Service-Oriented Manufacturing Input in China and its Moving-up in the Global Value Chain

Jiajie Li, Tongtong Xu*

School of International Trade and Economics, Shandong University of Finance and Economics, Shungeng Road, Jinan, China
*Corresponding author

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Abstract: Based on the cross-industry panel data of China's manufacturing sector from 2000 to 2014, this paper measured and analysed the impact of China's manufacturing industry's servitization on China's global value chain climb from the perspective of manufacturing industry's servitization. The empirical study finds that :(1) the input of service factors has a significant positive effect on the global value chain climb of China's manufacturing sector; (2) after further distinguishing the sources of service factor input, it is found that domestic service factor input still has a significant positive effect on the global value chain climb of China's manufacturing industry, while the effect of imported foreign service factor input on the global value chain climb of China's manufacturing industry becomes insignificant; (3) after distinguish the heterogeneity of the service elements found that domestic elements into capital-intensive and labour-intensive and technology-intensive, rise of global value chain in China has significant positive effect, but the effect of different levels: capital-intensive service elements into higher impact on the global value chain of China is the largest, the second is technology intensive service elements, the last is labour-intensive service inputs.

1. Introduction

With the advantage of low labour cost, China's manufacturing industry has integrated into the division of labour system of global value chain (GVC), and achieved rapid development in a short period of time. However, with the disappearance of the advantage of cheap labour force, the development of China's manufacturing industry has been embarrassed being big but not strong and lacking of core technology. In order to break through the "low-locked" dilemma at present and achieve the goal of bringing China's industry to the middle and high segment of the GVC, it is urgent for it to change its old development thinking. The intensification of international competition makes the competition strategy of manufacturing enterprises begin to change from manufacturing-centered to service-centered. According to the statistics of WIOD website, in 2014, the value added of services in global exports accounted for about 48% of the total exports, accounting for more than 30% of the total exports of manufacturing industry, which shows that the trend of service-oriented manufacturing industry is becoming more and more obvious. As an effective means to break through the current predicament of Chinese manufacturing enterprises, the service-oriented manufacturing industry helps not only to improve their competitiveness, but also to enhance their added value of exports, thus promoting them to climb to the high end of the value chain. Therefore, it is of great significance to scientifically measure the position of Chinese enterprises in the GVC, clarify the mechanism and path of service-oriented manufacturing industry to upgrade the position of the value chain, and classify and compare the differences of service-oriented manufacturing industry in China to push its way up the GVC. So, how to measure China's current position in the GVC? What is service-oriented manufacturing? Moreover, under the condition that the trade between countries is becoming more and more intensive and the industries of different countries are closely integrated, does the input of domestic and foreign factors have the same impact on China to move up the GVC? How to quantify the service level of manufacturing industry effectively? In addition, do different types of factors have the same impact on China to move up the GVC? In this paper, an in-depth study will be made on the above issues through empirical methods.

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2. Literature review

2.1 Mechanism analysis

With a relatively intuitive impact mechanism, service-oriented manufacturing industry promotes the overall upgrading of the value chain to improve the international competitiveness of enterprises, mainly through the following three ways: Firstly, it promotes the rise of China's value chain by improving the organizational efficiency, enriching human capital and enhancing the R&D capability of enterprises. Secondly, it promotes the development of the whole industry through the scale effect of economy, improves the core competitiveness of enterprises, and then promotes the rise of the whole value chain.[1] Thirdly, it promotes the traditional manufacturing industry to a higher division of labor in the GVC through the strategy of differentiation of consumer market and the upgrading of service in logistics and after-sales links. From the point of view of industrial development, participation in global vertical specialization production only improves the production and management processes of enterprises. Moreover, the "low-end capture" effect of the division of labor production mode of GVC on developing countries and its weak technology absorptive capacity also force the majority of developing countries' enterprises to choose the path of transformation and upgrading of manufacturing services. From the point of view of consumers, more and more of them are no longer confined to the products provided by enterprises, but focus more on the services accompanied by similar products and [2]enterprises are also actively catering to consumer preferences, to obtain more trade value-added, and then move up the value chain.

