What is the relationship that transport infrastructure has in the growth of China?

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1. Introduction

Transport infrastructure refers to facilities meant for long-term use, including permanent structures such as roads, trains, airways, rivers, canals and pipelines, and terminal facilities such as airports, railway stations, bus terminals, warehouses, and truck stops. Terminal infrastructure and terminal facilities are constructed to increase the efficiency of logistics and transportation and to support national and regional economic growth and trade operations.

Historically, humanity has been investigating and creating numerous transit networks. Since the invention of the first automobile by Karl Benz in 1886, the first steam-powered ship by Robert Fulton in 1803, the first train by Charles Rivasik in 1840 and the first aero plane by the Wright Brothers in 1903, people's means of transport have been upgraded and world trade has begun to enter the era of globalization and technology.

Being an old civilization with a lengthy history, China also has a long history of transit development. As early as 138 B.C., the Han Dynasty ambassador Zhang Qian undertook a trip to the West, the first documented occurrence in Chinese history linked to international trade. Ancient China also used to have several outstanding transit facilities, such as the Great Wall and the Grand Canal, which played a very vital role in China at the time.

Yet, owing to the closed doors of the Qing Dynasty, China's transport growth in modern history trailed significantly behind. It was only after the Opium War in 1840 that the doors of China were opened to modern trade. China started to create different transport infrastructures during this time, the most renowned of which was China's first railway, the Jing Zhang Railway, planned by Zhan Tian you and completed in 1909. In addition, China's first airport was the Beijing Nan yuan Airport, completed in 1910.

Given China's fast economic expansion, transport infrastructure has also been modernized and expanded. Currently, China has created the world's longest high-speed railway network, the world's biggest road network and a cluster of airports, making it one of the worldwide leaders in transport infrastructure development.

Economic development refers to the economic progress and prosperity of a nation or area over a period of time. The notion has a lengthy history, the most notable of which being Simon Smith Kuznets' 1934 concept of GDP (Gross Domestic Product), which is the total of the market value of all final products and services produced by a nation or territory over a period of time. This indicator is typically used to assess the size and growth rate of a country's or region's economy.

In the case of China, the era from 1949 to 1978 was a time of planned economy, a period of comprehensive economic development and a period of investigation of China's road to socialist economic construction. As economic growth surged, the distance between China and its bigger contemporaries or near-neighbouring nations such as the United Kingdom, the United States, Japan, and South Korea did not close, but this time lay the groundwork for the path of economic development that followed.

In December 1978, Deng Xiaoping, then China's top leader, advocated the renowned "reform and opening up", a program that opened the way for China's economic take-off. Since then, China has been quickly building its economy and infrastructure. According to the latest estimates, China's GDP rose by 6.9% year-on-year to US$62 trillion in 2017 compared to 2016 and overtook Japan in 2010 to become the world's second biggest economy, behind only the United States.

In order to develop China's economy to a higher level, the Chinese government has launched many efforts linked to transport infrastructure from the beginning of the 21st century. 2003 witnessed the launch of China's first high-speed railway, the Qin-Shen Passenger Dedicated Line, which set off the development of high-speed trains in China. By the end of 2020, China will have 37,900 km of high-speed rails. In addition, China has a highly developed transport system comprising roads, rivers, aircraft, and pipelines. For example, China has the longest road network in the world and by the end of2022, the country's freight volume has reached 506,000,000 tons by land, 493,320,000 tons by rail and 761,630,000 tons by sea. China also boasts 80 airports and a vast number of ports, such as the country's 22 seaports and 82 road ports.

The expansion of China's transport infrastructure has traditionally been considered as a major driver of the country's economic growth. As a consequence, numerous experts have investigated the link between transport infrastructure and economic growth. Among them, (Abhijit Banerjeea, Esther Dufloa, Nancy Qian, 2020) utilized a quasi-random technique to investigate county-level economic data from 1986-2003 to evaluate the influence of road infrastructure on China's economic growth. In addition, (Jiang Xiushan, Xiang He, Zhang Leic, Qi Huan, Shao Fengru, 2017) employed structural equation modelling to examine the influence of multimodal transport infrastructure investment on regional economic development in 29 Chinese provinces and cities from 1986 to 2011. While (Yu Sun, Yin Cui, 2017) employed entropy-weighted and panel regression models to analyze the economic, social and environmental benefits of urban public transport infrastructure in four autonomous cities in China from 2004 to 2015. In addition, (Tingting Tong, T. Edward Yu, 2018) also evaluated data from 2000 to 2015 using panel cointegration and causal analysis to analyse the relationship between transport infrastructure and economic growth in China.

