The Impacts of Urban Functional Division on Economic Growth from the Perspective of the Spatial Agglomeration Theory
--The Empirical Analysis Based on Panel Data Model

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Abstract
From the perspective of the spatial agglomeration theory, this paper focuses on the impact of changes in the agglomeration level of productive service industry and manufacturing industry and its externalities on urban economic growth caused by the process of urban functional division, so as to have a deeper understanding of the economic effect of urban functional division. The empirical analysis are carried out based on the panel data of 26 cities in the Yangtze River Delta Urban Agglomeration from 2003 to 2018, the following conclusions are drawn: 1) The agglomeration level of manufacturing industry has a significant negative effect on economic growth, and the collaborative agglomeration level of productive service industry with manufacturing industry has a significant positive effect on economic growth. 2) Mar externality of manufacturing industry and productive service industry have significant negative effects on economic growth. Jacobs externality of productive service industry with manufacturing industry has a significant positive effect on economic growth. Porter externality of productive service industry has a significant positive effect on economic growth.

Keywords*-Functional Division; Industrial Agglomeration; Externality; Economic Growth; the Yangtze River Delta Urban Agglomeration*

1. INTRODUCTION

In recent years, the division of urban functions has become a common phenomenon in China's regional economic activities, which has a profound impact on the development of urban economy and even regional economy. The division of urban functions can not only promote the economic growth of each city, but also realize the regional economic growth; through the division of labor in the industrial chain, the economic ties of different cities are strengthened, and the process of regional integration is promoted, which is conducive to the coordinated development of the region; it has become the research focus of regional economy.

2. LITERATURE REVIEW AND THEORETICAL ANALYSIS

Cui Xiangyang et al. (2018) proposed that the division of urban functions is the specialized production of each city according to different links of the regional value chain, and each link creates different amount of value, thus forming a regional division system with the value proliferation link as the object[1]. Duranton and puga (2005) pointed out that with the agglomeration of most producer services in central cities and the agglomeration of most manufacturing industries in peripheral cities, the division of labor pattern in which central cities mainly play the role of producer services and peripheral cities mainly play the role of production and manufacturing has finally formed in the region[2]. Therefore, urban function division is essentially the manifestation of regional value chain division at the

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urban level. Most scholars have empirically analyzed the direct impact of urban functional division on urban economic growth. Shang Yongzhen, Chen Yao (2019), Wang Qing, etc. (2020) and Jin Tianlin, Wang Zhendong (2021) have constructed a panel regression model to conclude that urban functional division can promote urban economic growth[3-5].

In fact, in the process of urban functional division of labor, a certain number of producer services and manufacturing industries in the region have undergone spatial migration and urban exchange, resulting in changes in the number of producer services and manufacturing industries in various cities. The number of producer services in central cities has increased, while the number of manufacturing industries has decreased, The number of manufacturing industry in peripheral cities increases, while the number of producer services decreases. Finally, most of the number of producer services gather in central cities, and most of the number of manufacturing industry gather in peripheral cities[6] (Hou Jie, Zhang Meiqing, 2020). Therefore, the process of urban functional division changes the number of manufacturing industry and producer service industry in each city, which will cause the agglomeration level of manufacturing industry and producer service industry in the city to change, and then the change of urban industrial agglomeration and its externality will have an impact on urban economic growth [7] (Xiao Weidong, 2013).

According to the theory of spatial agglomeration, industrial agglomeration and its externality can improve labor productivity and increase returns to scale to promote economic growth [8] (Krugman, 1992). Industrial agglomeration is not only the same industrial agglomeration, but also the collaborative agglomeration of different industries. The two forms of industrial agglomeration will have an impact on economic growth. Furthermore, the externality of industrial agglomeration will also have an impact on economic growth. Among them, the same industrial agglomeration brings specialized economy and competitive economy, which produce Mar externality and Porter externality respectively; the collaborative agglomeration of different industries brings about diversified economy and Jacobs externality [9](Fujita et al., 2013). The existing literature discusses the impact of urban industrial agglomeration and its externality on urban economic and social development. Based on the theory of spatial agglomeration, Yang Renfa (2013) used the panel data of 269 cities in China from 2003 to 2010 to study the impact of urban industrial agglomeration and its externality on urban wage level by using the method of system generalized moment estimation. Firstly, it points out that industrial agglomeration can be divided into the same industrial agglomeration and different industrial collaborative agglomeration. Empirical analysis shows that manufacturing agglomeration has a negative impact on urban wage level, while service agglomeration has a positive impact on urban wage level; the collaborative agglomeration of manufacturing industry and service industry will also have an impact on urban wage level. Secondly, this paper empirically analyzes the influence of manufacturing and service industry agglomeration externalities on urban wage level, and finds that mar externalities of manufacturing industry have no significant influence on urban wage level, while Porter externalities and Jacobs externalities have significant influence on urban wage level; only Porter externality of service industry has a significant impact on urban wage level [10]. Yu Binbin (2019) used the panel data of 285 cities in China from 2003 to 2014 to construct the influence mechanism of the externality of industrial agglomeration on the upgrading of industrial structure. The empirical analysis found that the agglomeration of urban producer services mainly promoted the upgrading of urban industrial structure through Porter externality, while Mar externality and Jacobs externality had a significant inhibitory effect on the upgrading of urban industrial structure [11].

