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The Impact of China's Transportation Industry Development on GDP

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Abstract

The transportation industry is the most basic of many economic industries in China, but it plays an irreplaceable role in the development of our economy. As an important part of the national economy, China's transportation industry has great influence on the economic development of the country. This paper analyzes the relationship between the transportation industry and GDP, studies the contribution of the transportation industry to GDP and the impact mechanism of the development of the transportation industry on GDP growth, and systematically analyzes the development status quo, characteristics, problems and countermeasures of China's transportation industry by using literature analysis, data collection, empirical analysis and problem research methods. The empirical method used in this paper is co-integration analysis method. Through this method, it is concluded that highway mileage, inland waterway mileage and regular flight route mileage have no significant impact on China's GDP, while railway operating mileage, oil (gas) pipeline mileage and cargo throughput of coastal ports have significant impact on China's GDP. China's GDP will increase by 81,383.5 billion yuan; Every 1% increase in the mileage of oil and gas pipelines will reduce China's GDP by 27,851.4 billion yuan; For every 10,000 tons increase in cargo throughput at coastal ports, China's GDP will increase by 0.934126 million yuan. This paper aims to provide scientific basis for the study on the relationship between the development of China's transportation industry and GDP, and provide theoretical and practical support for promoting the sustainable development of the transportation industry and promoting China's economic growth.

Keywords: Transportation industry；GDP；China；Integration analysis

1. Introduction

China's transportation industry is a rapidly developing and highly diversified field that has experienced significant development and modernization in recent years. China has invested heavily in transport infrastructure in recent years, including roads, railways, waterways and airports. The rapid development and upgrading of these infrastructures has helped promote economic growth and reduced the loss of goods due to inaccessibility. With the shift in e-commerce models, especially in fast fashion, there is a growing demand for air freight. Some Chinese companies have aggressively expanded their cargo fleets to accommodate the growth of the straight-line mode of transportation in e-commerce. In terms of e-commerce logistics automation, China has reached a high level. Warehouse operations and omnichannel integration face new consumer trends and challenges that require more technology investments to improve efficiency. China's transportation industry is constantly developing and adapting to new market demands through technological innovation, infrastructure investment and industry consolidation. These changes are not only having an important impact on the domestic economy, but also reshaping the logistics and transport industry on a global scale.

1.1 Research Background

As China is a developing country, the impact of transportation on the economic and social development of our country is very great. In recent years, with the rapid growth of China's economy, under the influence of the national strategy to promote the development of the west, China's transportation industry has developed rapidly, and various transportation networks have gradually improved and the layout is more reasonable. Therefore, it can be said that the transportation industry is a prerequisite for the survival and development of other sectors of the national economy and determines the development and progress of modern society [1]. However, at present, there are not enough theoretical studies on the impact of the development of China's transportation industry on GDP, so it is necessary to further study this.

1.2 Research Objectives

The purpose of this paper is to explore the impact of the development of China's transportation industry on GDP, and analyze its impact mechanism. Through the analysis of the relationship between the transportation industry and GDP, this paper studies the contribution degree of the transportation industry to GDP and the impact mechanism of the development of the transportation industry on GDP growth. It can provide a scientific basis for the government to formulate relevant policies, promote the sustainable development of the transportation industry, and promote economic growth.

1.3 Research significance

The significance of this study on China's transportation industry is multifaceted and has important strategic significance. Transportation is the foundation and power source of economic development and GDP growth. Efficient transport networks help facilitate the rapid movement of goods and people, which is essential to enhance market efficiency, reduce logistics costs, and increase productivity. It is related to People's Daily travel, quality of life and social well-being. By studying China's transportation system, we can better understand how to provide safer, more convenient and more environmentally friendly transportation services, and how to improve people's living and working conditions through transportation. An in-depth study of China's transport sector can provide policymakers with valuable insights and data support to help them make more informed decisions and formulate more effective policies and programs to promote the healthy and sustainable development of the transport sector. This study of China's transport sector not only contributes to a deeper understanding of its economic and social role at home, but also provides valuable lessons and insights on how to build efficient and sustainable transport systems on a global scale.

1.4 Main contents of the study

The transportation industry is an important support for national economic development. Developed transportation networks can promote the flow of goods and people, accelerate the allocation of resources and market exchanges, and promote economic prosperity. Transportation plays a fundamental role in economic development. Transportation is one of the infrastructure of national economic development, which provides a guarantee for the flow of production factors. Whether the transportation network is perfect or not directly affects the circulation and allocation efficiency of various resources. For example, areas with convenient transportation can access resources faster, reduce production costs, and improve economic efficiency. In addition, in the modern economy, the division of labor is increasingly refined, frequent logistics transportation is required between various links, and the speed of transportation also directly affects the timely delivery of products, further affecting the production efficiency and market competitiveness.

