

Service-Manufacturing Integration and the “Baumol’s Disease” Trap: Experience from China and Global Patterns

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The slow relative productivity growth in the service sector is at the heart of “Baumol’s disease”, and the integration of services and manufacturing may offer a critical pathway to address this issue. This paper uses China’s tax survey data and OECD-ICIO input-output tables to examine how service inputs enhance the relative productivity of Chinese service firms and help overcome the “Baumol’s disease” trap. Additionally, it validates global patterns of this phenomenon through cross-country data. The results indicate that (1) increasing service sector input to the manufacturing sector improves the relative productivity of the service sector, narrows the wage cost gap between the two industries, and facilitates the crossing of the “Baumol’s disease” trap; (2) service sector input into high-tech manufacturing and into the manufacturing sector in developed countries is particularly effective in overcoming the “Baumol’s disease” trap, with producer services playing a significant role; (3) service sector input into manufacturing enhances competition, scale, and innovation within the service sector, which is vital for improving its relative productivity; and (4) cross-country data support the conclusion that service sector input into manufacturing can enhance the relative productivity of the service sector, establishing a global framework for overcoming the “Baumol’s disease” trap.

Keywords: industrial integration, “Baumol’s disease” trap, relative productivity of services, regular pattern in the world

1. Introduction

Promoting the integration of advanced manufacturing and the modern service sector is essential for cultivating a contemporary industrial system and achieving high-quality development. For example, Lodefalk (2014), Liu *et al.* (2016), Xu *et al.* (2017), and Liu and Ni (2018), respectively, explored the upgrading of the manufacturing value chain, technological progress, domestic added value, and improvements in export product quality resulting from the integration of these two industries. Traditionally,

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the service sector has been regarded as an auxiliary force in the development of core industries such as manufacturing. However, the shift from an “industrial economy” to a “service economy” is an inevitable trend in industrial transformation and upgrading worldwide (Wang, 2021b; Xu *et al.*, 2021). In China, as early as 2012, the share of the service sector in the total economy surpassed that of the manufacturing sector. The development of the service sector not only reflects a country’s competitiveness but also serves as a cornerstone for the transformation and development of core industries, such as manufacturing and agriculture, acting as a crucial driving force for economic growth. Therefore, this paper examines the integration of the service sector from the perspective of its input into the manufacturing sector and its impact on service sector development.

Improving productivity in the service sector has always posed a challenge for industrial development. The low productivity of the service sector compared to manufacturing is central to “Baumol’s disease” in industrial transformation. The coexistence of a “rapid decline in the share of manufacturing” and a “slow improvement in the productivity of the service sector” leads to a shift in labor from high-productivity manufacturing to low-productivity services, hindering economic growth and resulting in the trap of “Baumol’s disease”¹. This issue is prevalent in the industrial transformation of countries globally, and China is facing similar challenges. Data show that, around 2012, the proportion of China’s service sector in GDP increased from an average of 43.7% in 2007–2011 to an average of 48.8% in 2012–2016, while the manufacturing share decreased from 40.5% to 35.9%.² Meanwhile, the productivity of the service sector remains low, with growth rates significantly lagging behind those of the manufacturing sector, revealing an imbalance in productivity between the two industries. Thus, coordinated development of the service and manufacturing sectors, particularly achieving productivity catch-up of the low-productivity service sector relative to the high-productivity manufacturing sector, is crucial to avoiding the “Baumol’s disease” trap. The convergence of these sectors may provide a solution to overcoming the “Baumol’s disease” trap, which is central to this research.

Currently, China faces a paradoxical “divergent” industrial transformation characterized by “the rising status of the service industry and the relatively low productivity of the service sector”. There is an urgent need to identify an effective

¹ “Baumol’s Disease” is an important theory proposed by American economist William Baumol in 1967. He argued that, in an economy, labor productivity growth varies across different sectors. Under such disparities, wage increases in the “progressive sector” with faster productivity growth will simultaneously increase wages in the “stagnant sector” with slower productivity growth, consequently causing the “stagnant sector” to attract more labor and generate greater output. The increasing proportion of the “stagnant sector” in the overall economy reduces the economy-wide productivity. Generally, manufacturing-dominated sectors with higher total factor productivity (TFP) represent the progressive sector, while service-dominated sectors with lower TFP constitute the stagnant sector.

² The authors conducted measurements based on data from the China Statistical Yearbook over the years and tax survey data from 2007 to 2016. Due to space limitations, specific statistical charts are not presented here but are available upon request.

path that not only fosters service sector development but also enhances its relative productivity. Furthermore, theoretical gaps remain regarding how the integration of services and manufacturing can improve service sector productivity and help overcome the “Baumol’s disease” trap. This paper aims to contribute in three significant ways. First, it explores the “Baumol’s disease” trap from the novel perspective of service sector input into manufacturing, broadening the research scope on the integration of these sectors. Second, it employs data from China’s tax survey to measure the productivity of service and manufacturing enterprises, quantifying the relative productivity of the service sector to provide a foundation for further research on “Baumol’s disease”. It discusses the influence mechanisms of the service sector concerning relative competition, innovation, and scale effects, offering a theoretical reference for global solutions to this issue. Third, the research encompasses numerous Chinese enterprises and includes cross-border studies, maximizing the generalizability of the findings.