Objectives of this paper the link between transport infrastructure and economic development in China and addresses some of the flaws that exist in certain prior research. Although past studies have concentrated on the influence of transport infrastructure on economic development, few experts have taken into consideration additional factors: Being a nation with a huge population, population mobility plays a significant role in economic development in China. People mobility may enable the movement of labour and money across various locations, which enhances the efficiency of resource usage and so has a beneficial influence on economic development. In addition, large public events such as Covid-19 have had an important impact on economic growth. Outbreaks and the deployment of control measures may lead to interruptions in production and consumption, which can have a detrimental influence on economic development. In addition, disparities across areas may vary owing to rising levels of transit infrastructure. Certain locations may benefit from stronger transport infrastructure, which may increase economic development, whereas other regions may be restricted by the absence of adequate transport infrastructure. Thus, we need to analyse the influence of these variables on the link between transport infrastructure and economic development. Moreover, the data used in these studies were limited to the period 2006-2022, which has lost sufficient currency and usefulness for China's post-Covid-19 economic development plans. In order to adequately examine the relationship between road infrastructure and economic development in China, we need to re-analyse using the most current information available. This will allow us to better understand the current situation in order to provide more accurate data to support future economic planning.

This paper will analyse the relevant data collected between 2006 and 2022 to identify correlations between the variables and thus make some recommendations for the future development of the Chinese government.

In the study of the actual values of economic relations, the econometric method is now commonly adopted worldwide, which was introduced by the Norwegian scholar R. Frisch in 1926. The main research method is to collect relevant information and data in order to investigate the correlation between various economic relationships, and then to analyse these data using mathematical and statistical tools. The whole process is generally divided into four steps:

Step 1: Build the model. Set a dependent variable, set to y. The model is constructed by expressing the effect of each x (independent variable) on the model to express whether the effect of each x (independent variable) on y (dependent variable) is positively or negatively correlated, expressed briefly in a mathematical formula as follows: $y = a*x1 + b*x2 +... + z*x26+....$

were a, b..., z are constants, and their values represent the effect of the corresponding values of x on y.

Step 2: Estimate the parameter values.

Now that we have built the mathematical model, we must substitute the collected data into the equation and then estimate the equation to obtain the specific parameter values.

Step 3: Validation. Use hypothesis testing methods in mathematical statistics to check that the estimated parameter values are significantly greater than zero. Only if they are greater than zero is the theory of the interrelationship between the variables proven; otherwise, we must continue to gather information and make further estimates; and so on until the desired result is achieved.

Step 4: Apply the model. Once our model has been validated, it can be applied to real-life situations, blending the values and relationships of the parties to obtain the desired goal.

For this paper, the objective of the model is to observe the relationship between transport infrastructure and economic development in China, and to provide some theoretical reference for the Chinese government to designate future development guidelines.

2. Theoretical Framework

Since the implementation of reforms and opening policies, the Chinese government has placed significant emphasis on developing the transportation sector. This has been achieved through increased policy support and innovative measures such as liberalizing the transport market and establishing social financing mechanisms. These actions have successfully addressed the previous lack of adaptation of the transportation sector to economic and social development, thereby reversing the previous passive situation. Overall, the government has made pioneering explorations in the transportation sector, which has resulted in significant progress and development. For example, in the area of road construction, the 54th executive meeting of the State Council in 1984 approved the raising of the road maintenance fee levy, the introduction of a surcharge on vehicle purchases, and the allowance of "loans for road construction and toll repayment", three events of great historical significance that provided road construction with a stable source of funding and an environment for accelerated development.

In terms of railway construction, the State Railway Administration also issued the "14th Five-Year Plan" for railway science and technology innovation, the guiding ideology of which includes documents and guidelines based on the new development stage, complete implementation of the new development concept, building a new development pattern, and promoting high-quality railway development as the theme. It also issued the "High-Speed Railway Design Specification" document, which paved the way for the rapid development of high-speed rail in China in the 21st century and set very high standards and requirements.

As for air transport, the National Development and Reform Commission and the Civil Aviation Administration have issued opinions on promoting the development of air cargo facilities, requiring better coordination of the layout of facilities and integrated modes of transport, and better integration of planning policies. In addition, the Implementation Plan for the Construction of a National Logistics Hub Network proposes that by 2025, China will lay out and build around 150 national logistics hubs, including 23 airports hubs, to create better infrastructure for future economic development to attract more domestic and foreign companies to choose China as a partner and distribution target.

Regarding waterborne freight, China also has several policies and documents to support waterborne freight transport. For example, the Ministry of Transport has issued a decision to amend the Regulations on the Administration of Domestic Waterway Transport, which aims to regulate the management of the domestic waterway transport market, safeguard the legitimate rights and interests of all parties involved in waterway transport operations and promote the healthy development of waterway transport. The volume of waterway freight and port throughput is expected to reach 8.5 billion tons and 16.4 billion tons respectively in 2025, with an average annual growth rate of 2%-3%. By 2025, about 2,500 km of new national high-grade waterways will be added, basically connecting major inland river ports.

