**Asian Journal of Empirical Research**
Volume 14, Issue 3 (2024): 52-59.

http://www.aessweb.com/journals/5004

# Spatial spillover effect of service industry agglomeration on industrial structure upgrading: Evidence from China

**Le Xiao Bing**[a,b]
**Sarma Binti Aralas**[c] †

[a]Faculty of Business, Economics and Accountancy, Universiti Malaysia Sabah Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia.
[b]School of Management, Academy of Science, Wuzhou University, Wuzhou 543002, Guangxi, China.
[c]Faculty of Business, Economics and Accountancy, Universiti Malaysia Sabah, Centre for Economic Development and Policy, Universiti Malaysia Sabah Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia.

† ✉ miasarma@ums.edu.my (Corresponding author)

## Article History
**Received:** 9 May 2024
**Revised:** 12 July 2024
**Accepted:** 23 July 2024
**Published:** 5 August 2024

## Keywords
Industrial structure
Service industry
Spatial Durbin model
Spillover effect
Spatial weight matrix
Chinese economy.

## ABSTRACT
The industrial structure upgrading is a significant indicator in the High-quality economic development. Despite the crucial role that the cluster of service sectors play in improving the industrial system, the research on the impact of service industry agglomeration on industrial structure upgrading is scant, especially the spatial correlation between them. This paper aims to discuss this objective. The current study employs the Spatial Durbin Model to examine the association between service industry gathering and the advancement of industrial systems based on the panel data of Chinese provincial units for the years 2000 to 2020. Findings from the empirical analysis disclose that the concentration of service-related activities in the same province plays a notable role in the optimization of the industrial framework. Moreover, service industry agglomeration demonstrates a noteworthy spatial spillover effect. The gathering of the service industry breaks through geographical constraints and facilitates the enhancement of industrial framework in adjacent regions through radiation effect. Subsequently, the enhancement of the industrial framework in neighboring areas further stimulates the local industrial configuration through spill-over impacts. This research provides a theoretical framework for analyzing the spatial correlation between the service industry group and the enhancement of the industrial framework, and presents practical reference for local authorities to foster the transformation of industrial structure.

**Contribution/Originality:** The study constructs the Spatial Durbin Model, and uses method of the Maximum Likelihood Estimation to analyze the data. The paper is original and contributes to the discussion of the role of service industry agglomeration in promoting the industrial structure upgrading in China.

DOI: 10.55493/5004.v14i3.5136
ISSN(P): 2306-983X/ ISSN(E): 2224-4425

**How to cite:** Bing, L. X., & Aralas, S. B. (2024). Spatial spillover effect of service industry agglomeration on industrial structure upgrading: Evidence from China. *Asian Journal of Empirical Research, 14*(3), 52–59. 10.55493/5004.v14i3.5136



## 1. BACKGROUND

As the Chinese economy transitions from the phase of industrialization to that of post-industrialization, there has been a corresponding shift in the role of the service sector in fostering economic growth, evolving from a mere lubricant to a propellant (Zhang et al., 2014). The experience of industrialized nations in Europe and the United States post-Second World War demonstrates a pattern where the service sector has been positioned as the driving force of growth in the development of the manufacturing sector. Bryson (1997) highlights that starting from the 1980s, the service sector in developed Western nations has emerged as the primary promoter of industrial advancements and economic progress. Various industrialization strategies, including the Re-industrialization of the United States, Industry 4.0 of Germany, and Made in China 2025, have recognized the service industry as a key driver for enhancing the industrial structure and fostering economic innovation and growth. Moreover, the spatial distribution of the service industry exhibits distinct agglomeration characteristics, as seen in examples such as Silicon Valley in the United States for electronic information, the financial industry hub in London, the electronic technology cluster in Beijing's Zhongguancun area, and the financial services cluster in Shanghai's Lujiazui district. In China, there is a growing emphasis from the government on establishing service industry clusters to mitigate environmental and resource constraints, optimize regional industrial frameworks, and ultimately achieve high-quality economic development (Chen & Tang, 2018).

Data from the National Bureau of Statistics of China disclose that the service sector value-added accounted for 46.1% of the Gross Domestic Product (GDP) in 2023, surpassing the value-added of the secondary industry for the first time in China. In 2021, it accounted for 53.3% of the GDP and contributed 54.9% to economic growth. Nonetheless, due to the vast disparities in regional economic development and business environment in China, the service sector tends to be concentrated in a few locations. The ratio of service sector value-added to GDP in Beijing ranked first with 81.7%, followed by Shanghai with 73.3%. The tertiary industry value-added in Inner Mongolia, which ranks bottom, accounts for only 43.5% of the GDP.

