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Original Article

Analysis on the accident casualties influenced by several economic factors based on the traffic-related data in China from 2004 to 2016

Li-Lu Sun*, Dan Liu, Tian Chen, Meng-Ting He

School of Economy and Finance, Chongqing University of Technology, Chongqing 400054, China

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ABSTRACT

Purpose: By studying the economic data related to road traffic accidents in recent 10 years, this paper explores the impact of various economic factors on the number of casualties in traffic accidents in China, and puts forward related prevention and management measures.

Methods: Based on five economic factors including the number of new health institutions, health investment, transportation investment and disposable income per capita, this paper collects the data of traffic accidents in 31 provinces and municipalities of China from 2004 to 2016 and estimates the parameters using fixed effect model.

Results: The number of health institutions, health investment, transportation investment and disposable income per capita are negatively correlated with the number of traffic accident casualties; the number of new health institutions is positively correlated with the number of traffic accident casualties; health investment and transportation investment have a great impact on the number of road traffic accident casualties.

Conclusion: Economic development has a positive impact on improving traffic conditions, but the increase in the number of new health institutions does not reduce the number of casualties in accidents. The irrational layout of health institutions and imperfect road traffic management mechanism should be taken into account.

Introduction

With the rapid development of economy and the improvement of living standards of residents, the level of motorization and the scale of road construction in recent years have shown a significant upward trend. The rapid improvement of motorization level and the expansion of road construction scale bring new challenges to traffic management system, especially the pressure of prevention mechanism, traffic management and afterwards rescue system, which have a negative impact on economic sustainable development and social stability. The Global Status Report on Road Safety 2015 shows that about 1.3 million people worldwide die from traffic accidents every year.[1] The number of traffic accidents in China decreased from 567.75 thousand in 2004 to 212.85 thousand in 2016, a decrease of 62.51%, and the number of casualties decreased from 587.94 thousand in 2004 to 289.52 thousand in 2016, a decrease of 50.76%. Compared with the decline rate of the number of traffic accidents, the decline rate of the number of casualties is not obvious, which indicates that the implementation of existing traffic prevention and management policies has played a role in reducing the accident rate, but not expected role in reducing the number of casualties. Therefore, influencing factors for road traffic casualties are still an important issue of concern to the government and academia.[2,3]

At present, researches on the influencing factors of traffic accident casualties in China mainly focuses on individuals, environment and the interaction between them. Chi et al.[4] analyzed the influencing factors of traffic accident casualties from two aspects of driver and environment, and found that speeding is the main cause of road traffic accident casualties. Shi et al.[5] found that gender and age factors have a significant impact on the number of casualties in major traffic accidents. Ning et al.[6] analyzed the number of traffic accident deaths under different weather conditions and found that the number of traffic accident deaths caused by foggy weather was the highest. Wang et al.[7] found that haze-induced casualties have

* Corresponding author.
E-mail address: Linda66@163.com (L.-L. Sun).
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the highest probability and greatest impact on traffic accidents, and gale has the longest impact on the accidents. At the same time, the impact of ice and snow pavement on traffic accidents cannot be ignored. Li and Zhao[8] found that all kinds of human factors have a great impact on traffic accident casualties by analyzing different psychological and behavioral characteristics of drivers, pedestrians and traffic policemen. Li[9] made a statistical analysis of highway traffic accidents in Sichuan province and showed that besides fatigue driving, bad road conditions and complex weather conditions also increase the probability of traffic accidents.

Although many scholars have studied traffic accident casualties and their influencing factors and confirmed that economic factors have an impact on traffic accident casualties, there is no effective demonstration on how the specific categories of economic factors play a role in traffic accident casualties, which leads to the lack of theoretical support on whether the implementation of economic measures can achieve results. Therefore, based on the existing research and panel data from 2004 to 2016 in China, this paper tries to analyze five economic factors, namely, the number of health institutions, the number of new health institutions, health investment, transportation investment and per capita disposable income, by constructing a fixed-effect model to study the impact of economic factors on traffic accident casualties. It provides decision-making basis for road traffic management system, provides reference for effective traffic safety management, and promotes a sound development of China's traffic management system.

