THE RELATIONSHIP BETWEEN URBAN TRANSPORTATION AND INDUSTRY STRUCTURES: A CASE STUDY OF NANJING IN CHINA

Wei Wang, Corresponding Author
Jiangsu Key Laboratory of Urban ITS
School of Transportation, Southeast University
Room 318, Si Pai Lou 2, Nanjing, China, 210096
Tel: +86-02583795356
Email: wangwei@seu.edu.cn

Xiucheng Guo
Jiangsu Key Laboratory of Urban ITS
School of Transportation, Southeast University
Si Pai Lou 2, Nanjing, China, 210096
Tel: +86-02583795524
Email: seuguo@163.com

Cong Qi
Jiangsu Key Laboratory of Urban ITS
School of Transportation, Southeast University
Room 318, Si Pai Lou 2, Nanjing, China, 210096
Tel: +86-02583795356
Email: 724596743@qq.com

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ABSTRACT

Urban transportation is one of the four fundamental functions of a city. The growth of urban transportation demand is an inevitable result of the national economic development and it also plays significant roles in the economic development. The object of this study is to understand the relationship between industrial structure and urban transportation. Reveal of this relationship will help the professionals and the city administrators to improve the urban transportation planning and managements, especially useful for those rapid developing cities in China.

Based on the analysis of the evolvement rule of the industry structure, the correlation theory of industry structure and urban transportation is deployed to study the relationship of the two above. Grey correlation degree analysis can provides a quantitative measurement for the developing tendency, which is quite suitable for the dynamic historical data analysis. Correspondingly, a gray correlation model with four steps is proposed to find the impact of industry structure on urban transportation.

Statistical data from Nanjing is incorporated into the proposed model. Results show that the second industry with the gray correlation degree of 0.62 has the most significant influence on urban freight transportation, and the third industry with the gray correlation degree of 0.75 has the most obvious impact on urban passenger transportation. Overall the results suggest that the industry structure has tightly relationship with urban transportation, and needs to be considered in urban transportation planning and managements.

Keywords: National Economics, Urban Transportation, Industry Structure, Gray Correlation Model
INTRODUCTION
Urban transportation development is an important premise and foundation for the
development of urban economy(1). Urban transportation facilities in China has not played its
serving and stimulating role to improve the comprehensive development of the urban
economy. While the city governments have been vigorously promoting the economic
development, the investment in urban transportation is still insufficient. The insufficient
development of urban transportation result in the failure to achieve the goal of the
synchronous development of the two. The insufficient transportation investment even affects
the sustained growth of urban economy. In this context, we should notice that the
fundamental problem of urban transportation is its relationship with the economy
development. Thus, studies focusing on the relationship between urban transportation and the
urban economy are particularly important.

The relationship between urban transportation and the industrial structure of urban
structure is the problem that few experts have been studied, and the causal relationship
between the two has not yet been revealed. This paper uses the methods of correlation
analysis to analyze the relationship between the two quantitatively, the result will help to
understand the interaction effects between transportation and urban economy.

LITERATURE REVIEW
A dynamics model of the relationship between the regional transportation and industrial
structure was established by Ronghui(2). The improvement of regional traffic facilities
creates conditions for the industrial transfer and innovation in the national economy, so that
the regional overall industrial structure changes. They used the system dynamics model to
carry on quantitative research on the national economy and the development of regional
transportation. The fitting and comparison of the real data illustrated the rationality of the
model, which was also used for prospective prediction.

Qualitative and quantitative methods are frequently chosen in research (3-7). A
research for the influence of the transportation infrastructure on economic growth and
industrial structure optimization in small towns was carried out by Xingju(8). They took the
city of Shijiazhuang as an example. According to the interaction of the modern industrial
systems in small towns, they quantitatively analyzed the urban industrial structure and the
economic situation of Shijiazhuang, which provided a scientific basis for the industrial layout
and the construction of transportation facilities in small towns.

Yueping(9) quantitatively analyzed the impact of the changes in the economic
structure on the urban transportation in China. The research results shows that there is a
strong correlation between the transportation industry and the economic developing stages.

Wei(10) studied the influence that transport infrastructure had on the resources
allocation, social environment and national economy from five aspects. These five aspects
include the regional developmental effect of transportation infrastructure, industrial
agglomeration effect, efficiency improvement effect, external overflow effect and modernized
effect. Their results show that there is a positive correlation between the transport
infrastructure and economic growth.

