The Impact of Producer Services Development on the Servitization of Manufacturing Industry

LiXian Chen*, XinMing Cai, and KaiZhang Zou

School of Economics and Trade, Guangdong University of Foreign Studies, GuangZhou, China
**Email: chenlixian2015@163.com*

Abstract

Producer services are important intermediate inputs in manufacturing industry, so does the development of producer services promote the servitization of manufacturing industry? To answer this question, this paper uses provincial panel data from 2004 to 2020 to empirically analyze the impact of producer services development on manufacturing servitization. The empirical results show that producer services promote the servitization of manufacturing industry at the significance level of 1%, and the development of producer services promotes the level of servitization by improving human capital and promoting technological innovation. Besides, the eastern region and technology-intensive manufacturing industry have more obvious effects. This study enriches the content of manufacturing field and provides empirical evidence for realizing high-quality development of manufacturing industry.

Keywords: *Producer Services Development; Servitization; Manufacturing Industry*

1.Introduction

The 14th Five-Year Plan and the outline of the vision and goals for 2035 clearly set out to strengthen the competitive edge of the manufacturing industry and promote high-quality development of the sector. Considering the fact that China's manufacturing industry is at the low end of the global value chain with low added value. And producer services are important intermediate inputs of manufacturing industry. Can the development of producer services increase the added value of manufacturing industry and promote the climb of manufacturing value chain? Crozet and Milet (2017) based on the data of French manufacturing enterprises from 1997 to 2007, it is found that the development of producer services will promote the servitization of manufacturing and bring significant employment and economic effects. Kamp et al. (2017) found in his case study that compared with the regions with poor environment of producer services, the manufacturing industries in regions with good development of producer services would choose to carry out service business. Bellandi and Santini (2019) explored the problems of servitization transformation of small and medium-sized manufacturing enterprises in The textile zone of Prato, Italy from 2005 to 2013, and believed that the local service industry environment was an important factor. Kozłowska (2020) selected the Polish machinery industry as the research sample, and found that due to the support from the government and industry associations, most enterprises in this industry choose to invest in producer service elements to improve their international competitiveness. Desmarchelier et al. (2020) research also believes that the good development of producer services is the primary consideration for local manufacturing enterprises to choose service-oriented transformation. The above research shows that the development of producer services is an important factor affecting the servitization of manufacturing industry, which also lays a solid theoretical foundation for the research of this paper. However, there are few studies on China's manufacturing industry and they are generally limited to case studies. Therefore, based on the data of provinces in China from 2004 to 2020, this paper explores the impact of producer services development on manufacturing servitization, and conducts an empirical analysis based on geographic location and heterogeneity of manufacturing factor intensity.

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2.Variables and Data

2.1. Variables

2.1.1. Development of producer services

Compared with previous studies, most scholars describe the development of producer services from the single dimension of added value or number of employees, this paper describes the development of producer services based on the scale and efficiency of producer services. First of all, the scale of producer services is expressed as the proportion of added value of producer services in added value of service industries. The calculation formula is as follow:

$$pros1_{it} = \frac{pser_{it}}{ser_{it}} \quad (1)$$

In Formula (1), $pros1_{it}$ represents the scale of producer services in region i in the year t, $pser_{it}$ and ser_{it} represent added value of producer services and added value of services respectively.

The efficiency of producer services is expressed by the ratio of added value of producer services to employees of producer services, that is, the more service products produced per unit time, the higher labor productivity. The calculation formula is shown in Formula (2). $pros2_{it}$ and lor_{it} represent the efficiency and employment of producer services respectively.

$$pros2_{it} = \frac{pser_{it}}{lor_{it}} \quad (2)$$

2.1.2.The servitization of manufacturing industry

Based on the provincial input-output tables of 2002, 2007, 2012 and 2017 years, this paper first calculates the total consumption coefficient of the manufacturing industry to the service industry in each province, and the calculation formula is shown in Formula (3). Secondly, in order to obtain the servitization of manufacturing industry in consecutive years, formula (3) is used to multiply the annual manufacturing output value, and take logarithms of the results. The calculation formula is shown in Equation (4). In summary, the servitization manufacturing industry at provincial level from 2004 to 2020 can be obtained.

$$se_k = a_k + \sum_{m=1}^{n} a_{jm} a_{mk} + \sum_{s=1}^{n} \sum_{m=1}^{n} a_{js} a_{sm} a_{mk} + \ldots \quad (3)$$

$$manu_{it} = se_{it} \times manuf_{it} \quad (4)$$

Based on the above formula, se_k refers to the servitization of manufacturing industry, the first item on the right is the direct consumption of service industry by manufacturing industry, and the second item is the quantity of service industry indirectly consumed by manufacturing industry in the first round, the third item is the quantity of service industry indirectly consumed by manufacturing industry in the second round, and so on.