Methods

Data source and sample interval description

The panel data related to economy and road traffic in 31 provinces and municipalities of the country from 2004 to 2016 were obtained from the annual report of traffic accident statistics of the People's Republic of China, the website of the National Statistical Bureau (http://www.stats.gov.cn/) and the websites of provincial and municipal statistical bureaus of the Ministry of Public Security.

Selection and explanation of various economic factors

Number of casualties in traffic accidents

The number of casualties in traffic accidents is one of the key indicators to measure the severity of traffic accidents. Expert analysis indicates that from 2000 to 2020, the number of road traffic deaths in low- and middle-income countries will increase by 83%, and road traffic injuries will rank the third in the global burden of disease and injury by 2020.[10] Ren and Peng[11] pointed out that the problem of road traffic casualties is closely related to local social and economic environment, and has a strong regionality and timeliness. It is difficult to simply copy the existing research results and past experience. The data show that although the number of traffic accident casualties in China keeps decreasing year by year from 2004 to 2015, it has increased from 232.26 thousand in 2015 to 289.52 thousand in 2016, and the number of casualties has increased by 57.23 thousand. It shows that the current control policies of traffic casualties in China still need to be improved, and the study of economic related factors may have a new direction and theoretical significance for the relevant policies.

Health investment

In 2004, China's health investment amounted to 83.23 billion yuan, which increased to 1306.76 billion yuan by 2016, 15.7 times as much as that in 2004. The increasing investment in health represents the increase in the number of health institutions and the improvement of rescue capacity, which is of great significance for the post-accident rescue of the casualties in traffic accidents and relates to the safety of life and property of the casualties.

Number of health institutions

At present, domestic and foreign scholars' research on health institutions mainly focuses on the macro-level, such as health facilities, the development trend and direction of health institutions, but less on the micro-level, such as the relationship between health institutions and road traffic casualties. The number of health institutions in China has increased rapidly from 291.32 thousand in 2004 to 983.39 thousand in 2017, an increase of 237.56% in the past 13 years, which shows that the country is constantly improving its health care. The number of health institutions directly affects the rescue capacity and quality of road traffic accidents, and is closely related to the life safety of traffic accident casualties.

Number of new health institutions

In 2004, a total of 5169 new health institutions have been set up in China, but in 2016 the number was negative 134. Overall, the number of new health institutions in China has slowed down year by year in recent years, and decreased in 2016. The number of new health institutions has an important impact on the timeliness of traffic accident rescue, thus affecting the life safety of accident victims. However, in recent years, the decrease of new health institutions does not necessarily mean that the level of health care has been declined. It may be due to the merger of health institutions and thus has made the institutions develop towards high quality. So it does not mean that it is unfavorable to the injured in traffic accidents.

Transportation investment

With the development of China's economy and the increasing emphasis on road traffic, the proportion of the State's investment in transportation has been increasing. The State's investment in the field of transportation has steadily increased from 24.48 billion yuan in 2004 to 968.66 billion yuan in 2016, an increase of 38.6 times in 13 years and a cumulative investment of 6508.60 billion yuan. This shows that our country attaches more importance to road traffic management and construction.

Per capita disposable income

Yu[12] hold that residents' disposable income is the real income remaining after paying personal income tax, property tax and other recurrent transfer expenditure. At present, the related research on residents' disposable income in our country mainly focuses on the differences between urban and rural income, the impact on various economic aspects, the development trend and so on; while the impact on per capita disposable income and traffic accident casualties is less involved. Per capita residents' income will affect people's car ownership from the micro level, and can reflect the level of economic development from the macro level. It also affects the State's investment on transportation and medical treatment, which will have an impact on road traffic accidents. China's per capita disposable income has been raising steadily year by year, from 9.42 thousand yuan in 2004 to 25.97 thousand yuan in 2016, which shows that people's living standards have been improving continuously and social economy has been developing continuously.