2.2 Measuring the position in GVC

Because of the repeated calculation in measuring the position in the GVC with the method of total trade accounting in the early stage, it is not accurate to measure the distribution of interests of the countries participating in international trade, which hence promotes the innovation of the measurement method of the division of labor status of GVC, and then accurately estimates the vested interests of participating countries. At present, there are two persuasive indicators: one is the status index of GVC based on the relative value of a country's import and export intermediaries [3], Koopman[4], the other is the calculation method of industrial upstream measurement proposed by Antras & Fally, et al[5], that is, the method to measure the position of a sector in the GVC in a country's production by calculating the number of production stages of the final product in an industry. However, due to the neglect of "downstream" links such as "logistics, marketing, after-sales" in the method of GVC status index, there are still some disputes about the estimation of a country's position in the GVC. Comparatively speaking, the calculation method of industrial upstream measurement is not only closer to the reality, but also more comprehensive. The greater the upstreamness of the industry, the farther the weighted average distance between the industry and the end product, the lower the division of labor in the GVC and the lower the added value of the product; otherwise the closer the weighted average distance between the industry and the end product, the lower the division of labor in the GVC of the industry, and the higher the added value of the product.

2.3 Measurement of service-oriented manufacturing industry

The service-oriented manufacturing industry was first proposed by Vandermerwe & Rada[6], after which White[7] and others carried out horizontal expansion, measured from two perspectives: output and input. As the proportion of intermediate trade in world trade is increasing year by year, and it has reached about 2/3 of the total world trade, which shows that the importance of intermediate investment for the development of a country's manufacturing industry is increasing year by year, so it is very important to study the service-oriented manufacturing industry from the perspective of investment. This paper focuses on the latter, that is, the input of service factors in manufacturing process.

It is not difficult to find from the above literature review that the existing research on service-oriented manufacturing input is based on the development status of service-oriented manufacturing itself, while the research on service-oriented manufacturing and moving up the value chain is still

insufficient. Therefore, on the basis of previous studies, this paper uses the data of Chinese manufacturing industry to measure and analyze the impact of service-oriented manufacturing input on China's moving-up in the GVC, and, carries out a robustness test based on the source and heterogeneity of service factor input.

3. Measurement of industrial upstreamness index and service-oriented manufacturing input

3.1 Measurement of industrial upstreamness index

In this paper, the industrial upstreamness index of 17 manufacturing sectors in China is measured and calculated based on Actors (2012) and Fally (2012). The total output of a certain industry in a country is expressed as the sum of the intermediate input and the final use of the industry by using the input-output analysis method [8-11]. Therefore, the following formulas can be obtained:

$$Y_i = F_i + \sum_{j=1}^{N} d_{ij}F_j + \sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik}d_{kj}F_j + \sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{i=1}^{N} d_{il}d_{lk}d_{kj}F_j + \cdots \quad (1)$$

Where,

dij = the quantity of product i consumed in the production of department j,

dij = the direct consumption coefficient matrix of the country, recorded as D;

Fi = the final product produced by department i.

Based on Leontief 's input-output model, Antras proposed the industrial upstreamness index U_i and established a quantitative model.

$$U_i = 1\times\frac{F_i}{Y_i} + 2\times\frac{\sum_{j=1}^{N} d_{ij}F_j}{Y_i} + 3\times\frac{\sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik}d_{kj}F_j}{Y_i} + \cdots \quad (2)$$

In formula (2), U_i denotes the weighted average proportion of final products and intermediate products in each stage of industry i in the total output of the industry. The farther the intermediate products are from the final products, the greater the weighted value they are given. Therefore, U_i must be greater than or equal to 1, and only if all products in industry i are final products, U_i is equal to 1. The farther industry i is from the final product, the greater its upstreamness, which means lower value-added rate and higher value chain division status. Since formula (2) is infinite in practical calculation, Antras et al. estimated formula (2) by Fally's method and obtained the upstreamness of each industry under closed conditions, see formula (3):

$$U = \left[I - \Delta\right]^{-1} u \quad (3)$$

Where,

Δ = the matrix with dijYj/Yi as the (i, j)-th element;

u = the N-dimensional unit column vector;

I= the unit matrix.

In order to simplify the calculation method of the model, formula (3) is simplified in this paper.

