

# Study on the Spatial Effect of Integrated Transport Efficiency on Service Sector Agglomeration

Changping Zheng

College of Finance and Economics, Jiangsu University, Zhenjiang, 212013

**Abstract**— The comprehensive transportation efficiency has attracted more and more public attention, and the improvement of service industry agglomeration has become an urgent practical need. It is very important to study the relationship between the two. Based on this, the super-efficiency DEA method is used to measure the comprehensive transport efficiency of 30 provinces in China, and then the SDM model and the panel data from 2013 to 2020 are Based on this, the super efficiency DEA method is used to measure the comprehensive transport efficiency of 30 provinces in China, and then the SDM model and the panel data from 2013 to 2020 are used to conduct a quantitative analysis of Based on this, the super efficiency DEA method is used to measure the comprehensive transport efficiency of 30 provinces in China, and then the SDM model and the panel data from 2013 to 2020 are used to conduct a quantitative analysis of the relationship between the comprehensive It is found that the improvement of comprehensive transportation efficiency can significantly improve the degree of agglomeration of Therefore, it is necessary to coordinate the transportation links between regional core cities It is found that the improvement of comprehensive transportation efficiency can significantly improve the degree of agglomeration of service industry, and promote the neighboring areas.

**Keywords**— Service industry agglomeration; Integrated transportation efficiency; Super efficiency DEA; Overflow of space.

## I. INTRODUCTION

In recent years, the construction of various types of transportation in China has shown explosive development. At the end of 2020, the mileage of high-speed railways in China was as high as 37,900 kilometres, ranking first in the world. During the "13th Five-Year Plan" period, the construction of China's comprehensive transportation system has made historic achievements. During these five years, China's transport infrastructure network has become increasingly perfect, with the total mileage of the comprehensive transport network exceeding 6 million kilometres, the "10 vertical and 10 horizontal" comprehensive transport corridors basically completed, the mileage of high-speed railways doubled, the coverage rate of cities with a population of over one million exceeding 95%, the coverage rate of motorways for cities with a population of over 200,000 The coverage rate of expressways in cities with a population of 200,000 or more exceeds 98%, civil transport airports cover about 92% of prefecture-level cities, and rail transport in mega and mega cities has been accelerated to form a network. At the same time, the problem of unbalanced and insufficient transport development in China is becoming increasingly prominent. The balanced layout, rational structure and smoothness of the transport network are not enough, the supply of transport products does not match the demand, and the task of talent, innovation capability, core technology and green development is arduous. "The 14th Five-Year Plan period, China is facing a more complex and severe form, under the impact of the new pneumonia epidemic, the global economic counter-current. The 14th Five-Year Plan for the development of a modern integrated transport system proposes to vigorously promote the development of new technologies to improve the quality and efficiency of transport, enhance the resilience of the integrated transport system, adjust development methods, integrate green and low-carbon development concepts into the entire development process, improve national operational and strategic security capabilities,

and promote the construction and transport management and transport facilities and services in a coordinated manner, and to promote deeper integration of economic development and transport, thereby promoting high-quality transport development.

The combined effects of socio-economic base, city size and integrated transport system<sup>[1]</sup> The development of transport will strengthen economic development and widen the inequalities between regional economies<sup>[2,3]</sup> and the uneven economic development of China's regions<sup>[4,5]</sup>. The development of transport can enhance economic development and widen the inequality between regional economies, resulting in uneven regional economic development. The development of transportation can promote the flow of information, technology, population and other factors between cities<sup>[6, 7]</sup>. The transportation hubs are gradually becoming centres of industrial concentration. Efficiency refers to the organisation of different resources in pursuit of higher results with certain inputs. In the field of transport, efficiency refers to the use and allocation of resources in transport, and is usually expressed as a ratio of inputs to outputs of transport infrastructure elements<sup>[8]</sup>. It is usually expressed as the ratio of inputs to outputs of transport infrastructure elements. Initially, most of the studies were conducted on a certain kind of transport infrastructure as the object of study<sup>[9]</sup>. However, with the development of efficiency, the study of transport efficiency has gradually emerged, with the integration of public transport efficiency and urban vehicle energy consumption<sup>[10]</sup>. The study of transport efficiency has emerged as a valuable combination of public transport efficiency with urban vehicle consumption, metro efficiency with productive services, etc<sup>[11]</sup>. The study of transport efficiency has emerged as a valuable combination of public transport efficiency with urban vehicle energy consumption and metro efficiency with productive services. In the measurement of transport efficiency, the dimensions involved range from the macro level of provinces<sup>[12]</sup> and urban agglomerations<sup>[13]</sup> to the micro-enterprise level<sup>[14]</sup>. The transport modes chosen include

