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Impact of Manufacturing Servitization on Factor Productivity of Industrial Sector Using Global Value Chain

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Abstract: The current study estimates the impact of manufacturing servitization on industrial productivity from the perspective of global value chain division. For this purpose, from 2000 to 2014, the study uses the World Input–Output Database (WIOD) to measure the servitization level of China's manufacturing industry based on the non-competitive input–output model. Moreover, it develops a unified framework of source and structural differences in service factors and explores the mechanism and impact of manufacturing servitization on industrial productivity from the perspective of global value chain division. The results showed that if the division status of the manufacturing industry in the global value chain is higher, there will be a higher productivity effect of servitization. Regarding service factor country difference, foreign service factor input positively strengthened the industrial productivity effect, whereas domestic service factor input had no obvious effect on industry productivity. Furthermore, it was found that distribution and transportation services do not play a significant role in promoting industry productivity, whereas modern service factors such as information technology, finance, and business services have significant driving effects on industry productivity. The study suggests optimizing the layout of the industrial chain and improving the servitization of the manufacturing industry.

Keywords: servitization; manufacturing industry; factor sources; structural differences; total factor productivity; global value chain

Citation: Zhang, J. Impact of Manufacturing Servitization on Factor Productivity of Industrial Sector Using Global Value Chain. *Sustainability* **2022**, *14*, 5354. https://doi.org/10.3390/su14095354

Academic Editors: Ehsan Elahi, Guo Wei and Tasawar Nawaz

Received: 15 March 2022
Accepted: 18 April 2022
Published: 29 April 2022

1. Introduction

Transformation of the world economy from "product economy" to "service economy" in the Global Value Chain (GVC) division system is characterized by international production segmentation and international trade integration [1]. To maintain their competitive advantage in the international market, Apple, Amazon, and IBM have been leading the trend of global industrial development from the manufacturing sector to the service sector [2–4]. Similarly, Chinese manufacturing enterprises have achieved rapid growth with the help of reform and opening-up policies [5]. On the one hand, the traditional advantages of Chinese manufacturing enterprises long attached to the division in the global value chain have gradually weakened, and the pressure of "low-end locking" has increased [1]. The enterprise operation and industrial structure have faced an urgent need for transformation and upgrading. On the other hand, severe challenges have been brought to China's foreign trade and economic cooperation because of the weakness of global economic growth after the international economic crisis in 2008 [6]. Restrictions on global trade were implemented during the era of COVID-19 [7]. This unfavorable situation of "internal and external difficulties" makes it necessary to find more breakthroughs in China's industrial development in the future [8]. In 2018, the Central Economic Work Conference put forward the specific requirements of "promoting the deep integration of advanced manufacturing industry and modern service industry and building a manufacturing power" [9,10]. It aims to accelerate the efficient allocation of resources and enhance industrial production and international competitiveness to boost China's manufacturing industry towards high-quality development [11]. Therefore, in-depth exploration is required to understand how to improve the

servitization level of the manufacturing industry, which is an important way to seek the release of the vitality of production factors. It is also an inevitable choice to comply with the trend of the service-oriented global industrial development.

In 2019, the World Trade Organization proposed that "trade in services has been the most dynamic part of global trade" [12]. Many studies have conducted extensive and in-depth discussions on the great potential of the service sector to promote global industrial transformation and upgrading [13,14], and have introduced the concept of manufacturing servitization in changing the mode of manufacturing enterprises to provide a "product–service package" [15]. Some studies enriched the connotation of manufacturing servitization by including the dynamic transformation process of service value-added in the whole product life cycle [16–18]. Previous studies have also focused on the characteristics of enterprise behavior and industrial development [19–21]. Studies also focused on the behavior of farmers in the agricultural sector to conserve resources and the environment [22–26]. The input of high-end service elements can promote the mode of innovation of enterprise technology and management. It reduces unnecessary expenses, such as variable costs or hidden costs, thus forming spillover effects among enterprises or within industries and improving factor productivity to promote industrial transformation and value chain upgrading [27,28]. The service elements were not conducive to the improvement of enterprise performance, and there is a "service trap" [29]. This phenomenon is due to the non-efficiency of management and operation caused by the poor acceptance of service by consumers [30]. There is a nonlinear relationship between manufacturing servitization and productivity [31].