2. Literature Review

2.1. Research on the Concept, Measurement, and Impact of the Integration of the Service and Manufacturing Sectors

The integration of the service and manufacturing sectors is characterized by mutual penetration, interaction, and deep integration within the industrial chain and value chain, ultimately leading to the formation of new industries and business models. Academic discussions focus primarily on two categories. The first is the servitization of the manufacturing sector, which involves increasing the use of service elements in the production process and shifting from selling products to offering “products and services”. This concept was first proposed by Vandermerwe and Rada (1988), who argued that the servitization of manufacturing integrates goods and services to enhance the value of core products and achieve a higher market share. Liu *et al.* (2016) referred to the transformation from a manufacturing-centered to a service-centered approach as manufacturing servitization; Liu and Ni (2018) posited that this transformation reflects the embedding of service-added value in manufacturing enterprises, an important form of integration between the service sector and manufacturing. Building on these concepts, quantitative methods for measuring the servitization of the manufacturing sector have become relatively established. Some scholars have employed the direct or complete input coefficient of manufacturing to the service sector for measurement (Liu *et al.*, 2016; Xu *et al.*, 2017). With advancements in the decomposition method of trade value-added, some studies have depicted the servitization of manufacturing from the perspective of value-added proportions (Peng *et al.*, 2017). Additionally, some research has used indices such as the proportion of operating income from firm services to total revenue to assess the level of servitization in the manufacturing sector

(Crozet and Milet, 2017). The second category relates to the manufacturingization of services, which has sparked debate over its definition. Some scholars assert that it involves the introduction of manufacturing production methods and products into the service sector, while others contend that the service sector extends the industrial chain and engages with the original manufacturing sector (Yu *et al.*, 2021). Du and Hou (2021) emphasized the reverse integration from manufacturing to the service sector, proposing that manufacturingization is measured by the contribution of the manufacturing sector to the service sector.

From the perspective of the economic impact of integrating the service and manufacturing sectors, many scholars have focused on the servitization of the manufacturing sector, typically examining the performance of manufacturing industries or enterprises. At the industrial level, Xu and Sun (2009) found that integrating the information and manufacturing sectors enhances the performance of the manufacturing sector. At the enterprise level, Liu and Ni (2018) demonstrated that the servitization of the manufacturing sector improves total factor productivity (TFP) and promotes technological progress. Liu *et al.* (2016) and Crozet and Milet (2017) studied the effects of manufacturing servitization on value chain upgrading and firm performance, respectively. However, there are relatively few studies on the impact of service manufacturingization. Du and Hou (2021) noted that the effect of service manufacturingization on service productivity remains uncertain. In summary, the current concepts and measurements of the integration of the service and manufacturing sectors remain incomplete, and research examining the impact of the service sector on manufacturing input from the perspective of the service sector is lacking. This paper aims to explore the level of input from the service sector to the manufacturing sector, thereby supplementing the concepts and measurement methods related to the integration of these two industries.

2.2. Discussion of “Baumol’s Disease” and Research on Factors Influencing Productivity in the Service Sector

The essence of “Baumol’s disease” lies in the low productivity of the service sector compared to the manufacturing sector. Several studies have provided empirical evidence for the existence of “Baumol’s disease.” Baqaee and Farhi (2019) found that stagnant sector sales growth exacerbated “Baumol’s disease,” leading to a decline in overall TFP growth in the United States. Sen (2020) found that “Baumol’s disease” caused only a minor decline in economic growth. In China, Cheng (2004) observed that labor productivity in the service sector lagged and developed unevenly. Wang (2021) reported that changes in the price structure of the tertiary industry negatively impacted economic growth. Lin and Xu (2023) found that technological progress in manufacturing led to a decline in the domestic share of manufacturing and a drop in

the relative prices of manufacturing products in China, further verifying the existence of “Baumol’s disease”.

Regarding the current state of service productivity, most of the literature indicates that China’s service sector productivity is low, as noted by Tan and Zheng (2012) and Chen and Hou (2021). Previous studies have also explored paths for improving service sector productivity. Factors such as service openness (Chen and Wei, 2018; Chen *et al.*, 2022), digital transformation (Peters *et al.*, 2018; Jiang and Luo, 2019; Li *et al.*, 2022), and human capital (Li, 2016), and migration (Ottaviano *et al.*, 2018) all positively influence service TFP. However, few studies have examined the effect of the integration of the two industries on service sector productivity improvement. Du and Hou (2021) indicated that integrating the service and manufacturing sectors can alleviate “Baumol’s disease”. Indeed, alleviating “Baumol’s disease” involves not just enhancing service sector productivity but improving its productivity relative to the manufacturing sector—a topic that has been largely overlooked in current research.

