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# A Comparative Analysis of Spillover Effects on Surrounding Cities of Beijing And Shanghai

-- Based on Inter-regional Input-output Tables

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**Abstract:** Industrial linkage is the key channel for spillover effect, and improving the spillover effect of central cities is an important task to realize the coordinated development of regional economy. From the perspective of industrial linkages, this paper uses the 2017 China's Inter-city input-output table to build a three regional input-output model to compared with the two-way overflow between Beijing and surrounding cities and the two-way overflow between Shanghai and its surrounding cities. The research findings are as follows: 1. Central cities and cities with higher economic development level have higher two-way spillovers, and the two-way spillover effect between Beijing and surrounding cities is smaller than that between Shanghai and surrounding cities; 2. There is an imbalance between central cities and surrounding cities in value-added gains. Beijing Tianjin Hebei and Yangtze River Delta present different situations. The share of spillover effects in GDP of surrounding cities to Beijing is generally small, and Beijing's value-added spillover to surrounding cities is greater than that of surrounding cities to Beijing. The share of spillover effects in GDP of surrounding cities to Shanghahi is generally high, and most of the surrounding cities' value-added spillovers to Shanghai are greater than Shanghai's value-added spillovers to the surrounding cities. 3. In terms of industry, Beijing and Shanghai have the largest added value spillover in the tertiary sector, followed by the secondary industry, and the value-added spillover of the primary industry is the smallest; From the perspective of 42 industry sectors, Beijing and Shanghai are relatively consistent in industries with large spillover effects on surrounding cities, which are the dominant industries of Beijing and Shanghai, and are concentrated in the secondary and tertiary industries. 4. Compare the value-added spillover effect of Shanghai and Beijing on urban agglomeration as a whole. The per capita spillover effect of Beijing on Beijing Tianjin Hebei is smaller than that of Shanghai on the Yangtze River Delta. Finally, according to the research conclusions, starting from the regional industrial advantages, it provides relevant policy recommendations for regional development and promoting the high-quality development of regional integration.

**Keywords:** Central city, Industrial linkage, Spillover effect, Multi region input-output model.

## 1. Introduction

In the practice of regional economic development, there is a huge gap between big cities and surrounding areas. For example, Beijing and Shanghai, as the two largest cities with the highest level of economic development in China, have different economic relations with the surrounding areas: Beijing is surrounded by the poverty belt around the capital, while Shanghai is surrounded by the rich Yangtze River Delta. The above phenomenon is vividly called "poor relatives around Beijing, rich neighbors around Shanghai". From the perspective of spatial spillover, with the further strengthening of the agglomeration effect of central cities, central cities will have spillover effects on the economic growth of surrounding cities. Beijing's relationship with surrounding cities is different from Shanghai's relationship with surrounding cities, which may be due to the fact that the central cities have not played a good role in driving growth poles. In this scenario, it is necessary to explore the ability of central cities to promote regional economic development from the perspective of industrial linkages. Based on the interregional input-output table, this paper compares the spillover interaction between the central cities of Beijing Tianjin Hebei and the Yangtze River Delta urban agglomeration and the surrounding cities.

## 2. Literature Review

The role and status of central cities in the process of regional economic development in China have attracted the attention of scholars. Some studies believe that the central city will play a role as a growth pole in the region (Sun Bindong, Ding Song, 2016; Sun Tieshan, 2016; Cai Zhibing, 2017)[1-3], that is, in the process of economic development, the economy of the central city will take the lead in developing, and drive the development of surrounding cities. However, some studies believe that not all central cities will play a growth pole role. On the one hand, some central cities have not been fully developed, and their driving capacity is weak (Sun Hongling, 2012; Cao Qingfeng, Ni Pengfei, 2020; Shi Lei, 2020)[4-6]; , On the other hand, because the circular cumulative causal mechanism plays an important role, some central cities will attract regional factor resource agglomeration through the siphon effect, promote their own economic development and have a negative impact on the economic development of surrounding cities, such as Zhu Hong, Xu Yanchao and Yin Heng (2012), Cai Zhibing (2016), Han Dong (2020)[7-9], Shanghai has a positive driving effect on the economic development of the surrounding regions, while Beijing has a negative air absorption effect on the economic development of the surrounding regions. However, the spillover effect of Beijing and Shanghai on surrounding cities is not static, and will change with different target and time. For example, Cai Zhibing (2018) and An Shuwei (2022)[10-11]respectively investigate the difference of the driving role of central cities from the ease of industrial matching and the radiation capacity of core cities, the carrying

capacity of peripheral cities and the factor flow channels, It is found that both Beijing and Shanghai can drive the economic growth of peripheral areas, but the spillover effect of Shanghai is stronger. Zhang Xianfeng (2014)[12]reached the same conclusion. The above literature is studied through econometric models, which cannot fully show the industrial level economic relationship between the central city of the urban agglomeration and the surrounding cities. Therefore, it is more advantageous to study the economic links between cities based on the interregional input-output table.

Miller (1963)[13]used input-output technology for the first time to study the spillover effect and feedback effect between regions. Later, Pyatt and Round (1979), Round (1985), Sonis and Oosterhaven et al. (1993), Linden and Oosterhaven (1995)[14-17]gradually improved the measurement methods of the multiplier effect, spillover effect and feedback effect between regions. Pan Wenqing (2007, 2012)[18-19]improved the measurement of interregional spillover effect and feedback effect on the basis of the two region input-output model, and examined the feedback and spillover effect between China's inland and coastal. Through their research. Wu Fuxiang and Zhu Lei (2010)[20]developed a three region input-output model based on the two region input-output model. Zhang Youguo (2017)[21]measured the spillover, feedback and multiplier effects of demand side and supply side among regions in China based on China's interregional input-output table. Pan Wenqing (2015)[22] used the inter regional input-output tables of eight provinces and regions in China in 1997 and 2007 to compare and analyze the internal multiplier effect, spillover effect and feedback effect of the corresponding regions. Wang Yong (2016), Xie Rui and Chen Xiangjie (2020), Wang Lafang and Xie Rui (2020)[23-25]measured the spillover effect of added value between China and other countries using the inter country input-output table. There are also some researches on Beijing Tianjin Hebei and Yangtze River Delta. For example, Wu Sanbusy and Chen Weiming et al. (2016), Quan Shifan and Wu Yabin et al. (2017), Liu Lijia and Wang Haoyu (2018), Liao Jiaxin and Zhou Guofu (2023)[26-29]used interregional input-output tables in different years to measure the pulling effect of three types of final demand between Beijing, Tianjin and Hebei. Ye Zuoyi (2020)[30]measured the regional multiplier effect, spillover effect, self feedback effect and mutual feedback effect among the four provinces in the Yangtze River Delta through a multi regional input-output model and carried out a comparative analysis. The conclusion shows that Shanghai has played a leading role in the Yangtze River Delta, but the role is not significant. Huang Ruiling and Zhang Xu (2020)[31]used the three region input-output model to measure the multiplier effect, spillover effect and feedback effect of the Yangtze River Delta, respectively, and analyzed the inter regional industrial linkages.

The input-output method relies on the preparation of the input-output table, which is slow due to the need for a large number of basic data. At present, many different research teams in China have prepared and studied China's inter regional or regional input-output tables, most of which are compiled every five years. Therefore, the input-output method has the defect of time lag, but it is still one of the powerful tools in terms of inter regional spillovers and feedback effects.

Compared with existing studies, the possible marginal contribution of this paper lies in: (1) In terms of methodology, Most of the existing literature uses measurement methods or constructs index systems to study the driving effect of cities on surrounding cities. This paper first uses input-output analysis to study the spillover effect of central cities in Beijing Tianjin Hebei and the Yangtze River Delta. At present, the literature on spillover effects based on the input-output table mainly focuses on the pull effect of three types of final demand between countries, regions (such as China's coastal and inland areas, China's three major, the three major economic zones, and urban agglomerations), and provinces and cities. Few literature studies the spatial spillover effects between cities in this way. Lenin said: "Cities are the center of economic, political and people's spiritual life, and the main driving force for progress. Cities play an important role in the national economic and social development. If only the spillover and feedback effects between large regions are examined, the differences in spillover effects between different cities will be covered up. (2) In terms of indicators, This paper optimizes the analysis indicators of urban spillover effects, and constructs the spillover impact indicators of per capita GDP after considering the population size factor, so as to compare the spillover effects of Beijing and Shanghai.