Existing evidence states that the influence of service industry gathering on industrial transformation is significant (Sun, Wang, & Li, 2020; Yu, Li, & Zhu, 2020). First, Clusters may help most small service businesses reach external economies of size, which enlarge the market demand and scale. Moreover, it also imposes more demands on the industrial division, which makes industries to be subdivided further. Enterprises in the agglomeration area focus more on production efficiency and promote the overflow of professional knowledge and technological innovation of enterprises, which supports the advancement of industrial structure. Second, With the increase in the number and size of enterprises, the homogeneous competition in the agglomeration area is also becoming increasingly intense. It will force enterprises to continuously raise the standard of service and update production technology, which is conducive to industrial system upgrading. Third, during the process of service sector agglomeration, firms penetrate and communicate with each other, which enhances the accumulation among enterprises and promotes the establishment of an information network in the agglomeration region. It contributes to developing new knowledge and ideas, increases the distribution and diffusion of knowledge in the region, and encourages technological innovation in the metropolitan area. The advancement of the technological innovation capacity may promote technological upgrading, and facilitate the gradual transfer of industries from low value-added and low technology to high value-added and high technology.

However, influenced by the city's resource endowment, industrial policy, and development orientation, it is difficult to fully integrate the manufacturing industry with its productive services (Luo, Zhu, Zhang, & Chen, 2022) necessitating that manufacturing firms seek services from neighboring regions. Manufacturing enterprises in a region may need to rely on the productive service industry in neighboring regions to meet their intermediate service demands, and the productive services within the region may also benefit neighboring regions. For example, when population, resources, and the environment in major cities reach their limit, local capital, talents, and industries will spill over to neighboring cities in search of new development space. Additionally, due to the limited market size of service targets, it is difficult for service-oriented enterprises to support their operating costs in one region. To gain more market share and profits, they often explore the market and seek cooperation with manufacturing enterprises located further away, thus generating spillover effects (Hu, 2021). Consequently, this study concludes that the service industry group has a positive spatial spillover effect.

This work contributes to the existing knowledge in two ways. First, we measure the level of service industry agglomeration in each province in mainland China using the location entropy index and analyze the spatial characteristics. Second, we construct a neighborhood spatial weight matrix and a geospatial weight matrix to explore the influence of service industry clustering on the optimization of industrial systems using the Spatial Durbin Model.

The remaining of this research is as follows. Section two reviews the literature related to this work. Section three details the methodology, including the interested variables, data sources, and econometric model. Section four presents the research findings, and it ends with conclusions in section five.

## 2. LITERATURE REVIEW

The clustering of the service industry has been the focus of attention in academic circles. Based on the urban panel data and a spatial econometric model empirical test, Zeng and Han (2019) stated that the productive service sector substantially enhances the quality of local economic development but limits the economic growth rate in nearby regions. Liu (2021) found that the productive service industry has considerable agglomeration features in its spatial distribution and substantially impacts manufacturing exports' upgrading. Zhou and Wang (2018) took the Beijing-Tianjin-Hebei region as an example. They concluded that the gathering of the service industry considerably influences the short-term promotion of economic growth but does not affect the long-term advancement of economic growth. The study by Yang and Chen (2016) suggested that the specialized aggregation of the service industry is positively connected to urbanization quality, whereas the diverse agglomeration is negatively related to urbanization quality. Wang and Li (2020) believed that the accumulation of productive services affects not only the local urban innovativeness but also the urban innovativeness of the adjacent regions. Han (2021) discovered that service industry aggregation has a substantial spatial spillover effect on the environment. Guo and Huang (2021) found that service industry agglomeration can successfully increase the quality of economic development using panel data from 82 nations.

Additionally, findings from some studies suggested that service sector collection benefits industrial system upgrading. Hui and Zhou (2016) used inter-provincial data to establish the favourable effect of productive service industry gathering on industrial structure improvement in China, which is more robust in the eastern and central than in the western. Wen (2020) concluded that the information service industry accumulation has the most significant effect on industrial constitution advancement, followed by logistics, finance, scientific and technological services, and business services agglomeration in descending order. Lin and Cao (2020) discovered that the aggregation of productive services significantly promoted the industrial construction progression of local and neighbouring regions. Yao (2020) stated that the assembly of the science and technology service industry positively promotes industrial structure heightening through labour productivity, and the aggregation of the science and technology service industry in eastern and western regions can promote industrial design boosting through the economic development level.

