	-2.01	-3.12

ΔS_j denotes the aggregate change in service intensity in the constant sample of firms in industry j. $\overline{Y}_{i,j}$ is the average share of firm i in the production of industry j, $\Delta Y_{i,j}$ is its change. $\overline{S}_{i,j}$ is the average service intensity of firm i in industry j, $\Delta S_{i,j}$ is its change (i.e. the servitization whenever this is positive). The first term on the right-hand side of Equation 1 captures the aggregate change in service intensity due to shifts in market shares between firms with different service intensities (the between margin). The second term captures the within margin, i.e. the aggregate evolution of service intensity attributable to changes in individual firms' shares of services in total production (the within margin). The results for the 1997-2001 and 2003-2007 periods are shown in Tables 4 and 5 respectively. Taking the manufacturing sector as a whole, the share of services in

Table 5 – Change in Service Intensity Between 2003 and 2007 (Percentage Point Changes)

Industry	Total Change	Within	Between
All Manufacturing	0.65	1.77	-1.12
Tobacco	9.19	9.33	-0.13
Pharmaceutical products	5.22	9.22	-4
Other non-metallic mineral products	2.68	3.53	-0.85
Chemical products	1.82	5.48	-3.66
Motor vehicles	1.51	1.66	-0.15
Recorded Media	1.43	-0.1	1.53
Beverage	1.35	0.93	0.42
Electrical equipment	1.35	2.21	-0.86
Fabricated metal products	1.32	1.16	0.16
Furniture	1.18	0.6	0.58
Machinery	0.96	2.19	-1.23
Computer, electronic products	0.72	2.95	-2.24
Other manufacturing	0.57	2.26	-1.69
Food Products	0.51	0.51	0
Wearing Apparel	0.41	4.64	-4.23
Plastic products	0.39	0.56	-0.17
Wood products	0.18	0.26	-0.08
Paper products	0.17	0.24	-0.07
Textiles	-0.29	1.05	-1.34
Basic metals	-0.39	0.55	-0.94
Leather	-0.51	0.53	-1.04
Coke, petroleum	-0.79	0.08	-0.87
Other transport equipment	-2.98	-3.43	0.44

production sales increased by almost one percentage point between 1997 and 2001, and by 0.65 percentage point between 2003 and 2007 (these results differ from those in Figure 4 as we focus here on a constant sample of firms). In both periods, the between-firms component contributed negatively to the shift toward services. This indicates that firms with low service intensity grew faster than firms with high service intensity, thus pulling the overall change down. But these between-firms effects are more than compensated for by the within-firm changes. The increase in the average firm-level service intensity accounts for 170% of the aggregate servitization in the first period, and for 272% in the second period. Looking at the details industry by industry, we observe that the within-firm component contributes positively to the overall servitization and dominates the between effect in almost each industry. The exceptions are the leather and petroleum industries in the first period, and recorded media and other transport equipments in the second period.

The findings presented in Tables 4 and 5 suggest that the main driver behind the servitization of the French manufacturing sector is not that highly servitized firms performed better than less servitized ones. It is that each manufacturing firm, on average, shifted away from the production of goods and toward the production of services. We now further describe this firm-level shift toward servitization

Figure 2 has highlighted the bimodal shape of the distribution of firms' service intensity, and the decomposition exercise shown in Tables 4 and 5 suggests that, on average, firms have increased this intensity. We now want to look at how the distribution of service intensity has shifted over time. Do firms become extremely specialized in the provision of services (moving to the right peak of the distribution), or do they only marginally change their service intensity? To answer this question, we consider a continuous sample of firms in each period. For each period, we construct ten groups of firms according to their initial service intensity. Firms in the first bin (d1) have a service intensity below 10% at the beginning of the period. Firms in the second bin (b2) have a service intensity between 10% and 20%, and so on. Additionally, we consider firms that do not produce services (0%), or only produce services (100%). We then look at the position of these firms in the classification four years later. Each cell of these transition matrices (Tables 6 and 7) indicates the share of firms that moved from one bin to another during the period.