To sum up, this paper constructs a multi regional input-output model based on the 2017 China's inter regional input-output table of cities in zhengheran (2021)[32], examines the spillover effects of central cities in Beijing Tianjin Hebei and Yangtze River Delta urban agglomeration from the perspective of industrial linkages, and makes vertical and horizontal comparisons, thus revealing the characteristics of the industrial structure linkages between central and peripheral cities, as well as the direction of further optimization, In order to improve the economic driving capacity of the central city and achieve regional integrated development.

# 3. Research Methods and Data Sources

## 3.1. Three regional input-output spillover effect model

Compared with the traditional input-output model, the interregional input-output model can reflect the flow of product factors in various sectors of the region, which is helpful to understand the interregional industrial linkages. Miller (1963)[13]identified the interval feedback effect based on the two region input-output model. On this basis, Round (1985)[15]further decomposed the regional multiplier effect, interval spillover effect and interval feedback effect. Pan Wenqing and Li Zinai (2007)[18]verified the consistency of the multiplicative decomposition and additive decomposition of the three effects of the input-output model. Zhang (2017)[33]expanded the effect decomposition of the three region input-output model on its basis. The basic form of the three regional input-output model is as follows:

$$\begin{bmatrix} X^a \\ X^b \\ X^c \end{bmatrix} = \begin{bmatrix} A^{aa} & A^{ab} & A^{ac} \\ A^{ba} & A^{bb} & A^{bc} \\ A^{ca} & A^{cb} & A^{cc} \end{bmatrix} \begin{bmatrix} X^a \\ X^b \\ X^c \end{bmatrix} + \begin{bmatrix} Y^a \\ Y^b \\ Y^c \end{bmatrix} \quad (1)$$

Among them, $A^{ab}$ is Direct consumption factor matrix for products from region $a$ consumed in region $b$; $X^a$ is The total output vector for region $a$; $Y^a$ is The final product usage vector in region $b$. According to Zhang (2017)[33],

order:

$$M^{aa}=(I-A^{aa})^{-1};D^{ab}=(I-A^{aa})^{-1}A^{ab};$$
$$F^{aa}=[I-D^{ab}D^{ba}-S^{ac}(D^{cb}D^{ba}+D^{ca})]^{-1};$$
$$S^{ac}=(D^{ab}D^{bc}+D^{ac})(I-D^{cb}D^{bc})^{-1};U^{ab}=D^{ab}+S^{ac}D^{cb}; \quad (2)$$

Among I is the identity matrix, $M^{aa}$ Is the inter regional multiplier effect, that is the impact of the unit final product of Region $a$ on its own total output through intra-regional industrial linkages; $F^{aa}$ Is the feedback effect between regions, that is the impact on total output of a unit of final product in a region through interregional industrial linkages; $S^{ac}$ and $U^{ab}$ represents the impact of the final products of units in region $c$ and region $b$ on the output of region $a$, whic is an interregional spillover effect. Therefore, equation (2) can also be expressed in the following matrix form:

$$\begin{bmatrix}X^a\\X^b\\X^c\end{bmatrix}=\begin{bmatrix}B^{aa}&B^{ab}&B^{ac}\\B^{ba}&B^{bb}&B^{bc}\\B^{ca}&B^{cb}&B^{cc}\end{bmatrix}\begin{bmatrix}Y^a\\Y^b\\Y^c\end{bmatrix}=\begin{bmatrix}F^{aa}M^{aa}&F^{aa}U^{ab}M^{bb}&F^{aa}S^{ac}M^{cc}\\F^{bb}S^{ba}M^{aa}&F^{bb}A^{ab}M^{bb}&F^{bb}U^{bc}M^{cc}\\F^{cc}U^{ca}M^{aa}&F^{cc}S^{cb}M^{bb}&F^{cc}A^{cc}M^{cc}\end{bmatrix}\begin{bmatrix}Y^a\\Y^b\\Y^c\end{bmatrix}$$
$$=\begin{bmatrix}F^{aa}&0&0\\0&F^{bb}&0\\0&0&F^{cc}\end{bmatrix}\begin{bmatrix}I&U^{ab}&S^{ac}\\S^{ba}&I&U^{bc}\\U^{ca}&S^{cb}&I\end{bmatrix}\begin{bmatrix}M^{aa}&0&0\\0&M^{bb}&0\\0&0&M^{cc}\end{bmatrix}\begin{bmatrix}Y^a\\Y^b\\Y^c\end{bmatrix} \quad (3)$$

Among them, $B^{ab}$ is a submatrix of the intersection of region $a$ and region $b$ in the Leontief inverse matrix, which reflects direct and indirect industrial linkages between regions $a$ and $b$. According to the multiplicative decomposition method, the Leontief inverse matrix is decomposed into the product of interval feedback effect, inter region spillover effect and intra region multiplier effect. Based on the homogeneity of multiplicative decomposition method and additive decomposition method, equation (3) is divided into equation by addition, as follows:

According to the above derivation, multiplier effect factors $M^{aa}$, feedback effect factor, spillover effect factor $SE^{ab}=U^{ab}M^{bb}$ and $SE^{ac}=S^{ac}M^{cc}$ are obtained, Taking the final use of Y as the weight of the corresponding region, multiplying it with each factor can obtain the three effects of final use.. This paper focuses on the spillover effects of Beijing and Shanghai with the surrounding cities. Formula (4) The second item on the right is the spillover effect of the other two regions on the region in the three region input-output model. The spillover effects of regions $b$ and $c$ on the total output of region $a$ are $U^{ab}M^{bb}Y^b=SE^{ab}Y^b$ and $S^{ac}M^{cc}Y^c=SE^{ac}Y^c$, represents the increase in total output in Region $a$ due to final products in regions $b$ and $c$, respectively.

## 3.2. Construction of value-added spillover effect indicators

First, we construct the index of value-added spillover effect at the city level. In order to better reflect the impact of interregional spillover effects on regional economic development, this paper analyzes the characteristics of spillover effects of Beijing and Shanghai on surrounding cities from the perspective of value-added spillovers. The spillover effect index of added value, the contribution rate index of economic growth spillover and the spillover effect index of per capita added value are constructed respectively.

1. Value added spillover effect., which refers to the total added value of another region caused by the production of the final products in one region. There are regional value-added coefficient vectors $V^a$, $V^a=VA^a/X^a$, then value-added spillover effect from region $b$ to region $a$ is $VA\_SE^{ab}$:

$$VA\_SE^{ab}=V^aSE^{ab}Y^b \quad (4)$$

2. Share of spillover effects in GDP. In order to further measure the relative contribution of the value-added spillover effect of region $b$ to the economic growth of region $a$, the added value of regional sectors is introduced, Share of spillover effects in GDP from region $b$ to region $a$ is $VA\_GSE^{ab}$,

$$VA\_GSE^{ab}=\frac{V^aSE^{ab}Y^b}{GDP^a} \quad (5)$$

Secondly, by analyzing the spillover effect between central cities and the surrounding cities from the industrial level, we can understand the industries that play an important role in the central cities, so as to find the connection point to enhance the spillover effect of the central cities and promote the coordinated development of urban agglomeration.