Some studies have argued that the role of service agglomeration in promoting industrial structure upgrading can only be realized under certain conditions. For instance, Yu (2019) found that the role of service industry agglomeration in promoting the upgrading of the industrial structure becomes apparent only when the city reaches a certain scale. Using inter-provincial panel data from China, Lin and Cao (2019) demonstrated that there is a threshold of innovation level for the industrial system advancement effect of productive service sector aggregation and that the industrial structure can only be optimized when the innovation level of productive service industry exceeds the threshold.

Existing literature encompasses numerous studies on this topic. However, few studies investigate the relationship from the perspective of space. This study seeks to identify the spatial spillover effect of service industry agglomeration by incorporating spatial analysis techniques.

## 3. METHODOLOGY

### *3.1. Research Variables*

This section provides details of the related variables and the methods of measurement, including dependent variable, independent variable, and control variables.

#### *3.1.1. Industrial Structure Upgrading*

According to SWang, Zhou, and Zhong (2020) we measure industrial structure upgrading by comparing the value of tertiary industry added to the value of secondary industry added. The equation is as follows:

$$ISU = Y_3/Y_2 \quad (1)$$

Where $ISU$ is the level of industrial structure optimization. $Y_3$ and $Y_2$ are the output values of tertiary and secondary industries, respectively.

#### *3.1.2. Service Industry Agglomeration*

Following the research from Song, Liao, and Wang (2019) and Yang, Qin, and Chen (2021) we calculate the level of service industry agglomeration by location entropy index. The equation is as follows:

$$SS_i = (q_i/q)/(gdp_i/gdp) \quad (2)$$

Where $i$ is the province. $q_i$ and $q$ represent the output added by the tertiary industry in each province and the whole of China, respectively. $gdp_i$ and $gdp$ represent the gross domestic product in each province and the whole of China, respectively. $SS$ is the agglomeration level of the service sector. If $SS > 1$, the advantage of service industry agglomeration is more pronounced compared to the national level. Table 1 presents the mean value and ranking of the service industry agglomeration levels for each province from 2000 to 2020. Based on the data in Table 1, we draw the distribution of service industry gathering. Only a few provinces exhibit significant agglomeration advantages ($SS > 1$, red color in Figure 1).

**Table 1.** Average and ranking of service industry agglomeration, 2000-2020.

| Province | Mean | Ranking | Province | Mean | Ranking | Province | Mean | Ranking |
|---|---|---|---|---|---|---|---|---|
| Beijing | 1.6792 | 1 | Yunnan | 0.9820 | 12 | Jiangsu | 0.9161 | 23 |
| Shanghai | 1.3111 | 2 | Gansu | 0.9813 | 13 | Shaanxi | 0.9086 | 24 |
| Tibet | 1.2186 | 3 | Hunan | 0.9721 | 14 | Fujian | 0.9062 | 25 |
| Tianjin | 1.1304 | 4 | Zhejiang | 0.9705 | 15 | Shanxi | 0.8971 | 26 |
| Qinghai | 1.1146 | 5 | Guizhou | 0.9673 | 16 | Hebei | 0.8964 | 27 |
| Hainan | 1.0513 | 6 | Anhui | 0.9641 | 17 | Shandong | 0.8739 | 28 |
| Guangdong | 1.0443 | 7 | Liaoning | 0.9519 | 18 | Jiangxi | 0.8423 | 29 |
| Jinlin | 1.0103 | 8 | Guangxi | 0.9457 | 19 | Henan | 0.7956 | 30 |
| Chongqing | 1.0101 | 9 | Hubei | 0.9432 | 20 | Heilongjiang | 0.7890 | 31 |
| Neimenggu | 0.9874 | 10 | Xinjiang | 0.9243 | 21 | | | |
| Ningxia | 0.9869 | 11 | Sichuan | 0.9240 | 22 | | | |

