

The Impact of Economic and Financial Agglomeration on China's Energy from Spatial Econometric Analysis

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ABSTRACT

The rapid development of China's economy has caused environmental pollution in China. This paper will explore whether the external economies of scale caused by China's urban economic and financial agglomeration will affect the energy efficiency of cities and enterprises in the same industry in the city, and help China reduce pollutant emissions. In addition, the paper will analyze the spatial attributes of the impact of economic and financial agglomeration on urban energy efficiency through spatial autocorrelation and spatial heterogeneity. Through the article comparing the pollutants of China's five economic and financial agglomeration areas (Beijing, Shanghai, Guangzhou, Haikou, and Shenyang) in 2014 and 2020, and the pollutant data of neighboring cities in the financial agglomeration area, this paper mainly argues that economic and financial agglomeration areas The external economies of scale caused by agglomeration can increase the efficiency of urban energy utilization, and urban energy efficiency exhibits spatial autocorrelation. The research in this paper can help to understand the impact of economic agglomeration on China's energy use. This paper can help to better balance the problem of economic development and energy emissions.

Keywords: *economic agglomeration, financial agglomeration, energy efficiency*

1. INTRODUCTION

With the development of economy and industry since Chinese economic reform, China has rapidly developed the process of urbanization. But at the same time, with it comes the underutilization of resources, environmental damage, and air pollution. Coal combustion is a significant source of air pollution problems in China [1], with more than 400,000 premature deaths associated with residential coal combustion (RCC) [2]. During the winter heating period (November 2014-March 2015), the RCC sector in urban and rural areas emitted 26% and 32% of atmospheric fine particulate matter (PM_{2.5}), respectively [3]. Entering the 21st Century, how to balance economic development and energy issues (reducing emissions, making full use of energy, and energy access) has become the primary issue that China needs to consider.

With the reform of China's financial industry and the relaxation of financial supervision, China's financial market has become more and more free, and the spatial agglomeration characteristics of the financial industry have become more and more with the rapid development of urbanization in China, urban agglomeration has

become an inevitable event. Urban agglomeration is a spatial concentration or spatial clustering. Urban agglomeration will generate financial agglomeration and economic agglomeration, which will have an impact on energy utilization efficiency. It is worth noting that financial agglomeration and economic agglomeration may have both positive and negative effects on energy issues. Positive effects: Since the gathering produces a geographically concentrated, companies or individuals can exchange ideas and information; share products, industrial chains, and technologies, and more easily match their own energy needs. This can help companies or individuals maximize energy efficiency, reduce energy use, and reduce environmental damage and air pollution while controlling costs. At the same time, financial and economic agglomeration may also have a negative impact on energy use and efficiency issues. When the city is clustered to the apex, it represents the maximum energy utilization rate. If more companies and individuals join, it will lead to a decrease in energy efficiency and an increase in costs. In addition, as financial and economic markets become more freer, barriers are getting lower and lower, leading to an increase in companies and individuals, expanding unnecessary production quantities and scales leading to

unnecessary increases in energy use and increased pollutant emissions. emission.

In recent years, researchers have gradually moved away from the inherent thinking of analyzing energy efficiency and pollution from a single dimension. More researchers have begun to pay attention to the impact of economic and financial agglomeration on energy efficiency and pollution problems. Ibrahim, Muzafar and Mohd (2017) stated that the authors used the cointegration method to study how carbon dioxide emissions in different sectors are affected by financial development [4]. The authors found that the long-term and short-term results were consistent with the conclusion that "financial development increases carbon dioxide emissions and causes environmental degradation". Hongli and Boqiang (2019) explained that there is a non-linear relationship between industrial agglomeration and energy efficiency the relationship between industrial agglomeration and energy efficiency is not invariably proportional or inversely proportional [5]. The authors show that in the case of low industrial agglomeration, adding new companies or individuals will improve energy efficiency. When the industrial agglomeration reaches a certain value, the agglomeration of new companies or individuals will reduce the efficiency of energy use. Marian, Weslyne and Juan (2008) argue that industrial symbiosis in economic agglomeration can not only increase productivity but also reduce negative environmental externalities [6]. Rui, Wei, Siling and Qi (2021) used the method of location entropy and directional SBM-DEA to study the impact of financial agglomeration on urban green energy [7]. The authors say the findings suggest that financial agglomeration increases green total factor productivity in each city (an important measure of urban green economic development and transformation), while at the same time significantly reduces green total factor productivity in urban peripheries. Huaxi, Tianshu, Yidai, Yaobin and Xinyue (2019) discussed how financial agglomeration affects green development based on agglomeration economics theory [8]. And the author studies the impact of financial agglomeration on green energy from the perspective of regional and urban heterogeneity.