3. Theoretical Analysis and Research Hypotheses

The core of the discussion on how the integration of the service sector can help overcome the “Baumol’s disease” trap is to study its effect on improving the productivity of the service sector in relation to the manufacturing sector. Input from the service sector enhances the productivity of the manufacturing sector, and improving manufacturing productivity fosters reducing service sector costs and fostering innovation, creating a mutually beneficial development model. The effects and mechanisms through which service sector input impacts the manufacturing sector will, in turn, promote increases in relative productivity, as explained below.

3.1. *Impact of Service Sector Input to the Manufacturing Sector Regarding the “Baumol’s Disease” Trap*

The deep integration of the service and manufacturing sectors is crucial for improving service sector productivity. According to the theory of “demand compliance,” the development level of the manufacturing sector—an important demand side for the service sector—directly affects the service sector’s development, particularly regarding market size and growth potential for producer services. As the manufacturing sector expands, the demand for efficient and professional services increases, stimulating continuous innovation and efficiency improvements in the service sector. Additionally, technology spillovers from the manufacturing sector help modernize and intelligently transform the service sector, thereby enhancing productivity. Simultaneously, the value-added portion of the manufacturing sector is gradually shifting to the service sector,

increasing the demand for service intermediate inputs in manufacturing, which promotes the growth of the service sector and the enhancement of service quality, ultimately improving productivity. In summary, this paper proposes the following hypothesis:

Hypothesis 1: The service sector's input to the manufacturing sector can improve the relative productivity of the service sector and help overcome the "Baumol's disease" trap.

3.2. Mechanism by which Service Sector Input to the Manufacturing Sector Overcomes the "Baumol's Disease" Trap

First, consider the competitive effect. Currently, the enhancement of the core competitive advantage of the service sector drives the manufacturing sector to absorb service sector inputs to boost its competitiveness. This enriches the value chain of the manufacturing sector, increases the added value of products and services, and enables it to respond flexibly to market changes and achieve sustainable development. From the perspective of manufacturing production, service sector inputs (such as systems, software, talent, and technological innovation) improve production efficiency and reduce costs. From the sales perspective, the combination of service and product sales enhances overall product competitiveness. However, increased competition in the manufacturing sector also raises the demand for high-quality services, promoting the refinement of labor division, efficiency improvements, and quality optimization within the service sector, intensifying internal competition and fostering innovation and upgrading. In the long run, the service sector's input into the manufacturing sector under this integration intensifies competition in the manufacturing sector, which expands the demand for services and further intensifies competition among service providers. This two-way interaction increases the competitive dynamic between the service and manufacturing sectors, serving as a vital pathway to improve service sector productivity and helping to overcome the "Baumol's disease" trap. In summary, we propose the following hypothesis:

Hypothesis 2a: The input of the service sector to the manufacturing sector enhances the relative productivity of the service sector by improving its competitive dynamics, serving as a crucial mechanism to overcome the "Baumol's disease" trap.

Second is the scale effect. In economics, the scale effect arises from factors such as the application of new inputs, specialized division of labor, and spatial agglomeration. The service sector's contributions to the manufacturing sector can significantly enhance the scale effect, which manifests in several ways. First, it introduces new management concepts, systems, financial capital, human capital, and R&D innovation, thereby improving production efficiency and promoting the scale effect. Second, it generates new manufacturing formats, refines the division of production, and strengthens specialized production. Third, it breaks geographical space segmentation, enabling "cloud agglomeration" of the industrial chain, which forms the scale effect.

Furthermore, as the manufacturing and service sectors interact and share resources, the scale effect in manufacturing also boosts the scale effect in the service sector. Specifically, first, the scale effect in manufacturing drives down costs in the service sector, facilitating large-scale production and eliminating inefficient enterprises. Second, the specialization within the manufacturing sector creates personalized demands for the service sector, enhancing its degree of specialization. Third, the concentration of physical space allows the service sector to provide services to more manufacturing industries, resulting in factor agglomeration. Following integration with the manufacturing sector, the relative scale effect of the service sector increases, ultimately enhancing its productivity compared to the manufacturing sector. In summary, this paper proposes Hypothesis 2b.

Hypothesis 2b: The service sector's input to the manufacturing sector enhances the relative scale effect of the service sector and improves its relative productivity, serving as a crucial mechanism to overcome the trap of "Baumol's disease."

Third is the innovation effect. In chain production modes, innovation requires the full mobilization of resources from all parties to create a synergistic effect. The service sector, as a vital input for the manufacturing sector, enhances its competitiveness and productivity. Simultaneously, the development of the manufacturing sector also fosters innovation in the service sector. First, it generates new demands for the service sector, such as high-end talent, information connectivity, and knowledge spillover, which drive deeper innovation and enhance research and development. Second, it provides application scenarios, experimental spaces, and mediums for transmitting innovation insights, facilitating the exchange of ideas and sparking inspiration through production networks. Third, it offers learning, training, and financial support for service sector innovation, creating more learning opportunities and funding for innovation activities. Innovation is fundamentally essential for improving enterprise productivity, and enhancing the relative innovation effect of the service sector is a key pathway to boosting its relative productivity. In summary, this paper proposes Hypothesis 2c.