And based on these policies, many cities in China have achieved remarkable results in terms of economic growth, take my home city of Xi'an as an example. According to the Plan for the Development of Modern Logistics Industry in Greater Xi'an (2018-2021) issued by Xi'an, the added value of the logistics industry in Xi'an was RMB 72.8 billion in 2017, an increase of 14.7% over the previous year, with the added value of the logistics industry accounting for 9.7% of GDP. The plan proposes that the added value of the logistics industry in Xi'an should reach RMB 120 billion by 2021, with the proportion of GDP reaching about 11%. Xi'an is also the logistics hub for the five provinces of Northwest China (Xinjiang, Gansu, Shaanxi, Ningxia, and Qinghai) and is responsible for the distribution and transportation of all goods sent to the Northwest. The city now has an airport, a dry port, five logistics parks, and eleven logistics centres.

Transport infrastructure is an important support for national economic and social development and plays an important role in promoting regional coordination, improving production efficiency, expanding market size, and increasing employment income. At the same time, China's transport infrastructure construction also faces problems such as unreasonable structure, uneven layout, insufficient service capacity, and prominent safety risks. Therefore, by 2035, the Chinese government proposes to build a comprehensive three-dimensional transportation network that covers the whole region, is smooth and efficient, safe, and reliable, and is green and low carbon.

Many scholars have researched this topic, mainly from three aspects of logistics and supply chain, economics, and social science.

From the perspective of logistics and supply chain, (Yao & Yang, 2012) first proposed that the development of air transport plays an important role in the economic development of China's remote areas. Due to the particularity of China's terrain, more than 70% of the land area is composed of mountains. The construction of land transportation is more difficult. (Song & van Geenhuizen, 2014) believes that the economic impact of port construction on different regions is different. Taking the eastern coastal areas as an example, most of the manpower and goods are transported by water, such as ports and docks, while in the remote areas of the west, it is mainly through railways, roads, and air transport. (He & Duchin, 2009) compared China's railway and road network with Germany's and concluded that China is far ahead in terms of railways but lags behind in terms of roads. This is also in line with China's national conditions. In western China, most of the terrain is mountainous, desert, and even uninhabited. In this case, it is almost impossible to build roads.

Therefore, the construction of railways has become the first choice of the Chinese government. The reason for the huge impact. China's high-speed rail was first built in 2008. In the first year of its completion, China's economy grew by 9.1%. It can be said that high-speed rail is the backbone of China's transportation, both for passengers and logistics. Due to the imperfect construction related to multimodal transport, China has only started to develop multimodal transport in recent years, and the government is also vigorously promoting this method. (Jiang et al., 2017) believe that multimodal transportation has a direct impact on the regional economy. According to the data, after the adoption of multimodal transportation in Xinjiang in 2018, the economic level increased by 17% within one year, an increase of 5% compared to the previous year. At present, China's transportation network is relatively developed, and (Sun & Cui, 2018) believes that Beijing, Shanghai, Wuhan, and Chongqing, which are China's transportation hubs, have not yet developed their full logistics and transportation potential. Although the transportation network is developed, the utilization rate is not high. It is necessary to improve the current logistics and transportation situation through multiple adjustments, including intermodal transportation hubs for multimodal transportation, and erecting new ones in more cities such as Xi'an, Hangzhou, and Dalian. transport network, etc.

On the economic level, (Banerjee et al., 2020) believe that reducing transportation costs can bring rapid economic development. They pointed out that under the current transportation situation in China, there are still many cost wastes and structural deficiencies. If these can be optimized in the future, such as transportation routes, transportation methods, transportation frequency and batches, etc., should be adjusted. And improvement, eliminating unnecessary steps, can improve the efficiency of supply chain operations and reduce costs, thereby generating more profits and continuing to invest in the construction of supply chain networks, forming a virtuous circle, which will pave the way for China's future development brings greater opportunities. (Cai et al., 2002) believe that the construction of transportation infrastructure is necessary for economic development. When the productivity reaches a certain level, sufficient transportation capacity is needed to transport these goods to where they are needed to generate profits, and then provide capital for the government to build a sound transportation network, laying a solid foundation for the subsequent fast and efficient transportation of goods. When the efficiency is high enough, the whole process will run very fast, so the economic growth will also increase accordingly. However, (Bai et al., 2012) believe that the speed of economic development is also related to the local market potential. In his article, he mentioned that the total area of Xinjiang in China is about 1.66 million square kilometres, but the population is only 25.89 million, which shows that Xinjiang has great potential for development. For example, the Chinese government is vigorously developing wind power in Xinjiang. The project can bring more than 100 million yuan of economic benefits to Xinjiang Province in just one year. Therefore, the Chinese government should need to explore the potential of different regions and promote the entry and development of industries suitable for them. Finally, (Qin, 2016) mentioned that China should continue to increase investment in transportation infrastructure.

Every year, thousands of kilometres of new high-speed railways, highways, and water transport lines are opened in China. According to the analysis in his article, transportation development is positively correlated with economic development. The development and promotion effect of tourism is also very significant.