Although many studies determined the impact of manufacturing servitization on industry productivity, limited studies have focused on the mechanism of the structure and source differences of the input service factor on the manufacturing production rate. Therefore, to fill the literature gap, the current study deals with two research questions: (1) What is the impact of factor input of the manufacturing industry of China through domestic and international channels on local industrial productivity? and (2) What are the mechanism and the different impacts on industry productivity due to the differences in the factor input structure brought about by the mechanism under the trend of further facilitation and high-end circulation of service factors. These questions provide new comparative advantages of China's manufacturing industry in the process of service-oriented transformation, to better promote the deep integration of the manufacturing and service industry, enhance the ability to create value-added products and services, and achieve high-quality economic development. Compared with the existing literature, the current study analyzes the source and structure of service factor input in the manufacturing industry in the same framework, and effectively distinguishes the productivity effect differences in the mechanism of the source and structure of different service factors based on the analysis of the mechanism of global value chain division on industry productivity. It maintains the logical consistency of problem research in discussing the relationship between global value chain division, manufacturing servitization, and industrial productivity.

In this paper, Section 2 deals with the theoretical mechanism and construction of the hypothesis based on the mechanism of manufacturing servitization on the global value chain. Section 3 discusses the materials and methods, including the data collection, regression function with least-squares regression model at the industry level, and Selection of variables. Section 4 shows the results and discusses the effects of service factors on productivity. Section 5 deals with the conclusions and policy implications based on the results.

2. Theoretical Mechanism and Construction of Hypotheses

The essence of manufacturing servitization is a service sector input process characterized by expanding the value-added space of value chain production and service [32]. If service factors are only regarded as "high-end factors" with intermediate input, the "service dividend" contained in manufacturing servitization can benefit the subjects participating

in all links of the global value chain [33]. On the one hand, to reduce cost, multinational corporations transfer low value-added links such as production and processing to the "geographical combination" with the most comparative advantage in the form of local outsourcing or offshore outsourcing such as the OEM mode commonly used in processing trade. The combination of the price advantages of factors such as land and labor force, and the industrial capital of the employers, make them continuously bring commodity supply to the global market based on the economic scale and economic scope where all parties obtain corresponding value profits [34–36]. On the other hand, with the increasingly serious problems of industrial assimilation and market homogenization, the simple commodity supply can no longer meet the capital needs in the value chain for differentiated competition and expanded reproduction. While the gradual increase in the embedding degree of service factors makes it possible for them to pursue more value-added in the global value chain. Modern services such as distribution services, transportation services, information technology services, financial services, and business services are bound to produce a "ripple effect" in the process of infiltration into the value chain, which objectively promotes the productivity and factor revenue ability of upstream and downstream enterprises in the value chain. Based on the theoretical mechanism, we proposed the given hypothesis:

Hypothesis 1. *Manufacturing servitization under the framework of global value chain division helps to improve the total factor productivity of the industry.*

With the deepening trend of embedding the service industry into the global value chain, the source differences, input forms, and factor revenues of service have important factors in measuring the value creation ability of a country's manufacturing industry [37]. When advanced service such as human capital, knowledge capital, and technological capital is embedded in the global value chain, the "ripple effect" brought by the high-end enterprises in the value chain will spill over to the middle and low-end enterprises. In the process of undertaking outsourced production and manufacturing activities in the early stage, plus the accumulation of certain technology and management capabilities through "learning by doing", coupled with the spillover effect of service elements, the middle and low-end enterprises have greatly improved the production efficiency and value creation ability [38]. As the initiator and driver of production division in the global value chain, multinational corporations in developed economies objectively form a "low-end lock" on their role in the division in the value chain while giving development opportunities to middle- and low-end enterprises based on the consideration of gaining maximum benefits when making a global layout of modern service [39]. As a result, medium- and low-end enterprises are always in a subordinate position. Furthermore, foreign factors create more value due to higher-end elements and stronger capital in terms of promoting the productivity of the manufacturing industry [40]. Therefore, differentiating service elements by the economic attribute of benefit acquisition ability is helpful to analyze and grasp the development characteristics of the service industry tending to "globalization" and "fragmentation", and to clarify and deconstruct the benefit distribution differences in different sources of elements in the global value chain. Accordingly, we proposed the given hypothesis:

Hypothesis 2. *The promotion to industry productivity effect of foreign service factors is stronger than that of domestic service factors due to the difference in benefit acquisition ability.*