Although this paper will use the above studies as the foundation and basic structural support of the research theory, there are still some limitations of these studies that deserve further study and discussion. The first point is the uncertainty of the measurement standard. There are still differences between researchers on the utilization index of coal resources, the pollution index, and the measurement standards of green energy. Second point: the financial structure of cities has been neglected in many studies. Different financial structures lead to different energy efficiency research results. For example, textile city, financial city, and industrial city. The differences of this kind of economic and financial

agglomeration institutions are worthy of our attention and discussion.

This paper will first use the theory of economic agglomeration, external economies of scale and Diseconomies of scale, to study and discuss whether and how economic agglomeration and financial agglomeration affect energy utilization and development. Next, this paper will observe and study the impact of economic and financial agglomeration in different cities and regions on energy efficiency from the perspective of spatial autocorrelation and spatial heterogeneity. The research questions of this paper are 1. Does and how does economic and financial agglomeration affect energy efficiency? 2. How do financial and economic aggregation have different effects on energy efficiency from the perspective of spatial economy? (The main direction of spatial economics research lies in what, where and why. For example spatial economics would involve regional analysis involving groupings of interrelated economic activities within proximity, specific regions or types of regions and interregional trade theory referring to the economic relationships between these regions.) [9]

2. METHODOLOGY

2.1. Data collection

This paper will focus on five major economic and financial clusters in China, Shanghai; Beijing; Shenyang; Haikou; and Guangzhou. In this article, the data comes from the 2004–2019 China Urban Construction Statistical Yearbook [10]; data population details released by the National Bureau of Statistics [11]; urban GDP data released by the National Bureau of Statistics [12].

2.2. Methods

2.2.1. External economies of scale

This paper will analyze the development of five urban agglomerations through external economies of scale. Troy Segal (2020) says that external economies of scale represent business-enhancing factors that occur outside the company but within the same industry [13]. In addition to lowering production and operating costs, external economies of scale can also reduce a company's unit variable costs due to operational efficiencies and synergies. In this article, the external economies of scale caused by economic agglomeration can help us determine the impact of economic and financial agglomeration on energy efficiency, because efficient economic agglomeration can lead to mutual influence and synergy between firms in the same industry leading to Increased energy efficiency and reduced costs.

2.2.2. Spatial autocorrelation and spatial heterogeneity

Spatial autocorrelation means that there is a mutual influence relationship between adjacent things. Spatial autocorrelation is based on Tobler's first law "Everything is related to everything else, but near things are more related than distant things —Tobler 1970 (in model urban population growth), like the second-order effect "Influence of process outcomes at one location on possible process outcomes at nearby locations". Spatial heterogeneity means that things are completely independent and do not affect each other. This paper will use spatial autocorrelation and spatial heterogeneity to identify the relationship between energy utilization in China's major economic and financial agglomeration areas and the surrounding environment, which can help us determine the impact of economic agglomeration on energy utilization issues. When comparing ongoing economic clusters with surrounding cities, in order to ensure the accuracy and reliability of the research results, the article controls the omitted variables between economic zones and surrounding cities. For example, the economic system, weather, population, and city-dominant industries are the same or similar between the economic agglomeration and surrounding cities.

3. RESULTS

3.1. The economy focuses on energy utilization

This paper will use the five economic and financial agglomeration areas in 2013 (Shanghai; Beijing; Shenyang; Haikou; Guangzhou) and the five economic and financial areas in 2020. The main pollutant emissions in the exhaust gas are compared, and the impact of the external economies of scale generated by economic aggregation on energy efficiency is found. Figure 1 comes from the data population details released by the National Bureau of Statistics. Figure 1 has three line graphs, the first line graph represents the change (x-axis) of the urban population (people) per year (y-axis). The second line graph represents the urban population as a percentage of the total population (x-axis) per year (y-axis). The third line graph represents the percent change in urban population as a percentage of total population (x-axis) for each year (y-axis). The picture shows that the proportion of China's urban population is gradually increasing. In 2013, China's urban population accounted for 54.5%, and in 2020, China's urban population accounted for 63.9%. The proportion of urban population is an important criterion for measuring urban agglomeration. Therefore, compared with 2014, Chinese cities show a trend of agglomeration in 2020.