To sum up, although existing studies have analyzed the impact of urban functional division on urban economic growth and the impact of urban industrial agglomeration and its externality on urban economic development, they have not yet analyzed the impact of agglomeration and externality of Urban Producer Services and manufacturing on urban economic growth on the basis of regional value chain. Therefore, this paper will focus on the impact of the agglomeration level and externality of producer services and manufacturing industries on urban economic growth caused by the process of urban functional division. From the perspective of spatial agglomeration theory, we can have a deeper understanding of the economic effects of urban functional division.

3. EMPIRICAL ANALYSIS

3.1. Research objects

This paper takes the Yangtze River Delta Urban Agglomeration as an example for empirical analysis. The spatial scope of the Yangtze River Delta urban agglomeration includes 26 cities including Shanghai, Nanjing, Wuxi, Changzhou, Suzhou, Nantong, Yancheng, Yangzhou, Zhenjiang, Taizhou, Hangzhou, Ningbo, Jiaxing, Huzhou, Shaoxing, Jinhua, Zhoushan, Taizhou, Hefei, Wuhu, Maanshan, Tongling, Anqing, Chuzhou, Chizhou and Xuancheng. Yangtze River Delta Urban Agglomeration has become one of the most important urban agglomeration in the Belt and Road Initiatives and the Yangtze River economic belt. It occupies a pivotal position in China's overall modernization and reform and opening-up. It is an important platform for China's participation in international competition, an important engine for economic and social development, and a

leader in the Yangtze River economic belt. It is one of the most mature urban agglomerations in China.

3.2. Measurement method

3.2.1. Measurement method of industrial agglomeration level

This paper uses the method of Yang Renfa (2013) for reference [10], and uses location quotient to measure the level of industrial agglomeration. The calculation formula is as follows:

$$aggl_{ij} = \frac{L_{ij}/L_i}{L_j/L} \quad (1)$$

In the formula, $aggl_{ij}$ is the agglomeration level of j industry in i city; j industry includes producer services and manufacturing（j=s, m）. L_{ij} is the number of employees of j industry in i City, L_i is the total number of employees in i city; L_j is the number of employees of industry j in the region, and L is the total number of employees in the region.

At the same time, referring to the practice of Chen Guoliang and Chen Jianjun (2012) [12], we use the relative difference of industrial agglomeration level to measure the level of industrial collaborative agglomeration. The calculation formula is as follows:

$$coaggl_i = 1 - \frac{|saggl_i - maggl_i|}{saggl_i + maggl_i} \quad (2)$$

In the formula, $coaggl_i$ is the level of industrial collaborative agglomeration of *i* city, $saggl_i$ is the industrial agglomeration level of producer services in *i* city, $maggl_i$ is the industrial agglomeration level of manufacturing industry *m* in *i* city.

3.2.2. Measurement method of externality

In this paper, we use the method of Wang Haining and Chen Yuanyuan (2010) for reference to measure the externality of industrial agglomeration, and the calculation formula is as follows:

$$MAR_{ij} = aggl_{ij}/com_i \quad (3)$$

$$Jacobs_i = coaggl_i \times com_i \quad (4)$$

$$Porter_{ij} = aggl_{ij} \times com_i \quad (5)$$

In these formulas, com_i is the industrial competition degree of i city; according to the practice of Liu Sheng and Gu Naihua (2015), the logarithm of the average wage of urban workers is used to measure. It is worth noting that mar externality and Porter externality exist in producer services and manufacturing industries (j = s, m).

