Empirical Analysis on Influencing Factors of Traffic Casualties in China

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Abstract: In order to further explore the complex correlation between the influencing factors of road traffic accidents in China, this paper takes the road traffic safety-related data of 31 provinces from 2004 to 2018 as the sample data, selects five index data that may affect the occurrence of traffic accidents in various regions of the country, i.e. resident population, urban population, population density, GDP and number of car drivers, and uses Eviews software for stepwise regression analysis to establish a fixed effect model of the influencing factors of traffic accidents and analyze the macro and micro factors that affect the death toll of traffic accidents in China. The model shows that each index has a significant impact on the number of road traffic casualties. Urban population, population density and number of car drivers are positively correlated with the number of road traffic casualties. The resident population and GDP are negatively correlated with the number of road traffic casualties. According to the research conclusions, this paper puts forward some suggestions, such as optimizing the management technology of road traffic construction, strengthening the education system of traffic safety awareness of residents in the new urbanization, increasing the investment in traffic construction, and establishing an institution for differentiated training and management of drivers based on driving experience.

1. PREFACE

With the development of the global economy, the expansion of roads and the sharp increase in the number of cars, road traffic accidents have become the most important injury factor that threatens human life and safety. This worldwide public hazard has attracted great attention from the international community and governments of various countries[1][2]. Under the background of rapid socio-economic development, China's road traffic construction has also achieved rapid development. By the end of 2020, China's national highway mileage, highway passenger volume and turnover and other indicators are ranked first in the world, and road traffic safety has become the focus of public governance and public opinion. According to the National Bureau of Statistics, the number of road traffic accidents in China in 2019 was 20,500, with 275,125 people injured in traffic accidents, representing a year-on-year increase of 6.4%. It can be seen the development of transportation brings serious traffic safety problems to the society while facilitating residents' travel and promoting economic growth [3]. Secondly, due to the unbalanced development of China's regional economy, a large number of floating population flows into economically developed areas, resulting in the imbalance of China's population structure and population density. Relevant research shows that population size is also the inducement of traffic accidents[4]. Therefore, this study intends to explore the impact of population size and economic development trend...
on traffic accidents, taking the number of resident population, the number of urban population and population density as the factors of population size change, taking the gross domestic product and the number of car drivers as the factors of economic development, measuring the level of road traffic safety by the number of road traffic deaths, constructing traditional panel data by stepwise regression, adding time effect variables, and analyzing the relationship between population-economic factors and road traffic safety. On this basis, the corresponding road safety prevention measures are put forward to provide theoretical basis for transportation investment and management system construction and practical suggestions for improving road safety management capabilities.

Traffic accident is a complex consequence caused by the interaction of people, vehicles, roads, environment and other factors in a specific traffic environment, and it is a dynamic process with randomness under certain conditions. There are slight differences in the nature of human, vehicle, road and environmental data, and different factors have different impacts on different accidents[5]. Among the factors affecting traffic safety, people are the decisive factor causing traffic accidents. Wang Xiaoxia (2015) found after scientific analysis of the causes of traffic accidents that drivers, pedestrians and passengers are not only the main participants in the road traffic system, but also the most important factors affecting traffic safety[6]. Salahadin Seid Yassin and Pooja(2020) believe that driver's experience, driving years and driver's age are important factors causing serious injury in traffic accidents[7]. From the perspective of vehicles, Chu Xuxin (2017 ) obtains the technical conditions of vehicles, qualified rate of regular inspection, complete condition of vehicle rescue equipment and safety facilities are the direct influencing factors that restrict road traffic safety according to the analysis results of the interpreted structure diagram[8]. Shuo Yang (2020) takes heavy-duty trucks as the research object, and finds out that the most serious traffic accidents occur when vehicles fail or change lanes[9]. From the perspective of traffic and road factors, Li Lingyu (2020) pointed out that the occurrence of road traffic accidents is closely related to the factors of road conditions [10]. Li Yijing (2020) believes that the difference between the improvement of traffic facilities and road safety control and the development speed of traffic demand has led to the increase of traffic safety pressure and the high number of road traffic accidents in our country[11]. In addition, traffic environment is also an important factor affecting traffic safety. Si Chundi (2014) established an evaluation index system of traffic environment factors such as weather conditions, road surface conditions and terrain conditions, and concluded that the occurrence of road traffic safety accidents is closely related to the traffic environment[12]. Zhong Shanshan (2017) believes that the root cause of traffic accidents is often related to traffic management and traffic environment [13].