Firstly, the matrix represented by Δ is written in the following form:

$$\begin{pmatrix} d_{11}\frac{Y_1}{Y_1} & \cdots & d_{1n}\frac{Y_n}{Y_1} \\ \vdots & \ddots & \vdots \\ d_{n1}\frac{Y_1}{Y_n} & \cdots & d_{nn}\frac{Y_n}{Y_n} \end{pmatrix} \quad (4)$$

(4) can be split into the following forms by simple matrix operations (5):

$$\left\{\left[D\begin{pmatrix} Y_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{pmatrix}\cdots\begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{pmatrix}\right]^T\begin{pmatrix} \frac{1}{Y_1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{pmatrix}\cdots\begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \frac{1}{Y_n} \end{pmatrix}\right\}^T \quad (5)$$

Formula (5) may be replaced by:

$$\left\{\left[DY\right]^T Y^{-1}\right\}^T \quad (6)$$

Formula (6) can be further simplified as follows:

$$Y^{-1}DY \quad (7)$$

Therefore, by substituting formula (7) into formula (3), a simplified formula of industrial upstreamness under closed conditions can be obtained.

$$U = \left(I - Y^{-1}DY\right)^{-1} u \quad (8)$$

Where, Y^{-1} = the inverse matrix of the diagonal matrix of the total output;
Y = the diagonal matrix of the total output matrix;
D = the direct consumption coefficient matrix.

Because the World Input-Output Table published by WIOD website contains the input-output relationship of 41 economies and 35 sectors, 41 economies in the table can be regarded as a "world country" and each sector of each country can be regarded as a sector of the "world country", thus forming a "world country" with 1,495 sectors. On this basis, in this paper, the industrial upstreamness of 17 manufacturing sectors in China is measured by the method of measuring the industrial upstreamness under closed conditions. The overall average industrial upstreamness index of 17 manufacturing sectors in China from 2000 to 2014 and its changing trend are shown in Table 1:

Table 1 The industrial upstreamness of 17 manufacturing sectors in China.

	2000	**2002**	**2004**	**2006**	**2008**	**2010**	**2012**	**2014**
C10-C12	1.9612	1.8731	2.0437	2.2822	2.3862	2.4862	2.6063	2.6813
C13-C15	2.2159	2.0719	2.1292	2.2575	2.4661	2.6068	2.7471	2.8384
C16	3.2130	3.0695	3.2607	3.5330	3.5042	3.5413	3.6483	3.7446
C17	3.6862	3.6263	3.8679	4.1092	4.1646	4.2419	4.3149	4.3877
C18	3.3212	3.2717	3.3052	3.4890	3.4791	3.5802	3.6926	3.7828
C19	4.0232	3.8820	4.0141	4.2428	4.2692	4.2530	4.3592	4.4184
C20	3.8789	3.7040	3.8014	4.0272	4.1379	4.2105	4.3629	4.4321
C21	2.2159	2.1120	2.2801	2.4423	2.4134	2.3153	2.2993	2.3348
C22	3.5437	3.4267	3.4466	3.5906	3.6815	3.7911	3.8551	3.9545
C23	2.8293	2.6320	2.6398	2.7343	2.7263	2.7310	2.8009	2.8415
C24	3.8541	3.6636	3.6912	3.8257	3.7985	3.7128	3.7750	3.8584
C25	3.1394	2.9689	3.0264	3.2222	3.2275	3.2095	3.2334	3.3408
C26	2.3441	2.3117	2.4092	2.5806	2.4073	2.9199	3.0369	3.1765
C27	2.7869	2.7120	2.5893	2.7260	2.7721	2.8465	2.8751	2.9837
C28	2.5492	2.5321	2.4867	2.6486	2.6808	2.6807	2.6493	2.7761
C29_C30	2.4717	2.4647	2.2222	2.3268	2.2988	2.2606	2.1817	2.3367
C31_C32	2.3421	2.1600	1.7659	2.2641	2.0372	2.2064	2.2173	2.3372

3.2 Measurement of service-oriented manufacturing input

The service factors of China's manufacturing industry input mainly include domestic and foreign service factor input. According to the latest version of China's input-output table published on the WIOD website, 15 industries in the standard industry classification are included in the category of service factors. The specific calculation steps need to be carried out according to the structure of the input-output table. The calculation formula is as follows:

$$S_j = \frac{\sum_{j=1}^{N} x_{ij}}{X_j} (i = 1, 2, 3, \cdots, n) \tag{9}$$

Where,

S_j=the service-oriented proportion of manufacturing sector j;

X_{ij}=the number of products used by the manufacturing sector j in the service sector i;

X_j= the total input of manufacturing sector j.

Figure 1 below shows the trends of the total China's domestic and foreign service factor in the 15 years from 2000 to 2014, respectively.