The research of Bing(11) shows that the improvements of the national economy and
the evolution of industrial structure in the future, will influence the development of passenger
travel structure in Zhejiang province. For passenger travel, highway transportation will
become the main mode to undertake passenger traffic. For freightage, the various modes of transport will play their own roles and develop coordinately.

To research the relationship of transportation and urban economy, most scholars used the methods of system dynamics model, correlation analysis and other methods for the qualitative and quantitative analysis. Although a lot of literatures could be found focusing on the relationship between transportation and the urban economy, there is a few existing work trying to reveal the relationship between transportation and the urban industrial structure. The primary objective of this study is to develop an analytical approach to quantitatively describe the correlation degree of the transportation and the urban industrial structures. The grey correlation theory is also call the grey correlation degree theory. It is based on the degree of similarity or dissimilarity among the development of the variables. The grey correlation degree is a new way to measure the degree of the correlation of the elements more reasonable and precise. In this research, the grey correlation theory will be deployed to archive the research objects.

EVOLVEMENT RULE OF THE INDUSTRY STRUCTURE
Throughout the history over the world, the overall tendency of the industrial structure can be summarized as the following two points.

Along with the modern economic growth, the industrial structure has been changing. The proportion of the first industry which takes agriculture as main part has declined, while the proportion of manufacturing among the social total production has increased. The structure of labor also changes with the upgrading of the industrial structure. The proportion of agricultural labors decreases, but its changing degree is far lower than that in agricultural products. With the improvement of productivity, labors in service industry increase significantly. In general, the proportion of agriculture in total assets decreases, the industry’s proportion significantly increases and the service industry continues to expand (1).

Individual farmers in agriculture decrease, and the proportion of the individual owners and family practitioners also decrease. On the other hand, the industrial, commercial and service industries develop from the unincorporated enterprises to the large-scale incorporated enterprises. The family enterprises are replaced by more employers. From the internal view of the industrial structure, the proportion of employees and value-added rate present a parallel growth. In the second industry, the proportion of the mining industry has always been small. In the third industry, the proportion of business grows. As for the service industry besides business, the proportion of family service decreases which is replaced by personal services, special services and government services.

CORRELATION THEORY OF INDUSTRY STRUCTURE AND URBAN TRANSPORTATION

The Evolution Law of the Industrial Structure and Urban Transportation
Definition of Economic development has two major points, economic growth and structure optimization. Economic growth refers to the GDP increases. Structure optimization means that the growth of different industries is not balanced, some industries have high developing rate while some have a slower or even negative speed.
As the endogenous demand of national economy, the development of transportation is closely related to the national or a regional production distribution, resource distribution, economic development level, industrial structure, people's consumption level and other factors. The transportation industry is a sub industry of the national economy. Affected by the economic changes and other industries’ development and evolution, its position and role in national economy is also changing. The evolution of the interaction between the transportation industry and the national economy roughly shows the following rules.

Firstly, when the per capita GDP is below 1000 dollars, it is at the early phase of industrialization. National economic structure is dominated by the textile industry, the mining industry of raw materials. And the transport need of large volume and low value added of bulk cargo, such as coal, ore, iron and steel, etc. increases. The scope of the freight volume growth is substantially faster than that of GDP. That is, the freightage demand elasticity is generally greater than or close to 1 and the freight volume of every GDP unit is gradually rising. At the mean time, the amount of passenger volume is quite low, so the per capita trips are not many, and the travel distance is short. Thus, the passenger transport elasticity coefficient is relatively small.

Secondly, when the per capita GDP is between 1000 to 4000 dollars, it is in the middle phase of industrialization. In this period, the industrial structure is undergoing great changes. Economic growth’s dependence on raw materials begins to decrease, but the freightage demand of the small batch but high added value products tends to rise. The freight volume growth slows down significantly compared with that of the previous period, and it generally keeps the same or even lower growth scope with the GDP. The freight volume per GDP unit decreases obviously compared with that in the initial industrialization. With the development of the national economy, people's living standards improve, passenger travel demand increases and the passenger transportation volume grows steadily, which makes the coefficient of elasticity relatively recover.

Finally, when the per capita GDP is between 4000 to 10000 dollars or more, it enters the late stage of industrialization. Economic structure becomes to be dominated by high-tech industries and the service industries. And the product structure is dominated by production with high added value and lightweight. Transportation mainly has to meet the needs of production which is consumer-oriented or even personalized, small batch and more flexible. The freightage is in a stable state. The freight volume per unit of GDP decreases significantly, but the transport service needs to be more reliable, fast and convenient. The growth scope of passenger traffic volume is generally higher than that of national income, and the higher requirement for being fast, safe, comfortable, convenient are putted forward(10).