This paper will analyze the development status of China's transportation industry, explore the impact of transportation industry on GDP, and analyze its impact mechanism, as well as analyze the development status of China's transportation industry, the development of various transportation industries, the total mileage of roads and railways, the improvement and expansion of urban roads, and the construction and application of intelligent transportation systems. And the impact and importance of current transportation on GDP [2].

1.5 Explanation of relevant basic theories

The transportation industry refers to the transportation of people, goods or resources to their destinations through various modes of transportation. This industry includes a number of different modes of transportation, including but not limited to land transportation (such as cars, trains), water transportation (such as ships, ships), air transportation (such as aircraft), and pipeline transportation (such as natural gas pipelines). The transportation industry plays a vital role in modern society. Although it does not create new material products, change the material form of the object of labor, nor increase its quantity, it can change the spatial position of the object of labor, increase the value of the product, and meet social needs. It connects different regions, countries and continents, promotes economic development and cultural exchanges, and this industry involves many aspects, including the construction of transport infrastructure, the manufacture of transport vehicles, the provision of transport services, and related management and supervision.

2. Literature review

2.1 Analysis of Chinese domestic literature

As of 2023, China's transport sector has shown solid development momentum, benefiting from proactive growth policies and consumption potential gradually released since the beginning of the year.

Wu Ying (2009) believes that transportation is the "vanguard" of economic development and plays a great role in promoting national economic development. However, in the period of rapid economic development and with limited social resources, transportation infrastructure investment in different regions has different impacts on economic growth [3].

Wang Zhigang (2010) believes that having strong infrastructure conditions, especially the increasingly perfect transportation system, is a favorable guarantee for China's rapid economic growth. In infrastructure construction, transportation infrastructure construction accounts for a considerable proportion. Therefore, the development of transportation industry has played an irreplaceable role in regional economic growth [4].

Liu Shenglong and Wu Li (2009) demonstrated the importance of infrastructure construction to the economic growth of developing countries and believed that transportation investment had a significant positive impact on economic growth [5].

Through co-integration test and Granger causality test, Hao Sijie and Zhu Changzheng (2013) find that expressway development is the Granger cause of real economic growth. By establishing a vector autoregressive model, they find that expressway development contributes more to economic growth in the middle and late period, but less in the early period [6].

Xie Weihua (2023) believes that in the new era, all aspects of national undertakings are developing rapidly. With the introduction of "Internet", the transportation industry has been given new vitality. In order to adapt to the overall development of society, the state should optimize fund management, improve service quality, and lay the premise and foundation for the development of transportation economy [7].

Zhang Sansheng (2006) believes in his research that the development focus of the transport industry will shift from the previous total expansion to total expansion, structural adjustment and risk adjustment, and implement the urban-rural transportation integration strategy [8].

Ge Yunhua(2021)believes in his research that we will increase investment in transport infrastructure, including building more roads, Bridges and transport hubs. At the same time, the construction and management of public transportation system should be strengthened to encourage people to use public transportation [9].

2.2 Literature analysis outside China

Scholars outside China have also done valuable research on the relationship between transportation and economy.

SlingSlien(2000) concluded that the research on the coordination between transportation and economy and society originated from the requirements of social sustainable development [10].

As the author of "Transport, Environment and Sustainable Development" and "Transport for a Sustainable Future: The Case of Europe", he analyzed the environmental hazards caused by transport in Europe and the United States, and gave policy countermeasures. The economic and environmental efficiency of the transport system should be improved by pursuing sustainable development [11].

With the development of China's economy, many foreign scholars studying China have paid great attention to the achievements of China's economic development in the new era. That is,

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continue to optimize economic structure, improve quality and efficiency, while increasing public financial revenue and promoting GDP growth [12].

2.3 Literature review

The above literature has achieved good results in the research direction of all aspects of transportation, enriched the literature materials in the database, and laid a solid foundation for subsequent research. The research direction is mainly from the impact of transportation development on social and national economy and the correlation between the two, extending to the path evolution of sustainable development in the later period. There are many research methods, including data empirical analysis and text description, which have played a great role in the subsequent research on the development of China's transportation industry. China's transportation industry is a very large industry system, which affects the economic lifeline of the society and the country, so the research on the development of China's transportation industry has very scientific theoretical and practical significance.

3. Current situation of China's transportation industry and GDP

After decades of development, the type and quality of transportation in our country have improved a lot. From the initial land transportation, to aviation, aerospace, Marine and other fields, the performance and safety of many vehicles have been significantly improved. Secondly, great achievements have been made in the construction of transportation networks. In recent years, with the improvement of road, railway, air, water and other transportation networks, our travel has become more convenient and efficient. In addition, the transportation industry also provides a large number of jobs for employment and has made positive contributions to China's economic development and growth [13].