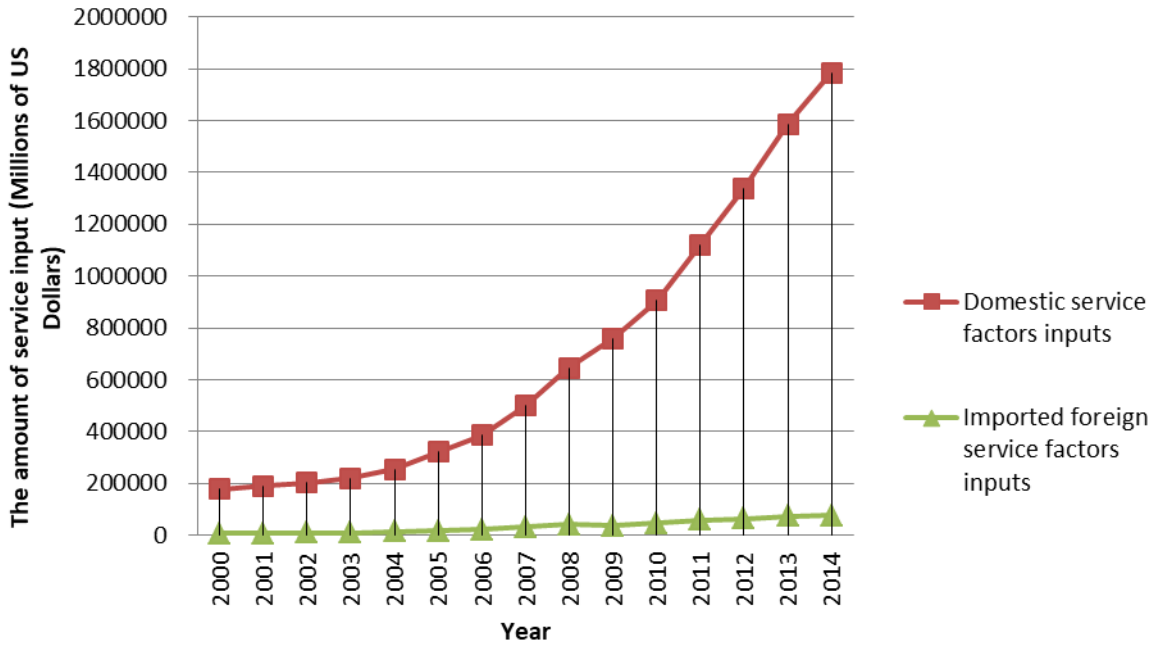

Figure 1 Comparison chart of domestic service factors inputs and imported service factors inputs.

Figure 1 shows that domestic service factor input accounts for a large proportion of total service factor input, and the total domestic service factor input is still growing, from $177.6 billion in 2000 to $1785.3 billion in 2014, an increase of about nine times. Moreover, its proportion in total service factor input increased from 96.91% in 2000 to 95.89% in 2014, so domestic service factor input plays a decisive role in the service-oriented manufacturing industry in China. By contrast, the input of foreign service factors accounted for only 4.11% of the total service factors in 2014.

4. Empirical model

In order to test the impact of China's manufacturing input servicing on China's moving-up in the GVC, the following econometric model is constructed in this paper:

$$\ln GVC_{it} = \beta_0 + \beta_1 \ln si_{it} + \beta_2 X_{it} + \alpha_i + \gamma_t + \mu_{it} \tag{10}$$

Where, i and t represent respectively the manufacturing sector and time in China, α_i is the fixed

effect of industry, and γ_t is the fixed effect of time, which affect the specific industry elements of the upstreamness index of manufacturing sector. μ_{it} is a random perturbation term. The interpreted variable $\ln GVC_{it}$ denotes the upstreamness level of sector i in the t-th year of 17 manufacturing sectors in China. The explanatory variable $\ln si_{it}$ is the logarithm of the proportion of service factors invested by the manufacturing sector i in t years to the total input of the manufacturing sector i. X_{it} indicates other control variables, including the number of enterprises (etp), fixed assets (fix), Hong Kong, Macao, Taiwan and foreign investment (fdi), openness of foreign trade (open) and internal R& D expenditure (rd_m) in each sector of China's manufacturing industry.