Hypothesis 2c: The service sector's input to the manufacturing sector enhances the relative innovation effect of the service sector, leading to improved relative productivity, which is an important mechanism to overcome the trap of "Baumol's disease."

4. Index Measures, Study Design, and Data

4.1. Index Measures

4.1.1. Measurement of the Service Sector's Input to the Manufacturing Sector

The servitization of manufacturing reflects the extent to which service factors are

used in manufacturing production. From the service sector's perspective, this paper quantifies the integration of the two industries by measuring the input of the service sector to the manufacturing sector, using the share of the added value of the service sector's input to the total output of the service sector as the index. This study adopts the value-added trade decomposition method used by Wang *et al.* (2015) for measurement. Based on a multi-country, multi-sector model, the paper introduces value-added decomposition and index calculation. The model assumes a world with M countries, each containing N sectors, with $N1$ manufacturing sectors and $N2$ service sectors. Under free trade, exports encompass both intermediate and final goods. According to the classical input–output model, the total output vector is expressed as

$$X = AX + Y = (I - A)^{-1} Y = BY \quad (1)$$

Here, X is the total output vector, A is the direct input coefficient matrix, and L is the Leontief inverse matrix (or total requirement matrix), while Y represents the final demand vector. Let V denote the value-added rate vector, which equals the ratio of the value-added vector to the output vector. Based on V and the expression in Equation (1), the value added in total output can be expressed as

$$VX = VBY \quad (2)$$

Here, the value-added vector in total output (VX) can be represented as the value-added output induced by final demand. By diagonalizing the value-added rate vector and the final demand vector, we can calculate the value-added in total output for each country and sector. Furthermore, by replacing the final demand vector Y in Equation (2) with the export vector and diagonalizing it, denoting the export matrix as the export matrix E , and diagonalizing vector V , Equation (2) evolves into the following form:

$$VBE = \begin{bmatrix} V^A & 0 & \cdots & 0 \\ 0 & V^B & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & V^M \end{bmatrix} \begin{bmatrix} B^{AA} & B^{AB} & \cdots & B^{AM} \\ B^{BA} & B^{BB} & \cdots & B^{BM} \\ \vdots & \vdots & \ddots & \vdots \\ B^{MA} & B^{MB} & \cdots & B^{MM} \end{bmatrix} \begin{bmatrix} E^A & 0 & \cdots & 0 \\ 0 & E^B & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & E^M \end{bmatrix} \quad (3)$$

According to the above definitions, Equation (3) is a matrix, with each element containing N sectors. Therefore, Equation (3) is a matrix, characterizing the decomposition of value-added in output at the country-sector level across M countries and N industries. The row vectors indicate the destination of value-added, representing forward-linkage-based decomposition of export value-added. They capture how value-

added from a specific “country-sector” is used by its own sector and downstream “country-sectors.” The column vectors, in contrast, reflect the origin of value-added, illustrating backward-linkage-based decomposition of export value-added. The value-added from service sector i in country r input to manufacturing sector j in country m (including the domestic case) can be expressed as $S_va_{ij}^{rm}$:

$$S_va_{ij}^{rm} = v_i^r b_{ij}^{rm} e_j^m \quad (4)$$

Here, i and j denote the service sector and manufacturing sector, respectively, while m and r represent countries.¹ v_i^r represents the direct value-added rate of service sector i in country r , b_{ij}^{rm} denotes the total input coefficient of manufacturing sector j in country m on the output of service sector i in country r , and e_j^m indicates the exports of manufacturing sector j in country m . We define $Sratiol_{ij}^{rm} = S_va_{ij}^{rm} / x_i^r$ as the degree of input from service sector i in country r to manufacturing sector j in country m , where x_i^r represents the total output of service sector i in country r .

Additionally, it is necessary to calculate the input intensity of the Chinese service sector i to manufacturing sector j , without considering the national dimension.² That is,

$$Sva_{ij}^c = \sum_m^M S_va_{ij}^{cm} = \sum_m^M v_i^c b_{ij}^{cm} e_j^m \quad (5)$$

In Equation (5), $m \in M$. This paper uses the ratio of value-added from Chinese service sector i to manufacturing sector j relative to the total output of that service sector in China, denoted as $Sratiol_{ij}^c = Sva_{ij}^c / x_i^c$, as the index for measuring service-to-manufacturing input intensity. Hereafter, this index is termed “Service-to-Manufacturing Input Intensity Level 1.” This measure accounts for the supply of services to the manufacturing sector.

In practice, service sector inputs to the manufacturing sector also depend, to some extent, on manufacturing’s demand for services. Therefore, we will adjust the above-mentioned index of “Service Sector to Manufacturing Input Level 1” by taking the

¹ Since this paper studies the value-added of a country’s service sector used by the manufacturing sector, it includes both the use of the domestic service sector by the domestic manufacturing sector and the use of the domestic service sector by the foreign manufacturing sector; thus, there is a possibility of $m = r$.