The Value added spillover effect of industry $j$ in region $b$ to region $a$ is $VA\_FSE_j^{ab}$:

$$VA\_FSE_j^{ab}=\sum_{i=1}^{n}v^ase_{ij}^{ab}y^b{}_j \quad (6)$$

The Value added spillover effect of industry $j$ in region $b$ to region $a$ contribution rate is $W\_VA\_FSE_j^{ab}$:

$$W\_VA\_FSE_j^{ab}=VA\_FSE_j^{ab}/VA\_SE^{ab} \quad (7)$$

3. Considering the differences in the number of cities and between cities in the Beijing Tianjin Hebei and Yangtze River Delta urban agglomerations, in order to compare the spillover effect capacity of Beijing and Shanghai, a per capita value-added spillover is $PVA\_FSE_j^{ab}$ and the per capita value-added spillover from per unit of final product is $PVA\_FSe_j^{ab}$, as follows:

$$PVA\_FSE_j^{ab}=\frac{\sum_{i=1}^{n}v^ase_{ij}^{ab}y_j^b}{P^a} \quad (8)$$

$$PVA\_FSe_j^{ab}=\frac{\sum_{i=1}^{n}v^ase_{ij}^{ab}}{P^a} \quad (9)$$

Among them, $PVA\_FSe_j^{ab}$ excludes the impact of industrial scale factors, which can be used to Compare the degree of correlation between the industries of the central city

and the industries of the surrounding cities.

### 3.3. Data source

he research objects of this paper are the Beijing-Tianjin-Hebei and Yangtze River Delta urban agglomerations. The Beijing Tianjin Hebei urban agglomeration includes Beijing, Tianjin, Shijiazhuang, Langfang, Tangshan, Chengde, Qinhuangdao, Zhangjiakou, Cangzhou, Handan, Xingtai, Hengshui and Baoding. The Yangtze River Delta city cluster includes Shanghai, Hangzhou, Jiaxing, Huzhou, Ningbo, Shaoxing, Zhoushan, Taizhou, Nanjing, Suzhou, Wuxi, Changzhou, Zhenjiang, Yangzhou, Nantong and Taizhou.

This paper uses the 2017 China's city-scale multi-regional input-output table based on entropy model compiled by Zheng Heran(2021)[32] of China Carbon Accounting Database(CEADs). The table includes 313 administrative units in mainland China, including 309 prefecture level administrative units and municipalities directly under the Central Government, and 4 provinces, covering more than 95% of the country's population and more than 97% of GDP. The input-output table includes 42 socio-economic industries and 5 final consumption (rural residents' consumption, urban residents' consumption, government consumption, capital formation and inventory change).

According to the research needs of this paper, the central cities and surrounding cities of the urban agglomerations will be reserved in turn, and other cities will be merged into other regions. Finally, a three region input-output table will be formed, which includes the central city (Beijing or Shanghai), the corresponding surrounding city, and other regions.

This paper combines China's GB/T4754-2017 national economy industry classification standard with industry classification in China's input-output data, and divides 42 industry sectors, as shown in Table 1:

**Table 1.** Industry Classification

| code | Segmented industries | code | Segmented industries |
|---|---|---|---|
| 01 | Agriculture, Forestry, Animal Husbandry and Fishery | 22 | Other manufacturing |
| 02 | Mining and washing of coal | 23 | Comprehensive use of waste resources |
| 03 | Extraction of petroleum and natural gas | 24 | Repair of metal products, machinery and equipment |
| 04 | Mining and processing of metal ores | 25 | Production and distribution of electric power and heat power |
| 05 | Mining and processing of nonmetal and other ores | 26 | Production and distribution of gas |
| 06 | Food and tobacco processing | 27 | Production and distribution of tap water |
| 07 | Textile industry | 28 | Construction |
| 08 | Manufacture of leather, fur, feather and related products | 29 | Wholesale and retail trades |
| 09 | Processing of timber and furniture | 30 | Transport, storage, and postal services |
| 10 | Manufacture of paper, printing and articles for culture, education and sport activity | 31 | Accommodation and catering |
| 11 | Processing of petroleum, coking, processing of nuclear fuel | 32 | Information transfer, software and information technology services |
| 12 | Manufacture of chemical products | 33 | Finance |
| 13 | Manuf. of non -metallic mineral products | 34 | Real estate |
| 14 | Smelting and processing of metals | 35 | Leasing and commercial services |
| 15 | Manufacture of metal products | 36 | Scientific research and polytechnic services |
| 16 | Manufacture of general purpose machinery | 37 | Administration of water, environment, and public facilities |
| 17 | Manufacture of special purpose machinery | 38 | Resident, repair and other services |
| 18 | Manufacture of transport equipment | 39 | Education |
| 19 | Manufacture of electrical machinery and equipment | 40 | Health care and social work |
| 20 | Manufacture of communication equipment, computers and other electronic equipment | 41 | Culture, sports, and entertainment |
| 21 | Manufacture of measuring instruments | 42 | Public administration, social insurance, and social organizations |

## 4. Two Way Spillover Effect Between Central City and Surrounding Cities in Urban Agglomeration

### 4.1. Beijing Tianjin Hebei urban agglomeration: two-way spillover effect between Beijing and surrounding cities

#### 4.1.1. City level: two-way spillover effect type between Beijing and surrounding cities

The two-way value-added spillover effect and the Share of spillover effects in GDP between Beijing and the cities around the urban agglomeration in 2017 were measured, and divided into high, medium and low levels according to the size of the data. The results are shown in Table 2 below.

In the classification of Beijing's value-added spillovers to 12 surrounding cities, Tianjin, Tangshan and Cangzhou belong to the "high $VE\_SE$ - High $VA\_GSE$ "Type, this type of city is the city with better economic development level. Shijiazhuang belongs to the "high $VE\_SE$ - Medium $VA\_GSE$ ", It has the characteristics of deep participation in the division of regional industries and huge economic volume; Xingtai and Hengshui belong to the "middle $VE\_SE$ - High $VA\_GSE$ "Type; Baoding, Langfang and Handan belong to the "middle $VE\_SE$ - Medium $VA\_GSE$ "Type; Qinhuangdao, Chengde and Zhangjiakou belong to "low

$VE\_SE$ - Medium $VA\_GSE$ "In 2017, the GDP of Qinhuangdao, Chengde and Zhangjiakou ranked the last three in the Beijing Tianjin Hebei urban agglomeration. Although Zhangjiakou and Chengde are adjacent to Beijing, their ties with Beijing still need to be strengthened, and there is still broad space for regional industrial coordination.

**Table 2.** Types of two-way spillover effect between Beijing and surrounding cities

| Spill direction | Beijing - surrounding cities | | Surrounding cities - Beijing |
|---|---|---|---|
| | GDP (100 million yuan) | Spill impact type | Spill impact type |
| Tianjin | 18595. 38 | (High SE, High GSE) | High GSE |
| Shijiazhuang | 5025. 33 | (High SE, Medium GSE) | Medium GSE |
| Baoding | 3132. 43 | (middle SE, middle GSE) | Medium GSE |
| Tangshan | 5916. 95 | (High SE, High GSE) | Low GSE |
| Cangzhou | 3816. 90 | (High SE, High GSE) | Low GSE |
| Langfang | 2881. 01 | (middle SE, middle GSE) | Low GSE |
| Handan | 3154. 98 | (middle SE, middle GSE) | Low GSE |
| Xingtai | 2090. 62 | (Medium SE, High GSE) | Low GSE |
| qinghuangdao | 1500. 34 | (Low SE, medium GSE) | Low GSE |
| Hengshui | 1523. 19 | (Medium SE, High GSE) | Low GSE |
| Chengde | 1465. 45 | (Low SE, medium GSE) | Low GSE |
| Zhangjiakou | 1427. 02 | (Low SE, medium GSE) | Low GSE |

Note: If$SE \leq$ 4 billion yuan, it is low; If 4 billion yuan<$SE \leq$ 10 billion yuan, it is medium; if$SE$>10 billion yuan, it is high; if$GSE \leq$ 1%, it is low; 1% < $GSE \leq$ 2. 5%, it is medium; if$GSE$>2. 5%, it is high.