2.1.3. Mediating variables

The mediating variables include human capital and technological innovation. Human capital (hum) is expressed as the natural logarithm of the number of university students in each province. Technological innovation (ino) is characterized by the natural logarithm of the sum of inventions, patents, and utility models in a region.

2.1.4. Control variables

Based on the existing related studies, the following control variables are added in this paper. Firstly, government intervention (gov). This paper uses the ratio of local government financial expenditure to regional GDP to measure. The government will affect the allocation of regional resources, and then affect the servitization of manufacturing industry. Secondly, marketization degree (mar) is expressed by the ratio of the number of private and foreign enterprises to the total number of enterprises. The higher degree of marketization means that factors of production can circulate freely between different regions and improve the servitization level of manufacturing industry. Thirdly, the openness of the region (open), the proportion of total import and export in GDP is used to represent the level of opening up. The higher the level of opening up is, the manufacturing enterprises can obtain more advanced experience and knowledge, which is conducive to improving the level of service.

2.2. Data

This paper uses two databases, one is the provincial input-output tables of 2002, 2007, 2012 and 2017 years, to measure the servitization of manufacturing industry. Second, China Statistical Yearbook and provincial statistical yearbook are used to measure core explanatory variables and control variables. Because there are many missing data in Tibet, this study does not include Tibetan data.

3.Research Method

In order to explore the impact of producer services development on the servitization of manufacturing industry, and considering the time-lag of producer services and the ability to better avoid the endogenous problems, this paper constructed the following econometric model based on provincial-level data：

$$manu_{it}=\alpha+\beta pros_{i,t-1}+X'_{it-1}\lambda+\gamma_t+\varphi_i+\varepsilon_{it} \quad (5)$$

In the above formula, the subscript t represents the year, and the subscript i represents the province, *manu* represents the servitization of manufacturing industry, *pros* represents the development level of producer services, including the scale and efficiency of producer services. X' represents a set of control variables. γ_t and φ_i represent year and province fixed effect respectively. ε_{it} represent the error term.

To explore the influencing mechanism, this paper constructed the following mediation effect model：

$$M_{it}=\alpha+\beta pros_{i,t-1}+X'_{it-1}\lambda+\gamma_t+\varphi_i+\varepsilon_{it} \quad (6)$$

$$\text{manu}_{it}=\alpha+\beta_1 pros_{i,t-1}+\beta_2 M_{it}+X'_{it-1}\lambda+\gamma_t+\varphi_i+\varepsilon_{it} \quad (7)$$

Where, M_{it} represents the intermediary variable, including human capital and technological innovation, and other variables have the same meanings as Formula (5).

Furthermore, to explore the heterogeneity of geographical location and manufacturing factor intensity of producer services development on the level of the servitization of manufacturing industry. For geographic heterogeneity, the samples were divided into eastern, middle and western regions for grouping regression. As for the heterogeneity of manufacturing factor intensive, this paper re-estimates the servitization of manufacturing industry level of technology, capital and labor-intensive manufacturing based on Equations (3) and (4). Then regression is performed based on econometric model (5).

4.Empirical results and explanation

4.1. Baseline Regression

OLS and FE methods were used in this paper to empirically analyze the impact of producer services development on the servitization of manufacturing industry. The estimated results are shown in Table 1.

As for the impact of producer services scale on the servitization of manufacturing industry reported in Columns (1) and (3), it can be found that pros1 coefficients are significantly positive at the level of 1%. This shows that the larger the scale of producer services, the higher the level of regional manufacturing servitization. Columns (2) and (4) report the impact of the efficiency of producer services on the servitization of manufacturing. It can also be found that the coefficient of pros2 is significantly positive at least at the level of 5%. This shows that regional improvement of the production efficiency of producer services will significantly promote the improvement of the level of manufacturing servitization. To sum up, the development of producer services is conducive to improving the level of manufacturing servitization. The possible reason is that producer services are important intermediate inputs in the manufacturing industry, and its development will inevitably improve the servitization of manufacturing induatry. Rymaszewska et al. (2017) also points out that the development of producer services will affect the proportion of manufacturing inputs to factors of production.

For control variables, either OLS regression or FE regression, it is found that government intervention (gov) is not conducive to the improvement of regional manufacturing servitization, but the improvement of marketization degree (mar) and the degree of opening (open) to the outside world is conducive to the improvement of manufacturing servitization. The estimation results of these control variables are consistent with the conclusions of existing literatures.