Building model

Wang et al.[13] found that some factors are directly related to the number of traffic casualties. Therefore, a single regression analysis was made to analyze the relationship between the number of road traffic casualties (P) and the number of health institutions (HA), the number of new health institutions (NHA), health investment (HI), transportation investment (I), and per capita disposable income (PDI). The results of single factor model test are shown in Table 1.

The t value of the number of new health institutions, health investment (100 million yuan) and per capita disposable income (yuan) of residents are less than 2, and R-square deviates from 1. The goodness of fit of the model is not good. The t value of traffic investment (100 million yuan) is 3.251,057, but R-square is 0.002797, which deviates from 1. The overall effect of the model is not good. Considering that the single factor model with five variables is not effective, this paper takes the number of traffic accident casualties (people) as the explanatory variable, and takes the number of health institutions (individuals), the number of new health institutions (individuals), health investment (billion yuan), traffic investment (100 million yuan), and the per capita disposable income (yuan) as explanatory variables to build a panel data model of economic factors related to traffic accident casualties.

Domestic and foreign scholars found that the cause of road traffic accidents is not the result of a single factor, but the result of a combination of multiple factors.[14–17] Therefore, considering the possible correlation among various factors, in our multi-factor model the relationship between the number of road traffic accident casualties (people) and the number of health institutions (individuals), the number of new health institutions (individuals), health investment (100 million yuan), transportation investment (100 million yuan), per capita disposable income (yuan) of residents were analyzed. Five variables from the database of 31 provinces and municipalities in China during the period of 2004–2016 were analyzed for multi-collinearity. The results are shown in Table 2.

The correlation coefficient matrix is used to analyze the collinearity among various economic factors. From Table 2, we can see that there is no complete collinearity among the variables of the number of health institutions (individual), the number of new health institutions (individual), health investment (100 million yuan), transportation investment (100 million yuan) and per capita disposable income (yuan). Therefore, we can build a regression model as follows:

$$P_{it} = C + \beta_1 HA_{it} + \beta_2 NHA_{it} + \beta_3 HI_{it} + \beta_4 I_{it} + \beta_5 PDI_{it} + \mu_{it} \qquad (1)$$

$(i = 1, 2, 3...31\ ;\ t = 1, 2, 3...13)$

“i” means 31 provinces and municipalities; “t” means 13 years; P_{it} means the number of traffic accident deaths (people); C is the intercept item; HA_{it} means the number of health institutions in each province and municipality (individual); NHA_{it} means the number of new health institutions in each province and municipality (individual); HI_{it} means the health investment in each province and municipality (100 million yuan); I_{it} means the transportation investment of each province and municipality (100 million yuan); PDI_{it} means the disposable income per capita of each province and municipality. μ_{it} is a random error term.

Table 1
Single factor model test results.

Variable	Coefficient	t value	p value	R-squared	F value
HA	0.055,213	1.915,493	0.0561	0.009067	3.669,112
NHA	0.137,817	1.761,653	0.0789	0.007680	3.103,420
HI	5.536,647	1.657,841	0.0981	0.006807	2.748,436
I	3.447,628	3.251,057	0.2896	0.002797	1.124,583
PDI	−0.085,932	−0.068,750	0.2121	0.003881	1.562,332

Table 2
Coefficient matrix.

	HA	NHA	HI	I	PDI
HA	1.000000	0.287,977	0.719,182	0.577,978	−0.163,274
NHA	0.287,977	1.000000	−0.012,300	−0.006520	−0.084,893
HI	0.719,182	−0.012,300	1.000000	0.869,384	0.591,445
I	0.577,978	−0.006520	0.869,384	1.000000	0.525,002
PDI	−0.163,274	−0.084,893	0.591,445	0.525,002	1.000000

Results

Unit root test

The unit root test of panel data adopts Fisher-ADF test with different root unit roots and LC (Levin-Lin-Chu) test with the same root unit roots. The test results are shown in Table 3.