road<sup>[15]</sup> and railways<sup>[16]</sup>. The choice of transport modes includes road, rail and other modes. The development of the service industry is an important way to optimise the economic structure and promote economic development, and agglomeration is a characteristic of spatial distribution<sup>[17]</sup>. The service industry agglomeration has a significant impact on industrial structure upgrading, innovation<sup>[18]</sup>. It has a significant impact on the upgrading of industrial structure, innovation and so on. At the same time, the service industry is characterised by a preference for the local area, so its agglomeration effect has a smaller boundary<sup>[19]</sup>. The development of transport can shorten the distance between cities. The development of transport can shorten the spatial distance between cities, which to a certain extent can link the shortcomings of the service industry, promote the circulation of the service industry between cities and reduce the barriers to entry set by the government<sup>[20]</sup>. The development of transport can reduce the spatial distance between cities, facilitate the flow of services between cities and reduce the barriers to entry set by the government. Most of the existing scholars have studied transport infrastructure and service industries together<sup>[21]</sup>. The majority of scholars have studied the link between transport infrastructure and services, or between a particular type of transport and services<sup>[11]</sup>. They have not considered the impact of integrated transport, including roads, railways, waterways and airlines, on the service sector.

In summary, as a sector with a strong agglomeration effect, the agglomeration of the service industry can achieve economies of scale, which can improve the industrial performance of the service industry itself and also facilitate the deep integration of the service industry with other industries, thus improving the level of China's industrial and value chains. A well-developed transport infrastructure such as railways, roads, civil aviation and water transport can promote the agglomeration of service industries, thus forming a regional service centre to promote high-quality economic development. Therefore, it is of great significance to improve the efficiency of transport and thus promote the development of the regional service industry.

## II. INTEGRATED TRANSPORT EFFICIENCY MEASUREMENTS AND ANALYSIS

### A. Research Methodology and Selection of Indicators

Integrated transport is a process of social development in which multiple modes of transport, including high-speed rail, give full play to their respective technical and economic characteristics, resulting in a rational layout, coordinated structure, connectivity, competition and cooperation. Integrated transport efficiency is a comprehensive indicator that takes into account social, economic and environmental aspects. In order to evaluate the multi-input and multi-output of integrated transport efficiency, this paper uses the improved super-efficiency DAE method to measure integrated transport efficiency.

The efficiency of integrated transport is influenced by a variety of factors in several aspects, and previous studies have mostly taken the mileage and capital of various modes of transport as proxies, but this paper adds two indicators for

energy and the environment. The paper adds energy consumption of electricity in the transport sector as an input indicator, while taking into account the undesired output, adding the indicator of CO<sub>2</sub> emissions in the transport sector as a proxy, with the data of CO<sub>2</sub> emissions coming from the China Carbon Accounting Database; finally, taking into account the environmental factors, this paper chooses internal expenditure on R&D as a proxy, with technology promoting transport innovation and facilitating the traditional transport sector to draw more effective creative elements, which has a role in transport efficiency improvement has a certain role. At the same time, drawing on Song Min and Chen Yixin's<sup>[13]</sup>. The design of the indicators is finally determined as shown below (TABLE I).