For traditional manufacturing enterprises, the embedding of manufacturing servitization in the form of distribution service, transportation service, information technology service, financial service, and commercial service will promote the flexible manufacturing level of enterprises in terms of R&D design, marketing, and brand management, and control ability [1,41–43]. Specifically, through distribution servitization, the manufacturing enterprises establish a more perfect marketing network, shorten the distance between manufacturers and consumers, enhance the ability to obtain market information, and cut

unnecessary expenses such as coordination cost, information collection cost, and channel construction cost caused by information asymmetry [44–46]. Transportation service provides convenience for the efficient allocation and integration of production factor resources by saving transportation time and increasing product added value. Based on an internet platform, information technology service can realize the "third unbundling" of the international division of production to break through the time and space constraints of traditional industrial chain and promote the rapid circulation of enterprise logistics, information flow, and cash flow, and thus to improve total factor productivity [47,48]. Financial service enhances the profitability of financial capital in R&D, innovation, and productive investment, and "feedback" enterprise production and manufacturing activities through high capital return by providing enterprises with more means of investment and financing, alleviating the liquidity constraints of enterprises. The role of commercial service in organization and management, marketing, property rights protection, legal consultation, and other links has greatly cut the hidden cost of enterprise operation and improved operational efficiency and market competitiveness. There is no doubt that service factors have great potential in promoting the in-depth integration, transformation, and development of industries. However, various service factors may have advantages and disadvantages in the overall effect of industry productivity due to different domestic and foreign economic environments. Due to the different characteristics of service subdivided industries, the effect may have obvious heterogeneity if the sources of service factors and the differences in input structure are included in the productivity effect. Thus, we proposed the following hypothesis:

Hypothesis 3. *The heterogeneity of the internal productivity effect may exist due to the difference in service factor structure.*

3. Materials and Methods

3.1. Source of Data Collection

Data on input–output (from 2000 to 2014) were collected from the China Industrial Statistics Yearbook, China Statistical Yearbook, and National Bureau of Statistics. The WIOD database was adopted to measure the global value chain and manufacturing servitization based on ISIC rec.3 classification, covering data of 43 economies and 56 industrial sectors, including 18 manufacturing industries. Particularly, data were used to calculate total factor productivity and control variables based on the Industrial Classification of the National Economy, including 31 manufacturing industries. As there is a difference between the industry classification standards of the two types of data, this paper matches and merges the subcategories of manufacturing products with the industries in the Industrial Classification of the National Economy, and finally obtains the panel data of 17 manufacturing sub-industries.

3.2. Construction of Regression Function

The current study mainly determines the impact of manufacturing servitization level on total factor productivity in the industrial sector under the background of the global value chain, and establishes the least-squares regression model at the industry level referring to the previous research:

$$tfp_{it} = \gamma_0 + \gamma_1 gvc\_pos_{it} + \gamma_2 maser_{it} + \gamma_3 gvc\_pos_{it}{}^{*} maser_{it} + \gamma controls + \mu_i + \mu_t + \varepsilon_{it} \quad (1)$$

where subscripts "i" and "t" represent industry and year, respectively. TFP stands for total factor productivity of the manufacturing industry. GVC_POS refers to the division index of the global value chain. Maser is the servitization level of the manufacturing industry. GVC_POS* maser indicates the cross term between the division of the variable global value chain and the servitization level of the manufacturing industry. Controls are the set of control variables, u_i and u_t are the fixed effects of industry and year, respectively. Both terms u_i and u_t represent random interference. Both are normally distributed with zero mean value and at constant variance [49–53].

3.3. Selection of Variables

3.3.1. Explained Variable

Industrial total factor productivity (TFP) will employ the Data Envelope Approach (DEA) model to measure, in which the input elements include capital and labor input [54–56]. Capital input is represented by the capital stock. Following [57], the current study attempts to measure the capital stock from the industrial level and selects the net value of fixed assets of the industry as the investment index. The base period is 2000, and the fixed asset investment price index is converted into constant actual investment sequence data. The base period capital stock is data of 2000 divided by 10%. The capital depreciation rate is set as 9.6%. When the labor is measured, labor hours are more accurate than the number of the labor force. However, it is difficult to obtain accurate data on labor hours. Labor input will adopt the number of employees at the end of each industry over the years. The output is the industrial output value, and they are deflated by the ex-factory price index of industrial products.

3.3.2. Core Explanatory Variable

This paper matches the WIOD industry data with the data of China's civil economy industry classification and subdivides the export value-added into 17 parts. Further, the division position in the value chain is calculated from the perspective of export added value, as given in the following expression:

$$\text{GVC\_POS}_{im} = ln\left(1+\frac{IV_{im}}{E_{im}}\right) - ln\left(1+\frac{FV_{im}}{E_{im}}\right) \tag{2}$$

where GVC_POS represents the value chain division of an industry in a country, IV is the added value of intermediate products exported by a country to other countries after processing, and FV stands for the added value of intermediate products imported by a country from a third country after processing and then exported to other countries. E is the value-added of total exports of a country's industry. Some scholars believe that if a country participates in the global value chain by providing intermediate goods to other countries, it will be in the high value-added link of the value chain system. Contrarily, if a country participates in the international division in the form of "processing export" of intermediate products imported from a third country, it is often in the low value-added link of the value chain [58]. Therefore, the indicators of the division of the global value chain measured in this paper are consistent with the above economic implication.