The industrial upstreamness index of 17 manufacturing sectors in China from 2000 to 2014 is measured and calculated based on the world input-output table, and the proportion of service factors, the openness of foreign trade and the complexity of export technology in 17 manufacturing sectors in China from 2000 to 2014 are calculated by using the input-output tables of China. The number of enterprises, the original price of fixed assets, Hong Kong, Macao, Taiwan and the amount of foreign investment in each sector of China's manufacturing industry in the control variables all come from China's Statistical Yearbook of Industrial Economy 2001-2015, while the internal R&D expenditure in each sector of China's manufacturing industry comes from China's Statistical Yearbook of Science and Technology 2001-2015.

5. Empirical results and analysis

5.1 Benchmark regression results

Based on China's cross-industry panel data from 2000 to 2014, the impact of domestic and foreign input of service factors on China's moving-up in the GVC in 17 sectors of manufacturing industry is analyzed . Descriptive statistics on key variables are shown in Table 2.

Table 2 Descriptive statistics of each variable.

Variable	Obs	Mean	Std.Dev.	Min	Max
open	255	0.218	0.191	0.040	0.890
lngvc	255	1.096	0.232	0.569	1.489
lndin	255	-2.281	0.242	-3.032	-1.647
lnfin	255	-5.450	0.415	-6.199	-4.192
lnetp	255	9.361	0.871	6.901	11.091
lnfix	255	8.619	1.098	5.955	11.028
lnfdi	255	6.595	1.083	4.185	9.082
lnrd_m	255	8.398	2.152	3.135	15.881
lnsi	255	-2.233	0.224	-2.767	-1.607

Because the panel data selected in this paper consists of 15 years of data from 17 industry sectors, the number of industry sectors is N=17 (10<N<20), and the time span is T=15 (10<T<40) and, N and T are relatively close and the data selection span is small, hence the estimation method of panel correction standard error under multi-equation model is selected, considering both the heteroscedasticity of cross-section data and the autocorrelation of time series data. Table 4 shows the input variables of service factors, enterprise unit number, fixed assets, Hong Kong, Macao, Taiwan and foreign investment, foreign trade openness and internal R& D expenditure, which are included in 17 sectors of manufacturing industry in turn. The estimated results are shown in Table 3.

The estimated results in Table 3 show that, with the increasing number of variables in the model, the input of service factors in the manufacturing sector of China has a significant negative effect on the upstreamness index of the sector, and the influence coefficient is significantly negative at the level of 1%. That is to say, with the increasing input of domestic service factors, the upstreamness index of the sector industry is gradually decreasing, and the lower upstreamness index of the industry represents a higher value-added rate and a higher value chain division status. Therefore,

there is a significant positive correlation between the input of service factors in China's manufacturing sector and the rise of China's position in the GVC. With the increasing input of service factors in manufacturing industry, China's position in the division of labor in the GVC is constantly improving, that is, it has a positive impact on China's moving-up in the GVC. According to the results of column (6) in Table 3, the estimated results of the other five control variables are significant at the level of 1%.

Table 3 Service-Oriented Manufacturing Input in China and its Moving-up in the Global Value Chain.

	(1)	(2)	(3)	(4)	(5)	(6)
lnsi	-0.355*** (-6.07)	-0.352*** (-7.02)	-0.359*** (-7.25)	-0.337*** (-7.61)	-0.247*** (-5.38)	-0.358*** (-5.92)
lnetp		-0.063*** (-6.73)	-0.114*** (-16.86)	-0.069*** (-6.76)	-0.060*** (-5.13)	-0.129*** (-7.91)
lnfix			0.067*** (10.63)	0.097*** (12.83)	0.098*** (14.51)	0.040** (3.29)
lnfdi				-0.069*** (-4.56)	-0.065*** (-4.58)	0.053* (2.25)
lnrd_m					-0.022*** (-4.42)	-0.017** (-3.02)
open						-0.530*** (-7.56)
_cons	0.302* (2.31)	0.903*** (6.89)	0.783*** (6.96)	0.607*** (7.00)	0.874*** (8.57)	1.062*** (10.37)
N	255	255	255	255	255	255

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

5.2 Robustness testing based on the source of input of service factors

As can be seen from the estimated results in Table 3, the input of service factors has a significant positive effect on China's moving-up in the GVC. However, the input of service factors in 17 sectors of Chinese manufacturing industry is divided into two parts, one is domestic service factor input, and the other is foreign service factor input. The above descriptive analysis of service factors input from different sources has been carried out. Table 4 below shows the robustness testing based on the source of service factors.