The relative order of spillover effects and the share of spillover effects in GDP of surrounding cities to Beijing is consistent. Therefore, surrounding cities are classified according to Share of spillover effects in GDP to Beijing. The results are shown in Table 2. It can be seen that only Tianjin's spillover effect on Beijing is"high $GSE$"type. The impact of other surrounding cities on Beijing's economic growth is generally small. And the stronger its economic strength, the stronger its influence on Beijing. From the numerical point of view, Tianjin's Share of spillover effects in GDP of Beijing reached 0. 58%, and Shijiazhuang and Baoding's Share of spillover effects in GDP of Beijing was only 0. 21% and 0. 16%. This shows that the Beijing Tianjin Hebei urban agglomeration has little impact on Beijing's economic growth.

#### 4.1.2. City level: comparison of two-way spillover effects between Beijing and surrounding cities

The value-added gains from interval trade are unevenly distributed between Beijing and surrounding cities. Except Baoding, Beijing's value-added spillover to surrounding cities is greater than that of surrounding cities to Beijing. In Table 3, the difference between Beijing's spillover to surrounding cities and the spillover from surrounding cities to Beijing is greater than 0, indicating that surrounding cities can obtain value-added spillovers from Beijing by participating in interregional division of labor through interval trade. The industrial dividends of the regional division of labor in the industrial chain are more distributed to surrounding cities, so promoting the regional division of labor in the industrial chain helps central cities drive the development of surrounding cities, It is an important means to narrow the gap between center and periphery and realize the coordinated development of regional industries.

**Table 3.** Comparison of two-way spillover effects between Beijing and surrounding cities

| | $VA\_SE$ (100 million yuan) | | | $VA\_GSE$ (%) | | |
|---|---|---|---|---|---|---|
| Spill direction | Beijing - | - Beijing | Difference between the two | Beijing - | - Beijing | Difference between the two |
| Tianjin | 331. 69 | 170. 52 | 161. 17 | 2. 69 | 0. 58 | 2. 12 |
| Shijiazhuang | 125. 67 | 62. 50 | 63. 17 | 2. 29 | 0. 21 | 2. 08 |
| Tangshan | 182. 16 | 26. 74 | 155. 42 | 3. 10 | 0. 09 | 3. 00 |
| qinghuangdao | 25. 60 | 12. 18 | 13. 42 | 1. 85 | 0. 04 | 1. 81 |
| Handan | 73. 56 | 21. 69 | 51. 86 | 2. 41 | 0. 07 | 2. 34 |
| Xingtai | 50. 53 | 14. 34 | 36. 19 | 2. 64 | 0. 05 | 2. 59 |
| Baoding | 46. 46 | 48. 13 | -1. 66 | 1. 69 | 0. 16 | 1. 53 |
| Zhangjiakou | 24. 94 | 8. 37 | 16. 57 | 1. 95 | 0. 03 | 1. 92 |
| Chengde | 32. 11 | 9. 02 | 23. 09 | 2. 46 | 0. 03 | 2. 43 |
| Cangzhou | 116. 31 | 25. 25 | 91. 06 | 3. 56 | 0. 09 | 3. 48 |
| Langfang | 59. 27 | 24. 15 | 35. 12 | 2. 28 | 0. 08 | 2. 20 |
| Hengshui | 44. 94 | 11. 61 | 33. 33 | 3. 21 | 0. 04 | 3. 17 |

#### 4.1.3. Industrial level: comparison of two-way spillover effects between Beijing and surrounding cities

Considering the industrial structure differences of each city in the Beijing Tianjin Hebei urban agglomeration, and combining with the functional positioning of each region, this paper analyzes the value-added spillovers of each city from the industrial level.

First, it analyzes the characteristics of value-added spillovers of the three industries in Beijing and surrounding cities. In Beijing's industrial structure, the tertiary industry accounts for a large proportion, and Beijing has entered the post industrial era, with high-end manufacturing industries such as Manufacture of communication equipment, computers and other electronic equipment, Manufacture of transport equipment, and productive services such as Information transfer, software and information technology services, and Scientific research and polytechnic services as the development core.

It can be seen from Table 4 that $W\_VA\_FSE$ of Beijing's three industries to surrounding cities have the following characteristics: First, compared with the secondary and tertiary industries, $W\_VA\_FSE$ of Beijing's primary industry is the smallest. Second, with the exception of Tianjin and Qinhuangdao, Beijing's secondary industry's $W\_VA\_FSE$ is greater than that of the tertiary industry. And $W\_VA\_FSE$ of three industries in the surrounding cities is similar to Beijing: the primary industry has the smallest $W\_VA\_FSE$, followed by the tertiary industry, and the secondary industry has the largest $W\_VA\_FSE$. The difference between the $W\_VA\_FSE$ of the surrounding cities and Beijing's three industries is that the $W\_VA\_FSE$ of the primary industry in the surrounding cities is greater than that in Beijing.

**Table 4.** $W\_VA\_FSE$ of three industries in Beijing and surrounding cities

(Unit:%)

| | Beijing -surrounding cities | | | Surrounding cities - Beijing | | |
|---|---|---|---|---|---|---|
| | primary industry | the secondary industry | the tertiary industry | primary industry | the secondary industry | the tertiary industry |
| Tianjin | 0. 27 | 45. 45 | 54. 29 | 0. 34 | 62. 40 | 37. 26 |
| Shijiazhuang | 0. 62 | 54. 77 | 44. 61 | 0. 83 | 69. 32 | 29. 85 |
| Tangshan | 0. 62 | 57. 55 | 41. 83 | 3. 04 | 61. 82 | 35. 13 |
| qinghuangdao | 1. 49 | 47. 59 | 50. 92 | 3. 17 | 59. 31 | 37. 52 |
| Handan | 0. 83 | 60. 17 | 39. 00 | 2. 71 | 56. 62 | 40. 67 |
| Xingtai | 0. 93 | 61. 98 | 37. 09 | 2. 82 | 59. 81 | 37. 37 |
| Baoding | 1. 24 | 51. 88 | 46. 88 | 1. 17 | 81. 56 | 17. 27 |
| Zhangjiakou | 1. 55 | 53. 24 | 45. 21 | 4. 73 | 46. 99 | 48. 28 |
| Chengde | 1. 35 | 55. 97 | 42. 68 | 3. 72 | 56. 57 | 39. 71 |
| Cangzhou | 0. 70 | 56. 50 | 42. 80 | 2. 21 | 70. 36 | 27. 43 |
| Langfang | 0. 62 | 56. 83 | 42. 55 | 1. 02 | 64. 96 | 34. 02 |
| Hengshui | 0. 91 | 54. 10 | 44. 99 | 3. 25 | 66. 63 | 30. 12 |

Then look at the industrial added value spillovers of Beijing and surrounding cities from 42 industrial sectors. Figure 1 shows the value-added spillover effect of Beijing's industries on other cities. The industries with large value-added spillover effect of Beijing's 42 industries on surrounding cities are relatively consistent.

The industries with greater spillover effect on surrounding cities in Beijing are concentrated in the secondary industry and the tertiary industry. The industrial sectors with large spillover effects are concentrated in Manufacture of transport equipment, Manufacture of communication equipment, computers and other electronic equipment and Construction. The service sector with large spillover effects focuses on Information transfer, software and information technology services, and Scientific research and polytechnic services. The biggest spillover effect in Beijing is in scientific research and technical services. And the spillover effect of Beijing's industries on Tianjin is greater than that on other cities.