Table 6 – Transition Matrix - Between 1997 and 2001 - 50,463 Firms

from\to	0%	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	100%
0%	**11.80**	**4.39**	0.23	0.09	0.05	0.04	0.04	0.02	0.03	0.02	**0.13**	**0.81**
d1	**4.68**	**33.74**	1.71	0.42	0.17	0.11	0.06	0.05	0.06	0.05	**0.24**	**1.01**
d2	0.11	1.33	**1.35**	0.46	0.14	0.06	0.03	0.03	0.02	0.00	0.03	0.16
d3	0.05	0.33	0.45	**0.54**	0.26	0.08	0.05	0.02	0.01	0.01	0.02	0.10
d4	0.02	0.11	0.12	0.22	**0.32**	0.20	0.10	0.03	0.02	0.02	0.02	0.08
d5	0.02	0.07	0.07	0.08	0.15	**0.24**	0.14	0.07	0.02	0.03	0.02	0.06
d6	0.02	0.05	0.03	0.03	0.08	0.10	**0.18**	0.11	0.06	0.04	0.03	0.06
d7	0.01	0.02	0.02	0.02	0.05	0.05	0.09	**0.16**	0.14	0.06	0.03	0.05
d8	0.02	0.04	0.01	0.02	0.00	0.03	0.06	0.09	**0.17**	0.16	0.07	0.09
d9	0.01	0.04	0.01	0.01	0.02	0.02	0.02	0.03	0.10	**0.27**	0.23	0.13
d1	**0.08**	**0.15**	0.03	0.02	0.02	0.02	0.03	0.03	0.06	0.15	**2.04**	**1.67**
100%	**0.53**	**0.93**	0.15	0.08	0.08	0.08	0.06	0.07	0.07	0.09	**0.89**	**21.71**

Table 7 – Transition Matrix - Between 2003 and 2007 - 42,801 Firms

from\to	0%	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	100%
0%	**12.57**	**4.41**	0.16	0.07	0.03	0.02	0.02	0.01	0.02	0.02	**0.06**	**0.38**
d1	**3.28**	**36.75**	1.85	0.36	0.17	0.08	0.07	0.06	0.02	0.05	**0.19**	**0.79**
d2	0.10	1.46	**1.73**	0.53	0.14	0.09	0.04	0.02	0.02	0.02	0.04	0.14
d3	0.01	0.30	0.47	**0.53**	0.25	0.10	0.04	0.03	0.01	0.01	0.02	0.07
d4	0.02	0.15	0.14	0.23	**0.27**	0.17	0.06	0.03	0.03	0.03	0.01	0.05
d5	0.00	0.07	0.06	0.13	0.14	**0.18**	0.11	0.07	0.04	0.02	0.02	0.05
d6	0.00	0.04	0.03	0.03	0.06	0.11	**0.13**	0.09	0.07	0.03	0.03	0.04
d7	0.01	0.03	0.02	0.03	0.03	0.05	0.10	**0.16**	0.05	0.04	0.02	0.06
d8	0.01	0.03	0.01	0.01	0.03	0.01	0.03	0.07	**0.13**	0.11	0.08	0.06
d9	0.00	0.05	0.01	0.00	0.02	0.01	0.03	0.03	0.07	**0.20**	0.14	0.12
d10	**0.04**	**0.11**	0.02	0.02	0.01	0.02	0.02	0.03	0.06	0.14	**2.16**	**0.79**
100%	**0.35**	**0.64**	0.12	0.07	0.04	0.02	0.05	0.05	0.06	0.13	**1.18**	**21.66**

Table 6 shows the transition matrix for the first period. The sample consists of 50,463 manufacturing firms. Several key features of the matrix have to be emphasized. First, most of the firms are in the diagonal of this matrix. Between 1997 and 2001, the vast majority of firms (72.5%) did not change their service intensity much. Second, most of

the changes happen in the top left corner, and in the bottom right corner. The four cells in the top left corner account for 54.61% of firms, while the four cells in the bottom right corner account for 26.31% of firms. Looking at the top left corner, we see that 4.68% of the firms that had a service intensity in the first bin (i.e. below 10%) in 1997 stopped their production of services four years later. Conversely, 4.39% of the firms that did not sell services in 1997 sold some services in 2001 (which accounted for less than 10% of their production sales). Regarding the bottom right corner, the same kind of pattern emerges. If firms were to increase their service intensity substantially (enough to move to another bin over time), then we should see higher figures above the diagonal rather than below it. We find that 15% of firms are above the diagonal, and 12.5% below. On average, more firms have increased their service intensity than decreased it. We also observe a substantial share of firms in the top right and bottom left corners of the matrix. These are firms that switch from one peak of the distribution to another. In the top right corner, we find firms that produced little or no services in 1997 and that were almost entirely servitized four years later. The four cells in the top right corner of Table 6 account for 2.2% of firms, but for 14.6% of the firms above the diagonal. Conversely, the four cells in the bottom left corner account for 1.7% of firms (or 13.5% of the firms below the diagonal). These firms were highly servitized in 1997 and almost stopped their production of services in 2001. The trends are similar in the second period (Table 7). Again, the vast majority of firms lie along the diagonal (76.47%), meaning that they did not change their service intensity much. Nevertheless, 12.8% of firms are above the diagonal against 10.7% below, which suggests that the slow shift toward higher levels of service intensity continued in the second period.