3.3. Model building

In this paper, the urban Cobb Douglas production function with technological progress is used to build the model:

$$Y_{it} = Ae^{\varphi_{it}} K_{it}^{\alpha} L_{it}^{\beta} \quad (6)$$

In the formula, *Y* stands for economic growth and is measured by real GDP Based on 2003; *K* stands for capital, which is measured by the capital stock calculated by perpetual inventory method with 2003 as the base period, and the depreciation rate is 9.6%; *L* stands for labor force, measured by the total number of employees. *i* is the city and *t* is the year. Ae^{φ} represents the level of technology, here represents the impact of industrial agglomeration and its externality on economic growth:

$$\varphi_{it} = \varphi(maggl_{it}, saggl_{it}, coaggl_{it}) \quad (7)$$

$$\varphi_{it} = \varphi(mMAR_{it}, sMAR_{it}, Jacobs_{it}, mPorter_{it}, sPorter_{it}) \quad (8)$$

By substituting equations (7) and (8) into equation (6) and taking logarithms on both sides, a panel regression model can be constructed:

$$lnY_{it} = c + maggl_{it} + saggl_{it} + coaggl_{it} + \alpha lnK_{it} + \beta lnL_{it} \quad (9)$$

$$lnY_{it} = c + mMAR_{it} + sMAR_{it} + Jacobs_{it} + mPorter_{it} + sPorter_{it} + \alpha lnK_{it} + \beta lnL_{it} \quad (10)$$

3.4. Data sources

The data used in this paper comes from the "China Urban Statistical Yearbook" from 2004 to 2019. At the same time, according to the national standard of industry classification, this paper subdivides the manufacturing industry and producer services: manufacturing industry includes mining industry, manufacturing industry, power, heat, gas and water production and supply industry, construction industry, a total of four industries; producer services include transportation, storage and post, information transmission, computer services and software, finance, real estate, leasing and business services, scientific research, technical services and geological exploration.

3.5. Regression results

Based on the regional differences between cities in the Yangtze River Delta urban agglomeration can not be ignored, this paper uses stata15.0 software to select fixed effect model for regression. At the same time, each city of Yangtze River Delta urban agglomeration is divided into central city group and peripheral city group for regression. Among them, Shanghai, Nanjing and Hangzhou constitute the central city group of the Yangtze River Delta urban agglomeration, because the scale level of these three cities reaches the level of mega city or mega city, and they mainly play the function of productive

services throughout the year. The regression results of each group are as follows.

3.5.1. The impact of industrial agglomeration on urban economic growth

The impact of urban industrial agglomeration on urban economic growth of Yangtze River Delta urban agglomeration is shown in Table 1.

TABLE 1. REGRESSION RESULTS OF INDUSTRIAL AGGLOMERATION ON URBAN ECONOMIC GROWTH (EXPLAINED VARIABLE: LNY)

Explanatory variable	population	Central city group	Peripheral city group
lnK	0.2518*** (0.0185)	0.3063*** (0.048)	0.2570*** (0.0215)
lnL	0.1811*** (0.0192)	-0.0053 (0.046)	0.1857*** (0.0208)
maggl	-0.1800*** (0.0536)	-0.0056 (0.1656)	-0.1675*** (0.0585)
saggl	0.0600 (0.0397)	-0.2020* (0.1084)	0.0561 (0.0432)
coaggl	0.1830*** (0.0415)	-0.3867* (0.208)	0.2076*** (0.0464)
c	10.1736*** (0.305)	11.9098*** (0.8331)	9.8915*** (0.3516)
Regional effect	Fixed	Fixed	Fixed
time effect	Fixed	Fixed	Fixed
R-squared	0.9763	0.9979	0.9746
F-value	761.87***	581.46***	622.35***
object	416	48	368

"***", "**" and "*" respectively indicate that they pass the test at the significance levels of 1%, 5% and 10%, and the values in brackets are standard deviations.

3.5.2. The influence of externality on urban economic growth

The impact of the externality of urban industrial agglomeration on urban economic growth of Yangtze River Delta urban agglomeration is shown in Table 2.