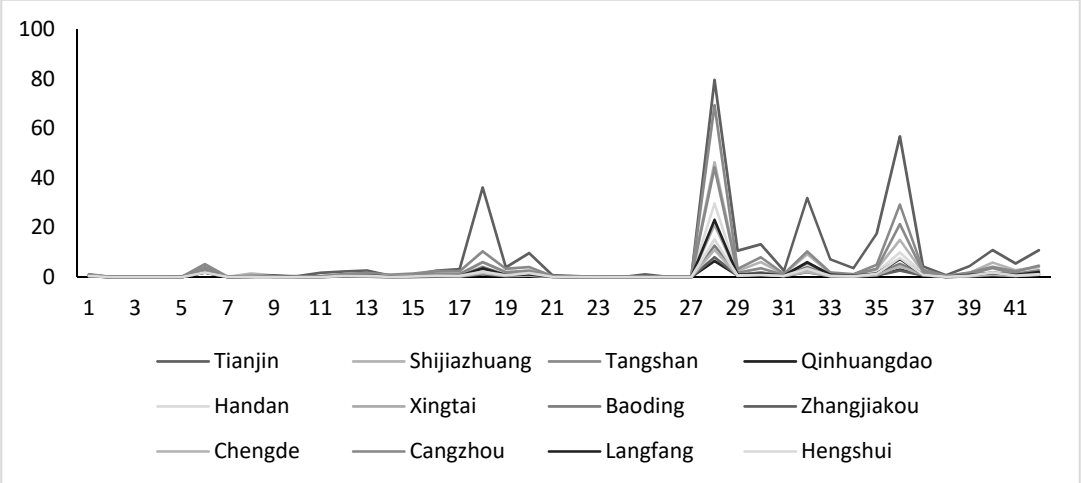


**Figure 1.** Spillover effect of Beijing's industries on surrounding cities (unit: 100 million yuan)

As shown in Figure 2, the spillover effects of industries in other cities on Beijing. The industries with large spillover effect from Tianjin to Beijing are concentrated in the secondary industry and the tertiary industry ; The spillover effect of Hebei cities on Beijing is concentrated in the secondary industry, and has regional differences, which is also related to the city's own resource endowment. The industries with greater value-added spillover effects in Tianjin's manufacturing industry are mainly Food and tobacco processing, Manufacture of leather, fur, feather and related products, Manufacture of transport equipment, Manufacture of electrical machinery and equipment, Manufacture of communication equipment, computers and other electronic equipment ; Among the service industries, the industries with greater value-added spillover effects are Wholesale and retail trades, Transport, storage, and postal services, Information transfer, software and information technology services, Scientific research and polytechnic services. The industries with large value-added spillover effects in cities of Hebei mainly include Food and tobacco processing, Manufacture of leather, fur, feather and related products, Manufacture of chemical products, Smelting and processing of metals, Manufacture of transport equipment, Manufacture of electrical machinery and equipment, Manufacture of communication equipment, computers and other electronic equipment; . The spillover effect of Tianjin's industries on Beijing is greater than that of other cities.

It can be seen that the traditional pillar industries such as heavy industry and manufacturing in Tianjin and Hebei cities have a strong pulling effect on Beijing's economic development.

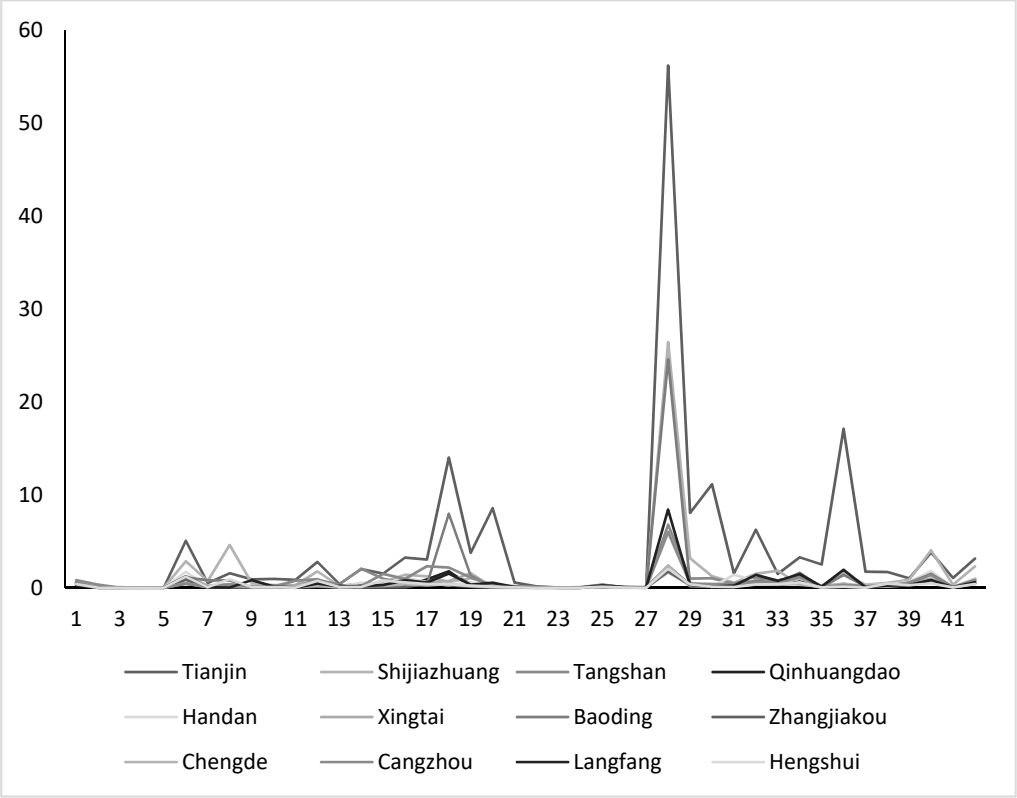


**Figure 2.** Spillover effect of industries in surrounding cities on Beijing (unit: 100 million yuan)

## 4.2. Yangtze River Delta Urban Agglomeration: Spillover Effect between Shanghai and Surrounding Cities

### 4.2.1. City level: two-way spillover effect type between Shanghai and surrounding cities

The two-way value-added spillover effect and the Share of spillover effects in GDP between Shanghai and the cities around the urban agglomeration in 2017 were measured, and divided into high, medium and low levels according to the size of the data. The results are shown in Table 5 below.

In the type of $SE$ from Shanghai to surrounding cities, Jiaxing, Hangzhou, Ningbo and Suzhou belong to the “High $SE$”which are all cities with better economic development or adjacent to Shanghai. Jiaxing belongs to the "high$SE$ - High $GSE$”Type. This is because only a small economic volume can have a high High$GSE$ when Shanghai's spillover effect is certain. Hangzhou and Ningbo belong to “High $SE$ - Medium$GSE$”, Suzhou belongs to "High"$SE$ - Low$GSE$”. These two types of cities have the characteristics of deep participation in the industrial division between regions and huge economic volume ; Shaoxing, Taizhou and Zhenjiang belong to the "middle$SE$ - Medium$GSE$”Type ; Nantong, Nanjing, Wuxi, Yangzhou, Taizhou and Changzhou belong to the "middle$SE$ - Low$GSE$”Type. The largest number of distribution is "medium$SE$ - Low$GSE$”Type, indicating that for most surrounding cities, Shanghai's spillover effect is quite limited compared with its economic volume.

**Table 5.** Types of spillover effects between Shanghai and surrounding cities

| Spill direction | Shanghai - surrounding cities | | Surrounding cities - Shanghai |
|---|---|---|---|
| | GDP (100 million yuan) | Spill impact type | Spill impact type |
| Hangzhou | 13160. 72 | (High SE, Medium GSE) | High GSE |
| Ningbo | 10146. 55 | (High SE, Medium GSE) | High GSE |
| Shaoxing | 5027. 48 | (middle SE, middle GSE) | High GSE |
| Suzhou | 16997. 47 | (high SE, low GSE) | High GSE |
| Nantong | 8034. 08 | (Medium SE, low GSE) | High GSE |
| Nanjing | 11894. 00 | (Medium SE, low GSE) | High GSE |
| Jiaxing | 4500. 26 | (High SE, High GSE) | High GSE |
| Wuxi | 10313. 07 | (Medium SE, low GSE) | Medium GSE |
| Yangzhou | 5078. 58 | (Medium SE, low GSE) | Medium GSE |
| Taizhou | 4424. 57 | (Medium SE, low GSE) | Medium GSE |
| Taizhou | 4386. 04 | (middle SE, middle GSE) | Medium GSE |
| Changzhou | 6478. 16 | (Medium SE, low GSE) | Medium GSE |
| Huzhou | 2607. 86 | (Medium SE, High GSE) | Medium GSE |
| Zhenjiang | 3714. 57 | (middle SE, middle GSE) | Low GSE |
| Zhoushan | 1129. 56 | (Low SE, medium GSE) | Low GSE |

Note: If$SE \leq$ 4 billion yuan, it is low ; If 4 billion yuan<$SE \leq$ 10 billion yuan, it is medium ; if$SE$>10 billion yuan, it is high ; if$GSE \leq$ 1%, it is low; 1% < $GSE \leq$ 2. 5%, it is medium ; if$GSE$>2. 5% it is high.