It can be seen that the existing research focuses on the influence of people, vehicles, roads and environment on traffic safety. Among them, most of the researches on people focus on the micro level, such as the psychological factors and behavioral factors of individual drivers, and rarely explore the macro population change trend related issues. Secondly, there are relatively few literatures that empirically study the evolution of traffic accidents with economic development from the perspective of economic development. From the point of view of road traffic safety, it is mainly considered from the macro level, and policy suggestions are only put forward according to theoretical analysis, lacking effective data support. Therefore, based on the existing research, according to China's road traffic safety panel data from 2004 to 2018, this paper selects five factors from the perspective of population-economy such as resident population, urban population, population density, GDP, and the number of car drivers to build a panel model for analysis, studies the impact of each factor on traffic accident casualties, and puts forward corresponding suggestions and management measures for China's road traffic safety development, providing theoretical basis and data support for improving China's road traffic safety problems.
2. ANALYSIS OF ROAD TRAFFIC CASUALTIES AND INFLUENCING FACTORS

2.1. Description of data source and sample interval
The data used in this study are from the website of the National Bureau of Statistics (http://www.stats.gov.cn/), the "Statistical Annual Report of Road Traffic Accidents of the People's Republic of China" published by the Traffic Management Bureau of the Ministry of Public Security and the websites of the statistical bureaus of various provinces and cities. The selected sample interval is the panel data of road traffic safety of 31 provinces (municipalities/autonomous regions) in China from 2004 to 2018.

2.2. Selection and analysis of influencing factors
Road traffic safety is a complex and systematic social problem, which is affected by many factors, among which population-economy has a significant impact on traffic safety. Population growth is a subjective factor affecting road traffic safety. China is the country with the largest population in the world. With the acceleration of China's urbanization process, a large number of rural workers are flocking to cities to work and live. With the rapid economic development, a certain amount of pressure has been placed on the roads[14]. Sin Duqiang (2020) found that with the growth of the resident population, the chances of participating in road traffic and exposing risks in traffic conflicts increased, the absolute number of accidents increased, and the death toll increased[15]. Secondly, there is an inseparable relationship between urbanization level and traffic safety. After analyzing the national and provincial traffic accident data from 1996 to 2012, domestic scholar Yang Heng (2014) found that there was a significant positive correlation between the level of urbanization and the number of traffic accident deaths. With the development of urbanization in China, the number of traffic accident deaths was also increasing. [16]. Ren Ying and Peng Hongxing (2013) established a panel model by analyzing macro and micro factors and selecting macro data from 2004 to 2010. The result shows that the urban population density directly affects the traffic safety situation. The higher the population density, the higher the traffic mortality rate[17]. From the perspective of economic development, Nie Huawei (2020) takes 9 influencing factors such as GDP as the main research object, and conducts the correlation analysis with the accidents, establishes the road traffic safety prediction model based on RBF neural network, and draws the conclusion that the economy has a strong correlation with the accidents [17]. With the rapid growth of the total GDP, the technology and level of highway construction are continuously improved, and the mileage of highway will correspondingly increase. With the increase of residents' consumption level, the demand for motor vehicles will increase, and the number of private cars and drivers will gradually increase. When the number of motor vehicles increases, the average road area will decrease and the average road motor vehicle density will increase. At the same time, the traffic infrastructure construction is backward and the road traffic operation environment is congested, which leads to traffic accidents.

In order to explore the specific relationship between road traffic fatalities and various factors, and further explore the direction of road traffic safety improvement, this paper initially selected resident population (P), urban population (UP), population density (D), gross domestic product (GDP), number of car drivers (ND), private car ownership (CO) as explanatory variables, and road traffic fatalities (TF) as explanatory variables for regression analysis.