TABLE 2. REGRESSION RESULT OF EXTERNALITY TO URBAN ECONOMIC GROWTH (EXPLAINED VARIABLE: LNY)

Explanatory variable	population	Central city group	Peripheral city group
lnK	0.2433*** (0.0181)	0.3434*** (0.0702)	0.2270*** (0.0219)
lnL	0.1920*** (0.0188)	-0.018 (0.0664)	0.2023*** (0.0205)
mMAR	-1.6929*** (0.5845)	-0.0634 (2.0967)	-1.6402** (0.661)
sMAR	-6.8397*** (1.7462)	-2.1361 (6.1188)	-8.3280*** (2.2044)
Jacobs	0.0192***	-0.0397*	0.0193***

	(0.0038)	(0.0196)	(0.0042)
mPorter	0.0005 (0.0027)	0.0047 (0.0051)	0.0001 (0.0034)
sPorter	0.0656*** (0.0152)	-0.0022 (0.0455)	0.0798*** (0.0196)
c	10.3645*** (0.302)	11.2876*** (1.2252)	10.4597*** (0.3658)
Regional effect	Fixed	Fixed	Fixed
time effect	Fixed	Fixed	Fixed
R-squared	0.9776	0.9980	0.9760
F-value	731.06***	526.84***	598.06***
object	416	48	368

"***", "**" and "*" respectively indicate that they pass the test at the significance levels of 1%, 5% and 10%, and the values in brackets are standard deviations.

It can be seen from table 2 that the overall regression results reflect that the Mar externalities of urban manufacturing and producer services have a significant negative effect on urban economic growth, and the Jacobs externalities of Urban Producer Services and producer services have a significant positive effect on urban economic growth, The porter externality of urban manufacturing industry has a positive effect on urban economic growth, but it is not significant. The porter externality of urban producer service industry has a significant positive effect on urban economic growth; capital and labor have a significant positive effect on urban economic growth.

The regression results of dividing central city group and peripheral city group reflect: 1) Jacobs externality of Urban Producer Services and manufacturing industry in central city group has a significant negative effect on its own economic growth, and capital has a significant positive effect on its own economic growth. 2) The Mar externalities of manufacturing industry and producer service industry in peripheral cities have significant negative effects on their own economic growth; the Jacobs externalities of producer services and manufacturing industry have a significant positive effect on their own economic growth; the porter externality of Urban Producer Services has a significant positive effect on its own economic growth; capital and labor have a significant positive effect on their own economic growth.

4. CONCLUSION AND SUGGESTION

Urban function division is the manifestation of regional value chain division at the city level. This paper examines the impact of agglomeration level and externality of producer services and manufacturing industries on urban economic growth caused by the process of urban functional division, and analyzes the economic effect of urban functional division from the perspective of spatial agglomeration theory. Based on the panel data of 26 cities in Yangtze River Delta urban agglomeration from 2003 to 2018, the following conclusions are drawn: 1) the agglomeration level of urban manufacturing industry has a significant negative effect on urban economic growth, while the agglomeration level of Urban Producer Services has a positive effect on urban economic growth, but it is not significant, The collaborative agglomeration level of producer services and manufacturing industry has a significant positive effect on urban economic growth. 2) The Mar externalities of urban manufacturing industry and producer service industry have significant negative effects on urban economic growth; the Jacobs externalities of producer services and manufacturing industry have a significant positive effect on urban economic growth; the porter externality of urban manufacturing industry has a positive effect on urban economic growth, but it is not significant. The porter externality of urban producer service industry has a significant positive effect on urban economic growth.

Therefore, based on the empirical regression results, this paper puts forward operational suggestions from the perspective of industrial agglomeration. For the Yangtze River Delta urban agglomeration, the agglomeration diseconomy caused by excessive agglomeration of manufacturing industry will lead to the decline of labor productivity and diminishing returns to scale, which will have a negative effect on urban economic growth; therefore, some manufacturing industries can be eliminated through industrial transformation and upgrading to weaken agglomeration diseconomy and promote urban economic growth. For the central city group and peripheral city group, the central city group focuses on the production service industry, while the peripheral city group focuses on the manufacturing industry; through industrial decentralization, we can adjust the level of urban industrial agglomeration and enhance the level of industrial collaborative agglomeration, avoid the economic loss caused by the

adverse results of resource depletion, environmental pollution, rising costs and homogeneous competition caused by excessive agglomeration of a certain industry in the city, realize the improvement of labor productivity and increasing returns to scale, and promote urban economic growth.

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