3.1 The throughput of China's coastal ports continues to rise

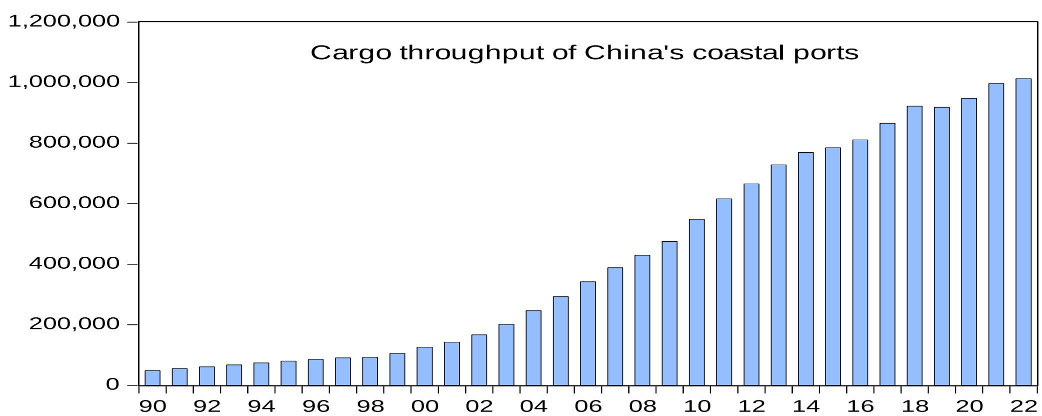

Figure 1. Cargo throughput of China's coastal ports, 1990-2022 (unit: 10,000 tons)

As can be seen from Figure 1, the cargo throughput of China's coastal ports in 1990 was 483.21 million tons. In 2022, the cargo throughput of China's coastal ports will be 10.13102 million tons, which is 21 times that of 1990. In the past 33 years, the cargo throughput of China's coastal ports has been on the rise.

3.2 The route mileage of China's highways and scheduled flights is on the rise

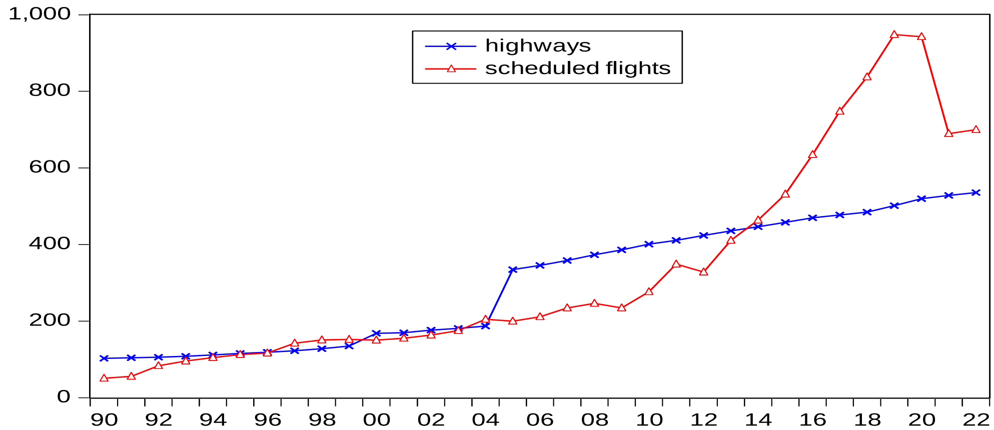

Figure 2. Route mileage of highways and scheduled flights in China from 1990 to 2022 (unit: 10,000 kilometers)

As can be seen from Figure 2, in 1990, China's highway mileage was 1,028,300 kilometers, and by 2022, the national highway mileage was 5,354,800 kilometers, an increase of 4,326,500 kilometers over 1990, more than five times that of 1990.

In 1990, China's regular flight routes were 506,800 kilometers, and in 2022, it was 6,998,900 kilometers, and the mileage in 2022 was 14 times that of 1990. In the past 33 years, except for a large decline in 2020 due to the impact of the epidemic, the overall trend is on the rise, and it has resumed its upward momentum after 2022.

3.3 The mileage of China's railways, inland waterways and oil (gas) pipelines continues to rise

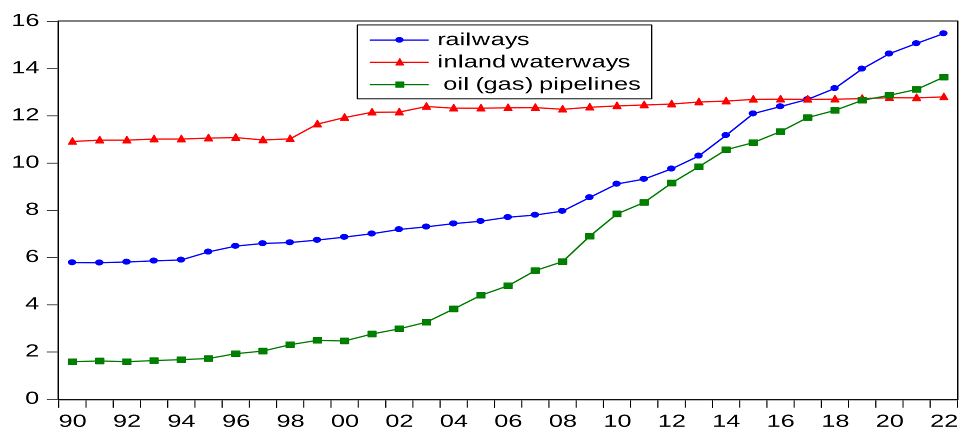

Figure 3. Length of railways, inland waterways and oil (gas) pipelines in China from 1990 to 2022 (unit: 10,000 kilometers)