The unit root test results of panel data show that P and NHA are stable at 1% significant level, thus rejecting the zero hypothesis of unit root; variables HA, HI, I and PDI are non-stationary at 1% significant level, but after first-order difference, they are stable at 1% significant level, thus rejecting the zero hypothesis of unit root. According to the results of LLC test, the p value of each variable test is less than 0.01, so each variable passes the unit root test and is stable, and the next step of cointegration test can be carried out.

Cointegration test

The methods of Panel Data Cointegration test mainly include KAO test and Pedroni test. Pedroni test is suitable for models with fewer variables. KAO test is suitable for models with more variables. Because this paper is a model involving six variables, it is more reasonable to use KAO test.

The t value is −5.762,321 and p value is 0.0000, which indicates that there is a long-term equilibrium relationship between the number of traffic accident casualties (persons) and the number of health institutions (individuals), the number of new health institutions (individuals), health investment (100 million yuan), transportation investment (100 million yuan) and per capita disposable income (yuan).

Model recognition and estimation

Cointegration test shows that there is a long-term stable cointegration relationship among variables, so a regression model is established to measure the specific quantitative relationship among variables.

Model recognition. There are three kinds of regression models for panel data: mixed estimation model, fixed effect model and random effect model. We use the likelihood ratio test of fixed utility and Hausman test of random utility to determine the appropriate model form. The test results are shown in Table 4.

From the results of likelihood ratio test in Table 4, the p value of F statistic is 0.0000, less than 0.05. Therefore, the original hypothesis should be rejected and the individual fixed effect model should be established.

According to the Hausman test results in Table 5, the p value of Hausman statistics is 0.0000, which is less than 0.05. Therefore, the original hypothesis should be rejected and an individual fixed effect model should be established.

Table 3
Unit root test results of panel data.

Variables		Levin, Lin&Chut		ADF- Fisher		Results
		Statistic	*p* value	Statistic	*p* value	
P	Level	−15.7195	0.0000	142.354	0.0000	stability
HA	D(1)	−17.4977	0.0000	206.013	0.0000	stability
NHA	Level	−34.4532	0.0000	309.750	0.0000	stability
HI	D(1)	−9.49,299	0.0000	118.517	0.0000	stability
I	D(1)	−12.5855	0.0000	218.129	0.0000	stability
PDI	D(1)	−25.2683	0.0000	245.141	0.0000	stability

Table 4
Likelihood ratio test.

Effects test	Statistic	df	*p* value
Cross-section F	89.345,027	(30,367)	0.0000
Cross-section Chi-square	853.016,422	30	0.0000

Table 5
Hausman test.

Test summary	χ^2	χ^2 df	*p* value
Cross-section random	136.357,686	5	0.0000

Model estimation. The estimated results of the model are as follows:

$$P_{it} = 17398.13 - 0.14HA_{it} + 0.01NHA_{it} - 8.29HI_{it} - 3.58I_{it} - 0.01PDI_{it}$$

$$t = (18.47)\ (-3.70)\ (2.14)\ (-2.31)\ (2.39)\ (2.39)$$

$$R2 = 0.927544 \quad F = 134.2334$$

The result shows that the *t* values of the number of health institutions (HA), the number of new health institutions (NHA), health investment (HI), transportation investment (I) and per capita disposable income (PDI) are −3.70, 2.14, −2.31, 2.39 and −2.65, respectively. Because $|T_i| > 2$, it shows that the number of road traffic accident casualties (P) is significantly correlated with the number of health institutions (HA), the number of new health institutions (NHA), health investment (HI), transportation investment (I), and per capita disposable income (PDI). According to the linear regression model, the number of health institutions (HA), health investment (HI), transportation investment (I), per capita disposable income (PDI) of residents are negatively correlated with the number of road traffic accident deaths (P), while the number of new health institutions (NHA) is positively correlated with the number of road traffic deaths (P).