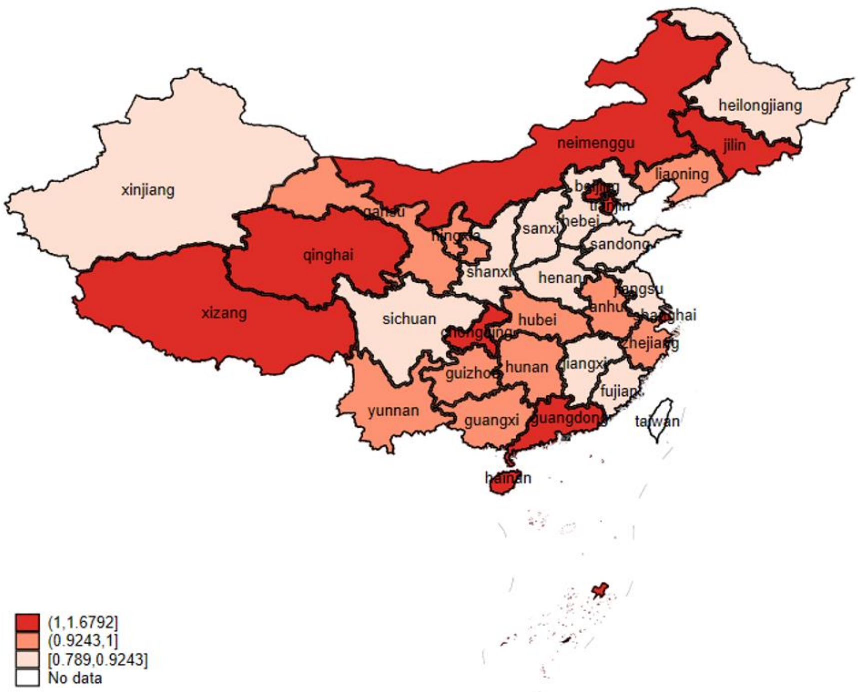


**Figure 1.** The distribution of service industry gathering.

### *3.1.3. Control Variables*

According to the research from Hao, Ren, and Liu (2021); Zhang and Huang (2021) and Wang and Wu (2022) we utilize four indicators as control variables, encompassing urbanization (quantified by the percentage of the urban populace within the overall population), fiscal expenditure (evaluated by the ratio of fiscal spending to GDP), foreign direct investment (assessed by the proportion of foreign direct investment to GDP), and infrastructure development (measured by the ratio of highway length to land area).

**Table 2.** Descriptive statistics.

| Variables | Code | Observations | Minimum | Mean | p50 | Maximum | Std. |
|---|---|---|---|---|---|---|---|
| Industrial structure upgrading | ISU | 651 | 0.518 | 1.191 | 1.038 | 5.297 | 0.623 |
| Service sector agglomeration | SS | 651 | 0.695 | 0.997 | 0.965 | 1.812 | 0.176 |
| Urbanization | URB | 651 | 0.195 | 0.512 | 0.505 | 0.938 | 0.160 |
| Fiscal expenditure | FIS | 651 | 0.069 | 0.243 | 0.201 | 1.354 | 0.183 |
| Foreign direct investment | FDI | 651 | 0.000 | 0.022 | 0.017 | 0.163 | 0.022 |
| Infrastructure | INF | 651 | 0.018 | 0.721 | 0.624 | 2.205 | 0.495 |

**Note:** p50 is the median. Std. is the standard deviation.

### *3.2. Data Collection*

This current study selects 31 provincial units in mainland China for the years 2000 to 2020 as the sample. Data are obtained from the China Statistical Yearbook (2001-2021). Table 2 presents descriptive statistics for the related variables. The sample size is 651. The mean value of variables does not deviate significantly from the median, indicating that the distribution of observations is relatively uniform.

### *3.3. Econometric Model*

To explore the relationship between variables, we construct the following baseline model.

$$ISU_{i,t} = \alpha_0 + \alpha_1 SS_{i,t} + \alpha_2 X_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where $i$ is the province. $t$ is the time dimension. $ISU$ is the industrial structure upgrading. $\alpha_0$ is intercept term. $SS$ is service industry agglomeration. $X$ is the control variable, and $\varepsilon_{i,t}$ is a random disturbance term.