As can be seen from Figure 3, the operating mileage of China's railways in 1990 was 57,900 kilometers, and that of China's railways in 2022 was 154,900 kilometers, which increased by three times compared with 1990. The trend is steadily increasing year by year. Overall, the railway network continues to expand and has a good momentum of development.
In 1990, the length of inland waterways in China was 109,200 kilometers, and in 2022, the navigable length of inland waterways in China was 12800 kilometers, which increased less than that in 1900, with a growth rate of only about 20 percent.

In 1990, China's oil (gas) pipeline mileage is 15,900 kilometers, and in 2022, China's oil (gas) pipeline mileage is 136,400 kilometers, which has increased by 13 times compared with 1990. Its changing trend is to increase rapidly year by year.

3.4 China's GDP continues to grow

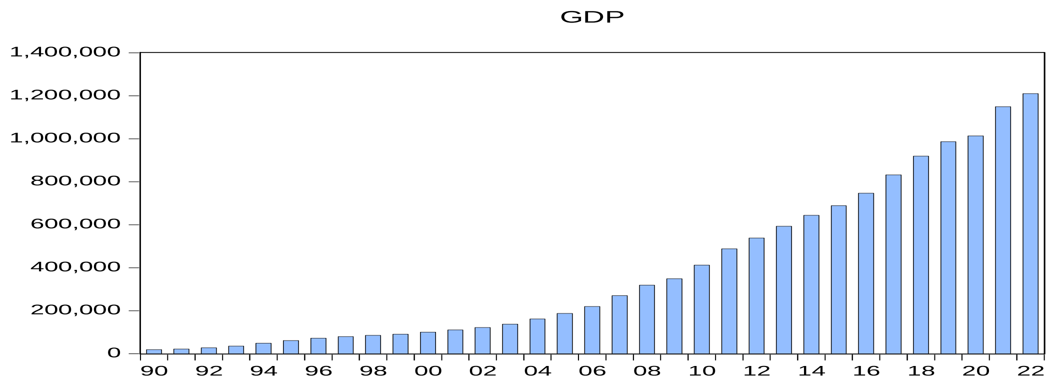

Figure 4. China's GDP, 1990-2022 (unit: 100 million yuan)

As can be seen from Figure 4, China's GDP has a growth trend from 1990 to 2022. Among them, in 1990, China's GDP was only 1,887.29 billion yuan, but in 2022, the annual GDP reached 12,1020.7 billion yuan, an increase of 60 times during the 33 years.

3.5 Mechanism of transport development on economic growth

China's transportation industry has a broad and far-reaching impact on GDP. The development of transportation provides efficient logistics and transportation networks, which can accelerate the circulation of goods and services and promote the improvement of productivity and consumption power. Through a more efficient transportation network, products can be quickly and safely transported from the production site to the hands of consumers, reducing transaction costs and improving market efficiency. It can promote the rapid development of social economy while promoting the expansion of production scale and market expansion of enterprises [14]. The development of transportation can also drive the development of its related industrial enterprises, for example, the development of transportation has promoted the infrastructure construction of roads, railways, airports, coastal ports along rivers and rivers, as well as the development of many automobile, ship, aircraft and other manufacturing industries, the growth of these related industries further stimulate economic growth, forming a virtuous circle. The construction of transportation infrastructure requires a large amount of capital and technical support, which can promote the technological innovation and development of related industries, thus further promoting economic development. The transportation industry is a labor-intensive industry, which can provide a large number of employment opportunities in the development, and promote the growth of social employment rate and the accumulation of human capital. At the same time, the transportation industry also needs a variety of professional talents, which promotes the training and development of human resources. The development of transportation industry plays a vital role in economic growth, not only as the basic support for economic activities, but also as an important driving force for economic structure optimization and regional development [15].

4. Empirical analysis of China's transportation industry on GDP growth

4.1 Variable tags and data sources

For the convenience of expression and modeling, we represent the railway operating mileage as X1, the highway mileage as X2, the inland waterway mileage as X3, the regular flight route mileage as X4, the oil (gas) pipeline mileage as X5, the cargo throughput of coastal ports as X6, and China's GDP as Y.

The data of the above variables come from Chinese statistical yearbooks of different years. The data of each variable are shown in Table 1.