The negative correlation between the number of health institutions (HA) and the number of road traffic accident deaths (P) is embodied in the following aspects: when other factors remain unchanged, the number of health institutions increases by 1, and the number of traffic accident casualties decreases by 0.14. The negative correlation between health investment (HI) and road traffic accident deaths (P) is embodied in: when other factors remain unchanged, for every 100 million yuan increase in health investment (HI), the number of road traffic accident deaths (P) decreases by 8.19 people. The negative correlation between traffic investment (I) and the number of road traffic accident deaths (P) is that when other conditions remain unchanged, the number of road traffic accident deaths (P) decreases by 3.58 people for every 100 million yuan increase in traffic investment (I). The negative correlation between per capita disposable income (PDI) and road traffic accident deaths (P) is as follows: when other conditions remain unchanged, per capita disposable income (PDI) increases by 1 yuan, the number of road traffic accident deaths (P) decreases by 0.01 people. The number of new health institutions (NHA) is positively correlated with the number of road traffic accident deaths (P). For each increase in the number of new health institutions (NHA), the number of road traffic accident deaths (P) increases by 0.01.

Discussion

There is a quantitative relationship between economic development and road traffic accident casualties. Song and Zhang[18] believe that economic development will raise the road traffic burden, resulting in an increase in road traffic accident injuries. This study found that with the increase of disposable income per capita, the number of health institutions, health investment and transportation investment, the number of road traffic accident casualties showed a downward trend. On the one hand, it may be due to geographical environment, population distribution characteristics, unbalanced economic development and other reasons, resulting in relatively concentrated areas of road traffic accidents. On the other hand, due to the continuous relaxation of China's traffic examination and approval,[19] and the proposed increase in investment of transport infrastructure in 2018, the proportion of the State's investment in transport construction and management network system has been increasing, and various related system improvements have achieved initial results.

With the increase of the number of new health institutions, the number of road traffic accident casualties increased. The number of new health institutions is positively correlated with the number of casualties. On the one hand, it may be that the distribution of health institutions does not match the distribution of casualties, which makes the new health institutions unable to give full play to the timely effect of emergency rescue. On the other hand, the new institutions can not effectively reduce the number of casualties, and further there are some problems in emergency rescue mechanism and rescue management mechanism, such as inadequate emergency management leads to lower rescue speed, uneven distribution of road resources, thus delaying the rescue time of the injured.

Health investment and traffic investment have a significant effect on reducing the number of traffic accident deaths. Li and Zhao[20] hold that the economic development and population structure change inversely correlated with the traffic accident casualty rate. Therefore increase of the investment in traffic safety infrastructure is favorable to reduce traffic accident deaths. At the same time, the distribution of health institutions and various rescue facilities should be matched with the place where the casualties occurred.

This study found that the new institutions have failed to effectively reduce the number of casualties, indicating that there are still problems in rescue, such as road congestion after the accident, complicated procedures for the division of accident liability, which may lead to the reduction of rescue efficiency and the inefficient use of health resources. Therefore, the linkage effect and feedback system of transportation, health and big data management departments should be strengthened continuously so as to link up the rescue process quickly and effectively, and optimize the time of high accident occurrence and the resource distribution of road sections. In addition, we should constantly optimize the emergency rescue mechanism so as to make timely management and effective allocation of medical resources.

With the development of economy and the change of road traffic environment, the characteristics of traffic accident casualties become more and more complex. Traditional traffic systems, such as road construction and traffic management methods, can no longer meet the current traffic demand. This study found that although the number of health institutions has a significant impact on the number of traffic accident casualties, overall, the number of casualties decreased by only 0.14 per 1 health institution increase, indicating that the effectiveness of capital investment still needs to be improved. Therefore, all departments concerned with transportation should take measures according to local conditions. For example, in the eastern plain area, in which the traffic system is complex, a real-time monitoring of road safety is needed; in the central and western areas, the terrain is complex, and natural disasters such as debris flow and landslide occur from time to time, so the level of road management and road maintenance should be strengthened.

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Ethical statement

None.

Conflicts of interest

There are no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cjtee.2019.02.002.

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