² In the empirical analysis of China, this study examines the alignment between the aforementioned indices and tax survey data. Therefore, when calculating China’s “Service-to-Manufacturing Input Intensity Level 1” indicator, the national dimension is excluded. The same approach applies to the subsequent “Service-to-Manufacturing Input Intensity Level 2” measure.

proportion of inputs from service sector i in country r used by manufacturing sector j in country m relative to the manufacturing sector's own output as the correction coefficient. The index that comprehensively considers the input of the service sector to the manufacturing sector and the manufacturing sector's demand for the service sector is constructed, expressed as follows:

$$Sratio2_{ij}^r = \frac{\sum_m^M (S_{-}va_{ij}^{rm} \times \frac{S_{-}va_{ij}^{rm}}{x_j^m})}{x_i^r} \quad (6)$$

In Equation (6), $S_{-}va_{ij}^{rm} / x_j^m$ represents the proportion of inputs from service sector i in country r used by manufacturing sector j in country m relative to the output of manufacturing sector j in country m . This index captures the intensity of the manufacturing sector's demand for service inputs. The construction logic remains consistent with the previous methodology. By replacing r with c in $Sratio2_{ij}^r$, we obtain $Sratio2_{ij}^c$ as an alternative index for measuring the Chinese service sector's input to the manufacturing sector, hereafter referred to as "Service-to-Manufacturing Input Intensity Level 2."

4.1.2. Service Sector Relative Productivity Measurement

The measurement of relative productivity in the service sector relies on enterprise-level TFP estimates. TFP quantifies the contribution of technological progress to output beyond traditional factor inputs, such as capital and labor. This study employs the ACF method to estimate enterprise TFP (see Appendix Table 1 for detailed variables). Building on this foundation, we calculate industry-level TFP for both manufacturing and service sectors and then construct a sectoral relative productivity index using their TFP ratio. Industry TFP is quantified through a weighted aggregation of enterprise-level TFP. Taking service sector i as an example, the index construction methodology is as follows:

$$IndTFP_{it}^c = \sum_k \left(\frac{P_{kit}^c}{P_{it}^c} \times TFP_{kit}^c \right) \quad (7)$$

Here, $IndTFP_{it}^c$ represents the (weighted) TFP of service sector i in China c during year t , where P_{kit}^c and TFP_{kit}^c denote the total output and total factor productivity, respectively, of enterprise k within service sector i in China during year t , and P_{it}^c

indicates the aggregate output of all enterprises in service sector i . This industry-level TFP calculation method better captures enterprise-level heterogeneity, providing a more accurate reflection of overall enterprise TFP characteristics.

Building on the estimated sectoral TFP, we calculate relative productivity by taking the logarithm of the productivity ratio between the two sectors. The relative productivity of service sector i compared to its target manufacturing sector j is given by

$$RTFP_{ijt}^c = \ln \left(IndTFP_{it}^c / IndTFP_{jt}^c \right) \quad (8)^1$$

In Equation (8), $RTFP_{ijt}^c$ represents the relative productivity of service sector i to manufacturing sector j . A higher value of $RTFP_{ijt}^c$ indicates improved productivity of the service sector relative to the manufacturing sector, while a lower value signifies declining relative productivity of services compared to manufacturing.

Additionally, in line with the essence of “Baumol’s disease,” it is important to not only demonstrate the increase in the relative productivity of the service sector but also to clarify changes in wage costs of the service sector relative to the manufacturing sector. To this end, we construct a relative wage cost index of the service sector. We substitute enterprise-level per capita wage (IC_{kit}^c) for TFP_{kit}^c in Equation (7), following the same methodology to calculate the relative wage cost (RIC_{ijt}^c) of Chinese service sector i relative to its input to manufacturing sector j in year t .

4.2. Methodological Model Setting

In this study, the data sample is constructed in the form of “industry pairs” formed by various service sectors and manufacturing sectors in China. The relative productivity of the service sector and its input to the target manufacturing sector is used as the explained and explanatory variable, and the econometric model is constructed as follows:

$$RTFP_{ijt}^c = \alpha_0 + \alpha_1 SR_{ijt}^c + \alpha F_{ijt}^c + v_{ij} + v_t + \varepsilon_{ijt}^c \quad (9)$$

¹ In practice, $\ln \left(IndTFP_{it}^c / IndTFP_{jt}^c \right)$ is mathematically equivalent to $\ln \left(IndTFP_{it}^c \right) - \ln \left(IndTFP_{jt}^c \right)$. However, since the enterprise-level TFP estimates in this study are already in logarithmic form, the relative productivity of service sector i versus manufacturing sector j is computed directly as the difference between the two sectors’ TFP values.