TABLE II. Indicators for measuring the efficiency of integrated transport

Index	Classification	Specific indicators	Unit
Input indicators	Network factor inputs	Share of motorways in total road mileage	%
		Railway mileage	Kilometres
		Inland waterway mileage	Kilometres
	Human factor input	Number of people working in transport	10,000 people
		Equipment and facilities input	Operating vehicle ownership
	Capital investment	Investment in fixed assets in transport	billion
		Energy inputs	Energy consumption in the transport sector
Output indicators	Technology environment	R&D internal expenditure	million
		Passenger traffic	billion people
	Volume output	Cargo volume	billion tonnes
		Capital output	Value added transport GDP
Non-desired outputs	Pollution output	CO <sub>2</sub> emissions	Million tons

### B. Integrated Transport Efficiency Results and Analysis

This paper uses the software Mydea to measure the comprehensive transport efficiency of 30 provinces in China from 2000 to 2020. At the same time, China's regions are divided into East, West and East-West according to their economic development levels, and the overall efficiency values of the three regions are derived.

Overall, by 2020, all 30 provinces in China will be greater than 1, and most of the top provinces have good levels of economic development. The cities in these provinces have a good economic base that attracts many foreigners, and as the cities' population grows and industries agglomerate to place higher demands on the cities, the growing need for transport has led to the gradual improvement of urban transport, the formation of zones and networks, and the gradual improvement of transport efficiency, and an efficient, convenient and low energy consumption transport system has led these cities to a better era of development.

Between 2000 and 2020, the comprehensive transport efficiency in the eastern region is relatively stable, basically remaining around 1.05, while the efficiency in the central and western regions is not very different, both fluctuating around

1.04. The efficiency of the central and western regions, such as Shandong, Qinghai and Xinjiang, shows a phenomenon of rising, then falling and then rising, while the efficiency values of the eastern cities, such as Shanghai, Jiangsu and Zhejiang, basically exceed 1. At the same time, the average value of all provinces is greater than 1, indicating that the development of China's comprehensive transport network has gradually entered the right track, and the development has gradually become mature and achieved good results.

### III. SPATIAL SPILLOVER ANALYSIS OF INTEGRATED TRANSPORT EFFICIENCY ON SERVICE SECTOR AGGLOMERATION

#### A. Spatial correlation analysis

First, select the following variables.

Explanatory variable: service sector agglomeration(LG). This paper therefore uses the locational entropy approach to the degree of agglomeration of service industries in the following provinces.

Core explanatory variable: combined transport efficiency (CTE). This variable uses the efficiency values measured above.

Control variables: urbanisation (x1). With urbanisation, people's production, life and travel have changed significantly, and the demand for services has increased<sup>[22]</sup>, which is measured in this paper as the share of urban population in the resident population. The degree of government intervention (x2). Measured using fiscal expenditure as a proportion of GDP. Level of informatisation (x3). Measured by the share of regional telecommunication services in the national average telecommunication services. Total number of star-rated hotels (x4). The number of star-rated hotels is chosen as a measure in this paper. Human capital (x5). Using Wang Yufei's proposed<sup>[23]</sup>. The logarithm of the number of years of education per capita<sup>1</sup> is used as a measure. Marketisation index (x6). This paper uses the measured values from the China Provincial and Municipal Marketization Index database to represent the index.

Second, conduct spatial correlation analysis. The Moran index allows for a spatial correlation analysis of the explanatory variable service sector agglomeration. From the results, it can be seen that the Moran index is basically significantly greater than 0 from 2000 to 2020, indicating the existence of positive spatial autocorrelation and a significant spatial agglomeration phenomenon.

#### B. Selection of spatial model

The spatial econometric model identification was tested. It was first subjected to Lagrange multiplier tests, including LM-error and LM-lag. the results showed that all statistics were significant under the adjacency matrix, indicating that there were spatial interaction effects between the explanatory variables and between the error terms. The Wald test was further conducted and the SDM model was selected based on the test results. Therefore, the more appropriate SDM model was used in this paper. At the same time, the Hausman test was conducted and a joint significance test was carried out, and the

model was finally determined to be an individual fixed effects model.