Manufacturing servitization (maser) is to be measured by the direct consumption coefficient and complete consumption coefficient under the input–output framework [59]. The direct and complete consumption of final products per unit is provided by the manufacturing sector on service inputs from the service sector [60,61]. Specifically, when department j produces final products Q_j, the service input of i department is q_{ij}, the direct consumption coefficient can be written as:

$$a_{ij} = \frac{q_{ij}}{Q_j} \tag{3}$$

where a_{ij} is the direct consumption degree of j department on the input of elements from i department, and the direct consumption coefficient matrix can be written as:

$$A = \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{pmatrix} \tag{4}$$

In the production activities of the manufacturing sector, the consumption of factor inputs includes direct consumption and indirect consumption. The direct and indirect consumption of service factor input constitutes the complete consumption of the manufacturing industry to the service industry.

$$b_{ij} = a_{ij} + \sum_{k=1}^{n} a_{ik}a_{kj} + \sum_{s=1}^{n}\sum_{k=1}^{n} a_{is}a_{sk}a_{kj} + \cdots \quad (5)$$

The matrix can be written as:

$$B = A + A^2 + A^3 + \cdots + A^k = (I - A)^{-1} - I \quad (6)$$

where A and B are the direct consumption coefficient matrix and complete consumption coefficient matrix, respectively. A^2 is the indirect consumption matrix of the first round, and so on. A^K means the indirect consumption matrix of the $k-1$ round, and $(I-A)^{-1}$ represents the Leontief inverse matrix. The traditional specialization boundary between manufacturing and service industry gradually disappears with the improvement of production technology and the acceleration of inter-industry integration. The specializing division gradually gets rid of the situation that the "service industry only provides support for the manufacturing industry, and manufacturing industry only provides demand for service industry". Through the global value chain, participating in the international production division, promoting the cross-regional flow of production factors, and expanding the intensification of commodity trade, the manufacturing industry provides an opportunity for the close integration of international service factors and domestic production factors. Therefore, employing the input–output table at the global level of WIOD database, this paper constructs the consumption coefficient at home and abroad according to the source of service factors, and divides manufacturing servitization into five categories: distribution service, transportation service, information technology service, financial service, and commercial service according to the differences in service. The calculation was made with the help of MATLAB R2018b.

3.3.3. Control Variable

Since this paper mainly studies the manufacturing industry, the following control variables are considered:

(1) Industry size, which is measured by the ratio of the output value of each manufacturing sector to the total output value of each sector.
(2) Export intensity refers to the proportion of the export delivery value of each department in the total output value of the department.
(3) The proportion of state capital (CAPD) is the ratio of state-owned capital to the paid-in capital of the department.
(4) The proportion of foreign capital (CAPF) is measured by the ratio of foreign capital of the department to the paid-in capital.

4. Results and Discussion

4.1. The Impact of Manufacturing Servitization on Total Factor Productivity from the Perspective of the GVC Division

In columns 1 and 3 of Table 1, the core explanatory variables the GVC division and servitization of the manufacturing sector were included in the production function. The estimation coefficients of industrial productivity were significantly positive, and the preliminary results are consistent with the expected sign. After adding control variables to columns 2 and 4, the results showed that the sign and significance of the estimated coefficient of the core explanatory variable have not been changed. It indicates that the service-oriented manufacturing industry has a significant positive driving effect on the total factor productivity, and the improved GVC's division in the manufacturing sector also significantly promoted the improvement of the total factor productivity. Column 5 introduces the interaction between the GVC division and manufacturing servitization and found that the estimation coefficient is significantly positive. It indicates that the improvement of the GVC division in the manufacturing sector strengthens the driving effect of servitization on total factor productivity. The higher the division of the GVC, the

more obvious that the manufacturing service factor investment is the "adhesive", which further expands the application of high-end factors. The spillover effect caused by the flow of innovative human capital, high-tech production technology, and advanced management and operation mode in different departments indirectly drives the upgrading of production factors in relevant industries. To consolidate and strengthen their position in the value chain and occupy more divisions in the GVC, local manufacturing enterprises are more focused on increasing investment and looking for partners to further reduce transaction costs by implementing standardized contracts and agreements, thus providing more market players with the opportunity to integrate into the international division. The joint of the upgrading of production factors and the diversification of market players has promoted the rise of the GVC's division in the manufacturing sector and the increased correlation effect in manufacturing servitization, and finally strengthened the driving effect of manufacturing servitization on total factors productivity (this finding is according to Hypothesis 1).