Tables 6 and 7 suggest that there is no radical change in service intensity. Instead, we find a slow and steady trend toward a greater share of services in production for a substantial number of firms. To evaluate the statistical significance of this trend, we estimate the following equation:

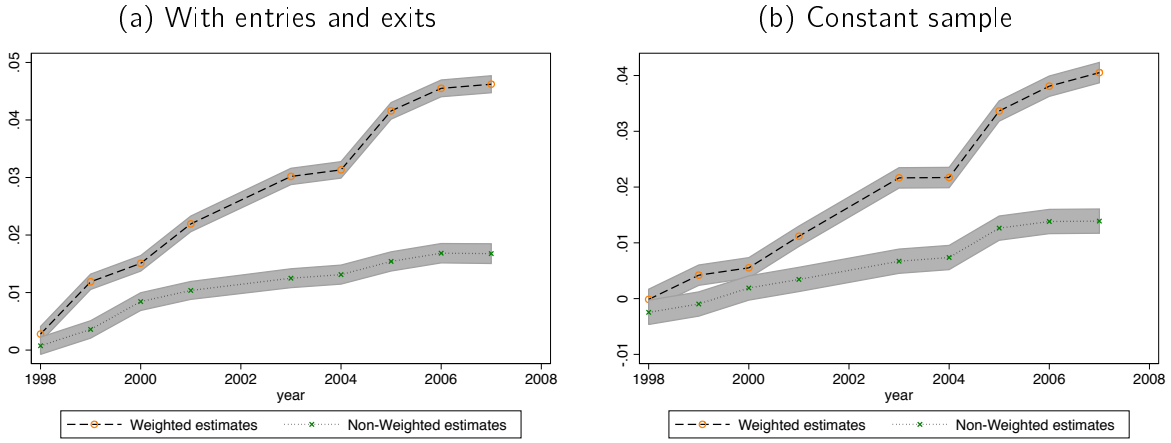
$$ServiceIntensity_{it} = \alpha_i + \gamma_t + \epsilon_{it}, \tag{2}$$

where $ServiceIntensity_{it}$ is the service intensity of firm i at date t, α_i is a firm fixed effect, γ_t is a set of year dummies and ϵ_{it} is the error term. The firm fixed effect control for any observable or unobservable factor which is firm-specific and constant over time. This means that the time dummies, γ_t, measure the average yearly change in service intensity within firms. Figure 5 displays these time dummies graphically, along with a 95% confidence interval. The year 1997 is taken as reference. A positive coefficient means that, on average, each firm has increased its service intensity with respect to its initial level in 1997. In panel (a), we use the full sample of firms, allowing for the entry and exit of firms. Instead, panel (b) shows the estimates obtained with a sample of firms that were continuously active between 1997 and 2007. In each panel, the dashed line shows unweighted estimates, while the dotted line shows estimates obtained from regressions weighted by the firm size (i.e. average firms' employment over the period).

The results confirm that on average, after controlling for firm-specific factors, each firm increased its service intensity between 1997 and 2007. The unweighed regression indicates that the service intensity of each firm increased by 1.7 percentage point on average in

panel (a), and 1.4 percentage point on average in panel (b). These results hide strong heterogeneity among firms, especially regarding their size. In both panels, the estimated coefficients obtained from the weighted regressions are systematically above the unweighed ones. This suggests that larger firms increased their service intensity more than smaller firms. Comparing panels (a) and (b), we see that service intensity increased at a slower pace when considering a constant sample of firms. This means that firms entering during the period increased their service intensity faster than incumbent firms, and exiting firms increased their service intensity less than incumbent firms. In other words, the net entry of firms contributed positively to the servitization of the manufacturing sector.