Similarly, surrounding cities are classified according to their $VA\_GSE$ to Shanghai. The results are shown in Table 5. It can be seen that nearly half of the cities around the Yangtze River Delta urban agglomeration have a high $VA\_GSE$ on Shanghai; Only Zhenjiang and Zhoushan have a small impact on Shanghai's economic growth, and $VA\_GSE$ of other cities to Shanghai is between 1% and 2. 5%. And the stronger its economic strength, the stronger its influence on Shanghai. This shows that the Yangtze River Delta urban agglomeration has a great impact on Shanghai's economic growth.

#### 4.2.2. City level: comparison of two-way spillover effects between Shanghai and surrounding cities

It can be seen from Table 6 that the value-added gains from interval trade are not distributed consistently between Shanghai and surrounding cities. Shaoxing, Ningbo, Nantong, Suzhou, Yangzhou, Taizhou, Hangzhou, Nanjing, Changzhou and Zhoushan, a total of 10 cities have greater spillover effects on Shanghai than Shanghai has on these cities. The spillover effect of Wuxi, Taizhou, Jiaxing, Zhenjiang and Huzhou on Shanghai is smaller than that of Shanghai on them, but the difference is not significant. As far as $VA\_GSE$ is concerned, Shanghai's value-added spillover has a stronger ability to pull the economic growth of these cities, because Shanghai's economy is larger.

Although from the perspective of value-added spillover effect, there are 10 cities whose value-added spillover to Shanghai is greater than Shanghai's value-added spillover to them, which shows that the siphon effect of Shanghai should be greater than the diffusion effect, However, the magnitude of the value-added spillover effect reflects the driving ability of Shanghai to surrounding cities based on the industrial chain linkage. The contribution rate of Shanghai to the economic growth spillover of surrounding cities is greater than that of surrounding cities to Shanghai. Therefore, there is more cooperation, mutual assistance and common development between Shanghai and surrounding cities.

**Table 6.** Comparison of two-way spillover effects between Shanghai and surrounding cities

| | $VA\_SE$ (100 million yuan) | | | $VA\_GSE$ (%) | | |
|---|---|---|---|---|---|---|
| Spill direction | Shanghai - | - Shanghai | Difference between the two | Shanghai - | - Shanghai | Difference between the two |
| Shaoxing | 85. 24 | 197. 88 | -112. 64 | 1. 68 | 0. 61 | 1. 07 |
| Ningbo | 137. 07 | 247. 75 | -110. 68 | 1. 40 | 0. 76 | 0. 64 |
| Nantong | 54. 97 | 150. 62 | -95. 65 | 0. 73 | 0. 46 | 0. 27 |
| Suzhou | 115. 13 | 186. 15 | -71. 02 | 0. 70 | 0. 57 | 0. 12 |
| Yangzhou | 43. 28 | 86. 09 | -42. 81 | 0. 89 | 0. 26 | 0. 62 |
| Taizhou | 40. 50 | 74. 73 | -34. 23 | 0. 88 | 0. 23 | 0. 65 |
| Hangzhou | 226. 39 | 257. 68 | -31. 29 | 1. 81 | 0. 79 | 1. 02 |
| Nanjing | 96. 39 | 119. 87 | -23. 49 | 0. 85 | 0. 37 | 0. 48 |
| Changzhou | 58. 97 | 65. 03 | -6. 06 | 0. 93 | 0. 20 | 0. 73 |
| Zhoushan | 16. 41 | 17. 52 | -1. 12 | 1. 28 | 0. 05 | 1. 23 |
| Wuxi | 89. 93 | 88. 33 | 1. 60 | 0. 89 | 0. 27 | 0. 62 |
| Taizhou | 74. 25 | 68. 23 | 6. 02 | 1. 68 | 0. 21 | 1. 47 |
| Jiaxing | 109. 02 | 102. 70 | 6. 32 | 2. 51 | 0. 32 | 2. 19 |
| Zhenjiang | 41. 27 | 32. 18 | 9. 09 | 1. 07 | 0. 10 | 0. 97 |
| Huzhou | 94. 72 | 62. 69 | 32. 03 | 3. 82 | 0. 19 | 3. 63 |

#### 4.2.3. Industrial level: comparison of two-way spillover effects between Shanghai and surrounding cities

Similarly, the paper analyzes the value-added spillovers of each city from the industrial level. In Shanghai's industrial structure, the tertiary industry is also the main industry, supplemented by the secondary industry. It can be seen from Table 8 that $W\_VA\_FSE$ of Shanghai's three industries to surrounding cities has the following characteristics: First, compared with the secondary and tertiary industries, Shanghai's primary industry has the smallest $W\_VA\_FSE$. Second, with the exception of Taizhou, Shanghai's secondary industry's $W\_VA\_FSE$ is greater than that of the tertiary industry.

And $W\_VA\_FSE$ of three industries in the surrounding cities is similar to Shanghai: the primary industry has the smallest $W\_VA\_FSE$, followed by the tertiary industry, and the secondary industry has the largest $W\_VA\_FSE$. The difference between the $W\_VA\_FSE$ of the surrounding cities and Shanghai 's three industries is that the $W\_VA\_FSE$ of the primary industry in the surrounding cities is greater than that in Shanghai. 2, with the exception of Huzhou and Zhoushan, the $W\_VA\_FSE$ of the secondary industry in surrounding cities is greater than that of Shanghai; 3, Except Huzhou, the $W\_VA\_FSE$ of Shanghai's tertiary industry is larger than that of surrounding cities.

**Table 8.** $W\_VA\_FSE$ of three industries in Shanghai and surrounding cities

(Unit:%)

| | Shanghai to surrounding cities | | | Surrounding cities to Shanghai | | |
|---|---|---|---|---|---|---|
| | primary industry | the secondary industry | the tertiary industry | primary industry | the secondary industry | the tertiary industry |
| Nanjing | 0. 29 | 54. 49 | 45. 22 | 0. 49 | 63. 98 | 35. 53 |
| Wuxi | 0. 24 | 67. 65 | 32. 11 | 0. 38 | 71. 47 | 28. 15 |
| Changzhou | 0. 29 | 67. 94 | 31. 77 | 0. 66 | 73. 01 | 26. 34 |
| Suzhou | 0. 27 | 62. 14 | 37. 59 | 0. 34 | 73. 49 | 26. 17 |
| Nantong | 0. 50 | 65. 34 | 34. 15 | 0. 56 | 85. 31 | 14. 13 |
| Yangzhou | 0. 49 | 65. 71 | 33. 80 | 0. 82 | 82. 66 | 16. 52 |
| Zhenjiang | 0. 34 | 68. 91 | 30. 75 | 0. 63 | 68. 55 | 30. 83 |
| Taizhou | 0. 48 | 66. 13 | 33. 39 | 0. 60 | 81. 85 | 17. 55 |
| Hangzhou | 0. 32 | 51. 57 | 48. 11 | 0. 41 | 67. 50 | 32. 10 |
| Ningbo | 0. 50 | 57. 75 | 41. 74 | 0. 45 | 81. 89 | 17. 66 |
| Jiaxing | 0. 27 | 80. 33 | 19. 40 | 0. 65 | 80. 56 | 18. 79 |
| Huzhou | 0. 30 | 85. 09 | 14. 61 | 1. 01 | 79. 26 | 19. 74 |
| Shaoxing | 0. 43 | 67. 14 | 32. 42 | 0. 35 | 83. 54 | 16. 11 |
| Zhoushan | 1. 85 | 65. 48 | 32. 68 | 4. 99 | 59. 51 | 35. 50 |
| Taizhou | 0. 86 | 41. 82 | 57. 32 | 2. 36 | 69. 51 | 28. 13 |

Then look at the industrial added value spillovers of Shanghai and surrounding cities from 42 industrial sectors. Figure 3 shows the value-added spillover effect of Shanghai's industries on other cities. The industries with large value-added spillover effect of Shanghai's 42 industries on surrounding cities are relatively consistent

The industries with large spillover effects on surrounding cities in Shanghai are concentrated in the secondary and tertiary industries. The industrial sectors with large spillover effects are concentrated in Manufacture of general purpose machinery, Manufacture of transport equipment, Manufacture of communication equipment, computers and other electronic equipment and Construction. The service sectors with large spillover effects are concentrated in Transport, storage, and postal services, Information transfer, software and information technology services, Scientific research and polytechnic services.