Table 1. Impact of manufacturing servitization on TFP from the perspective of the GVC.

Variables	(1)	(2)	(3)	(4)	(5)
	tfp	tfp	tfp	tfp	tfp
gvc_pos	0.721 ** (0.251)	0.679 *** (0.211)	0.616 ** (0.273)	0.485 ** (0.222)	0.491 ** (0.224)
ser			0.812 *** (0.221)	0.815 *** (0.251)	0.836 ** (0.289)
gvc_pos *ser					0.074 ** (0.178)
capd		0.068 (0.071)		0.039 (0.058)	0.027 (0.076)
capf		−0.293 * (0.151)		−0.335 ** (0.136)	−0.338 ** (0.135)
expd		0.161 ** (0.076)		0.077 * (0.105)	0.076 * (0.102)
size		−0.250 (0.319)		−0.434 (0.334)	−0.413 (0.335)
Year effect	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes
Constant	1.297 *** (0.0189)	1.497 *** (0.2667)	1.015 *** (0.0762)	1.387 *** (0.253)	1.367 *** (0.262)
R^2	0.684	0.691	0.671	0.679	0.680
Total number of observations	255	255	255	255	255

Standard errors are given parenthesis. *, **, *** show significant level at 10%, 5%, and 1%, respectively.

4.2. Productivity Effects of Service Factors

The formation of the global value chain division system stems from the transnational flow of production factors driven by comparative advantage and factor endowment. This specialized division further promotes the construction and improvement of the domestic production network system characterized by undertaking foreign contracting and allocating international and domestic factor resources. For the production of China's manufacturing sector, different sources of service factors may have different effects on industry productivity. Table 2 reports the impact of different service factor inputs on the productivity of the manufacturing industry under the GVC framework. According to columns 1 and 3 of Table 2, the estimated coefficients of the division of the global value chain are significant at the 1% level of significance. This means that it can still effectively promote total factor productivity, and the input of different service factors at home and abroad will also have a significant positive driving effect on productivity [62–64]. Columns 2 and 4 of Table 2 show that when the interactions of the GVC division and servitization of China (SER)_DW) and abroad (SER)_FW) were added, the estimation results were different, with the former being positive, but not significant, and the latter being significantly positive. The effects of significance are quite different. The logic in the difference is that the benefit distribution pattern under the global value chain is determined by the value-added links of enterprise or industry departments. Without differentiating sources of intermediate inputs and final products, the manufacturing and production of Chinese enterprises rely on a loose foreign investment environment, low-cost labor force and relatively perfect infrastructure, the transnational flow of production, and service factors to improve productivity rapidly in a short time [65–67]. However, if intermediate inputs from different sources at home and

abroad are stripped from the global value chain, the high-end service factors owned by multinational corporations at both ends of the "smile curve" of the value chain have more advantages in promoting productivity and can obtain more factor revenue in the whole chain. The domestic service factors are mostly invested at the bottom of the "smile curve", and the value-added ability is weak; thus, the improvement of industrial productivity is dwarfed, which verifies Hypothesis 2.

Table 2. Estimation of the GVC's division, source of service factors, and TFP.

Variables	(1)	(2)	(3)	(4)
	tfp	tfp	tfp	tfp
gvc_pos	0.603 *** (0.205)	0.623 *** (0.209)	0.684 *** (0.326)	0.752 ** (0.379)
ser_dw	0.576 *** (0.143)	0.573 *** (0.147)		
ser_fw			0.118 * (0.062)	0.119 * (0.063)
gvc_pos*ser_dw		0.078 (0.174)		
gvc_pos*ser_fw				0.069 ** (0.076)
capd	0.073 (0.072)	0.075 (0.073)	0.031 (0.085)	0.0329 (0.087)
capf	−0.314 * (0.152)	−0.307 * (0.158)	−0.299 ** (0.141)	−0.298 * (0.145)
expd	0.142 * (0.071)	0.142 * (0.070)	0.129 * (0.065)	0.131 * (0.747)
size	−0.234 (0.296)	−0.235 (0.295)	−0.255 (0.333)	−0.252 (0.338)
Year effect	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
constant	1.3584 *** (0.2924)	1.4706 *** (0.2441)	1.4789 *** (0.2849)	1.4754 *** (0.2921)
R^2	0.6931	0.6965	0.6988	0.6986
Total number of observations	255	255	255	255

Standard errors are given parenthesis. *, **, *** show significant level at 10%, 5%, and 1%, respectively.