Figure 5 – Firm-Level Trend in Service Intensity

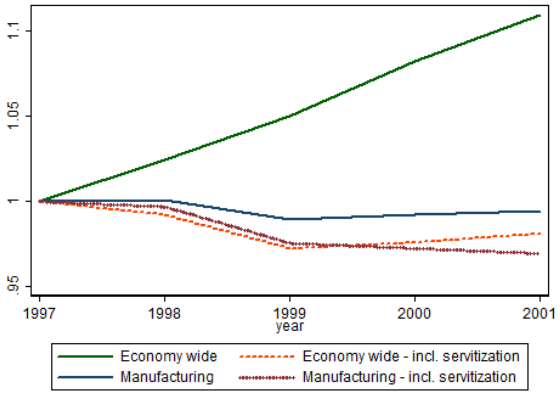


5. The Hidden Deindustrialization

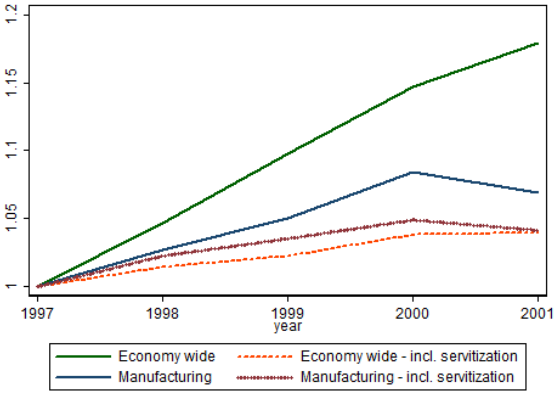
The usual assessments of the deindustrialization such as the one shown in Table 1 are based on simply counting the relative importance of the manufacturing sector in the economy. However, the evidence presented in the previous sections suggests that the boundary between manufacturing and service activities is very blurry and that the deindustrialization may also take a more insidious form. If, as shown above, a large proportion of manufacturing firms also supplies services, then deindustrialization is not only a shift of production and employment away from the manufacturing sector, it is also a shift within the manufacturing sector (and within manufacturing firms), toward the production of services. The within-manufacturing shift toward services is invisible to the analyses based on industry classifications. In this section, we try to quantify the importance of this "hidden" deindustrialization process. For each firm, we approximate the number of workers employed in the production of goods by multiplying the total employment of the firms by the share of goods in production sold (i.e. one minus our measure of service intensity). Summing over all firms gives us a rough but simple approximation of the number of workers actually employed in the production of manufactured products. The evolution over time of this aggregate employment is a measure of the deindustrialization that accounts for the shift toward services both between firms and sectors (i.e. the net entry rates of firms and their relative growth) and within firms. The same method is applied to firms' value added to obtain a measure of manufacturing value added net of the servitization of manufacturing firms.

Figure 6 – Evolutions of Employment and Value Added Using the Share of Services in Production Sold as Weights

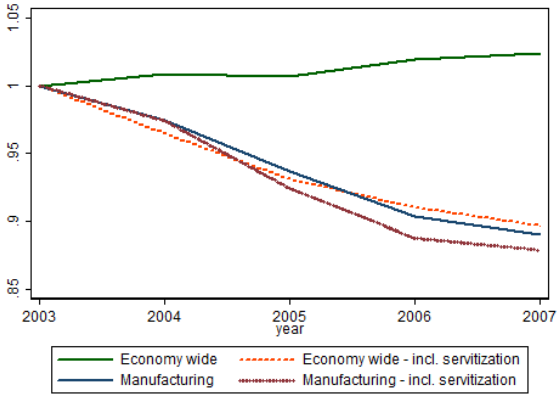
(a) Employment: 1997-2001



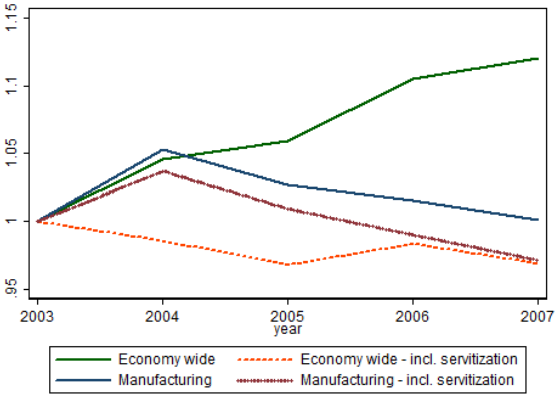
(b) Value Added: 1997-2001



(c) Employment: 2003-2007



(d) Value Added: 2003-2007



The results are presented in Figure 6. It compares the evolution of the different measures of employment and value added for the two periods (1997-2001 and 2003-2007). For each period, figures are taken in reference to the initial year of the period. Panels (a) and (b) present the evolution of employment and value added in the first period respectively. Let us start with the description of Panel (a). The top solid line represents the change over time in the total number of workers in our sample of firms, with no distinction between sectors. Between 1997 and 2001, the total employment recorded in our database increased steadily by about 2.5% per year. The bottom solid line shows the evolution of the number of workers in manufacturing firms (classified according to their main activity). Unsurprisingly, this line is declining, supporting the abundant evidence of the deindustrialization of the French economy. The decline is moderate, but considering that total employment grew over the period, this trend denotes a sharp decrease in the share of workers employed by manufacturing firms, by about 12% between 1997 and 2001. The dotted line incorporates the within-firm shift toward services obtained by using the information on the service intensity of manufacturing firms. It represents the change over time of the estimated number of workers in manufacturing firms employed in the production of goods. The previous sections have shown that service intensity increased over the period. It is not a surprise then to observe that taking this dimension into account provides a harsher diagnosis about the deindustrialization of the French economy. The share of workers