Table 1. Transport and GDP data for China, 1990-2022

Year	Railway mileage/ Ten thousand kilometers	Highway mileage/ Ten thousand kilometers	Inland waterway mileage/ Ten thousand kilometers	Mileage of scheduled flights/ Ten thousand kilometers	Oil (gas) pipeline mileage/ Ten thousand kilometers	Cargo throughput of coastal ports/ Ten thousand tons	GDP/ Hundred million yuan
1990	5.79	102.83	10.92	50.68	1.59	48321	18872.9
1991	5.78	104.11	10.97	55.91	1.62	54690	22005.6
1992	5.81	105.67	10.97	83.66	1.59	61059	27194.5
1993	5.86	108.35	11.02	96.08	1.64	67428	35673.2
1994	5.90	111.78	11.02	104.56	1.68	73797	48637.5
1995	6.24	115.7	11.06	112.9	1.72	80166	61339.9
1996	6.49	118.58	11.08	116.65	1.93	85494	71813.6
1997	6.6	122.64	10.98	142.5	2.04	90822	79715
1998	6.64	127.85	11.03	150.58	2.31	92237	85195.5
1999	6.74	135.17	11.65	152.22	2.49	105162	90564.4
2000	6.87	167.98	11.93	150.29	2.47	125603	100280.1
2001	7.01	169.8	12.15	155.36	2.76	142634	110863.1
2002	7.19	176.52	12.16	163.77	2.98	166628	121717.4
2003	7.30	180.98	12.4	174.95	3.26	201126	137422

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2004	7.44	187.07	12.33	204.94	3.82	246074	161840.2
2005	7.54	334.52	12.33	199.85	4.4	292777	187318.9
2006	7.71	345.7	12.34	211.35	4.81	342191	219438.5
2007	7.80	358.37	12.35	234.3	5.45	388200	270092.3
2008	7.97	373.02	12.28	246.18	5.83	429599	319244.6
2009	8.55	386.08	12.37	234.51	6.91	475481	348517.7
2010	9.12	400.82	12.42	276.51	7.85	548358	412119.3
2011	9.32	410.64	12.46	349.06	8.33	616292	487940.2
2012	9.76	423.75	12.5	328.01	9.16	665245	538580
2013	10.31	435.62	12.59	410.6	9.85	728098	592963.2
2014	11.18	446.39	12.63	463.72	10.57	769557	643563.1
2015	12.1	457.73	12.7	531.72	10.87	784578	688858.2
2016	12.4	469.63	12.71	634.81	11.34	810933	746395.1
2017	12.7	477.35	12.7	748.3	11.93	865464	832035.9
2018	13.17	484.65	12.71	837.98	12.23	922392	919281.1
2019	13.99	501.25	12.73	948.22	12.66	918774	986515.2
2020	14.63	519.81	12.77	942.63	12.87	948002	1013567
2021	15.07	528.07	12.76	689.78	13.12	997259	1149237
2022	15.49	535.48	12.8	699.89	13.64	1013102	1210207.2

Data source: China National Statistical Yearbook.

4.2 Unit root test

In order to solve the "pseudo-regression" problem caused by the non-stationarity of time series data and to ensure the accuracy of our test results, stationarity tests must be performed on both explanatory and dependent variables. In this study, we used the ADF unit root test method to evaluate the stationarity of variables, and the test results are shown in Table 2.

Table 2. ADF unit root test results

Testing variables	**Type verification**	**ADF statistic**	**Critical values of ADF at a significant level**			**D.Wvalue**	**P-value**	**Test results**
	(C,T,K)		**1%**	**5%**	**10%**			
Y	(C,0,0)	7.0474	-3.6537	-2.9571	-2.6174	2.180	1.000	unstable
ΔY	(C,T,8)	-5.2807	-4.4163	-3.6220	-3.24860	1.705	0.002	stable
ΔlnY	(0,0,2)	-1.7520	-2.6471	-1.9529	-1.6100	1.976	0.076	unstable
X1	(0,0,2)	3.3023	-2.6443	-1.9525	-1.6102	1.867	0.999	unstable
ΔX1	(C,0,0)	-2.4398	-3.6617	-2.9604	-2.6192	1.776	0.140	unstable
ΔlnX1	(C,0,0)	-3.1466	-3.66171	-2.9604	-2.6192	1.774	0.033	stable
X2	(0,0,0)	2.5526	-2.6392	-1.9517	-1.6106	1.982	0.997	unstabl