4.3. Effect of Service Factor Input Heterogeneity on Productivity

The above analysis found the effect of different sources of manufacturing service factors on productivity from the perspective of the GVC. Whether the total effect of this difference is caused by the heterogeneity of service factor input is tested in this part. According to the nature of the service industry, combined with the WIOD industry classification and China's national economic industry classification, this paper classifies services into five categories: distribution services, transportation services, information technology services, financial services, and commercial services [68]. Columns 1 to 5 of Table 3 reported the impact of the interaction items of distribution service (retser), transportation service (traser), information technology service (itser), financial service (finser), and commercial service (Busser) with GVC characterized by domestic service factor input on productivity. Columns 6 to 10 report the effect of the interaction between the five types of services characterized by foreign service factor input with GVC productivity.

In general, the productivity effects of different service factor inputs are significantly different in all links of the global value chain division. Specifically, the distribution service from domestic and foreign countries has a positive effect on productivity. Particularly, the statistical level of foreign distribution service is significant at 1%, while the domestic distribution service is not significant. These results depict that the distribution service can enhance the participation of manufacturers in the industrial chain by shortening the "distance" between producers and consumers, effectively avoiding blind production and inefficient allocation of resources due to information asymmetry, cutting the information cost for manufacturers to master market dynamics, thus contributing to the improvement of productivity to a certain extent. Compared with distribution services at home and abroad, the productivity improvement effect brought by domestic distribution services has not fully appeared [69]. As for domestic and foreign transportation services, the impact on productivity does not pass the statistical level of 10%, and the sign of the estimation coefficient is quite opposite. A possible explanation is that local transportation service helps enterprises save time and cost and improve productivity in the process of gradually

improving transportation infrastructure [70]. With the entry of foreign high-end factors, it has produced a "squeezing out effect" on the input of local transportation services, occupying the market of domestic transportation services, thus forming a long-term transportation service trade deficit for local industries, weakening the positive effect of foreign service factors on productivity. The comprehensive effect of the above two functions greatly weakens the role of transportation service. The estimated coefficients of domestic and foreign information technology services are significant at the statistical level of 10%, but the former is positive, and the latter is negative. With the improvement of science and technology, domestic information service tends to be high-end, providing manufacturers with better-controlled factor conditions for production operation, supply, and marketing [71,72]. Manufacturers can use the industrial chain information management to reduce the information barrier between enterprises and promote output efficiency and coordinated operation efficiency [73]. When foreign information technology service enters the domestic market, multinational corporations are in a monopoly position for the intellectual property protection of new technologies [74]. Through controlling enterprise operation information of their technology, local enterprises push foreign information technology services out of the domestic market [75]. As for financial service, the estimated coefficients of financial service factors both at home and abroad are positive and significant at a 10% level of significance. Financial service is a typical feature of the internationalization behavior of multinational corporations and local enterprises [76]. As an institution providing financial services, by functioning as "savings mobilization", financial service alleviates the liquidity constraints encountered by enterprises and contributes a lot to promote the financial support of technological innovation and R&D investment. The reduction in transaction costs and the drive of technological innovation greatly improve productivity, will then drive the improvement of the whole industry's efficiency [77]. For commercial service input, the estimated coefficient of productivity is significantly positive at the statistical level of 1%, regardless of whether it comes from local or foreign sources, indicating that manufacturing enterprises obtain modern business services such as enterprise management, financial leasing, legal consulting, and marketing through commercial service. It helps to improve the efficiency of enterprise product management and business execution, and then significantly strengthens the productivity of business service investment [78].

Table 3. Estimation of heterogeneity of service factor input in the manufacturing industry.

Variables	Domestic Service Factor Input					Foreign Service Factor Input				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Distribution	Transport	IT	Finance	Business	Distribution	Transport	IT	Finance	Business
gvc_pos	0.780 ***	0.674 ***	0.636 ***	0.627 **	0.520 ***	0.515 **	0.598 **	0.671 ***	0.593 **	0.338 **
	(0.235)	(0.217)	(0.201)	(0.217)	(0.162)	(0.225)	(0.251)	(0.216)	(0.260)	(0.216)
retser	−0.107					0.332 ***				
	(0.138)					(0.064)				
traser		0.043					−0.211			
		(0.839)					(0.312)			
itser			0.168 *					−0.075		
			(0.081)					(0.043)		
finser				0.158 ***					0.072 *	
				(0.053)					(0.036)	
busser					0.189 **					0.288 ***
					(0.063)					(0.096)
gvc_pos* ser_dw	0.046	0.034	0.027 **	0.142 **	0.227 **					
	(0.112)	(0.496)	(0.045)	(0.008)	(0.429)					
gvc_pos* ser_fw						0.175 **	−0.012	−0.047 *	0.668 **	0.172 ***
						(0.297)	(0.053)	(0.099)	(0.169)	(0.255)
capd	0.064	0.068	0.081	0.053	0.036	0.043	0.046	0.069	−0.029	0.010
	(0.077)	(0.071)	(0.069)	(0.078)	(0.082)	(0.053)	(0.079)	(0.071)	(0.067)	(0.079)
capf	−265	−0.295 *	−0.308 *	−0.243	−0.279 *	−0.269 *	−0.362 **	−0.282 *	−0.291 *	−0.351 **
	(0.152)	(0.157)	(0.148)	(0.151)	(0.158)	(0.131)	(0.146)	(0.151)	(0.147)	(0.143)
expd	0.165 *	0.161 *	0.141 *	0.157 *	0.121	0.050	0.106 *	0.165 *	−0.030	0.126
	(0.079)	(0.077)	(0.075)	(0.085)	(0.092)	(0.096)	(0.051)	(0.078)	(0.061)	(0.101)