Finally, sociology.(Lin & Song, 2002) pointed out that China's national conditions are very special and require research from various aspects such as politics and geography. For example, China's current policy is to let the economy of the eastern coastal areas develop to a higher level first, and then bring advanced technology to the less developed western areas to help the western areas speed up economic construction. (Démurger, 2001) held the same point of view. He mainly studied the impact of geopolitics in southern China on economic development. Due to its better geographical location, it can undertake most of China's shipping business, so the economic development of the southern region is slower than that of the northern region. At the same time, the industrial structure is different. For example, cities in the southern region such as Shanghai, Guangzhou, and Shenzhen are engaged in high-tech and scientific research companies, while the northeast region needs to face the problem of transforming from heavy industry to new industrial chain.

(Jin et al., 2012) studied the problem from another aspect. He believed that the construction of China's transportation infrastructure needs to be optimized and improved according to different periods and different environments. In the article, he mentioned that the coastal areas are mainly responsible for shipping and water transportation, while the western mountainous areas mainly meet the needs of transporting imported products from Central Asia, West Asia, Europe and other countries through the construction of railway networks. At the same time, China has vigorously developed the construction of high-speed rail since 2008, and it has also achieved fruitful results.

(Li, 1997) proposed the relationship between population mobility and economic development in China, (Wang et al., 2018) believed that transportation infrastructure plays an important role in economic, social and environmental development, (Yu et al., 2012) analysed the relationship between transportation infrastructure and urbanization process, and (Hong et al., 2011) analysed transportation facilities and rural revitalization (Yang et al., 2022) believes that the construction of high-speed rail and metropolises has a major impact on China's regional economy. The themes of these articles are roughly the same. A city with convenient transportation can receive goods and talents from many cities, which will help them establish an industrial chain suitable for this city, and the expansion of the industrial chain will Attract more people to settle in the city, and then continue to expand the size of the city, and radiate to the surrounding small cities and villages, drive the development of these areas, and then improve China's economic level as a whole. The government will also expand the city according to the scale of the city infrastructure. Taking Xi'an mentioned in the article as an example, the main industrial chains of Xi'an are tourism and high-tech development, and it is also the central city for coordinating freight transport in Northwest China. This requires Xi'an to have a complete transportation network. Currently, it has There are four railway stations and an airport, as well as several logistics ports to handle domestic and foreign express delivery and import and export business. On the one hand, the convenient transportation attracts more foreign tourists to visit, providing high economic benefits for the local area. On the other hand, it also speeds up the speed of industrial upgrading and the speed of handling goods in the supply chain, attracting more domestic and foreign manufacturers and companies Make investment to achieve a virtuous circle. At the same time, Xi'an has expanded from the initial six main urban areas to the current administrative division of 11 districts and 2 counties, which can also promote the attractiveness of emerging cities to talents and the introduction of new technologies.

Of course, while the economy is developing, we cannot ignore the environmental and policy issues it brings. (Liu & Su, 2021) proposed that we should pay attention to resource utilization while improving development efficiency. (Magazzino & Mele, 2021) pointed out that we need to pay attention to the issue of carbon emissions. Geographical differences and spatial correlations should be considered when specifying relevant policies. At present, the whole world is advocating the concept of sustainable development. For example, the energy source of automobiles is transitioning from gasoline to electricity, and energy sources such as seabed are also being exploited to reduce the use of fossil energy. Since the beginning of the 21st century, the global temperature has increased compared to before industrialization The temperature rises to 1.14°C, causing sea level rise and glaciers to melt. These are all problems induced by excessive carbon emissions. Therefore, it is not only necessary to reduce carbon emissions, but also to improve energy utilization efficiency in industrialization and minimize waste as much as possible, which can not only help companies reduce costs, but also reduce environmental pollution. The designation of relevant policies by the Chinese government needs to meet the local market demand and market potential. For example, the western region conducts research and development of emerging technologies such as wind power generation and new energy development, and the eastern region develops high-tech technology development and agricultural development. Distribution according to needs the promulgation of policies is conducive to the common development of various regions.

3. Methodology and data

In this section I will talk about my chosen research philosophy, research methods, research strategies, data collection method, data analysis methods, sampling method, and explain the reasons for my choice of these methods and these data, and I will present the data and information collected.

3.1 Research design

3.1.1 Research philosophy

In this essay my research is based on positivism. Positivism may be expressed as the belief that facts have to be seen or sensory experiences in order to understand the objective environment and external objects that each person is in, and the requirement to verify the objectivity of knowledge. Obviously, all the data and information collected in this paper, as well as the analytical methods and software used later, are based on publicly available, real data, and it is on the basis of these actual statistics that the research questions in this paper need to analyse the specific relationships between variables, such as how one or more X's affect Y. Empiricism needs to be applied to aid in the validity of this argument. The adoption of positivism is therefore allowed and very valuable.