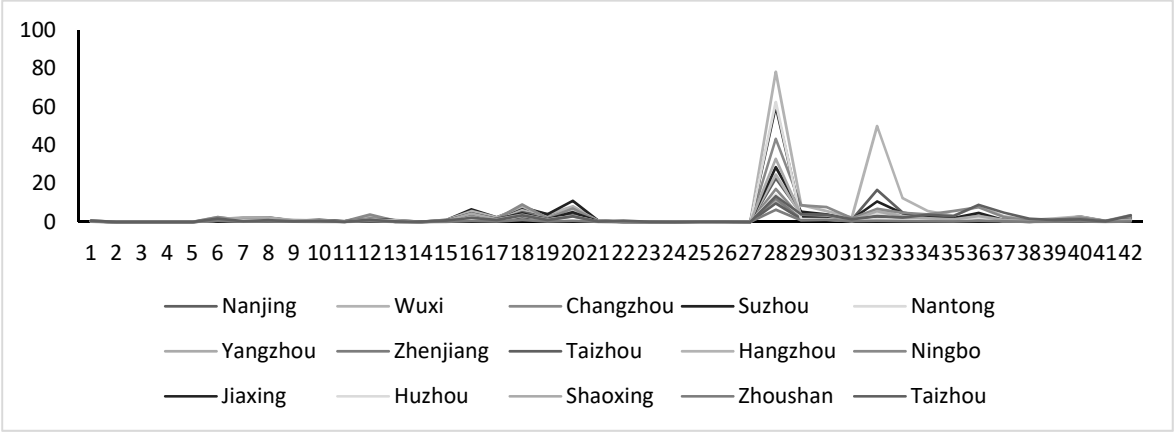


**Figure 3.** Spillover effect of Shanghai's industries on surrounding cities (unit: 100 million yuan)

As shown in Figure 4, The industries with large spillover effect from other cities to Shanghai is concentrated in the secondary industry and has regional differences, which is also related to the resource endowments of each city. The industries with greater value-added spillover effect in the manufacturing industry of each city are mainly Food and tobacco processing, Textile industry, Manufacture of leather, fur, feather and related products, Manufacture of chemical products, Manufacture of general purpose machinery, Manufacture of special purpose machinery, Manufacture of transport equipment, Manufacture of electrical machinery and equipment, Manufacture of communication equipment, computers and other electronic equipment ; Among the service industries, the industries with greater value-added spillover effects are i Information transfer, software and information technology services, Finance, Real estate, Scientific research and polytechnic services.

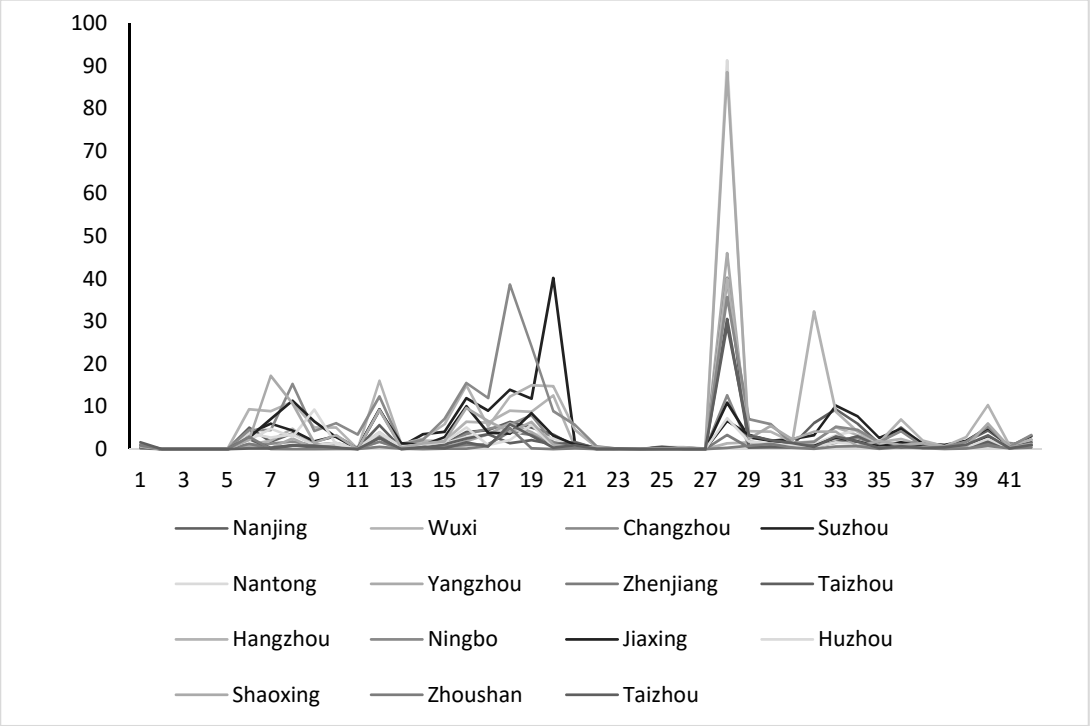


**Figure 4.** Spillover effect of industries in surrounding cities on Shanghai (unit: 100 million yuan)

## 4.3. Comparison of spillover effects between Beijing, Shanghai and surrounding cities

Sort the spillover effects between Beijing and surrounding cities and between Shanghai and surrounding cities in order of highest to lowest, and described by scatter plots, we can draw the following conclusions: First, Shanghai's value-added spillover effect on the cities in the Yangtze River Delta urban agglomeration is generally greater than Beijing's spillover effect on the cities in Beijing Tianjin Hebei region, but Beijing's value-added spillover effect on Tianjin is the largest; Second, the spillover effect of cities in the Yangtze River Delta urban agglomeration on Shanghai's added value is generally greater than that of cities in the Beijing Tianjin Hebei urban agglomeration on Beijing;

Because there are differences in the number of cities, city size and urban economic development level between the Beijing Tianjin Hebei and Yangtze River Delta urban agglomerations, if we only measure the pulling effect on the total urban economy, we cannot accurately reflect the improvement in the per capita welfare of urban agglomerations caused by the economic pull of Beijing and Shanghai on urban agglomerations. Therefore, the resident population data of each city in 2017 is introduced to calculate the per capita value-added spillover. The results are shown in Table 9.

Compared with the spillover effect of Beijing and Shanghai on urban agglomeration, the per capita spillover effect of Beijing on Beijing Tianjin Hebei is smaller than that of Shanghai on the Yangtze River Delta, which also shows that Shanghai has a stronger ability to drive the development of surrounding economies than Beijing.

From the perspective of per capita spillovers of the three industries, the per capita value-added spillovers of Beijing and Shanghai to the urban agglomeration have the same characteristics that the primary industry has the smallest per capita value-added spillovers, and the secondary industry has the larges per capita value-added spillovers, The per capita value-added spillover of Shanghai's secondary industry is larger than that of Beijing, while the per capita value-added spillover of Shanghai's tertiary industry is smaller than that of Beijing. However, without considering the scale, the per capita value-added spillover induced coefficient of Shanghai's tertiary industry is greater than that of Beijing.