To examine the spatial spillover effect of the service industry cluster, we introduce the spatial factor and build the econometric model, as depicted in Equation 4.

$$ISU_{it} = \rho \sum_{j=1}^{n} W_{ij} ISU_{it} + \beta \sum_{j=1}^{n} W_{ij} SS_{it} + \delta SS_{it} + \mu \sum_{j=1}^{n} W_{ij} X_{it} + \theta X_{it} + \varepsilon_{it} \quad (4)$$

Where $\rho$ is the Spatial autocorrelation coefficient. $\varepsilon_{it}$ is the random disturbance term. $W_{ij}$ is the spatial weight matrix. This study establishes adjacent spatial weight matrix (*W1*) and second-order inverse distance spatial weight matrix (*W2*, *W3*) by Equations 5, 6, 7, and 8.

$$W_{ij} = \begin{cases} 1, & \text{If province } i \text{ is adjacent to province } j \\ 0, & \text{Others} \end{cases} \quad (5)$$

$$W_{ij} = \begin{cases} \frac{1}{d_{ij}^2}, & i \neq j \\ 0, & i = j \end{cases} \quad (6)$$

$$W_{ij} = \begin{cases} \frac{1}{c_{ij}^2}, & i \neq j \\ 0, & i = j \end{cases} \quad (7)$$

$$W = \begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1n} \\ w_{21} & w_{22} & \cdots & w_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ w_{n1} & w_{n2} & \cdots & w_{nn} \end{bmatrix} \quad (8)$$

Where $d_{ij}$ represents the straight-line distance between provincial capitals. $c_{ij}$ represents the geographic distance between provinces, calculated by the longitude and latitude of each provincial capital.

## 4. RESULTS

To determine the appropriate spatial econometric model, we first conduct the Lagrange Multiplier (LM), Wald, and Hausman tests. The results are presented in Table 3. According to the outcomes of LM and Wald tests, the null hypothesis of degradation to the Spatial Error Model (SEM) or Spatial Lag Model (SLM) is rejected at the 1% level. The results of the Hausman test indicated that fixed effects are preferred over random effects. Therefore, we use the Spatial Durbin Model (SDM) with fixed effects for further analysis.

**Table 3.** The tests of LM, Wald, and Hausman.

| Test type | Statistics | p-value |
|---|---|---|
| LM-SEM | 179.707 | 0.000 |
| Robust LM-SEM | 154.166 | 0.000 |
| LM-SLM | 33.065 | 0.000 |
| Robust LM-SLM | 7.524 | 0.006 |
| Wald-SEM | 115.710 | 0.000 |
| Wald-SLM | 115.590 | 0.000 |
| Hausman | 33.040 | 0.000 |

Due to the probably endogenous problem in the spatial econometric model, the regression results may be ineffective by ordinary least squares (OLS) (Anselin, 2013). Following the research from Elhorst (2003), we employ Maximum Likelihood Estimation. The outcomes are displayed in Table 4.

**Table 4.** The results of regression.

| Variables | Column (1) FE | Column (2) SDM(W1) | Column (3) SDM(W2) | Column (4) SDM(W3) |
|---|---|---|---|---|
| SS | 2.154*** (0.625) | 2.018*** (0.117) | 1.946*** (0.112) | 2.052*** (0.114) |
| URB | 1.194* (0.684) | -2.647*** (0.263) | -2.953*** (0.264) | -3.166*** (0.302) |
| FIS | 0.175 (0.504) | -0.956*** (0.153) | -1.166*** (0.164) | -1.096*** (0.155) |
| FDI | -4.353*** (1.075) | -0.254 (0.584) | -0.523 (0.569) | -0.494 (0.572) |
| INF | 0.175 (0.199) | 0.112 (0.071) | 0.092* (0.050) | 0.076 (0.051) |
| Constant | -1.640** (0.733) | - | - | - |
| $\rho$ | - | 0.375*** (0.045) | 0.364*** (0.047) | 0.340*** (0.046) |
| Observations | 651 | 651 | 651 | 651 |
| $R^2$ | 0.381 | 0.662 | 0.691 | 0.693 |

**Note:** Standard errors are in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. Dependent variable is ISU. Column (1) presents the results of the baseline model. Column (2), Column (3), and Column (4) present the reports of SDM under *W1*, *W2*, and *W3*, respectively.

In Column (1), the coefficient for service industry agglomeration is 2.154 (p=0.000), which is significantly positive at the 1% level, and the findings from the reports of SDM are consistent ($\beta_1 = 2.018, p_1 = 0.000$; $\beta_2 = 1.946$, $p_2 = 0.000$; $\beta_3 = 2.052$; $p_3 = 0.000$). Both traditional econometric models and spatial econometric models show that service industry gathering optimizes the industrial structure. The $R^2$ is 0.386 in column (1), while in SDM, there is a significant improvement in $R^2$ (0.662, 0.691, 0.693). Meanwhile, the spatial autocorrelation coefficients are significantly positive at the 1% level ($\rho_1 = 0.375, p_1 = 0.000$; $\rho_2 = 0.364, p_2 = 0.000$; $\rho_3 = 0.340, p_3 = 0.000$). This suggests that it is more effective to use a model that includes spatial factors to capture the effect.