As discussed above, in different phases of the national economic development, the focus of the industrial development is different, which determines the different transportation demand.

**Relational Theory of the Industrial Structure and Urban Transportation**

For a country or region in the stage of industrialization, its upgrading of the industrial structure will has higher requirements for transportation demand. The development of the first industry makes the freight transportation increase, and derive the needs of high efficiency and low cost transportation system. With the development of the second industry, the proportion of light-weight, deep processing, and high added value products increase, and
the market competition turns from the price-based competition into a multifaceted
competition which includes quality, price and speed, etc. The rising of the proportion of the
third industry, especially the development of modern logistics industry and tourism industry,
makes peoples have the higher requirements for the choices of the transportation modes for
passenger and freight.

The industrial structure levels in different periods have different needs for
transportation. In the period of a low level, it only has to meet the transportation need in
quantity. In the period of high level, it also has to meet the transportation need in quality,
which put forward a higher request. If the development of transportation industry of a country
or region cannot meet the need of the economic development, then there will be a negative
effect on the economic growth. And the slow growth of national economy will leads to the
financial strains, reducing the investment in transportation, which will eventually affect the
development of the transportation industry. Conversely, if a country or region has high level
transport infrastructure, it will vigorously support and stimulate the development of local
economy. Then the economy growth will in turn promote the development of the
transportation, that is, to increase the investment in the transportation. Thus the transportation
and national economy build the relationship of mutual restriction and promotion.

DEVELOPMENT OF INDUSTRY STRUCTURE AND URBAN TRANSPORTATION
OF NANJING

Industrial Structure Development of Nanjing
Figure 1 shows the industry development of Nanjing. Generally a sequence of ‘the second,
the third and the first’ can be found in the figure, and Nanjing is in the middle of the
industrialization according to the information in the figure. When the proportion of the first
industry decreases, the totally production of the first industry is growing at the mean time.
The developing tendency of the second industry is similar to the first industry, but the total
production amount is far more higher than the first. The Proportion and production amount of
the third industry is increasing steadily. The gross value added per year increased from 1.528
billion in 1984 to 435.656 billion in 2013, and the GPD proportion increased 33.48
percentage. Since 2008, the proportion of the third industry has been higher than the second
industry, the industry structures show a sequenced relationship as ‘the third, the second and
the first’. This means that Nanjing has begun to enter the late stage of industrialization
The industry development of Nanjing focus on traditional area between 1984 and 1990, high-tech industry has just getting started. Since 1990, the city government of Nanjing begun to implement a new industrialization strategy which tend to develop industries with high technology such as electronics, new material, medicine and new energy etc. Take the electronic and communication industries for example, the proportion of this industry has risen from 11.16% in 1990 to 17.18% in 2013. Meanwhile, the development of traditional industries is relatively slow, and the proportion of gross industrial output for labor intensive and capital intensive industries has been falling. For example, the proportion of oil industry has drooped from 12.19% in 1990 to 8.69% in 2013.

The Transportation development of Nanjing
The freight volumes of Nanjing has apparent increasing trend between 1984 and 2013 as illustrated in figure 2. In the first stage between 1984 and 2005, the growth rate of total freight cargo is relatively slow and steady. Then from 2006 to 2013, there are obvious changes for the freight volume and its proportion, the growth rate of freight increases significantly.

The proportion of highway freight and railway freight shown in figure 2 illustrated a obvious change between 1984 and 2013. Although both of highway and railway freight are growing, but the highway freight mode is showing its dominant industry role in the freight market of Nanjing.
FIGURE 2 Freight volumes evolution of Nanjing
The passenger volumes show a consistency increasing trend in figure 3. The passenger volume before 2009 fluctuates growth slowly, and the highway passenger volumes have a proportion higher than 80%. From 2009 to 2013, the passenger volumes of Nanjing has risen from 2.6 billion in 2009 to 4.9 billion in 2013. The advantage of the highway passenger transportation in Nanjing is becoming significant.