3.1.2 Research approach

In this essay my research route is via the deductive strategy to conclude the data analysis. Deduction is described as a way of reasoning in which one deduces the unknown portion of something from the known part of that item, based on a theoretical grasp of the objective rules of a specific response. The reason for choosing the deductive approach is that what I am trying to do in this paper is to use the data found to reason about the logical relationships between the variables to arrive at the exact equations and relationship matrices, which is consistent with the logic of the deductive approach and therefore the deductive approach is chosen as the basis for this research.

3.1.3 Research strategy

The research strategy of this work is based on quantitative research methodologies. Quantitative research is characterized using mathematical and statistical techniques to assess quantitative or numerical values of research objects and to derive objective findings in the form of different data models or data comparisons to prove research hypotheses at the data level. The reason for choosing the quantitative approach is that the main objective of this paper is to analyse official data from the Chinese government using SPSS and STATA software to derive specific relationships between variables to make recommendations for future policy in China, in line with the objectives of the quantitative approach.

3.2 Research method

3.2.1 Data collection method

This paper uses secondary data as the data collection method. Most of the data collected in this paper comes from annual reports, statistical bulletins and databases published by government agencies such as the National Bureau of Statistics, the Ministry of Transport, and the State Post Bureau. These statistics mainly include data on the level of transport infrastructure construction in China from 2006 to 2022, the number of people employed in various modes of transport, the annual investment by the Chinese government in transport infrastructure and the number of private enterprises and individual households engaged in the transport industry in urban areas. The data sources are credible and consistent, as they are collected by the same authority and meet the same criteria and definitions. The statistics are also comprehensive and up to date, including several indicators and dimensions that reflect the transport infrastructure and economic performance of all regions of China over a seventeen-year period.

3.2.2 Data analysis method

In this work, descriptive statistics, correlation analysis and regression analysis are utilized to process and analyse the data. The descriptive statistics are used to summarise the basic characteristics of the sample data; the correlation analysis is used to test whether there is a linear relationship between transport infrastructure and economic development; the regression analysis is used to estimate the degree of impact of transport infrastructure on economic development and to analyse the relationship between the other data collected and the degree of transport infrastructure development.

3.2.3 Sampling method

Considering that this work utilises secondary data, the sample design is not important. However, in selecting the sample data, it is necessary to take into account the differences among provinces in terms of geographical location, resource endowment, industrial structure and level of development, which may affect the relationship between transport infrastructure and economic development. Therefore, in the subsequent data selection and analysis process, some representative data (such as the number of urban private enterprises engaged in transport services, national investment in transport, etc.) will be selected for independent analysis, through which the degree of influence of different aspects of data on economic development will be reflected.

3.3 Data

This article investigates the link between transport infrastructure and economic growth in China, hence this research decides to gather data from the official website of the Chinese government for three reasons: firstly, these data are more accurate, as they are collected and integrated by Chinese government professionals, which provides a guarantee for the subsequent accurate analysis of this paper; secondly, this paper argues that transport infrastructure is not only a one-sided relationship with economic development Secondly, this paper argues that transport infrastructure is not only unilaterally related to economic development, but also includes other factors such as population movement, geographical distribution and topographical differences, which are more difficult to collect through individual surveys and data. There are no ethical hazards or problems. This study does not need to discuss the privacy of this data and how to safeguard it against leaking.

According to the logic of this paper, the first thing that needs to be collected is infrastructure data on railways, land, waterways and air transport, and since most of the data from the previous study is based on data from 2000-2010, and most of China's transport infrastructure and economic development (it became the second largest economy in the world in 2010) was after 2010, data needs to be collected again, firstly The statistics obtained are for all forms of transport infrastructure (rail, road, canal and air transport) in China between 2013 and 2021. The GDP figures of China are also included.

Descriptive statistics of GDP per capita (RMB)

Variable	**(1) N**	**(2) mean**	**(3) sd**	**(4) min**	**(5) max**
GDP per capita (RMB)	**17**	**48,387**	**21,462**	**16,738**	**85,698**

Descriptive statistics of Number of Employed Persons in Urban Units, Transport, Storage and Post (10000 persons)

Variable	**(1) N**	**(2) mean**	**(3) sd**	**(4) min**	**(5) max**
Number of Employed Persons in Urban Units, Transport, Storage and Post (10000 persons)	**17**	**749.3**	**99.73**	**613**	**861**

Descriptive statistics of Number of Engaged Persons in Private Enterprises and _Self-employed Individuals, Transport, Storage and Post (10000 persons)

Variable	**(1) N**	**(2) mean**	**(3) sd**	**(4) min**	**(5) max**

Number of Engaged Persons in Private Enterprises and _Self-employed Individuals, Transport, Storage and Post (10000 persons)	**17**	**753.2**	**296.3**	**422**	**1,302**