Since the SDM model cannot accurately capture the correlation between variables, according to LeSage and Pace (2009) we decompose the spillover effect into Direct Effect (DE) and Indirect Effect (IE) using the SDM partial differentiation method. The DE reflects the influence of service industry clustering on the enhancement of industrial framework within the same region as well as the feedback effect from foreign regions, while the IE captures the influence of service industry gathering from neighboring regions, as shown in Figure 2.

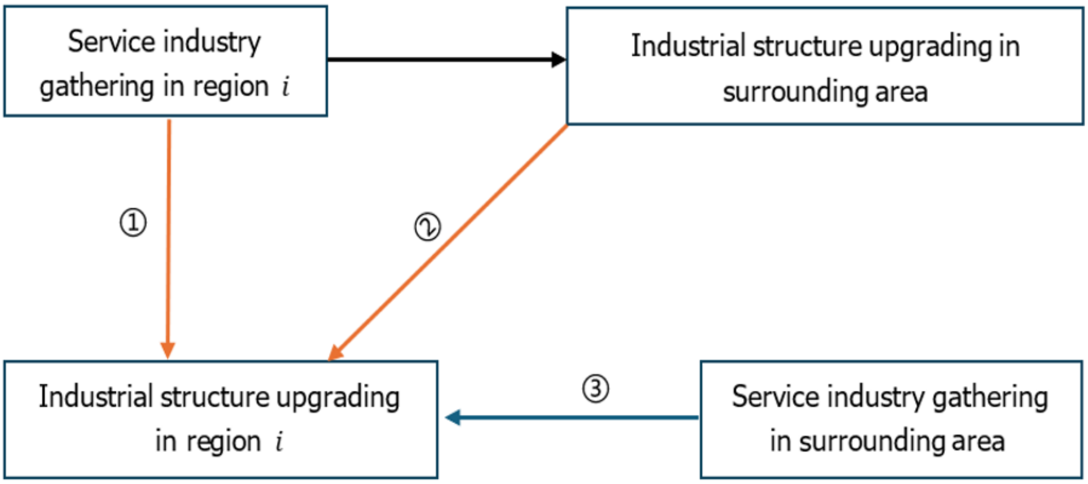


**Figure 2.** Direct effect and indirect effect.

**Note:** The feedback effect is represented by ②. The direct effect is the sum of ① and ②, and the indirect effect is represented by ③.

The outcomes of the decomposition impacts are illustrated in Table 5. In the DE, the coefficients of SS are 2.158 (p=0.000), 2.035 (p=0.000), and 2.094 (p=0.000) under *W1*, *W2, and W3* with statistical significance at the 1% level, indicating that, in the same province, service agglomeration promote the industrial structure upgrading. In the IE, the coefficients of SS are 1.999 (p=0.000), 2.316 (p=0.000), and 0.940 (p=0.028) with statistical significance at the 1% level under *W1* and *W2* while at the 5% level under *W3*, indicating that the service industry agglomeration in neighboring areas has a positive promoting role on the upgrading of local industrial structure through the radiation effect.

**Table 5.** decomposition results of spatial spillover effect.

| Variables | W1 | | W2 | | W3 | |
|---|---|---|---|---|---|---|
| | DE | IE | DE | IE | DE | IE |
| SS | 2.158*** | 1.999*** | 2.035*** | 2.316*** | 2.094*** | 0.940** |
| URB | -2.326*** | 4.890*** | -2.801*** | 4.405*** | -2.980*** | 4.888*** |
| FIS | -0.854*** | 1.267*** | -1.054*** | 2.624*** | -1.026*** | 1.366*** |
| FDI | -1.146** | -13.060*** | -1.210** | -18.540*** | -1.356** | -21.090*** |
| INF | 0.096 | -0.248** | 0.083* | -0.252** | 0.068 | -0.213** |

**Note:** *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable is ISU.

## 5. CONCLUSIONS AND DISCUSSIONS

This research explores the correlation between service industry accumulation and the optimization of the industrial framework, utilizing the SDM with panel data encompassing 31 provinces in mainland China spanning from 2000 to 2020. The analysis reveals that the concentration of the service industry notably facilitates the improvement of industrial structure, aligning with the discoveries from Xu and Wang (2022). Being a sector reliant on technology and knowledge, the service industry supplies human and intellectual capital essential for the production of the manufacturing sector (Li, 2020) thus serving as a crucial pillar for the transformation and advancement of industries (Yu, 2019).