employed in the production of goods in manufacturing firms decreased by 3% between 1997 and 2001. This figure is to be added to the 12% decrease obtained when the firms' servitization is not considered. However, to have a comprehensive assessment of the evolution of the share of workers involved in the production of manufacturing goods, the production of goods in firms registered in the service sector must be taken into account. This is what the dashed line shows. Here, we ignore the information on firms' main activity. For each firm in our sample, we simply compute the total number of workers presumably involved in the production of goods, and sum these numbers over all the firms in our sample. The results suggest that firms in the service sector also decreased their own service intensity, producing relatively more goods over time. All in all, the estimated share of workers employed in the production of goods decreased by 13% between 1997 and 2001. This number is higher than the 12% decrease provided by the usual measures of deindustrialization based on the observation of total employment by firms registered in the manufacturing sector. This simple counting exercise suggests that there is indeed a "hidden" deindustrialization which occurs within firms, and that the usual assessment of the deindustrialization process, which is simply based on sectoral classification, underestimates the shift of employment toward services by more than 8% (=13/12).

Panel (b) confirms this conclusion by showing similar evidence based on value added rather than employment. Accounting based on sectoral classifications (represented by the spread between the two solid lines) reveals that the share of manufacturing firms' value added in total value added declined by 10% between 1997 and 2001. But our measure of deindustrialization based on firms' actual production of goods suggests that the share of manufacturing value added declined by almost 12% during this period, i.e. 20% more than the usual measure.

Panels (c) and (d) of Figure 6 replicate the same counting exercise for the 2003-2007 period. During these five years, the total employment registered in the BRN database remained roughly unchanged. However, the employment in manufacturing firms decreased by 10% (the bottom solid line in panel (c). Using our measure of the total number of workers employed in manufacturing firms for the production of goods, we find a decline of 12%, due to the growing servitization of manufacturing firms. However, this effect is almost entirely compensated for by the increase in the production of goods in service firms (or by the fact that service firms which also produce goods grew faster than others). In terms of value added, however, the growth of the production of goods in service firms has almost no impact on our measure of deindustrialization. The share of value added associated with the production of goods in total value added decreased by 3%. This figure is to be compared with the fact that there was virtually no change in the share of manufacturing firms in total value added.

6. Concluding Remarks

During the last decades, the importance of the manufacturing sector has been declining steadily in most developed economies. These profound changes in the economic structure of developed countries, in a context of relatively slow growth and/or persistent unemployment, is a very serious concern for policymakers.

A vast literature has discussed the possible causes for the shift of employment and value added away from manufacturing and toward services. Factors such as differences in productivity growth between the manufacturing and the service sector, changes in consumer preferences, international competition or outsourcing strategies have been put forward to explain the decline of the manufacturing sector. In this paper, we argue that deindustrialization is not only a shift of resources between industries, but also a phenomenon that occurs within the manufacturing sector and within manufacturing firms. Our investigation of the production of services by manufacturing firms, based on a very large sample of more than 635,000 French manufacturing firms, suggests that this within margin of the deindustrialization process is not negligible. French manufacturing produces many services and tends to produce more and more. On average over the 1997-2007 period, services accounted for more than 11% of the total production sold by manufacturing firms. This proportion increased steadily over the period, by more than 10% between 1997 and 2001 and by almost 3% between 2003 and 2007. The main driver behind this servitization of the French manufacturing sector is a dynamic that occurred within firms. Even if few firms radically changed their production mix toward services, changes in the individual share of services in total production is non-negligible. During the 1997-2007 decade, the share of services in the total sales of each firm increased by 1.7 percentage point on average.

This within-firm shift toward services is an additional margin of the deindustrialization process that has been ignored by studies that rely on the sectoral classification of firms. The slow but steady servitization of manufacturing firms suggests that deindustrialization is in fact more severe than usually reported. However, beyond the simple evidence provided by the basic counting exercises presented in this paper, further research would be necessary to explore the causes and consequences of the servitization of manufacturing firms in terms of firm performance and economic growth.

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