In Equation (9), i , j , and t denote the service sector, manufacturing sector, and time period, respectively. This study focuses on samples across the “time-service-manufacturing” dimension, consistent with prior definitions. $RTFP_{ijt}^c$ represents the relative productivity of Chinese service sector i to its target manufacturing sector j (as previously defined). SR_{ijt}^c captures the input intensity from Chinese service sector i to manufacturing sector j , where $SR_{ijt}^c \in \{Sratio1_{ijt}^c, Sratio2_{ijt}^c\}$. $\mathbf{F}_{ijt}^c$ represents a set of control variables selected for this study, all derived from enterprise-level weighted data. The construction of these control variables follows the same methodology as the relative productivity measures for the service sector described earlier. The underlying enterprise-level data are sourced from administrative tax records. In the equation, the “industry-to-industry” fixed effect (ν_{ij}) and time fixed effect (ν_t) of the service-manufacturing sector, along with robust standard errors, are included. To test Hypothesis 1, the coefficient α_1 is of key concern. If $\alpha_1 > 0$ significantly passes the test, it indicates that, an increase in the level of service sector input to the manufacturing sector leads to a significant increase in the relative productivity of the service sector.

4.3. Data Sources and Data Processing

This study primarily utilizes two databases. The first is the OECD Inter-Country Input-Output (ICIO) database, which provides input-output tables covering 67 countries/regions and 45 sectors (17 manufacturing sectors, 20 service sectors) from 2000 to 2020. The OECD-ICIO database was selected because it contains input-output information among industries in China and many other countries, allowing for a clear measurement of China’s service sector input to the global manufacturing sector over a long and continuous time span. The second database, China’s National Tax Survey Database, covers the period 2007–2016 and is mainly used to measure enterprise-level TFP and industry-weighted productivity. This database includes over 200 indices reflecting enterprise characteristics, with a sample size of more than 310000 enterprises in 2007, over 610000 in 2016, and more than 700000 in subsequent years. We clean the data in the Tax Adjustment Database.¹ We match the OECD-ICIO input-output

¹ The first step is to delete enterprises with negative or missing gross output value, added value of enterprises, main business income, worker remuneration, fixed assets, and number of employees. The second step is to delete enterprises with total assets at the end of the period less than fixed assets. The third step is to delete enterprises established before 1949. For enterprise TFP and control variables, we use methods from the abovementioned research for specific calculations, and we will not repeat them here.

table database with the National Tax Survey database.¹ Additionally, this paper uses the database of listed companies to measure the relative productivity of the service sector, with results presented in the robustness test. The TFP data and control variables of listed companies are sourced from the statistics of the characteristic indices of listed companies in the Guotaian database.

Furthermore, the follow-up study is tested at the cross-country level, using the 2016 edition of the World Input-Output Tables database (2000–2014, 43 countries, 56 sectors) and the Socio-Economic Accounts Database (SEA) to calculate TFP.

5. Analysis of Empirical Results

5.1. Benchmark Regression Results Analysis

Columns (1) and (2) of Table 1 demonstrate that an increase in the level of service sector input to the manufacturing sector significantly enhances the relative productivity of the service sector and narrows the TFP gap between the two industries, thereby verifying Hypothesis 1. In fact, alongside the low productivity of the service sector relative to the manufacturing sector, there exists the issue of higher wage costs in the service sector compared to the manufacturing sector, which contributes to “Baumol’s disease.”

To address this, we use the previously measured relative wage cost of the service sector as an expanded estimate of the explained variable in Equation (9). The results are presented in columns (3) and (4) of Table 1. The findings indicate that as the level of service sector input to the manufacturing sector increases, there is no significant increase in the relative wage cost of the service sector, and it even exhibits a downward trend to some extent. This alleviates the problem of high relative wage costs in the service sector associated with “Baumol’s disease.” According to the results in Table 1, increasing the level of service input to manufacturing can help overcome the “Baumol’s disease” trap in terms of both productivity and wage costs. Since the issue of relative productivity is central to “Baumol’s disease,” and relative wages and prices are fundamentally determined by productivity (Song and Zheng, 2017), the examination of relative productivity will be used in subsequent articles to address the “Baumol’s disease” trap unless otherwise specified.

¹ To match the OECD-ICIO input-output table database with the national tax survey database, the industry serves as the intermediate matching variable. The former database follows the ISIC Rev4 classification method, while the latter uses the national economic industry classification. Therefore, manual matching is necessary to align the two classifications, and the specific matching situation is shown in Table 2 of the online appendix. Note that data for industry 45 in the OECD-ICIO input-output table are missing and will not be considered here.

Table 1. Baseline Regression

Variable	Relative productivity of the service sector		Relative wage costs of the service sector	
	(1)	(2)	(3)	(4)
<i>Sratio1</i>	0.3550** (0.079)		-0.0355 (0.029)	
<i>Szratio2</i>		3.2396*** (0.628)		-0.5697*** (0.209)
Control variables	Yes	Yes	Yes	Yes
“Industry-to-industry” fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Sample size	12381	12381	12381	12381
R ²	0.402	0.403	0.673	0.673

Note: *, ** and *** indicate that the estimated coefficient values are significant at the levels of 10%, 5% and 1%, respectively, and the values in parentheses are standard errors, the same for the table below. If the control variables and fixed effects are not shown in the table below, the two parts are the same as those in Table 1 and will not be repeated.