Furthermore, it has been observed that the influence of service industry agglomeration on the enhancement of industrial structure exhibits spatial spillover effects. The concentration of service industries breaks through spatial constraints, resulting in inter-regional flows and arrangements that facilitate the advancement of industrial structures in nearby areas (Sun & Li, 2012). The enhancement of the industrial structure in neighboring regions consequently stimulates the improvement of the local industrial structure through spillover effects. Additionally, the aggregation of service industries in neighboring areas is significant in advancing the local industrial structure. The escalation in service industry concentration in adjacent provinces generates a diffusion impact, triggering the transfer of knowledge and capital, thereby fostering the progression of the local industrial structure. Findings from the analysis suggest that the concentration of service industries not only offers assistance to the local industrial framework but also exerts a spillover impact on the surrounding regions.

This investigation furnishes a theoretical framework for examining the correlation between service industry clustering and the enhancement of industrial composition. Moreover, it delivers practical instructions for local authorities to foster the evolution of industrial composition. Nonetheless, this study encounters certain constraints. Initially, owing to data availability, solely the data from Chinese provinces was contemplated. The outcomes derived from cities at the prefecture level might be more precise due to their extensive sample size. In future research, we will try to utilize statistics from cities at the prefecture level to refine the empirical assessment of this study. Secondly, we only establish the neighborhood weight matrix and the geographic weight matrix in the empirical analysis. Due to technological constraints, certain crucial spatial weight matrices, like the economic weight matrix, are disregarded.

**Funding:** This research is supported by the National Social Science Foundation of China (Grant number: 21BJL072), the Philosophy and Social Science Planning Research Project of Guangxi (Grant number: 22FJY040), the Scientific Research Project of Wuzhou University (Grant number: 2023B010), the Young and Middle-aged Teacher's Basic Ability Improvement Project of University in Guangxi (Grant number: 2023KY0693).
**Institutional Review Board Statement:** Not applicable.
**Transparency:** The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
**Competing Interests:** The authors declare that they have no competing interests.
**Authors' Contributions:** All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

## REFERENCES

Anselin, L. (2013). Spatial econometrics: Methods and models. In (pp. 32-36). New York: Springer Science & Business Media.

Bryson, J. R. (1997). Business service firms, service space and the management of change. *Entrepreneurship & Regional Development, 9*(2), 93-112.

Chen, Y., & Tang, X. (2018). Impact of service industry agglomeration on urban green productivity. *Urban Issues, 37*(11), 49-56+64.

Elhorst, J. P. (2003). Specification and estimation of spatial panel data models. *International Regional Science Review, 26*(3), 244-268.

Guo, W., & Huang, F. (2021). Industrial agglomeration and the quality of economic growth - an empirical analysis based on panel data from 82 countries and regions around the world. *Economic Theory and Economic Management, 41*(01), 37-51.

Han, F. (2021). Agglomeration of productive service industry and upgrading of urban environmental quality: A study based on the regulatory effect of land market. *Statistical Research, 38*(5), 42-55.

Hao, H., Ren, D., & Liu, M. (2021). Does service agglomeration promote population diffusion in central cities? *Macroeconomic Research, 43*(04), 94-112.

Hu, X. (2021). The 'double-edged sword' effect of resource diversity in alliance combinations - mediated by product market power. *Journal of Finance and Economics, 37*(04), 83-93.

Hui, N., & Zhou, X. (2016). Clustering and industrial structure upgrading of sub-productive service industries - an empirical analysis from provincial economic data. *Journal of Northwest University (Philosophy and Social Science Edition), 46*(04), 94-99.

LeSage, J., & Pace, R. K. (2009). *Introduction to spatial econometrics*. New York: Chapman and Hall/CRC. https://doi.org/10.1201/9781420064254.

Li, J. H. (2020). Structure, layout, and prospects of China's productive service industry. *Southeast Academic, 33*(05), 93-103+246.