Table 1 Benchmark regression results of producer services development and the servitization of manufacturing industry

	OLS		FE	
	(1)	(2)	(3)	(4)
pros1	0.0034*** (0.0007)		0.0042*** (0.0013)	
pros2		0.0142** (0.0057)		0.0183*** (0.0006)
gov	-0.0204*** (0.0031)	-0.0047 (0.4222)	-0.0172*** (0.0020)	-0.0059 (0.5833)
mar	0.2380*** (0.0179)	0.0892*** (0.0074)	0.1898*** (0.0074)	0.0661*** (0.0038)
open	0.0027*** (0.0008)	0.0079*** (0.0001)	0.0106*** (0.0018)	0.0082*** (0.0023)
year fixed effect	yes	yes	yes	yes
province fixed effect	yes	yes	yes	yes
R^2	0.3894	0.4028	0.3840	0.4124
F test	38.405 (0.0000)	49.592 (0.0000)	37.093 (0.0000)	40.294 (0.0000)
observations	510	510	510	510

In brackets is the standard error for clustering to an enterprise. ***, **, * represent significance at 1, 5 and 10 percent, respectively. The following tables are the same.

4.2. Robustness Check

In order to ensure the accuracy of the estimation results, this paper re-conducts empirical analysis from two aspects of constructing cross-sectional data and re-calculating the explained variables.

First of all, because the input-output table is updated every five years, it is not continuous data. For this reason, this paper only uses the data of 2007, 2012 and 2017 for regression, and the empirical results are shown in columns (1) and (2) of Table 2. It can be found that

the estimated coefficient of the scale and efficiency of producer services is still significantly positive at least 5% after the inclusion of control variables and fixed effects. Secondly, this paper constructs the servitization of manufacturing industry based on the direct consumption coefficient of manufacturing industry to the service industry, and conducts empirical analysis based on model (5) again. The estimated results are shown in columns (3) and (4) of Table 2. Similarly, the larger the scale of producer services and the higher the efficiency of producer services, the higher the level of regional manufacturing services. This shows the robustness of the previous estimation results.

Table 2 Robustness test results

	cross section data analysis		the explained variable is re-measured	
	(1)	(2)	(3)	(4)
pros1	0.0084*** (0.0003)		0.0023*** (0.0004)	
pros2		0.0394*** (0.0030)		0.0098*** (0.0013)
control variable	yes	yes	yes	yes
year fixed effect	yes	yes	yes	yes
province fixed effect	yes	yes	yes	yes
R^2	0.5093	0.4765	0.4679	0.4988
F Statistics	47.395 (0.0000)	54.850 (0.0000)	40.501 (0.0000)	38.435 (0.0000)
observations	90	90	510	510

4.3. Influence mechanism analysis

Table 1 has demonstrated that the development of producer services will play a positive role in promoting the servitization of manufacturing industry. Further, in order to explore how the development of producer services affects the servitization of manufacturing industry, this paper analyzes the intermediary effect based on Equations (6) and (7).

Table 3 reports the empirical results, while part1 reports the empirical results of the scale of producer services. It can be found that the scale of producer services at 1% level significantly promotes the increase of human capital and technological innovation. By comparing the estimated coefficients of Table 1 and columns (2) and (4) in Table 3, it can be seen that the scale of producer services promotes the improvement of the servitization level of manufacturing industry by increasing human capital and improving technological innovation. Part2 reports the estimated efficiency of producer services. It can also be found that for human capital and technological innovation, the efficiency coefficient of producer services is significantly positive at the testable level. Further compare the estimated coefficients of pros2 in Table 1 and columns (6) and (8) in Table 3. It can be found that the efficiency of producer services can also promote the improvement of manufacturing servitization level by increasing human capital and improving technological innovation. This is because producer services such as financial services, scientific and technological innovation and brand design often involve high-end talents and have a high level of technological innovation. Therefore, it can be concluded that the development of producer services plays a role in regional manufacturing servitization through human capital and technological innovation.

Table 3 Mediating effect estimation results

	human capital effect		technological innovation effect	
	hum	manu	ino	manu
Part1:	(1)	(2)	(3)	(4)
pros1	0.0074*** (0.0031)	0.0022*** (0.0007)	0.0123*** (0.0042)	0.0028*** (0.0010)
hum		0.0192*** (0.0032)		
ino				0.0234*** (0.0033)
R2	0.3648	0.3849	0.4852	0.4623
F test	57.390 (0.0000)	47.502 (0.0000)	48.924 (0.0000)	59.391 (0.0000)
Part2:	(5)	(6)	(7)	(8)
pros2	0.0064*** (0.0008)	0.0031*** (0.0010)	0.0037*** (0.0002)	0.0034*** (0.0006)
hum		0.0038*** (0.0001)		
ino				0.1929*** (0.0237)
R2	0.4568	0.4456	0.4890	0.4757
F test	50.394 (0.0000)	38.427 (0.0000)	43.405 (0.0000)	59.284 (0.0000)
Part3:control variable	yes	yes	yes	yes

year fixed effect	yes	yes	yes	yes
province fixed effect	yes	yes	yes	yes
observations	510	510	510	510

4.4. Heterogeneity test

Considering the inconsistent development level of producer services in different geographical locations and the inconsistent demand for producer services from non-factor intensive manufacturing industries. Therefore, this paper will further explore the differential impact of producer services development on the geographical location and factor intensity of manufacturing servitization.