								e
ΔX2	(C,0,0)	-5.5605	-3.6617	-2.9604	-2.6192	2.008	0.000	stable
ΔlnX2	(C,0,0)	-5.5658	-3.6617	-2.9604	-2.6192	2.003	0.000	stable
X3	(C,T,8)	-10.320	-4.3943	-3.6122	-3.2431	2.509	0.000	stable
ΔX3	(C,T,7)	-5.5647	-4.3943	-3.6122	-3.2431	1.009	0.001	stable
ΔlnX3	(C,T,7)	-5.3831	-4.3943	-3.6122	-3.2431	0.975	0.001	stable
X4	(0,0,0)	1.1834	-2.6392	-1.9517	-1.6106	1.415	0.936	unstable
ΔX4	(0,0,0)	-3.8221	-2.6417	-1.9521	-1.6104	1.917	0.000	stable
ΔlnX4	(C,0,0)	-4.5747	-3.6617	-2.9604	-2.6192	2.094	0.001	stable
X5	(0,0,1)	1.8371	-2.6417	-1.9521	-1.6104	2.376	0.982	unstable
ΔX5	(C,0,0)	-2.6861	-3.6617	-2.9604	-2.6192	2.425	0.088	unstable
ΔlnX5	(C,0,0)	-3.4498	-3.6617	-2.9604	-2.6192	2.257	0.017	stable
X6	(C,T,7)	-5.1305	-4.3743	-3.6032	-3.2381	1.792	0.002	stable
ΔX6	(C,0,7)	-2.9995	-3.7379	-2.9919	-2.6355	1.960	0.049	stable
ΔlnX6	(0,0,3)	-0.8635	-2.6501	-1.9534	-1.6098	2.014	0.333	unstable

Note :(C, T, K) represents the type of test, where C represents the presence of a constant term in the test, T represents the presence of a time trend term in the test, K represents the order of lag, and Δ represents the first-order difference.

As can be seen from Table 2, at the 5% significance level, the original sequences X3 and X6 are stationary, while the original sequences X1, X2, X4, X5 and Y are non-stationary. In the original sequence first-order difference series, ΔX1 and ΔX5 are non-stationary at the 5% significance level, and ΔX2, ΔX3, ΔX4, ΔX6 and ΔY are stationary. In log-sequence first-order difference sequences, ΔlnY and ΔlnX6 are non-stationary at the significance level of 5%, and ΔlnX1, ΔlnX2, ΔlnX3, ΔlnX4 and ΔlnX5 are all stationary.

4.3 Model Construction

According to the results of the unit root test, lnX1, lnX2, lnX3, lnX4, lnX5, X6 and Y are all first-order stationary and full of integral modeling conditions, so the co-integration modeling method can be adopted for modeling. We assume that the co integration model is represented by the regression equation (1).

$$Y = C + \beta_1 \ln X1 + \beta_2 \ln X2 + \beta_3 \ln X3 + \beta_4 \ln X4 + \beta_5 \ln X5 + \beta_6 X6 + u \qquad (1)$$

Where C is the constant term, $\beta_1 \sim \beta_6$ is the estimated parameter, and u is the residual term.

4.4 Cointegration test

A cointegration test is a statistical test used to determine whether two or more time series are cointegrated. Cointegration refers to the long-term relationship between two or more non-stationary time series, that is, despite short-term fluctuations, they are somewhat balanced in the long run.

The most commonly used cointegration test is the Engel-Granger test, which involves estimating the regression model between more time series and then testing the stationarity of the residual. If the residuals are stationary, it indicates that multiple time series are cointegrated. The cointegration test consists of two steps: first, the parameters of the cointegration model are estimated; Second, ADF test is carried out on the residual of the cointegration model.

Step 1, Based on the time series data of China's GDP, railway operating mileage, highway mileage, inland waterway mileage, regular flight route mileage, oil (gas) pipeline mileage and cargo throughput of coastal ports from 1990 to 2021, the parameters of regression equation (1) were estimated by using the least square method (LS method), and regression equation (2) was obtained. Let's call the residual e.

$$Y=-1705104+1027209\ln X1+107285\ln X2-112081\ln X3-43230.92\ln X4-354523\ln X5+0.8413X6$$
$$T=\ (-2.22)\quad (5.97)\qquad (1.67)\qquad (-0.31)\qquad (-1.22)\qquad (-3.95)\qquad (4.36)$$
$$R^2=0.993695,\ F=682.9777,\ SC=24.12895,\ DW=0.910958,\ N=33. \qquad (2)$$

Step 2, Perform ADF test on residual e of regression equation (2), and the test results are shown in Table 3.

Table 3. ADF unit root test of residuals

Testing variables	**Type verification**	**ADF statistic**	**Critical values of ADF at a significant level**			**D.W value**	**P-value**	**Test results**
	(C,T,K)		**1%**	**5%**	**10%**			
e	(0,0,5)	-3.586	-2.653	-1.954	-1.610	2.260	0.001	stable

Note :(C, T, K) indicates the type of test, where C indicates whether there is a constant term in the test, T indicates whether there is a time trend in the test, and K indicates the order of lag.