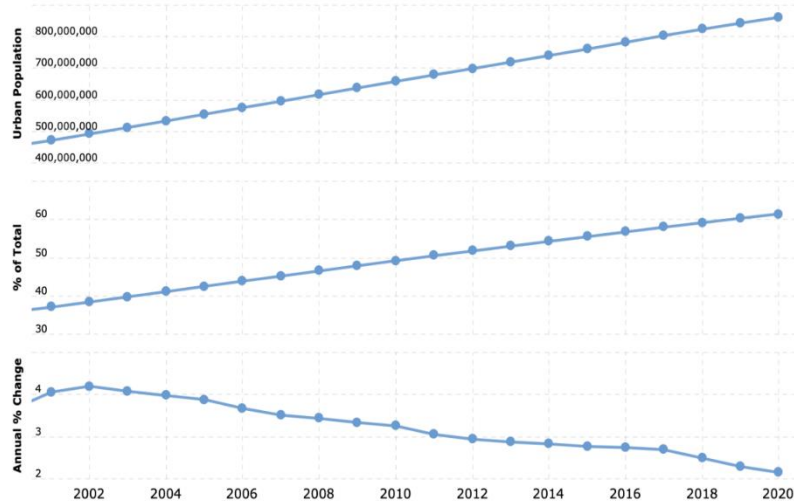


Figure 1 : data population details

Next, specific regions are analyzed. This paper will measure the external economies of scale generated by economic agglomeration in the five economic agglomeration regions by comparing the GDP of the five economic and financial agglomeration regions in 2014 and 2020. The GDP of the five economic and financial clusters in 2014 is: Shanghai: 23560.94, Beijing: 21330.8, Shenyang: 7098.7, Haikou: 1091.7, Guangzhou: 16700. The GDP of the five economic and financial clusters in 2020 is: Shanghai: 38,701, Beijing: 36,103, Shenyang: 6571.6, Haikou: 5532.39, Guangzhou: 25,019. GDP represents the economic development of the city, the growth of the city GDP

represents the progress of the city's economic agglomeration, and the city is enjoying the advantages brought by the external economies of scale, such as Beijing, Shanghai, Guangzhou, and Haikou. According to the previous prediction of the article, economic aggregation and financial aggregation will trigger external economies of scale in cities, helping counterpart companies in the same industry to reduce production and operating costs.

In addition, due to operational efficiency and synergies, external economies of scale can also reduce the company's unit variable costs, improve resource use

efficiency, and reduce pollutant emissions. Table 1 and 2 are from the data released in the China Statistical Yearbook. By comparing the emission of major pollutants in the exhaust gas of the five economic and financial agglomeration areas in 2014 and 2020, it is found that the emission of major pollutants in the other economic agglomeration areas has decreased significantly. This phenomenon can preliminarily verify

the previous conjecture in the article that economic aggregation and financial aggregation will lead to external economies of scale in cities, which can improve the efficiency of resource use and reduce pollutant emissions. Because the emission of pollutants is proportional to the urban economic and financial agglomeration (urban population ratio, urban GDP development).

Table 1. 2014 main pollutant emissions

| CITY | Industrial SO2 Emissions | Industrial NOx Emissions | Industrial Particle Emissions | Domestic and other sulfur dioxide emissions | Living and other nitrogen oxide emissions | Domestic and other particulate matter emissions |
|-----------|--------------------------|--------------------------|-------------------------------|---|---|---|
| Beijing | 40347 | 64400 | 22710 | 38475 | 14109 | 31556 |
| Shanghai | 155360 | 228621 | 131433 | 32765 | 18734 | 4017 |
| Shenyang | 131344 | 80459 | 83226 | 7251 | 2564 | 13115 |
| Haikou | 1773 | 172 | 998 | 15 | 19 | 229 |
| Guangzhou | 60159 | 51607 | 22136 | 2363 | 720 | 214 |

Table 2. 2020 main pollutant emissions

| CITY | Industrial SO2 Emissions | Industrial NOx Emissions | Industrial Particle Emissions | Domestic and other sulfur dioxide emissions | Living and other nitrogen oxide emissions | Domestic and other particulate matter emissions |
|-----------|--------------------------|--------------------------|-------------------------------|---|---|---|
| Beijing | 988 | 9571 | 4376 | 761 | 8613 | 4538 |
| Shanghai | 5200 | 23396 | 7899 | 232 | 4211 | 1298 |
| Shenyang | 9671 | 15885 | 4178 | 2680 | 1541 | 6774 |
| Haikou | 475 | 130 | 66 | 0 | 178 | 16 |
| Guangzhou | 2005 | 10605 | 6077 | 1437 | 2421 | 4285 |

3.2. The impact of economic and financial agglomeration in different regions on energy efficiency

In this step, the paper will still select three study areas (Shanghai, Beijing, and Guangzhou) from five economic and financial agglomeration regions (Shanghai; Beijing; Shenyang; Haikou; Guangzhou) to explore the impact of three economic and financial agglomeration areas on the resource utilization of surrounding cities and find out whether the impact of economic and financial agglomeration on energy efficiency is spatially autocorrelated or spatially heterogeneous.