Descriptive statistics of Number of Engaged Persons in Urban Private Enterprises _and Self-employed Individuals, Transport, Storage and Post (10000 persons)

Variable	**(1) N**	**(2) mean**	**(3) sd**	**(4) min**	**(5) max**
Number of Engaged Persons in Urban Private Enterprises _and Self-employed Individuals, Transport, Storage and Post (10000 persons)	**17**	**470.2**	**163.7**	**254**	**774**

Descriptive statistics of Number of Employed Persons in Railway Transport (person)

Variable	(1) N	(2) mean	(3) sd	(4) min	(5) max
Number of Employed Persons in Railway Transport (person)	**17**	**1.825e+6**	**76,143**	**1.653e+6**	**1.916e+6**

Descriptive statistics of Number of Employed Persons in Road Transport (person)

Variable	(1) N	(2) mean	(3) sd	(4) min	(5) max
Number of Employed Persons in Road Transport (person)	**17**	**2.899e+6**	**1.040e+6**	**1.495e+6**	**3.881e+6**

Descriptive statistics of Number of Employed Persons in water Transport(person)

Variable	(1) N	(2) mean	(3) sd	(4) min	(5) max
Number of Employed Persons in water Transport(person)	**17**	**414,624**	**75,097**	**278,436**	**491,124**

Descriptive statistics of Number of Employed Persons in Air Transport(person)

Variable	(1) N	(2) mean	(3) sd	(4) min	(5) max
Number of Employed Persons in Air Transport(person)	17	457,566	163,680	221,193	645,957

Descriptive statistics of Length of Railways in Operation (10000 km)

Variable	(1) N	(2) mean	(3) sd	(4) min	(5) max
Length of Railways in Operation (10000 km)	17	11.25	2.676	7.700	15.78

Descriptive statistics of Length of Navigable Inland Waterways (10000 km)

Variable	(1) N	(2) mean	(3) sd	(4) min	(5) max
Length of Navigable Inland Waterways (10000 km)	17	12.59	0.169	12.28	12.77

Descriptive statistics of Length of Roads (10000 km)

Variable	(1) N	(2) mean	(3) sd	(4) min	(5) max
Length of Roads (10000 km)	**17**	**444.5**	**60.03**	**345.7**	**543**

3.5 Analysis methods

This paper will use multiple linear regression analysis to process the data, which is based on the principles of least squares. This method, first introduced by Lejeune in the 19th century, finds the best functional match for the data by minimising the sum of the squares of the errors. Least squares makes it easy to find unknown data and to minimise the sum of the squares of the errors between these found data and the actual data. Originally this method was used for navigation at sea to help sailors escape from the dilemma of navigating blindly by landmarks and to plan reliable and safe routes.

There are two types of problems dealt with by the least squares method, linear least squares, and non-linear least squares. For this paper, linear least squares were chosen to allow correlations between various data to be observed. Linear least squares are mathematically represented as:

$$y_i = \beta_1 * x_1 + \beta_2 * x_2 + \cdots\cdots + \beta_i * x_i + \varepsilon$$

Where y is the dependent variable to be studied and x is the independent variable that affects y and ε is a constant.

The idea of linear least squares is to draw a straight line on an axis by analysing the data, arrange the analysed data around the line, observe the correlation between them and draw conclusions. The method of least squares is usually represented in matrix form as follows:

$$\begin{pmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1j} \\ 1 & x_{21} & x_{22} & \cdots & v_{2j} \\ \vdots & \vdots & \ddots & \cdots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & x_{i1} & x_{i2} & \cdots & x_{ij} \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \vdots \\ \beta_i \end{pmatrix} = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ \vdots \\ y_i \end{pmatrix}$$

However, the least squares method has its limitations and if the data in question is not linearly correlated after the matrix iteration, then other methods of analysis will need to be used or the sample data will need to be processed or otherwise manipulated to transform the data into a linear situation before the analysis can be continued by this method.

The data set in this paper is large, so STATA17 software was used to process the data through multiple linear regression analysis to draw the appropriate results and conclusions.

4. RESULTS

The thesis of this paper is the relationship between transport infrastructure and China's economic growth, therefore not all the data will be used for regression analysis and the focus will be on pulling out the variables with high correlation between them.