As can be seen from Table 3, the regression residual e is significantly stable at the 5% level, rejecting the null hypothesis. This indicates that the residual sequence is stationary. This indicates that there is a cointegration relationship between dependent variable Y and explanatory variables lnX1, lnX2, lnX3, lnX4, lnX5 and X6, indicating that there is a long-term equilibrium relationship between them, and there is no pseudo-regression phenomenon.

4.5 Multicollinearity test and correction

4.5.1 Multicollinearity test

Multicollinearity is the phenomenon of high linear correlation between explanatory variables in a linear regression model. This can lead to inaccurate estimates. In order to detect multicollinearity, a multicollinearity test must be performed.

According to the regression equation (2), R^2= 0.993695, but the T statistics of lnX2, lnX3 and lnX4 are 1.67, -0.31 and -1.22 respectively, and their absolute values are far less than 2, indicating that these variables fail the significance test at the significance level of 5%. Therefore, the regression equation (2) has multicollinearity.

4.5.2 Multicollinearity correction

Stepwise regression is a method of selecting variables and building models. It can be divided into two types: forward stepwise regression and reverse stepwise regression.

Reverse stepwise regression is used here. Backward step-up regression starts with a complete model containing all variables and iteratively selects the least significant variable to be removed from the model until a predetermined stopping criterion is reached. This approach gradually removes variables from the model, one at a time, with each contributing the least to the model.

The explanatory variable lnX3 is removed from the regression equation (2) to obtain the regression equation (3).

Y= -1911309+1004673lnX1+102583lnX2 -42401lnX4-367002lnX5+ 0.879772X6
T= (-5.00) (6.54) (1.67) (-1.22) (-4.65) (6.04)
R^2= 0.993672, F= 847.9282, SC= 24.02670, DW= 0.898922, N= 33. （3）

Observe the regression equation (3), SC decreases from 24.12895 to 24.02670, the explanatory variable lnX3 is valid, and R^2= 0.993672, but the T statistics of lnX2 and lnX4 are 1.67 and -1.22 respectively, multicollinearity still exists, and the regression equation (3) continues. Regression equation (4) was obtained by removing explanatory variable lnX4.
Y= -1891955+ 885061lnX1+ 105911lnX2 -396287lnX5+ 0.953042X6
T= (-4.91) (7.42) (1.71) (-5.22) (7.12)
R^2= 0.993322, F= 1041.296, SC= 23.97448, DW= 0.826969, N= 33. (4)

Observe the regression equation (4), SC decreases from 24.02670 to 23.97448, and the removal of explanatory variable lnX4 is valid, while R2= 0.993322, but the T statistic of lnX2 is 1.71, which still has multicollinearity. Continue to remove explanatory variable lnX2 from the regression equation (4). The regression equation (5) is obtained.
Y= -1327724+ 813835lnX1 -278514lnX5+ 0.934126X6
T= (-6.44) (7.05) (-8.40) (6.78)
R^2= 0.992622, F= 1300.539, SC= 23.96828, DW= 0.572109, N= 33. (5)
In the regression equation (5), SC is reduced from 23.97448 to 23.96828, and it is effective to remove explanatory variable lnX2, while R2= 0.992622, the T statistics of lnX1, lnX5 and X6 are 7.05, -8.40 and 6.78, respectively, and their absolute values are much greater than 2.It shows that these variables can pass the significance test at the significance level of 5%, so there is no multicollinearity.

4.6 Sequence correlation test and correction

4.6.1 Sequence correlation test

Sequence autocorrelation test is a statistical method to detect the autocorrelation of time series data. Autocorrelation refers to the correlation between observations in time series data and their own observations at different points in time.

We use the Lagrange multiplier (LM) test to check the sequence correlation. Table 3 shows the results of the Lagrange multiplier (LM) test, which is designed to check whether the residual of the regression equation (5) has a serial correlation.

Table 4. Results of Lagrange multiplier (LM) test

Obs*R-squared	**LMvalue**	**Prob.Chi-Square(k)**	**P-value**
Obs*R-squared	16.78099	Prob.Chi-Square(1)	0.0000
Obs*R-squared	17.07669	Prob.Chi-Square(2)	0.0002
Obs*R-squared	17.09757	Prob.ChiSquare(3)	0.0007
Obs*R-squared	17.31412	Prob.Chi-Square(4)	0.0017
Obs*R-squared	18.00371	Prob.Chi-Square(5)	0.0029
Obs*R-squared	23.62717	Prob.Chi-Square(6)	0.0006
Obs*R-squared	25.87256	Prob.Chi-Square(7)	0.0005
Obs*R-squared	27.24571	Prob.Chi-Square(8)	0.0006
Obs*R-squared	27.51282	Prob.Chi-Square(9)	0.0011
Obs*R-squared	27.51706	Prob.Chi-Square(10)	0.0022
Obs*R-squared	27.77519	Prob.Chi-Square(11)	0.0035
Obs*R-squared	28.58438	Prob.Chi-Square(12)	0.0045
Obs*R-squared	28.59793	Prob.Chi-Square(13)	0.0075
Obs*R-squared	29.12020	Prob.Chi-Square(14)	0.0101
Obs*R-squared	29.14102	Prob.Chi-Square(15)	0.0154
Obs*R-squared	29.50520	Prob.Chi-Square(16)	0.0207
Obs*R-squared	29.50597	Prob.Chi-Square(17)	0.0301
Obs*R-squared	29.78737	Prob.Chi-Square(18)	0.0396
Obs*R-squared	30.14170	Prob.Chi-Square(19)	0.0500
Obs*R-squared	30.24718	Prob.Chi-Square(20)	0.0659

Note: k is the order of lag.