Lin, X., & Cao, Z. (2019). Nonlinear characteristics of the impact of spatial agglomeration of productive service industries on industrial structure upgrading - an empirical study based on chinese provincial panel data. *Exploration of Economic Issues, 40*(06), 128-134.

Lin, X., & Cao, Z. (2020). The impact of productive service industry agglomeration on industrial structure upgrading and regional differences in China. *Journal of Xi'an Jiao Tong University (Social Science Edition), 40*(01), 30-37.

Liu, L. (2021). Productive services agglomeration and urban manufacturing export upgrading - an empirical test based on spatial Durbin model. *Research on Technical Economics and Management, 42*(04), 122-128.

Luo, C., Zhu, P., Zhang, C., & Chen, W. (2022). Does productive services agglomeration promote green innovation in cities: A perspective based on the 'local-neighbourhood' effect. *Journal of Southwest University (Social Science Edition), 48*(01), 97-112.

Song, Y., Liao, R., & Wang, Y. (2019). Research on the impact of manufacturing agglomeration on new urbanization--based on the perspective of spatial spillover effect. *Journal of Chongqing University (Social Science Edition), 26*(06), 1-13.

Sun, J., & Li, H. (2012). Financial agglomeration and industrial structure upgrading - An empirical analysis from inter-provincial economic data from 2003-2007. *Economist, 24*(3), 80-89.

Sun, Y., Wang, W., & Li, G. (2020). Has service industry agglomeration promoted industrial structure optimization? *Science Studies, 38*(05), 797-805.

Wang, P., & Li, J. (2020). Industry interaction externality, productive services aggregation, and urban innovativeness - An empirical comparison of seven major city clusters in China. *Industrial Economics Review, 11*(02), 17-33.

Wang, S., Zhou, M., & Zhong, S. (2020). Research on the impact of manufacturing agglomeration on industrial structure upgrading in resource-based regions--Take Shanxi Province as an example. *Exploration of Economic Issues, 41*(02), 85-93.

Wang, Y., & Wu, S. (2022). Service industry agglomeration, internet development and changes in residents' consumption rate - empirical evidence from China's modern distribution industry. *China Circulation Economy, 36*(05), 14-29.

Wen, T. (2020). Productive service industry agglomeration, spatial spillover, and industrial structure upgrading - an empirical test based on 239 prefecture-level cities in China. *Research on Science and Technology Management*, *40*(21), 143-153.

Xu, D. Y., & Wang, H. (2022). Influence of productive service industry agglomeration on industrial structure upgrading - based on the perspective of market production efficiency. *Journal of Huainan Normal University*, *24*(02), 61-69.

Yang, F., Qin, L., & Chen, S. (2021). Location entropy measurement of productive service industry agglomeration level under the threshold of system theory--take liaoning province as an example. *Journal of System Science*, *29*(03), 73-77+83.

Yang, X., & Chen, X. (2016). Does service clustering improve the quality of urbanization? --Examples from Zhejiang. *Journal of Soochow University (Philosophy and Social Science Edition)*, *37*(02), 114-123.

Yao, Z. (2020). Research on the impact of science and technology service industry agglomeration on industrial upgrading. *Journal of Beijing Technology and Business University (Social Science Edition)*, *35*(06), 104-114.

Yu, B. (2019). How does productive service clustering promote industrial structure upgrading? --An empirical analysis based on agglomeration externalities and city size constraints. *Comparison of Economic and Social Systems*, *35*(02), 30-43.

Yu, S., Li, D., & Zhu, S. (2020). Has the agglomeration of the productive service industry promoted the climbing of the manufacturing value chain: An empirical study based on 277 urban microenterprises. *International Trade Issues*, *46*(05), 57-71.

Zeng, Y., & Han, F. (2019). Has the agglomeration of producer service industries improved the quality of urban economic growth. *Journal Quant. Technology Economic*, *36*(5), 83-100.

Zhang, P., Liu, X. F., Yuan, F. H., Wang, H. M., Lu, M. T., & Zhang, L. (2014). Inefficiency shocks and deceleration governance of China's economic growth. *Economic Research*, *49*(12), 4-17+32.

Zhang, Z., & Huang, Q. (2021). The impact of industrial agglomeration on industrial structure upgrading - an empirical analysis based on the spatial measurement and panel threshold model. *Contemporary Economic Management*, *43*(02), 57-64.

Zhou, M., & Wang, S. (2018). Beijing-Tianjin-Hebei service industry agglomeration and economic growth. *Economic and Management Research*, *39*(01), 68-77.