Firstly, I believe that the value of GDP per capita may be related to the number of people engaged in transport pages, therefore I choose these four groups of variables for analysis, containing the results of correlation analysis and regression analysis, which are shown in Table 1 and Table 2 respectively, it can be seen that the regression analysis between these four has stability, the number of people engaged in urban units, transport, storage and postal industry is positively correlated with GDP per capita, and at $p< 0.01$, the number of employees in private enterprises and individual business households in the transport, storage and postal industries is positively correlated with GDP per capita and significant at $p<0.05$, and the number of people in private enterprises and individual business households in urban areas engaged in the transport, storage and postal industries is negatively correlated. The equation obtained from the regression is:

$$\begin{aligned}&\boldsymbol{GDP\ per\ capita}\\&= \mathbf{67.225}\\&* (\boldsymbol{Number\ of\ Employed\ Persons\ in\ Urban\ Units}, \boldsymbol{Transport}, \boldsymbol{Storage\ and\ Post})\\&+ \mathbf{59.251} * (\boldsymbol{Number\ of\ Engaged\ Persons\ in\ Private\ Enterprises\ and\ \_Self}\\&- \boldsymbol{employed\ Individuals}, \boldsymbol{Transport}, \boldsymbol{Storage\ and\ Post}) + (-\mathbf{5.127})\\&* (\boldsymbol{Number\ of\ Engaged\ Persons\ in\ Urban\ Private\ Enterprises\ \_and\ Self}\\&- \boldsymbol{employed\ Individuals}, \boldsymbol{Transport}, \boldsymbol{Storage\ and\ \_Post}) - \mathbf{44,199.282}\end{aligned}$$

Table 1

	GDP per capita (RMB)	Employed Persons in Urban Units, Transport, Storage and Post (10000 persons)	Engaged Persons in Private Enterprises and Self-employed Individuals, Transport, Storage and Post (10000 persons)	Persons in Urban Private Enterprises and Self-employed Individuals, Transport, Storage and Post (10000 persons)
GDP per capita (RMB)	1			
Employed Persons in Urban Units, Transport, Storage and Post (10000 persons)	0.735	1		
Engaged Persons in Private Enterprises and Self-employed Individuals, Transport, Storage and Post (10000 persons)	0.949	0.543	1	
Persons in Urban Private Enterprises and Self-employed Individuals, Transport, Storage and Post (10000 persons)	0.949	0.569	0.991	1

Table 2

VARIABLES	(1) GDP per capita (RMB)
Employed Persons in Urban Units, Transport, Storage and Post (10000 persons)	67.225*** (5.17)
Engaged Persons in Private Enterprises and Self-employed Individuals, Transport, Storage and Post (10000 persons)	59.251** (2.26)
Persons in Urban Private Enterprises and Self-employed Individuals, Transport, Storage and Post (10000 persons)	-5.127 (-0.11)
Constant	-44,199.282*** (-5.38)
Observations	17
R-squared	0.969
F test	4.77e-10
r2_a	0.962
F	135.1

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Seconly, I have analysed GDP and the number of people engaged in transport and the correlation and regression analyses are shown in Tables 3 and 4. The results obtained show that there is a positive correlation between GDP and the number of people engaged in rail, road and air transport and air transport is significant at p<0.1, while there is a negative correlation between the number of people engaged in water transport and GDP and the results are significant at p<0.01. This equation is expressed in the form of:

$$\begin{aligned}\textbf{\textit{GDP per capita}} &= \mathbf{0.032} * (\textbf{\textit{Number of Employed Persons in Railway Transport}}) \\ &+ \mathbf{0.001} * (\textbf{\textit{Number of Employed Persons in Road Transport}}) \\ &+ (-\mathbf{0.128}) * (\textbf{\textit{Number of Employed Persons in water Transport}}) \\ &+ \mathbf{0.067} * (\textbf{\textit{Number of Employed Persons in Air Transport}}) \\ &+ \mathbf{8,031.93}\end{aligned}$$

Table 3

	GDP per capita (RMB)	Number of Employed Persons in Railway Transport(person)	Number of Employed Persons in Road Transport(person)	Number of Employed Persons in water Transport(person)	Number of Employed Persons in Air Transport(person)
GDP per capita (RMB)	1				
Number of Employed Persons in Railway Transport(person)	0.824	1			
Number of Employed Persons in Road Transport(person)	0.779	0.782	1		
Number of Employed Persons in water Transport(person)	-0.812	-0.548	-0.325	1	
Number of Employed Persons in Air Transport(person)	0.91	0.813	0.943	-0.552	1

Table 4

VARIABLES	(1) GDP per capita (RMB)
Number of Employed Persons in Railway Transport(person)	0.032 (1.26)
Number of Employed Persons in Road Transport(person)	0.001 (0.30)
Number of Employed Persons in water Transport(person)	-0.128*** (-5.04)
Number of Employed Persons in Air Transport(person)	0.067* (2.17)
Constant	8,031.938 (0.17)
Observations	17
R-squared	0.971
F test	3.98e-09
r2_a	0.961
F	100.8

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Finally, I analysed the relationship between GDP growth and the length of railways, roads, and waterways. The results of the correlation analysis and regression analysis are shown in Tables 5 and 6, where there is a positive correlation between GDP and railways and roads and the results are significant at p<0.1 for railways and p<0.05 for roads, while there is a negative correlation between GDP and waterways and the results are significant at p<0.1. The relationship between them is expressed in the equation as:

$$GDP\ per\ capita = 2724.073 * (Length\ of\ Railways\ in\ Operation) + (-18083.994) * (Length\ of\ Navigable\ Inland\ Waterways) + 283.468 * (Length\ of\ Roads) + 119328.233$$