Table 3. *Cont.*

Variables	Domestic Service Factor Input					Foreign Service Factor Input				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Distribution	Transport	IT	Finance	Business	Distribution	Transport	IT	Finance	Business
size	−0.279	−0.243	−0.273	−0.335	−0.213 *	−0.480	−0.513	−0.232	−0.637 **	−0.506
	(0.304)	(0.271)	(0.299)	(0.321)	(0.339)	(0.309)	(0.320)	(0.327)	(0.299)	(0.347)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
constant	1.505 ***	1.489 ***	1.496 ***	1.499 ***	1.356 ***	1.376 ***	1.912 ***	1.480 ***	1.586 ***	1.458 ***
	(0.263)	(0.231)	(0.243)	(0.280)	(0.302)	(0.246)	(0.555)	(0.275)	(0.245)	(0.300)
R^2	0.693	0.692	0.695	0.697	0.698	0.684	0.594	0.693	0.587	0.638
Total number of observations	255	255	255	255	255	255	255	255	255	255

Standard errors are given parenthesis. *, **, *** show significant level at 10%, 5% and 1%, respectively.

From the perspective of service factor heterogeneity, the promotion effect of distribution and transportation services as traditional service factors on productivity is insufficient, while the positive effect of modern service factors characterized by information technology, finance, and business services on productivity is significant. As to the source of service factors, the effect of domestic service factors on productivity is positive, but some foreign service factors show an obvious inhibitory effect. The relative strength of the effect of various service factors under country difference is the reason for the total effect difference as mentioned above (the results satisfied Hypothesis 3).

4.4. Robustness Test

4.4.1. Endogenous Problem

There may be endogenous problems caused by missing variables and reverse causality between variables in the above benchmark model [79–82]. It may result in biased or inconsistent estimation because of two main reasons. Some non-observed factors cannot be captured, which inevitably leads to variable omission, making explanatory variables and control variables related to disturbance terms, resulting in endogenous problems. To pursue a higher position in the value chain and greater profit, enterprises with high productivity will further increase the investment in service, and gradually occupy the high value-added production links in the division by improving capital liquidity, R&D capital, and technology investment, which leads to reverse causality. Therefore, this paper followed the method of Fernandez-Stark and Gereffi of the two-stage least square method for estimation, and selects the lag phase I and lag phase II of China's manufacturing global value chain and manufacturing servitization as instrumental variables [83]. The selection of instrumental variables needs to meet two basic conditions of relevance and exogenous. Since the improvement of the global value chain and industrial integration degree has the characteristics of path dependence. Their lag variables have a direct impact on the current global value chain and industrial integration degree but have no direct impact on the current industrial productivity. Therefore, the instrumental variables selected in this paper are effective and reasonable, and the basic conclusions are also valid.

Through the Hausman test on each variable, it is found that the p-value is 0.0156, indicating that there is an endogenous problem in the variables of the model. The Kleigergen Paap rk LM statistic p value is 0.0039. Thus, the original hypothesis of "unidentifiable" can be rejected. The Cragg Donald Wald F statistic is 7.193, greater than the critical value of Stock–Yogo at the level of 10%. There is no weak identification of instrumental variables. According to the test of instrumental variables in columns 1 and 2 of Table 4 on lag phase I and lag phase II, there is no significant change was found between the estimation coefficient sign and significance of main variables and their cross terms. Moreover, the results of benchmark regression found that the estimation is robust and reliable.

Table 4. Correlation regression of robustness test.