5.2. Endogeneity Discussion¹

In benchmark regression, we control for sector pairs and time fixed effects while addressing the data dimension mismatch between the core explanatory variable and the explained variable. However, an endogeneity problem persists. To verify the accuracy of the results, we employ two instrumental variable methods to perform two-stage least squares estimation. First, following Liu and Ni (2018)’s study, we use Japan’s service sector input to the manufacturing sector as the instrumental variable for China’s service sector’s input to the manufacturing sector.² The results indicate that the instrumental variable is effective,³ and the service sector’s input to the manufacturing

¹ For the robustness test, heterogeneity test and cross-country examination, please refer to the Appendix on the journal’s website.

² The following considerations inform the selection of this instrumental variable. This paper examines the service sector’s input into the manufacturing sector, including inputs in both domestic and foreign manufacturing. Japan and China are the primary sources of foreign service input in each other’s manufacturing sectors (Liu and Ni 2018). This implies that China’s service sector’s inputs in Japan’s manufacturing sector is correlated with Japan’s service sector’s inputs in its own manufacturing sector, as well as Japan’s service sector inputs in China’s manufacturing sector.

³ Taking column (1) as an example, the p-value of the KP LM statistic is 0.00, which significantly rejects the null hypothesis that the instrumental variable is not identifiable. Furthermore, the KP Wald F statistic exceeds the critical value of 16.38 at the 10% level of the Stock-Yogo weak instrumental variable identification test, rejecting the null hypothesis of a weak instrumental variable and indicating that the instrumental variable is valid.

sector significantly enhances the relative productivity of the service sector. Second, referring to Fallah *et al.* (2021)'s study, the Bartik IV method is used to construct instrumental variables, and the estimation results further support the reliability of the baseline regression.

Table 2. Endogeneity Test

Variable	Japan's service sector input to manufacturing sector IV		Bartik IV	
	(1)	(2)	(3)	(4)
<i>Sratio1</i>	0.5763*** (0.127)		0.3015*** (0.083)	
<i>Szratio2</i>		4.6756*** (1.345)		3.2839*** (0.618)
Sample size	12381	12381	12381	12381
R ²	0.139	0.140	0.140	0.140
Kleibergen-Paap rk	790.592	96.626	13347.00	1795.404
Wald F Statistics	{16.38}	{16.38}	{16.38}	{16.38}
Kleibergen-Paap rk	511.965	118.089	370.228	53.171
LM Statistics	[0.0000]	[0.0000]	[0.0000]	[0.0000]

Note: The p-value in [] in Table 2 and the F-statistic in { } are the cut-off values at the 10% level of the Stock-Yogo weak identification test.

6. Influence Mechanism Test

After examining that service sector input to the manufacturing sector can increase the relative productivity of the service sector and mitigate the trap of “Baumol’s disease,” this paper investigates the mechanisms underlying this effect and test all inferences related to Hypothesis 2.

6.1. Mechanism Test Model

This paper examines the mechanism by which service sector input to the manufacturing sector improves the relative productivity of the service sector from three perspectives: the relative competition effect, relative scale effect, and relative innovation effect. The econometric model is constructed using a step-by-step

regression method as follows:

$$Channel_{ijt}^c = \beta_0 + \beta_1 SR_{ijt}^c + \beta F_{ijt}^c + \tau_{ij} + \tau_t + \varepsilon_{ijt}^c \quad (10)$$

$$RTFP_{ijt}^c = \gamma_0 + \gamma_1 Channel_{ijt}^c + \gamma F_{ijt}^c + \omega_{ij} + \omega_t + \varepsilon_{ijt}^c \quad (11)$$

In Equations (10) and (11), the variables i, j, t , and c retain their previous meanings. $Channel_{ijt}^c$ are the three mechanism variables studied in this paper,¹ and the control variables and fixed effect selection remain consistent with benchmark regression. The economic significance of Equation (10) lies in testing the influence of service sector input to the manufacturing sector on the mechanism variables. The economic significance of Equation (11) is to examine the impact of mechanism variables on the relative productivity of the service sector.

6.2. Testing the Mechanism of Competitive Effect

Drawing on Choi's (2023) study, this paper uses the Herfindahl-Hirschman index² to measure the level of competition within the industry. A value closer to 1 suggests stronger monopoly and lower competition. We quantify the relative competitive effects of the service sector by defining the relative competitive effect of service sector i on its input target manufacturing sector j as $RCE_{ijt}^c = HHI_i^c - HHI_{jt}^c$, where RCE_{ijt}^c represents the relative competitive effect of the service sector, measuring the degree of competition of the service sector relative to the input target manufacturing sector. A smaller RCE_{ijt}^c indicates a stronger relative competitive effect of the service sector. The test results are presented in Table 3, columns (1) and (2). The increase in input from the service sector to the manufacturing sector promotes the enhancement of the relative competitive effect of the service sector (Column 1), and the greater the relative competition of the service sector compared to the manufacturing sector, the greater the effect on improving the relative productivity of the service sector (Column 2). Therefore, the relative competitive effect of the service sector constitutes an important mechanism

¹ Among them, $Channel_{ijt}^c$ includes the relative competition effect (RCE_{ijt}^c), relative scale effect (RSE_{ijt}^c), and relative innovation effect ($RINV_{ijt}^c$).