FIGURE 3 Passenger volume evolution of Nanjing

IMPACT OF INDUSTRY STRUCTURE ON URBAN TRANSPORTATION IN NANJING

The Classification of Industrial and Urban Transportation Structure
Industrial structure mainly refers to the proportions of the essential productive factors across
the production sectors and their mutual dependent and restricted relation. There are many methods to classify the industries around the world, which mainly includes three times industrial classification, standard industrial classification, production structural classification and the classification based on the resource-intensity, etc. Based on the reality in Nanjing and considering the possibility and continuity of the data acquisition, this research proposes to use the three industrial classification and the resource-intensity based classification methods to classify the industry in Nanjing into the first industry, the second industry and the third industry. The heavy industry, the light industry and the construction industry, etc. are included in the second industry.

Transportation structure refers to the composite elements of transportation, and the internal proportion and interrelation of these elements. Transportation structure is a part of the industrial structure, and it is also the foundational structure of the national economy to make people and goods’ spatial displacement happen. This research proposes to use the freight and passenger volumes as the analysis indicators. Among which the freight volume is divided into the railway and highway freight volume, and the passenger volume is divided into the railway and highway passenger volume.

The analysis of the influence of industrial structure had on urban transportation

As mentioned above, the gray correlation theory is chosen to deploy the correlation research. The model and steps of the gray correlation analysis is as following.

1. Formulation of the reference sequence \( \{ C^* \} \) and the comparison sequence \( \{ C \} \):

\[
\{ C^* \} = [C^*_1, C^*_2, \ldots, C^*_n] \\
\{ C \} = [C^*_1, C^*_2, \ldots, C^*_m]
\] (1)

2. The dimensionless process of the reference and the comparison sequence.

Assume the interval of the index \( k \) is \([j_{k1}, j_{k2}]\), \( j_{k1} \) is the smallest value of the index \( k \) of all the evaluated objects, and \( j_{k2} \) is the biggest value of the index \( k \). Then we can use the following equation to transfer the initial data into the dimensionless value \( C^i_k \in (0, 1) \).

\[
C^i_k = \frac{f^i_k - j_{k1}}{j_{k2} - j_{k1}}, \quad i = 1, 2, \ldots, m; \quad k = 1, 2, \ldots, n
\] (2)

The equation (2) can achieve a better effect when applied to the bigger value, among which \( k \) represents the index, and \( i \) represents the year.

3. Calculation of the gray correlation coefficient between the reference and comparison sequence.

The equation (3) is used to calculate the gray correlation coefficient.
\[ \xi_i(k) = \frac{\min_j \min_k |C^{*}_k - C^i_k| + \rho \max_j \max_k |C^{*}_k - C^i_k|}{|C^{*}_k - C^i_k| + \rho \max_j \max_k |C^{*}_k - C^i_k|} \]  

(3)

In the equation, \( \rho \in (0, 1) \), and generally \( \rho = 0.5 \).

4. Calculation of the correlation degrees.

The method to calculate the correlation degree is to use equation (4) as following.

\[ r_j = \frac{1}{n} \sum_{k=1}^{n} \xi_i(k) \]  

(4)

If the correlation degree \( r_j \) is the max value, it suggests that \( C^i \) is the most close to the optimal index \( C^{*} \), i.e. the evaluated object \( i \) is better than the others, so we can rank the evaluated objects according to its correlation degree.

With the data of the industry and urban transportation from Nanjing Statistical Bureau, this research analysis the influence of the industrial structure evolution has on urban transportation in Nanjing using the prescribed steps and models.

1. To set up the reference and comparison sequence, this research takes the freight and passenger volume as the reference sequence, the three industries as the comparison sequence.

2. Because of the different quantization standards of all kinds of the statistics, to make sure the comparability among the same factors of all the statistics, equation (2) needs to be used to standardize the reference and the comparison sequence. The result is presented in table 1.

3. To calculate the gray correlation coefficient between the reference and comparison sequence, equation (3) and the data in Table 1 is chosen. The reference sequence is calculated from the freight and passenger volumes, and the gray correlation coefficient of the comparison sequence is calculated from the data of the three industries. The result is shown in table 2.