Table 4 Robustness testing based on the source of service factors.

	(1)	(2)	(3)	(4)	(5)	(6)
lndin	-0.357*** (-6.18)	-0.342*** (-7.00)	-0.324*** (-7.03)	-0.307*** (-7.35)	-0.227*** (-5.40)	-0.327*** (-5.91)
lnfin	0.058** (2.90)	0.028 (1.57)	-0.052* (-2.41)	-0.036 (-1.79)	-0.013 (-0.75)	-0.004 (-0.19)
lnetp		-0.055*** (-5.68)	-0.119*** (-13.82)	-0.072*** (-6.41)	-0.058*** (-4.60)	-0.119*** (-9.35)
lnfix			0.072*** (8.24)	0.097*** (9.99)	0.096*** (11.24)	0.035* (2.40)
lnfdi				-0.065*** (-4.38)	-0.064*** (-4.50)	0.052* (2.31)
lnrd_m					-0.022*** (-4.39)	-0.017** (-3.09)
open						-0.525*** (-7.50)
_cons	0.596*** (5.51)	0.980*** (7.94)	0.569*** (4.94)	0.472*** (4.68)	0.828*** (7.25)	1.063*** (7.77)

N	255	255	255	255	255	255

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

As can be seen from Table 6 (1) above, after distinguishing the sources for input of service factors, both the domestic and foreign service factor input are significant at the level of 5%. However, as the model gradually incorporates the variables of enterprise unit number, fixed assets, Hong Kong, Macao, Taiwan and foreign investment, internal R&D expenditure and foreign trade openness, the foreign service factor input becomes insignificant, while domestic service factors input is still significant at the level of 5%. The main reason for the above phenomenon is that the proportion of the foreign service factor input in total input of service factors is too small, about 4% in 2014. Therefore, after differentiating the sources of service factors, as the proportion of domestic service factors input reaches about 96%, its change has the most significant impact on the upstreamness index of manufacturing industry, while the impact of foreign service factor input has become less significant.

5.3 Robustness test based on heterogeneity of service factor input

From the estimated results in Table 3, it can be concluded that the input of service factors has the greatest impact on China's moving-up in the GVC, but the service factors are not homogeneous. What kind of service factors contribute the greatest to China's moving-up in the GVC needs to be further divided and analyzed. According to the difference of factor intensity, it can be divided into labour-intensive, capital-intensive and technology-intensive service factor input. As a result of the comparison above, it is found that there is a big gap between domestic and foreign service factor input. In order to better show the impact of each part on the upstreamness index of manufacturing sector, this paper tests the robustness based on the heterogeneity of domestic and foreign service factor input respectively.

Table 5 Robustness testing results based on the heterogeneity of domestic service factor input.

	(1)	(2)	(3)	(4)	(5)	(6)
lndc	-0.149 (-1.93)	-0.164* (-2.33)	-0.138* (-2.10)	-0.135* (-2.30)	-0.100 (-1.82)	-0.165** (-2.84)
lndl	-0.076*** (-4.95)	-0.063*** (-3.47)	-0.017 (-1.34)	-0.064*** (-3.46)	-0.059** (-3.19)	-0.062*** (-3.91)
lndt	-0.116*** (-3.35)	-0.106** (-2.97)	-0.181*** (-4.69)	-0.099* (-2.16)	-0.056 (-1.27)	-0.094** (-2.61)
lnetp		-0.053*** (-5.95)	-0.104*** (-17.39)	-0.051*** (-3.99)	-0.042** (-3.07)	-0.107*** (-10.19)
lnfix			0.069*** (8.18)	0.092*** (11.08)	0.094*** (12.56)	0.035** (2.71)
lnfdi				-0.073*** (-4.32)	-0.073*** (-4.51)	0.046** (2.58)
lnrd_m					-0.022*** (-4.58)	-0.017** (-3.27)
open						-0.524*** (-8.00)
_cons	-0.106 (-0.75)	0.451*** (3.31)	0.387*** (3.71)	0.219* (2.15)	0.571*** (4.91)	0.663*** (5.57)
N	255	255	255	255	255	255