2.2.1. Collinearity test
The occurrence of road traffic accidents is not the result of a single factor, but the result of the interaction of many factors. Because many factors may influence each other, if multicollinearity appears in explanatory variables, it is not easy to distinguish their independent influence on their respective explanatory variables. Therefore, When analyzing the relationship between road traffic fatalities (TF) and the six explanatory variables of resident population (P), urban population (UP), population density (D), gross domestic product (GDP), number of car drivers (ND) and private car ownership (CO), in order to avoid the possible high correlation between various factors and distortion
of the model estimation, the multicollinearity test was performed on six explanatory variables from 2004 to 2018 in 31 provinces of China to test whether the independent variables were completely collinear. The test results are shown in Table 1:

Table 1: Multiple collinearity test

| Variable | VIF   |
|----------|-------|
| P        | 0.7009|
| UP       | 8.8062|
| D        | 0.0011|
| GDP      | 0.0192|
| ND       | 7.4876|
| CO       | 36.1366|

2.2.2 Selection of variables
As can be seen from Table 1, the variance expansion factor (VIF) of private car ownership (CO) is greater than 10, which indicates that there is a severe collinearity between this variable and other variables. The variance expansion factors of resident population (P), urban population (UP), population density (D), gross domestic product (GDP) and number of car drivers (ND) are all less than 10, which indicates that there is no severe collinearity between these five variables and other variables. In order to avoid the model estimation distortion caused by multiple collinearities among various factors, private car ownership (CO) with severe collinearity is excluded, and the remaining five variables are taken as explanatory variables of the model for further analysis.

3. MODEL BUILDING
In order to study the influence of resident population, urban population, population density, GDP and the number of drivers on the number of road traffic fatalities in China, this paper takes the panel data of 31 provinces (cities and districts) in China from 2004 to 2018 as the research sample and sets the following econometric model:

\[ TF_i = C + \beta_1 P_i + \beta_2 UP_i + \beta_3 D_i + \beta_4 GDP_i + \beta_5 ND_i + \mu_i \quad (1) \]

\( i \) represents 31 provinces and cities. \( t \) represents 15 years. \( TF_i \) indicates road traffic fatalities; \( P_i \) represents resident population; \( UP_i \) represents the urban population; \( D_i \) represents population density; \( GDP_i \) represents gross domestic product; \( ND_i \) represents the number of car drivers. \( \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \mu_i \) represents the correlation coefficient of the corresponding influencing factors, \( C \) represents the error value, and \( \mu_i \) is a Random error term.

4. ANALYSIS OF REGRESSION RESULTS

4.1 Stationarity test
Although panel data can reduce the non-stationarity of data and reduce the correlation of variables, the time trend and intercept of each variable will result in pseudo-regression in the regression model. Therefore, in order to avoid false regression and ensure the validity of the estimation results, the stationarity of each panel sequence is tested first. In this paper, LLC test and Fisher-ADF test are selected for panel data unit root test. The test results are shown in Table 2.

Table 2: Test results of unit root stationarity

| Variable | Criterion | Levin, Lin & Chui | ADF- Fisher |
|----------|-----------|-------------------|-------------|
|          | Statistic | Prob.**           | Statistic   | Prob.**     | Judgement result |
| TF       | D(1)      | -5.62412          | 0.0000      | 15.0666     | 0.0005          | Smooth          |
| P        | D(2)      | -2.78260          | 0.0027      | 13.0141     | 0.0015          | Smooth          |
| UP       | D(1)      | -3.30566          | 0.0005      | 8.36906     | 0.0152          | Smooth          |
The unit root stationarity test results in Table 2 show that the variables TF, UP, D and ND are non-stationary at a significant level of 1%, but all stationary at a significant level of 1% after passing the first-order difference, thus rejecting the original hypothesis. The variables P and GDP are non-stationary at the significant level of 1%, but they are all stationary at the significant level of 1% after the second-order difference, thus rejecting the original assumption. In conclusion, the five variables of P, UP, D, GDP and ND are all stable and meet the following cointegration test conditions.

4.2. Cointegration test

The cointegration test methods of panel data are mainly divided into two categories: one is based on Johansen cointegration test, the other is based on Engle and Granger two-step test, and the specific methods mainly include Pedroni test and Kao test. Johansen test premise: there is a VAR representation in the data, which is inconsistent with the original hypothesis of this paper. The difference between Pedroni test and Kao test is that Pedroni test allows the existence of heterogeneous panels and is suitable for models with few variables. The Kao test is based on DF and ADF tests, and the zero hypothesis is that there is no cointegration relationship, and the residual of static panel regression is used to construct statistics. The econometric model in this paper involves five variables, and Kao test is more scientific and reasonable. Therefore, Kao test in Engle and Granger panel cointegration is more suitable. The results of Kao cointegration test are shown in table 3.

| t-Statistic | Prob. |
|-------------|-------|
| ADF         | -12.27422 0.0000 |
| Residual variance | 6084.591 |
| HAC variance | 3147.901 |

As shown in Table 3, the value of P is 0.0000. Through the cointegration test, it is shown that there is a long-term cointegration relationship between the number of road traffic fatalities of the explained variable and resident population, urban population, population density, gross domestic product and number of car drivers of the explained variable.