The results of geographic heterogeneity estimation are shown in Table 4. Columns (1) - (3) report the estimated results of the scale of producer services on the servitization of manufacturing industry in different geographical locations. It can be found that compared with the central and western regions, the increase of the scale of producer services only plays a significant role in promoting the improvement of manufacturing servitization in the eastern region. In columns (4) - (6), the estimated coefficient of efficiency of producer services is significantly positive in Column (4), which also indicates that the improvement of production efficiency of producer services only plays a positive role in promoting manufacturing servitization in the eastern region, but does not play a significant positive role in manufacturing servitization in central and western regions. This may be because the manufacturing industry in the eastern region is more developed, mainly high-tech and high value-added industries, and the development of producer services will play a more obvious role.

Table 4 Estimation of geographic heterogeneity

	eastern region	central region	western region
Part1:	(1)	(2)	(3)
pros1	0.0046*** (0.0012)	0.0030 (0.0785)	-0.0018 (0.0301)
R^2	0.4458	0.4707	0.4257
F test	45.560 (0.0000)	42.084 (0.0000)	57.897 (0.0000)
Part2:	(4)	(5)	(6)
pros2	0.0051*** (0.0016)	0.0036 (0.0672)	0.0026 (0.0458)
R^2	0.5102	0.4829	0.4852
F test	47.582 (0.0000)	50.783 (0.0000)	48.305 (0.0000)
Part3:control variable	yes	yes	yes
year fixed effect	yes	yes	yes
province fixed effect	yes	yes	yes
observations	187	136	187

Table 5 reports the estimated results based on factor intensive manufacturing. Items (1) - (3) are listed as the estimated results of producer service scale on the servitization of different factor-intensive manufacturing industries. It can be found that the increase in the scale of producer services promotes the improvement of the servitization level of technology-intensive manufacturing at the significance level of 1%, but has no significant impact on the servitization level of capital and labor-intensive manufacturing. Columns (4) - (6) are the estimated results of the efficiency of producer services on the servitization of different factor-intensive manufacturing industries. It can also be found that the productivity coefficient of producer services is only significantly positive in column (4), which indicates that the improvement of the efficiency of producer services only plays a positive role in the servitization of technology-intensive manufacturing. This may be because technology-intensive manufacturing requires more producer services in the process of production, while capital and labor-intensive manufacturing require only input labor production factors.

Table 5 Results of heterogeneity estimation for factor-intensive

	technology intensive	capital intensive	labor intensive
Part1:	(1)	(2)	(3)
pros1	0.0038*** (0.0011)	0.0034 (0.0763)	0.0022 (0.0489)
R^2	0.4728	0.4802	0.5245
F test	56.677 (0.0000)	58.293 (0.0000)	49.588 (0.0000)
Part2:	(4)	(5)	(6)
pros2	0.0049*** (0.0005)	0.0037 (0.0485)	-0.0026 (0.0583)
R^2	0.4821	0.5738	0.5273

F test	50.485 (0.0000)	48.596 (0.0000)	53.337 (0.0000)
control variable	yes	yes	yes
year fixed effect	yes	yes	yes
province fixed effect	yes	yes	yes
observations	510	510	510

5.Conclusion and policy implications

Based on the provincial panel data from 2004 to 2020, this paper explores the impact and mechanism of the development scale and production efficiency of producer services on the servitization of manufacturing industry. The results show that both the development scale and productivity of producer services can significantly improve the level of regional manufacturing servitization, mainly through increasing human capital and improving technological innovation. Heterogeneity analysis shows that the scale and production efficiency of producer services plays a positive role in the eastern region and technology-intensive manufacturing servitization, but not in the central and western regions, capital and labor intensive manufacturing servitization.

Based on the above research, this paper has the following policy implications. First, in order to achieve high-quality development of manufacturing industry and improve the international competitiveness of manufacturing industry, vigorously developing producer services is still a measure that local governments and enterprises need to focus on. Second, according to the influence mechanism of producer services development on manufacturing servitization, the positive role of human capital and technological innovation should be emphasized in the process of developing producer services. Thirdly, according to the different impact of producer services development on the geographical location and factor intensive of the servitization of manufacturing industry. Therefore, due to the local conditions, combined with the actual local economic development situation, formulate effective development strategies to promote the servitization of manufacturing industry.

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