As can be seen from Table 3, the P-values of hysteresis order 1 to hysteresis order 18 were all less than 0.05, and the significance level was 5%, indicating that the sequence was sequentially correlated from hysteresis order 1 to hysteresis order 18. The P-value of the lag order 19 is 0.05, which indicates that it is already sequence independent. That is to say, at the 5% significance level, the regression equation (5) has a maximum sequence correlation of 18 orders.

4.6.2 Serial correlation correction

Increase AR (k) in the regression equation (5) in turn, if SC can be reduced, at the same time, the absolute value of the T statistic of all variables is greater than 2, then keep this AR (k); Otherwise, remove it. After such processing, it is found that AR(1) and AR(6) meet the requirements and are retained to obtain the regression equation (6).

$$Y=-1327724+813835\ln X1-278514\ln X5+0.934126X6+0.725330AR(1)-0.344766AR(6)$$

$$T=(-6.44)\quad(7.05)\quad(-8.40)\quad(6.78)\quad(5.74)\quad(-2.05)$$

$$R^2= 0.997324,\ F= 1614.863,\ SC= 23.35838,\ DW= 1.897578,\ N= 33. \qquad (6)$$

In regression equation (6), R^2= 0.997324, the sample shows that the fitting integration is up to 99.7%; F= 1614.863, regression equation (6) overall significant; The T statistics of lnX1, lnX5, X6, AR(1) and AR(6) are 7.05, -8.40, 6.78, 5.74 and -2.05 respectively, and their absolute values are all greater than 2, indicating that at the significance level of 5%, the significance test of the variables passed, that is, there is no multicollinearity in the regression equation (6).DW= 1.897578, which is around 2, indicating that the regression equation (6) has no serial correlation. Therefore, regression equation (6) is the optimal regression equation.

5. Conclusions and policy recommendations

5.1 Main Conclusions

According to the optimal regression equation (6), the following main conclusions can be drawn:

(1)Highway mileage, inland waterway mileage and regular flight route mileage have no significant impact on China's GDP;

(2)Railway operating mileage, oil (gas) pipeline mileage and cargo throughput of coastal ports have a significant impact on China's GDP. Specifically, every 1% increase in railway mileage will increase China's GDP by 81,383.5 billion yuan; Every 1% increase in the mileage of oil and gas pipelines will reduce China's GDP by 27,851.4 billion yuan; For every 10,000 tons increase in the cargo throughput of coastal ports, China's GDP will increase by 903,4126 million yuan, or 93,412,600 yuan.

(3)Highway mileage, inland waterway mileage and regular flight route mileage are removed from the regression equation, so that the regression equation produces serial correlations. To eliminate these serial correlations, it is necessary to lag 1 period and 6 periods.

5.2 Policy Recommendations

Based on the above conclusions, the following policy recommendations are put forward:

First, encourage and support the increase of railway mileage to increase China's GDP, because the two are positive relationship;

Second, vigorously develop coastal ports and increase the cargo throughput of coastal ports, which can also increase China's GDP;

Third, limit the mileage of oil (gas) pipelines to the extent necessary for economic construction, and do not over-develop oil (gas) pipelines, because it is inversely related to GDP;

Fourth, moderate development of China's roads, inland waterways and scheduled flight routes, otherwise, there will be a maximum of six periods of delayed impact; Among them, the lag period 1 is a positive influence, and the lag period 6 is a negative influence.

6. Conclusion

Through the preliminary investigation and research of China's transportation industry, we can easily find that the impact of transportation industry on GDP in China is multi-faceted, extensive and far-reaching. Transportation as a basic industry of national economy, its development has very important economic, social and environmental significance. Promoting the improvement of transportation infrastructure and the improvement of transportation efficiency can effectively promote the development of all areas of our economy and thus promote the growth of GDP. The impact of China's transportation on GDP is not only reflected in the transport of goods, but also involves the flow of people, tourism, regional development and so on. In addition, the development of the transport industry can also promote inter-regional connectivity, promote the rational allocation of regional resources, and promote the balanced and rapid development of regional economy. Therefore, it can be predicted that rational and scientific planning of investment in the construction of the transport industry and promoting the innovative development of the transport industry are of great significance for promoting the sustained growth of China's economy.

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