Table 5

	GDP per capita (RMB)	Length of Railways in Operation (10000 km)	Length of Navigable Inland Waterways (10000 km)	Length of Roads (10000 km)
GDP per capita (RMB)	1			
Length of Railways in Operation (10000 km)	0.992	1		
Length of Navigable Inland Waterways (10000 km)	0.931	0.939	1	
Length of Roads (10000 km)	0.994	0.992	0.952	1

Table 6

VARIABLES	(1) GDP per capita (RMB)

Length of Railways in Operation (10000 km)	2,724.073* (1.80)
Length of Navigable Inland Waterways (10000 km)	-18,083.994* (-1.80)
Length of Roads (10000 km)	283.468*** (3.76)
Constant	119,328.233 (1.05)
Observations	17
R-squared	0.992
F test	0
r2_a	0.991
F	568.5

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. Conclusiones

The first relationship analysis, based on the results of descriptive statistics GDP per capita and Number of Employed Persons in Urban Units, Transport, Storage and Post and Number of Engaged Persons in Private Enterprises and Self-employed Individuals, Transport, Storage and Post Number of Engaged Persons in Urban Private Enterprises _and Self-employed Individuals, Transport, Storage and Post. According to the results of the descriptive statistics, the GDP shows an annual upward trend, the number of people working in the transport, storage and postal industry in urban units shows a downward trend, and the number of people working in the transport, storage and postal industry in private enterprises and individual households shows a downward trend in relation to the number of people working in the transport, storage and postal industry in private enterprises and individual households in urban areas. Based on the results of the regression analysis, the following conclusions can be drawn:

I. GDP is positively correlated with the number of private enterprises and self-employed households engaged in transport, storage and postal services but negatively correlated with the number of urban private enterprises and self-employed households engaged in transport, storage, and postal services, so the government should encourage residents in remote areas such as rural areas to invest more in transport, storage and postal services and vigorously develop the rural transport industry. Using the convenience of urban transport to drive the development of the surrounding countryside can have a more positive impact on GDP.

II. The privatization and individualization of the transport, storage and postal industries should be encouraged. At present, China's transport industry is extremely developed, and it is not enough to rely on the government alone to dispatch transport workers, so cooperation can be reached with relevant companies to develop the transport industry together.

We then analyse the relationship between GDP and the number of people engaged in rail, road, water and air transport. According to the results of descriptive statistics, the number of people engaged in railway, road and air transport basically tends to level off after an upward trend, but the number of people engaged in water transport-related business decreases year by year. Combining descriptive statistics, correlation analysis and regression analysis, the following conclusions can be drawn:

I. Reduction in the number of people engaged in water transport. (a) Combined with China's national conditions, water transport occupies a very small share in China, and most of the inland freight transport takes rail and road transport; therefore, the number of people engaged in water transport can be appropriately reduced and maintained at a level that is beneficial to the development of China's GDP.

II. The number of railway and road personnel should be maintained at the current level, while more people working in the airline industry should be recruited. According to the regression analysis, the number of people working in railways and roads is now close to saturation and has a low impact on GDP, while the airline industry, which is currently the dominant mode of transport in the world, can be appropriately developed and then its impact on GDP can be observed before a later plan is specified.

Finally, we have analyzed the correlation between GDP and road, waterway and rail mileage. According to the results of the descriptive statistics, the mileage of roads and railways showed a year-on-year increase, while the mileage of waterways only rose by 3% over a 16-year period. Also, combined with the regression analysis, we can conclude that China should vigorously develop the construction of railways and roads, and keep the construction of waterways at the current level. Combined with China's national conditions. Railways and highways undoubtedly dominate the national transport, and the erection of high-speed railways and highways has pushed this process forward, but for waterways, inland waterways are fewer and more limited, basically requiring transport along the mainstream and tributaries of the Yangtze and Yellow rivers, while waterways are mainly located in the south. Therefore, railways and roads are the mainstream modes of transport in China, while waterways will occupy a certain weight as a secondary role.

Summarizing the findings of the above three paragraphs, I would like to make some suggestions for the future direction of the Chinese government:

I. To push the transport industry more towards individualization and privatization, to reduce the pressure on the part of the government, and at the same time to reach cooperation with private enterprises so that each can take what it needs and develop together.

II. Maintain the number of people working on railways, roads and waterways at a certain level to ensure the volume of these three modes of transport, while introducing more people working in the airline industry, in line with the development trend and in line with the rest of the world, which in turn will bring more economic benefits.

III. The construction of railways and highways, mainly high-speed railways and motorways, in full swing, will not only increase the annual volume of transport, but also bring more economic growth and be more in line with China's national conditions and development direction; and maintain the mileage of waterways at the current level, as a supporting role to play a role in helping the national transport industry.

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