² The calculation formula for the Herfindahl index of industry i is $HHI_i = \sum_k \left(\frac{Asset_{ki}}{Asset_i} \right)^2$, where

$Asset_{ki}$ and $Asset_i$ represent the total assets at the end of the period for enterprise k in industry i and the total assets at the end of the period for all enterprises in industry i , respectively.

through which service sector input to the manufacturing sector promotes improvements in relative productivity.

6.3. Testing the Mechanism of Scale Effects

To measure the scale effect at the sector level, we use the proportion of enterprise output as a weight to aggregate the enterprise scale to the sector level (SE_{it}^c)¹. Next, we calculate the relative scale effect of the service sector to its input target manufacturing sector, RSE_{ijt}^c , where $RSE_{ijt}^c = \ln(SE_{it}^c / SE_{jt}^c)$.² RSE_{ijt}^c measures the scale effect of service sector i relative to the input target manufacturing sector j . A larger RSE_{ijt}^c indicates a greater relative scale effect of the service sector. Table 3, columns (3) and (4), show that inputs from the service sector can enhance the relative scale effect (column 3), and that this relative scale effect positively impacts the improvement in the relative productivity of the service sector (column 4). Therefore, the relative scale effect of the service sector is an important mechanism for enhancing its relative productivity.

6.4. Testing the Mechanism of Innovation Effect

Based on the measurement methods for scale effects, the adjusted basic index is the logarithm of the enterprise's R&D expenses. This index is used to calculate the innovation indices for both the service sector and the input target manufacturing sector, further measuring the relative innovation effect of the service sector. The specific measurement process aligns with the previously mentioned competitive effects and will not be reiterated here. Table 3, columns (5) and (6), show that inputs from the service sector can enhance its relative innovation effects (column 5) and that these relative innovation effects positively impact the relative productivity of the service sector (column 6). Therefore, the relative innovation effects of the service sector are a crucial mechanism for enhancing its relative productivity.

¹ The calculation formula for the scale effect at the industry level is $SE_{it}^c = \sum_k \left(\frac{P_{kit}^c}{P_{it}^c} \times Scale_{kit}^c \right)$, where

P_{kit}^c and P_{it}^c are consistent with the previous text, representing the total output value of enterprise k in industry i and that of all enterprises in industry i , respectively. $Scale_{kit}^c$ indicates the operating income of enterprise k at time t .

² In fact, consistent with the previous estimation of the competitive effect, this calculation essentially uses the "log value of the scale effect of the service industry" minus the "log value of the scale effect of the input targeted manufacturing industry" to calculate the difference.

Table 3. Mechanism Effects

Variable	Competition Effect Mechanism		Scale Effect Mechanism		Innovation Effect Mechanism	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Sratio1</i>	−0.0140*** (0.004)		0.1197** (0.057)		0.3925*** (0.068)	
<i>RCE</i>		−0.2379* (0.135)				
<i>RSE</i>				0.3741*** (0.015)		
<i>RINV</i>						0.0426*** (0.012)
Sample size	12381	12381	12381	12381	12381	12381
R ²	0.533	0.401	0.877	0.442	0.644	0.402

7. Conclusions and Policy Implications

This paper examines the impact of the service sector's input to manufacturing on the relative productivity of the service sector and its mechanisms, demonstrating a pathway to overcome the “Baumol's disease” trap. The main conclusions are as follows. (1) The input of the Chinese service sector to the manufacturing sector can enhance the relative productivity of the service sector and reduce relative wage costs, which is key to overcoming the “Baumol's disease” trap. (2) Input from the service sector to high-tech manufacturing and the manufacturing of developed countries, as well as the input of producer services to the manufacturing sector, has a more significant effect on improving the relative productivity of the service sector. (3) An increase in the service sector's input to the manufacturing sector enhances the relative productivity of the service sector by promoting competition, expanding scales, and driving innovation. (4) Cross-national data also confirm that the service sector's input to the manufacturing sector can enhance the relative productivity of the service sector, revealing global patterns to overcome “Baumol's disease.”

Based on this study, the following policy insights are proposed to enhance the relative productivity of the service sector and overcome the “Baumol's disease” trap. First, improve the level of integration between the service manufacturing sectors. Strengthen this integration, especially the service sector's input to manufacturing, explore new business models under the application of new technologies, such as the industrial internet, and promote the integration of raw materials, consumer goods, the internet, and modern logistics industries. Second, guide the integration of producer

services with the high-end manufacturing sector. Encourage producer services to input into high-tech manufacturing and manufacturing in developed countries, providing support in terms of policies, land, finance, and taxation while promoting international exchanges in services to enhance the global competitiveness of China's service sector. Finally, balance the development of the service and manufacturing sectors. While improving the productivity of the service sector and paying attention to "Baumol's disease," countries should also avoid prematurely reducing the proportion of the manufacturing sector, maintain a stable share of manufacturing, and reshape industrial competitive advantage through digital transformation.

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