**TABLE 1 Standardized Results Of The Industry Structure And Urban Transportation Of Nanjing**

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP (100 million yuan)</th>
<th>The first industry</th>
<th>The second industry</th>
<th>The third industry</th>
<th>Freight volume(Ten thousand ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>0.01</td>
<td>0.77</td>
<td>0.84</td>
<td>0.09</td>
<td>0.14</td>
</tr>
<tr>
<td>1986</td>
<td>0.01</td>
<td>0.59</td>
<td>0.61</td>
<td>0.33</td>
<td>0.18</td>
</tr>
<tr>
<td>1988</td>
<td>0.01</td>
<td>0.26</td>
<td>0.48</td>
<td>0.51</td>
<td>0.22</td>
</tr>
<tr>
<td>1990</td>
<td>0.01</td>
<td>1.00</td>
<td>0.31</td>
<td>0.53</td>
<td>0.19</td>
</tr>
<tr>
<td>Year</td>
<td>Highway freight volume (Ten thousand ton)</td>
<td>Railway freight volume (Ten thousand ton)</td>
<td>Passenger volume (Ten thousand)</td>
<td>Highway passenger volume (Ten thousand)</td>
<td>Railway passenger volume (Ten thousand)</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------</td>
<td>------------------------------------------</td>
<td>-------------------------------</td>
<td>----------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>1984</td>
<td>0.10</td>
<td>0.07</td>
<td>0.07</td>
<td>0.05</td>
<td>0.13</td>
</tr>
<tr>
<td>1986</td>
<td>0.17</td>
<td>0.11</td>
<td>0.08</td>
<td>0.06</td>
<td>0.18</td>
</tr>
<tr>
<td>1988</td>
<td>0.15</td>
<td>0.15</td>
<td>0.14</td>
<td>0.06</td>
<td>0.26</td>
</tr>
<tr>
<td>1990</td>
<td>0.13</td>
<td>0.11</td>
<td>0.07</td>
<td>0.05</td>
<td>0.18</td>
</tr>
<tr>
<td>1992</td>
<td>0.13</td>
<td>0.12</td>
<td>0.07</td>
<td>0.05</td>
<td>0.21</td>
</tr>
<tr>
<td>1994</td>
<td>0.14</td>
<td>0.17</td>
<td>0.14</td>
<td>0.12</td>
<td>0.20</td>
</tr>
<tr>
<td>1996</td>
<td>0.27</td>
<td>0.15</td>
<td>0.21</td>
<td>0.20</td>
<td>0.12</td>
</tr>
<tr>
<td>1998</td>
<td>0.24</td>
<td>0.10</td>
<td>0.26</td>
<td>0.26</td>
<td>0.12</td>
</tr>
<tr>
<td>2000</td>
<td>0.29</td>
<td>0.00</td>
<td>0.29</td>
<td>0.29</td>
<td>0.17</td>
</tr>
<tr>
<td>2002</td>
<td>0.29</td>
<td>0.00</td>
<td>0.36</td>
<td>0.31</td>
<td>0.20</td>
</tr>
<tr>
<td>2004</td>
<td>0.30</td>
<td>0.04</td>
<td>0.45</td>
<td>0.44</td>
<td>0.27</td>
</tr>
<tr>
<td>2006</td>
<td>0.45</td>
<td>0.27</td>
<td>0.44</td>
<td>0.43</td>
<td>0.27</td>
</tr>
<tr>
<td>2008</td>
<td>0.56</td>
<td>0.14</td>
<td>0.53</td>
<td>0.52</td>
<td>0.46</td>
</tr>
<tr>
<td>2010</td>
<td>0.74</td>
<td>0.78</td>
<td>0.79</td>
<td>0.79</td>
<td>0.60</td>
</tr>
</tbody>
</table>
For the factors between the two systems, the measurement of the relevance that changes with
time or different objects, is called correlation degree. If the variation tendency of two factors
are consistent, namely, the level of synchronous change is high, thus there is a high
correlation degree of the two variables. If the variation tendency is not match, then the
correlation is low. Grey correlation degree analysis provides a quantitative measurement for
the developing tendency, which is quite suitable for the dynamic historical data analysis.

Referring to the gray correlation degree equation, the MATLAB software is used to
analyze the correlation of the three industries and urban transportation. Taking freight and
passenger volume as the reference sequence and the three industries as the comparison
sequence, this paper calculates the grey correlation coefficient from the standardized data of
the freight and passenger volume. The grey correlation coefficients of the two variables are
shown in the table 2.