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

Table 5 shows the robustness test results based on the heterogeneity of domestic service factor input, and that after dividing domestic service factor input into capital-intensive (dc), labor-intensive (dl) and technology-intensive (dt) types, the impact of three types of domestic service factor input on the upstreamness of the manufacturing sector is significant at the level of 1%, but

the degree of impact is different. The input of capital-intensive domestic service factors has a negative impact on the manufacturing sector, and the impact on the upstreamness index of the sector is the most significant, followed by technology-intensive service factor input. A large amount of domestic technology-intensive service factor input will improve the overall technology level of domestic manufacturing sector to a certain extent, coupled with technology spillover effect and imitation effect, so a large amount of technology-intensive service factor input will play a positive role in China's moving-up in the GVC. The input of labour-intensive domestic service factors has a positive impact on the upstreamness of the manufacturing sector, and the regression results are significant. That is, the large amount of labour-intensive service factors invested in the domestic manufacturing sector is conducive to China's moving-up in the GVC, which is contrary to previous expectations.

Table 6 Robustness testing results based on heterogeneity of foreign service factor input.

	(1)	(2)	(3)	(4)	(5)	(6)
lnfc	0.163***	0.138***	0.132***	0.137***	0.137***	0.147***
	(11.14)	(10.43)	(8.23)	(8.56)	(8.59)	(9.17)
lnfl	-0.011	0.014	0.011	0.016	0.017	0.006
	(-0.97)	(1.29)	(0.97)	(1.49)	(1.54)	(0.49)
lnft	-0.221***	-0.236***	-0.235***	-0.225***	-0.229***	-0.217***
	(-10.52)	(-11.47)	(-11.34)	(-11.01)	(-8.27)	(-7.34)
lnetp		-0.070***	-0.075***	-0.051***	-0.051***	-0.094***
		(-13.59)	(-8.90)	(-4.02)	(-3.75)	(-5.23)
lnfix			0.007	0.019*	0.018	-0.022
			(0.94)	(2.20)	(1.85)	(-1.92)
lnfdi				-0.034*	-0.034*	0.053*
				(-2.42)	(-2.35)	(2.28)
lnrd_m					0.002	0.000
					(0.28)	(0.02)
open						-0.398***
						(-6.45)
_cons	0.544***	1.165***	1.089***	1.129***	1.117***	1.426***
	(3.82)	(8.44)	(6.57)	(7.13)	(6.36)	(7.52)
N	255	255	255	255	255	255

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6 shows the robustness test results based on heterogeneity of foreign service factor input, and that after dividing foreign service factor input into capital-intensive (fc), labour-intensive (fl) and technology-intensive (ft) types, they are different with the robustness test results of domestic service factor input based on heterogeneity, that is, foreign capital-intensive service factor input has a significant positive correlation with the upstreamness of China's manufacturing sector, which may be related to the investment structure of foreign capital. The foreign capital are flowing into China for the purpose of utilizing cheap labour resources and abundant natural resources, which are usually concentrated in labour-intensive and resource-intensive industries. The entry of foreign capital promotes the development of these industries to a certain extent, but because of low value-added rate, their development has a significant negative impact on China's moving-up in the GVC.

6. Conclusions and suggestions

In this paper, the following conclusions are drawn: (1) The input of service factors has a significant positive effect on the growth of China's manufacturing sector in the GVC. (2) After differentiating the sources of service factor input, it is found that domestic service factor input still has a significant positive effect on Chinese manufacturing industry's moving-up in the GVC, while foreign service factor input has no significant effect. (3) After differentiating the heterogeneity of

service factors, it is found that domestic factor input, whether capital-intensive, labor-intensive or technology-intensive, has a significant positive effect on China's moving-up in the GVC, but the degree of its effect is different: capital-intensive service factor input has the greatest impact, followed by technology-intensive, and finally labor-intensive service factor input.

The conclusion of this paper is of great significance to further study the transformation and upgrading of China's manufacturing industry and to rebuild the status of GVC. Based on the above empirical results, the following suggestions are put forward: (1) China should increase its input in manufacturing service factors, especially capital and technology-based service factors. (2) China should continue to maintain the pattern of opening to the outside world and actively introduce advanced technology-intensive service factors from abroad. (3) The input of labor-intensive industries should be targeted, and the transformation and upgrading of the industry should be promoted through active policy guidance, so as to realize the transition of the industry from low to high segment in the GVC. (4) The R&D investment in the manufacturing sector should be further increased. By introducing advanced equipment or increasing the salary of R&D personnel, the production and development of new technologies in the manufacturing sector should be continuously stimulated, and the upgrading of products and even the whole industrial sector should be realized through the driving role of new technologies.

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