**Table 9.** The per capita value-added spillover of central cities

| | | Spillover of per capita added value (10000 yuan) | Spillover contribution rate of per capita added value (%) | Spillover induced coefficient of per capita added value (yuan/person) |
|---|---|---|---|---|
| Beijing's Spillover Effect | total | 1271. 39 | | |
| | primary industry | 8. 27 | 0. 65 | 0. 04 |
| | the secondary industry | 675. 23 | 53. 13 | 0. 05 |
| | the service sector; the tertiary industry | 587. 89 | 46. 22 | 0. 02 |
| Shanghai's Spillover Effect | total | 1431. 37 | | |
| | primary industry | 5. 69 | 0. 40 | 0. 02 |
| | the secondary industry | 900. 67 | 62. 99 | 0. 04 |
| | the service sector; the tertiary industry | 525. 01 | 36. 62 | 0. 03 |

# 5. Conclusions and Suggestions

## 5.1. Conclusion

This paper uses the multi regional input-output model to measure the regional spillover interaction between the central cities and the surrounding cities in Beijing Tianjin Hebei and the Yangtze River Delta, and Compare the spillover between Beijing and surrounding cities and the spillover between Shanghai and surrounding cities. The following conclusions are drawn:

First, from the regional level, Beijing and Shanghai have uneven spillover effects on surrounding cities. The added value spillover effect of central cities on surrounding cities with high economic development is stronger. And Beijing's spillover effect on surrounding cities and Shanghai's spillover effect on surrounding cities are sorted by size, with Shanghai's spillover effect on surrounding cities accounting for a higher order. Second, the spillover effect of surrounding cities on Beijing and Shanghai is uneven, and the added value spillover effect of surrounding cities with high economic development on central cities is stronger. And the spillover effect of surrounding cities on Beijing and the spillover effect of surrounding cities on Shanghai are sorted by size, and the spillover effect of surrounding cities on Shanghai occupies a higher order.

Third, there is an imbalance between central cities and peripheral cities in value-added gains. Beijing Tianjin Hebei and Yangtze River Delta present different situations. The share of spillover effects in GDP of surrounding cities to Beijing is generally small and Beijing's value-added spillover to surrounding cities is greater than that of surrounding cities to Beijing. The share of spillover effects in GDP of surrounding cities to Shanghahi is generally high, , and most of the surrounding cities' value-added spillovers to Shanghai are greater than Shanghai's value-added spillovers to the surrounding cities. This shows that the economic cooperation between Beijing and the Beijing Tianjin Hebei urban agglomeration is more to help Surrounding cities's development, while Shanghai and other cities in the Yangtze River Delta urban agglomeration support each other and develop together.

Fourth, the value-added spillovers of the three industries in Beijing and Shanghai have similar characteristics: the contribution rate of value-added spillovers of the primary industry is the largest, followed by the secondary industry, and the value-added spillovers of the primary industry are the smallest.

Fifth, from the perspective of industry segments, Beijing and Shanghai are more consistent in industries with large spillover effects on surrounding cities, and they are concentrated in the secondary and tertiary industries. The manufacturing sectors with larger spillover effects include Manufacture of transport equipment, Manufacture of communication equipment, computers and other electronic equipment; The service sector with large spillover effects focuses on Information transfer, software and information technology services, Scientific research and polytechnic services. The biggest spillover effect in Beijing is in scientific research and polytechnic services. And the spillover effect of Beijing's industries on Tianjin is greater than that on other cities. The spillover effects of various industries in surrounding cities on Beijing and Shanghai are different due to the resource endowments of various cities. Except Tianjin, the industries with high value-added spillovers in surrounding cities are mostly concentrated in the secondary industry, and these cities mainly pull the economic development of Beijing and Shanghai through their advantageous pillar industries.

Sixth, compare the value-added spillover effects of Shanghai and Beijing on urban agglomeration as a whole. Beijing's per capita spillover effect on Beijing Tianjin Hebei is smaller than Shanghai's per capita spillover effect on the Yangtze River Delta, which also shows that Shanghai's ability to drive the development of surrounding economies is stronger than Beijing's. From the perspective of per capita spillovers of the three industries, the per capita value-added spillovers of Beijing and Shanghai to the urban agglomeration have the same characteristics that the primary industry has the smallest per capita value-added spillovers, and the secondary industry has the larges per capita value-added spillovers, The per capita value-added spillover of Shanghai's secondary industry is larger than that of Beijing, while the per capita value-added spillover of Shanghai's tertiary industry is smaller than that of Beijing. However, without considering the scale, the per capita value-added spillover induced coefficient of Shanghai's tertiary industry is greater than that of Beijing. which indicates that Shanghai's tertiary industry is more closely related to the industries of surrounding cities.

## 5.2. Recommendations

In order to strengthen the coordinated development of urban agglomeration industry and promote the construction of the integrated development demonstration area of urban agglomeration, this paper puts forward the following

suggestions:

First, Regional economic development should first focus on itself. Beijing in the Beijing Tianjin Hebei region should continue the process of deindustrialization and give full play to its advantages in finance, technology and information. Tianjin's modern manufacturing industry is also relatively developed, which can transfer some heavy industries and make use of its transportation advantages to become a regional manufacturing assembly and sales base. Other cities should further optimize the industrial production capacity structure, improve the production efficiency of heavy industry, promote the industrialization process, and realize the transformation and upgrading of industrial sectors.

Shanghai should play a leading role in its capital, technology and talent, strengthen its industrial level, accelerate the development of the service industry, strengthen its radiation to other regions of the Yangtze River Delta, promote the integration of trade services in the Yangtze River Delta, and expand the opening of trade services on the basis of the free trade zone. Other cities should consolidate the foundational role of industry, expand and strengthen their advantageous industries, increase the proportion of technology intensive industries, accelerate industrial transformation and upgrading, and move towards the middle and high end of the value chain;

Second, improve the interregional industrial linkages and drive the overall coordinated development of the Yangtze River Delta. The Beijing Tianjin Hebei region and the Yangtze River Delta should focus on a higher level under the new round of opening up pattern, and form a modern industrial system with reasonable division of labor and mutual cooperation. The Beijing Tianjin Hebei region and the Yangtze River Delta should take the construction of an integrated demonstration zone as an opportunity to optimize industrial division and layout and build a world-class manufacturing industry cluster center. The key to industrial integration lies in two-way industrial linkages. Therefore, under appropriate conditions, priority should be given to the development of industries with high spillover effects.

In order to improve the industrial connection with other cities in the Beijing Tianjin Hebei region, Surrounding cities should adhere to high-end manufacturing research and development, vigorously develop petroleum, coking products and nuclear fuel processing products, chemical products, metal smelting and calendering processing products to provide material support for the development of Beijing' industries; Beijing should give priority to the development of communication equipment, computers and other electronic equipment, transportation, warehousing and postal services, finance, leasing and business services to improve the industrial connection with Surrounding cities.

Surrounding cities in the Yangtze River Delta can give priority to the development of metal smelting and calendering products and chemical products in order to improve their industrial ties with Shanghai, and Shanghai can give priority to the development of transportation, warehousing, postal services, finance, etc. The development of these industries can not only drive the development of other regional industries, but also bring greater "echo effect" to the development of the region.

Third, improve the infrastructure network layout and enhance the connectivity level of Beijing Tianjin Hebei and the Yangtze River Delta. Infrastructure connectivity is the foundation and precursor of regional integration. On the one hand, it is necessary to strengthen the connectivity of hard infrastructure, improve the city's transportation capacity, promote the two-way flow of products between regions, improve the degree of industrial relevance, and narrow the regional space distance and expand the development opportunities. On the other hand, we should strengthen the connectivity of soft infrastructure, that is, further break down the barriers to the flow of production factors, remove explicit and implicit institutional barriers, promote the free flow of talent, capital and technology, and realize the real connectivity of the Urban agglomeration.

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