In this research step, this paper selects the economic agglomeration area Beijing and the surrounding city Tianjin; the economic agglomeration area Shanghai and the surrounding city Nanjing; the economic

agglomeration area Shenyang and the surrounding city Changchun. Table 3 and Table 4 show the emission of major pollutants in the exhaust gas of the three economic and financial clusters and surrounding cities in 2020 and 2014. The picture data comes from the data released in the China Statistical Yearbook. The picture shows that when the emission of major pollutants in the economic and financial agglomeration area decreases, the emission of pollutants in surrounding cities will also decrease (such as Beijing-Tianjin and Shanghai-Nanjing), but when the emission of major pollutants in the economic and financial agglomeration area When rising, the amount of pollutant emissions from surrounding cities will also rise (e.g. Shenyang-Changchun). Through the comparison and analysis of the data, it can be determined that the economic and financial agglomeration of the city and the external economies of scale caused by the economic agglomeration will have an impact on the

neighboring cities. In addition, the impact of the economic agglomeration area on resource utilization will also change the energy efficiency of the cities

surrounding the economic agglomeration area (showing a positive correlation).

Table 3. 2020 main pollutant emissions

| CITY | Industrial SO2 Emissions | Industrial NOx Emissions | Industrial Particle Emissions | Domestic and other sulfur dioxide emissions | Living and other nitrogen oxide emissions | Domestic and other particulate matter emissions |
|-----------|--------------------------|--------------------------|-------------------------------|---|---|---|
| Beijing | 988 | 9751 | 4376 | 761 | 8613 | 4538 |
| Tianjin | 9756 | 29167 | 10053 | 417 | 3458 | 4428 |
| Shenyang | 9671 | 15885 | 4178 | 2680 | 1541 | 6774 |
| Changchun | 16566 | 26811 | 15464 | 6318 | 3907 | 25371 |
| Shanghai | 5200 | 23396 | 7899 | 232 | 4211 | 1298 |
| Nanjing | 9685 | 23684 | 21820 | 1 | 1644 | 151 |

Table 4. 2014 main pollutant emissions

| CITY | Industrial SO2 Emissions | Industrial NOx Emissions | Industrial Particle Emissions | Domestic and other sulfur dioxide emissions | Living and other nitrogen oxide emissions | Domestic and other particulate matter emissions |
|-----------|--------------------------|--------------------------|-------------------------------|---|---|---|
| Beijing | 40347 | 64400 | 22710 | 38475 | 14109 | 31556 |
| Tianjin | 196395 | 216947 | 112187 | 13767 | 9517 | 21072 |
| Shenyang | 131344 | 80459 | 83226 | 7251 | 2564 | 13115 |
| Changchun | 56210 | 96025 | 70944 | 7344 | 1600 | 17800 |
| Shanghai | 5200 | 23396 | 7899 | 232 | 4211 | 1298 |
| Nanjing | 103949 | 103633 | 96177 | 1750 | 400 | 1000 |

4. CONCLUSION

In the last part, after analysis and research, this paper conclude that economic and financial agglomeration can affect energy utilization efficiency, and financial and economic agglomeration will lead to external economies of scale. External economies of scale will bring rapid development to the city, such as an increase in GDP and an inflow of population. More companies in the same industry will gather in this city, they can influence each other, exchange advanced ideas and methods to improve energy use, help all companies in the same industry to improve energy efficiency, reduce energy use, reduce emission of harmful gases. Just like the relationship found in the results of this paper 'pollutant emissions and urban economic and financial aggregation'.

Through the relationship between target cities and targets the analysis of pollutant emission data of surrounding cities, this paper can answer that the impact of financial and economic agglomeration on urban

pollutant emissions presents spatial autocorrelation in space the energy efficiency and pollutant emissions of neighboring cities with the same characteristics will be affected by the target city. In this paper, when the pollutant emission of the target city is affected by the financial and economic aggregation and decreases, the pollutant emission of the neighboring city with the same characteristics will also decrease. However, when the target city does not exhibit financial and economic agglomeration, which leads to an increase in pollutant emissions, the pollutant emissions of neighboring cities will also increase, which means that the target city and neighboring cities are spatially interdependent and exhibit spatial autocorrelation.

At the same time, it should be noted that this paper still has some limitations. First, this paper only focuses on the data comparison between 2014 and 2020, although the years selected in the paper are representative (China has launched the Belt and Road economic strategy in 2013, and the economic agglomeration of Chinese cities has begun to enter a new stage), more years of pollutant

emission data support is still needed to prove the reliability of the paper's point of view. In addition, the paper analyzes all cities as single-center cities in the analysis, and the paper needs more refined data and analysis to improve the integrity of the conclusions. For example, in Table 2 and 3, the data comparison of Beijing shows that the emission data of industrial pollution in the city has increased. The potential cause of this phenomenon may be the increase in the number of companies and production caused by economic agglomeration, resulting in the increasing amount of energy used. While improving energy efficiency, it will also lead to an increase in pollutant emissions. To answer these questions, this paper needs further data support as well as future research and discussions.

AUTHORS' CONTRIBUTIONS

This paper is independently completed by Yuheng Du.

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