#### C. Analysis of spatial spillover effects

TABLE II. SDM model estimation results

Variables	CTE	W*CT E	Direct effects	Indirect effects	Total effect	$\rho$
<b>z-value</b>	0.039 **	0.108 ***	0.037 **	0.093 ***	0.130 ***	-0.099 *
<b>t-value</b>	0.018	0.037	0.018	0.032	0.033	0.057

TABLE II. shows the results of the SDM model estimation. From the table, it can be concluded that the coefficient of transport efficiency is positive and passes the hypothesis test at the 5% significance level, rejecting the original hypothesis, indicating that the higher the transport efficiency, the higher the degree of agglomeration of its service industry. The coefficient of the spatial lag term of efficiency is also positive and rejects the original hypothesis at the 1% significance level, indicating that transport efficiency has a significant spatial effect, i.e. it shows that the comprehensive transport development in the province has some significant promotion effect on the development of service industries in other provinces as well. The latter part shows the results of the effect decomposition. The total effect of transport efficiency is positive and significant at the 1% level of significance, indicating that overall, transport efficiency can contribute to a limited increase in the agglomeration of service industries; the direct effect of transport on service industries is positive and significant, indicating that the increase in transport efficiency can significantly contribute to the increase in the agglomeration of service industries in the local area; the indirect effect of transport on service industries is also positive and significant, indicating that The indirect effect of transport on the service sector is also positive and significant, indicating that the efficiency of transport in the province has contributed to the increase of service sector agglomeration in the neighbouring areas during this period.

### IV. CONCLUSIONS AND RECOMMENDATIONS

#### A. Conclusion

This paper uses data from 30 provinces (municipalities and autonomous regions) in China from 2000 to 2020 as a sample, measures the agglomeration of service industries through locational entropy, combines the super-efficient DEA model to measure the integrated transport efficiency, analyzes the spatial and temporal evolution pattern of integrated transport efficiency, and explores the influence of integrated transport efficiency on the agglomeration of service industries, and obtains the following main conclusions:

1. China's comprehensive transport efficiency has generally improved, but there are differences between provinces and regions. In terms of development trend, the comprehensive transport efficiency of the whole country and each region has shown different degrees of growth, with the central and eastern

<sup>1</sup>Average years of schooling by province = 6L1 + 10L2 + 16L3. where L1, L2 and L3 denote the number of students enrolled in primary, general secondary

and general tertiary schools respectively.

regions having a clear lead and the western regions needing to be strengthened.

2. Integrated transport efficiency can, to a certain extent, promote service industry agglomeration. As the efficiency of integrated transport continues to improve, it shows a facilitating effect on the service industry agglomeration.

3. Integrated transport efficiency not only has a local effect, but also affects the agglomeration of service industries in neighbouring areas. Overall, integrated transport efficiency can significantly increase the local service industry agglomeration and produce positive spatial spillover effects on neighbouring regions.

### B. Recommendations

As China is the most dynamic and promising country in terms of economic development, there is still much room for improving the efficiency of integrated transport and the agglomeration of service industries, for which the following recommendations are made in this paper:

1. Coordinate the transport links between core cities and neighbouring cities to maximise the overall effect. Empirical studies have shown that the improvement of local transport efficiency will bring more significant positive spillover effects to the neighbouring areas. The next step is to grasp and utilise the spillover effects of the regional city centres, while integrating local resources and exploring potential zones, further refining the division of labour, promoting complementary advantages, and using various modes of transport to achieve a reasonable shift in the focus of regional development and form an internal polycentric development pattern.

2. Improve the spatial layout of integrated transport and service clusters. Provinces should take into account the characteristics of resource agglomeration, strengthen inter-regional cooperation, and promote the synergistic development of integrated transport. The government should consider cross-regional resource allocation and rely on inter-regional spatial linkages to bring into play the effects of integrated transport efficiency on neighbouring areas, as integrated transport promotes the development of service clusters in neighbouring areas.

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