Variables	2SLS_IV		OLS_FE	Quantile Regression		
	(1) Lag Phase I	(2) Lag Two Periods	(3) Indicator Replacement	(4) 25%	(5) 50%	(6) 75%
gvc_pos	0.593 ** (0.291)	0.295 *** (0.094)	0.154 ** (0.063)	0.205 (0.442)	0.099 * (0.551)	0.143 * (0.078)
ser	0.125 ** (0.061)	0.249 * (0.192)	0.365 ** (0.147)	−0.258 * (0.119)	0.415 *** (0.122)	0.639 *** (0.175)
gvc_pos*ser	0.446 ** (0.305)	0.124 *** (0.376)	0.168 ** (0.066)	0.173 (0.175)	0.053 * (0.218)	0.624 * (0.313)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.489 *** (0.294)	1.492 *** (0.193)	0.847 *** (0.153)	1.292 *** (0.058)	1.287 *** (0.082)	1.457 *** (0.099)
R^2	0.681	0.537	0.119	0.168	0.163	0.188
Total number of observations	238	221	255	255	255	255

Standard errors are given parenthesis. *, **, *** show significant level at 10%, 5%, and 1%, respectively.

4.4.2. Indicator Replacement

In the above analysis, the core explanatory variable is to take the complete consumption coefficient as the proxy variable of manufacturing service input, while the direct consumption coefficient method can more intuitively reflect the integration and interaction between service factors and manufacturing production. Column 3 of Table 4 states the OLS fixed effect estimation using the original variable of manufacturing service input replacement measured by the direct consumption coefficient as the core explanatory variable. The results showed that the sign and significance of the estimated coefficient of each main variable have not changed significantly. It depicts that the estimation is stable. The productivity effect of the cross term between the global value chain and manufacturing service input is stronger than that in benchmark regression.

4.4.3. Quantile Regression

To avoid the bias of the estimation caused by the extreme values, columns 4 to 6 of Table 4 report the estimation effect of productivity at 25%, 50%, and 75% quantile levels. The results showed that when the productivity is small, the servitization and value chain of the manufacturing industry has no obvious effect on its promotion, and even has a significant inhibitory effect on the service. When the productivity is great, the promotion effect of servitization and the global value chain of the manufacturing industry is significantly enhanced. It reflects that the servitization of the manufacturing industry and the division of the global value chain have a better positive effect on high-efficiency industries.

5. Conclusions and Policy Implications

This paper employed panel data constructed by the WIOD database and relevant statistical yearbooks from 2000 to 2014 to analyze the impact of manufacturing servitization on productivity based on the theoretical mechanism of manufacturing servitization from the perspective of global value chain division and the source differences and input structure of service elements. The results found that the manufacturing servitization plays the role of "adhesive" and "modular participation" in the international production division, and its positive effect on productivity is more and more significant for industries with a higher position in the value chain. From the perspective of different sources of service factors, foreign service factor investment positively improves productivity. While the effect of domestic service investment on productivity is not obvious. Measuring the value creation ability of a country's manufacturing industry by factor source, input form, and factor benefits can more clearly distinguish the benefit distribution in the value chain. The service-oriented manufacturing industry under national differences presents a variety of heterogeneous characteristics. Among them, the promotion effect of distribution and transportation services on productivity is not obvious, and the driving effect of modern services represented by information technology, finance, and business services on industry

productivity is significant. Moreover, the quantile regression results show that when the productivity is large, the promotion effect of manufacturing servitization and the global value chain is significantly enhanced. This implies that a positive effect of manufacturing servitization and global value chain division on high-efficiency industries is greater.

The study findings suggest optimizing the layout of the industrial chain and improving the servitization of the manufacturing industry. The labor-intensive industries that developed by relying on the advantages of the traditional labor force can no longer amplify the positive effect on productivity, and cannot meet the needs of the current industrial transformation. Therefore, the selective transfer of such industries to inland or Southeast Asia with labor advantages based on an overall assessment of risks and benefits should be considered, which is not only conducive to extending the "step size" of the value chain, but also provides space for the integration of domestic manufacturing industry and service industry. Meanwhile, stimulating the vitality of domestic service factors and strengthening the strategic positioning of service trade should also be considered. On the one hand, learning new rules and provisions of international regional trade agreements and mastering new trends in the development of trade in services would be helpful. On the other hand, we suggest implementing a policy of talent introduction, stimulating the innovative vitality of local high-end elements integration, and then promoting the simultaneous upgrading of the technology level and management mode. Moreover, it is important to distinguish the differences in the structure of service elements and promote the development of the service industry. Distribution services should aim to meet the individual needs of consumers, reduce transaction costs, and increase factor productivity. For transportation services, an increase in cargo transportation capacity for expanding international business and improving the balance of payments is suggested.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Publicly available datasets were analyzed in this study. This data can be found here: https://www.rug.nl/ggdc/valuechain/wiod/wiod-2016-release (accessed on 15 November 2021).

Conflicts of Interest: The author declares no conflict of interest.

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