### TABLE 2 The Correlation Coefficients Of Industry Structure And Urban Transportation In Nanjing

<table>
<thead>
<tr>
<th>Year</th>
<th>Freight volume</th>
<th>Passenger volume</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The first industry</td>
<td>The second industry</td>
</tr>
<tr>
<td>1984</td>
<td>0.73</td>
<td>0.89</td>
</tr>
<tr>
<td>1986</td>
<td>0.51</td>
<td>0.89</td>
</tr>
<tr>
<td>1988</td>
<td>0.48</td>
<td>0.97</td>
</tr>
<tr>
<td>1990</td>
<td>0.35</td>
<td>0.38</td>
</tr>
<tr>
<td>1992</td>
<td>0.42</td>
<td>0.38</td>
</tr>
<tr>
<td>1994</td>
<td>0.31</td>
<td>0.43</td>
</tr>
<tr>
<td>1996</td>
<td>0.43</td>
<td>0.56</td>
</tr>
<tr>
<td>1998</td>
<td>0.45</td>
<td>0.43</td>
</tr>
<tr>
<td>2000</td>
<td>0.45</td>
<td>0.55</td>
</tr>
<tr>
<td>2002</td>
<td>0.43</td>
<td>0.48</td>
</tr>
<tr>
<td>2004</td>
<td>0.38</td>
<td>0.53</td>
</tr>
<tr>
<td>2006</td>
<td>0.38</td>
<td>0.43</td>
</tr>
<tr>
<td>2008</td>
<td>0.36</td>
<td>0.46</td>
</tr>
<tr>
<td>2010</td>
<td>0.51</td>
<td>0.66</td>
</tr>
<tr>
<td>2012</td>
<td>1.00</td>
<td>0.87</td>
</tr>
<tr>
<td>2013</td>
<td>0.84</td>
<td>0.93</td>
</tr>
</tbody>
</table>
coefficients of each time point has to be transformed to a concentrated value, which is called the grey correlation degree or correlation degree.

The correlation coefficients of each time point are listed in Table 2. Referring to the equation (4), the correlation degree of the transportation volume and the industrial structures in Nanjing is calculated. The result is shown in Figure 4.

![CORRELATION DEGREE](image)

**FIGURE 4** The gray correlation degree of industry structure and urban transportation in Nanjing

For the freight volume, the highest correlation degree is 0.62 in the second industry, then the first industry comes in second by 0.50, and the lowest is the third industry by 0.44. It indicates that the influence of the second industry’s development on freight volume was relatively the highest. The second industry is still based on the industries which have large freightage needs in Nanjing from 1984 to 2013. The influence that the first and third industry’s development had on freight volume is smaller. With the continuous adjustment of the industrial structure, the first industry’s proportion has been descending. Although the second industry has gradually moved to the suburban areas and the third industry has been increasing, the proportion of freight volume generated by the third industry is not as high as the first and the second industries. Therefore, the second industry had the highest correlation with the freight volume in Nanjing, the primary industry came in second, and the third industry has the lowest correlation.

As for the passenger volume, the third industry had the maximum correlation degree of 0.75, followed by the second industry which is of 0.58, and the smallest is the first industry whose correlation degree is 0.42. Considering the actual travel demand of the residents in Nanjing, this result shows that the rapid development of the third industry has amplified the generation of various kinds of the travel demand, such as shopping, tourism, leisure and etc. To be compatible with the travel demand, the transportation supply such as passenger volume has increased a lot. Meanwhile, the transportation industry itself is also a part of the third industry.

To improve the environmental protection and industrial upgrading, Nanjing
government moved a large number of the second industries away from the city center to the suburban areas in the 1990s. This action forced the workers originally living around the city centers to travel through the city to work at the suburbs, which generated the commuting traffic. So the correlation degree of the second industry and the passenger volume is the second. At the mean time, with the upgrading of industrial structure, there was almost no production sectors of the first industry existing in the city area. In addition, the first industry’s freight demand is far greater than the passenger traffic demand. Correspondingly the correlation degree between the first industry and passenger volume is the lowest.

CONCLUSIONS

This study investigated the relationship between industry structure and urban transportation. It aims to evaluation the impact of the different industries on urban freight and passenger transportation. Based on the analysis of the evolvement rule of the industry structure, the correlation theory of industry structure and urban transportation is deployed to study the relationship of the two above. Correspondingly, a gray correlation model with four steps is proposed to find the impact of industry structure on urban transportation. The first step of the model is to choose the reference sequence and the comparison sequence. The second step is to dimensionless of the reference data and the comparison data. The third step is to calculate the gray correlation coefficient between the reference and comparison sequence. The last step is to calculate correlation degrees based on the coefficient in step three. Real statistical data from Nanjing are incorporated into the proposed model. The results show that the second industry has the most significant influence on urban freight transportation, and the third industry has the most obvious impact on urban passenger transportation. In future studies, the model can be extended to describe the relationship between different industry types and urban travel behaviors. overall the results suggest that the industry structure has tightly relationship with urban transportation, and needs to be carefully considered in urban transportation planning and managements.
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