4.3. Empirical results

According to the test results of the mixed estimation model, the estimated values of each parameter are shown in Table 4.

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|----------|-------------|------------|-------------|-------|
| C        | 16639.27    | 470.2965   | 35.38039    | 0.0000 |
| P        | -7.822396   | 0.330943   | -23.63672   | 0.0000 |
| UP       | 2.023009    | 0.304805   | 6.637064    | 0.0000 |
| D        | -0.030677   | 0.002569   | -11.94160   | 0.0000 |
| GDP      | -0.161485   | 0.008441   | -19.13002   | 0.0000 |
| ND       | 6.942321    | 0.275042   | 25.24099    | 0.0000 |

The model is estimated as:
\[ T_E = 16639.27 \times 7.82 + 2.02 \times U_P - 0.03 \times D + 0.16 \times G_D + 6.94 \times N_D \]  
\[ t = 35.38 \times (-23.64) \times (6.64) \times (-11.94) \times (-19.13) \times (25.24) \]
\[ R^2 = 0.978913 \quad F = 4261.669 \]
The data in Table 4 shows that the T-test values of resident population (P), urban population (UP), population density (D), gross domestic product (GDP) and number of drivers (ND) are -23.64, 6.64, -11.94, -19.13 and 25.24 respectively. Because of \( |T_i| > 2 \), therefore, the change rate of influencing factors such as resident population (p), urban population (UP), population density (d), gross domestic product (GDP) and number of drivers (nd) is significantly correlated with the number of road traffic fatalities (TF). The resident population (p) and gross domestic product (GDP) are negatively correlated with the number of urban road traffic accident deaths (TF). The number of urban population (UP), population density (D) and number of car drivers (ND) are positively correlated with the number of road traffic fatalities (TF).

There is a negative correlation between resident population (P) and the number of road traffic fatalities (TF), on the premise that other variables remain unchanged, the number of road traffic fatalities will decrease by 7.82% for every 1% increase resident population. There is a positive correlation between urban population (UP) and road traffic fatalities (TF), on the premise that other variables remain unchanged, the road traffic fatalities (TF) will increase by 2.02% when the urban population (UP) increases by 1%. There is a negative correlation between population density (D) and road traffic fatalities (TF), on the premise that other variables remain unchanged, the number of road traffic fatalities will decrease by 0.03% for every 1% increase in population density. There is a negative correlation between gross domestic product (GDP) and the number of road traffic fatalities (TF), on the premise that other variables remain unchanged, the number of road traffic fatalities will decrease by 0.16% for every 1% increase in GDP. There is a positive correlation between the number of car drivers (ND) and the number of road traffic fatalities (TF), on the premise that other variables remain unchanged, the number of road traffic fatalities (TF) will increase by 6.94% when the number of car drivers (ND) increases by 1%.

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

Based on the panel data of 31 provinces and cities in China from 2004 to 2018, this paper studies the impact of demographic and economic factors on road traffic safety in China. The impact of each factor is mainly in two aspects:

First of all, through data research, it is found that the number of resident residents and population density are negatively correlated with road traffic fatalities. In recent years, Chinese governments at all levels, especially the public security organs, have attached great importance to the publicity and education of traffic safety. The publicity and education of traffic safety have been brought into the scope of legal norms, and the socialization mechanism has begun to be established. Its role in preventing road traffic accidents has gradually become apparent. At the same time, with the significant improvement of the quality of our citizens and the continuous enhancement of public awareness of road traffic safety, the traffic safety situation in our country has improved in recent years. As China's regional economic development is uneven and a large number of people move to the eastern coastal areas, the economically developed areas tend to have a large population density, younger population and better development of medical and health services, which has a certain deterrent effect on traffic accident casualties. Secondly, there is a positive correlation between urban population and road traffic fatalities. With the acceleration of China's urbanization process, more and more rural population are integrated into the cities, and a large number of rural rich labor force are pouring into the cities, which stimulates the demand for road traffic between urban and rural areas. Urban residents, especially new urban residents, do not adapt or coordinate their transportation concepts and travel habits with the demands of urban road traffic, which leads to frequent traffic conflicts and even traffic accidents. The above problems are due to the imbalance of regional economic development in China, with a large number of population flowing into economically developed areas, resulting in the imbalance of regional population density in China. Although the cultural quality of our citizens has improved in recent years, due to the fact that rural areas account for the vast majority of China's national conditions, the transportation behavior of the vast majority of people is difficult to meet the needs of China's urbanization and motorization development. Relevant departments should focus on strengthening the
promotion of traffic safety civilization of non-registered population, migrant workers, floating population, etc., and speed up the construction of traffic safety culture and traffic safety civilization that quickly adapt to the inflow place. Through various forms, the traffic culture and traffic safety culture are infiltrated into the hearts of each traffic participant, so as to improve the traffic awareness and traffic safety awareness of traffic participants and reduce the traffic safety violations committed by pedestrians and vehicle drivers. At the same time, we will encourage more people to return to their homes for employment, increase the urban population density in remote areas in the west, bring into play the potential effects of transportation infrastructure, and promote more convenient cross-regional population movements.

Secondly, combined with the analysis results of this model, we know that the GDP is negatively correlated with road traffic fatalities. That is, the death toll from traffic accidents will show a downward trend with the economic growth. With the development of economy, the proportion of national investment in traffic construction and network management system has continued to increase. China's traffic facilities, traffic structure and road route planning have been gradually improved, providing a guarantee and a material basis for the improvement of traffic safety and reducing the number of deaths in traffic accidents to a certain extent. The economic growth has also improved the medical and health conditions. A sound medical system can ensure the timely rescue of traffic accident victims, reduce the traffic accident mortality rate and protect people's lives. At the same time, the number of car drivers has a positive impact on road traffic fatalities. On the premise of China's long-term steady economic development, residents' income, road expansion and the development of the automobile industry will inevitably lead to a continuous increase in the number of cars and car drivers, for example, the number of car drivers increased from 71.01 million in 2004 to 39.06 million in 2019, with a cumulative increase of 457%. The increase in the number of car drivers intensifies the burden on the roads, which is easy to cause traffic jams and other problems, and increases the risk of traffic accidents. The driver's individual factor is also the key to traffic accidents. Handling this link well can control the fundamental source of traffic accidents. The performance of drivers on the road is affected by many factors. According to relevant data, drivers with less than 3 years of driving experience account for a high proportion of the total number of traffic deaths. Therefore, the road traffic management department should take vehicle management and driver management as the fundamental tasks of traffic management, so as to make the number of motor vehicles and drivers increase in line with China's road construction and economic growth. Relevant departments can carry out differentiated training and management of drivers based on driving experience, and strictly train drivers to reduce the possibility of accidents at the source. From an economic point of view, China's economic growth continues to accelerate, stimulating investment in transportation infrastructure. The increasing scale of transportation facilities has further stimulated economic growth, and the number of traffic deaths has been reduced to a certain extent by improved transportation facilities. Therefore, relevant departments should continue to increase the investment in traffic safety funds, manpower and scientific research, continuously improve the infrastructure construction, give full play to the role of high technology in traffic management and traffic accident prevention, and provide guarantee and technical support for traffic safety improvement. With the rapid development of social economy, many traffic projects built in the early stage have been overloaded, and the problem of road congestion frequently occurs, which seriously affects the transportation efficiency. Therefore, we should speed up the optimization and upgrading of the road network to promote the sustainable development of the road industry.

This paper studies the five factors that affect road traffic fatalities, and based on a large number of data, analyzes the current situation of road traffic safety in China, and establishes a panel model of the five factors that affect the death toll in traffic accidents and road traffic fatalities, which can provide reference for national traffic safety management. The traffic system is a huge system, and the factors that affect traffic safety are interrelated. This paper only chooses resident population, the number of urban population, population density, gross domestic product, the number of car drivers to carry out quantitative analysis. For the lack of consideration of the non-quantifiable factors, the factors that are
not considered can be quantified in the future. At the same time, the model is predicted to improve the depth of the study.

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