An Empirical Research on the Effect of Driver Training Industry on Road Traffic Safety

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Abstract. The 12th Five-Year Plan of Road Traffic Safety and the 13th Five-Year Plan of Road Traffic Safety have been issued successively, demonstrating the CPC and the Chinese government has attached great importance to the driver training industry and road traffic safety. However, relevant studies in China are still very limited. Based on the cross-sectional data of 100 cities in 2015, this paper analyzes the impact of driver training quality in this industry on road traffic safety. The conclusion shows that the correlation between the passing rate of subject 2 and road safety is stable, as high passing rate can lead to the effective reduction of the occurrence of traffic accidents. The passing rate of Subject 1 and road traffic safety shows a positive correlation in the period when the section is relatively static, and a negative correlation in the panel analysis with timing characteristics.

1. Introduction
According to a report of the World Health Organization (WHO) in May 2017, about 1.25 million people die from road traffic crashes every year, half of whom are "vulnerable road users", namely pedestrians, cyclists and motorcyclists. About 20 to 50 million people suffer non-fatal injuries, many of them disabled. And the costs of road traffic crashes account for 3 percent of the gross domestic product of most countries. Without sustained action, road traffic accidents are expected to become the seventh leading cause of death in the world by 2030.

With the development of China's economy, road safety issues are increasingly attracting people's attention. In the road traffic system consisting of "people, vehicles, roads and environment", the human factor is the most critical, serving as the bridge connecting other elements. In the modern road traffic, the drivers’ skills and awareness of road safety are of great importance to road traffic, since they are the ones who comprehend the system, give the instructions and conduct the operation. And the driver training industry, which cultivates and trains a driver’s series of skills and habits, is deemed as a "source" of road safety management. It can be said that as the driver training industry is directly involved in the efforts to promote road traffic safety, and the industry is closely related to the road safety issues, the development of the industry comes with more social responsibilities.

At present, the number of motor vehicle driving license holders has exceeded 300 million in China, and the number will grow by over 20 million annually in the next 10 years¹. With the surge in the number, a problem which can’t be overlooked is the various levels of individual driving skills and road safety awareness, attributed to the various levels in the quality of driver training. Good training

¹Source of the data: The First International Forum on Driver Training and Road Traffic Safety held in June 2016 in Beijing
can help beginners exercise their driving skills with dexterity in complex situations and bear in mind the idea of road traffic safety whenever they are driving, while bad training would lead to the increase of the probability of road traffic accidents by producing more “road killers”. When it comes to driving schools, the quality of training is of great importance. Therefore, it can be said that the development of driver training industry is closely related to road traffic safety. At present, most studies on the correlation between driver training industry and road traffic safety in China are statistical research, and there are few researches that go deep into the quantitative and empirical level, leaving much blank in this field. In view of this, this paper intends to take the driver training quality as the focal point to analyze the impact of this industry on road traffic safety from the quantitative and empirical perspectives. It is an important supplement to the theory of driver training industry, and can also lay a foundation for the future policy making concerning driver training and the development of this industry, providing huge theoretical and practical significance.

2. Current Research Status at Home and Abroad

There are abundant studies on the correlation between the driving industry and road traffic safety abroad. O’Malley P M and Johnston LD (1999), through the survey data of 1984-1997 of the US by using Logistic regression to study the demographic factors (gender, region, average grade, population density, family education and race) and lifestyle factors (religious commitment, high school graduation, truancy, illegal drug abuse, night travel mileage per week, and weekly travel mileage) effects on drunk driving behavior of American high school students. It found a significant decline in teen drunk driving rates from the mid-1980s to the early 1990s or mid-1990s, but the decline did not continue. White male high school graduates living in the western and northeastern United States and the rural areas have a higher proportion of drunk driving. Truancy, the number of night trips, illegal drug abuse, and drunk driving behavior had significant positive correlations with the number of miles traveled per week, and the average grade and religious commitment were negatively correlated [1]. Eensoo D, Paaver M and Harro J (2011) studied the impact of interventions in driving school training on road traffic safety by dividing 1889 novice students into a control group and an intervention group. After three years of tracking, it was found that the drunk driving behavior of the control group was significantly higher than that of the intervention group, which indicated that psychological intervention can effectively reduce road traffic accidents caused by drunk driving behavior, but for some drivers with high impulsive tendency and long-term drinking behavior, short-term psychological intervention didn’t work[2]. Chakrabarty, Neelima Shukla, Anuradha Singh, H. Shokeen and Nancy (2012) argued that inappropriate driving behavior is one of the main causes of road traffic accidents in India. Traffic accidents increased as a result of various insecure behaviors of Indian drivers such as lack of lane discipline, disregard of traffic regulations, frequent traffic violations, and self-centered driving. Therefore, improving driver behavior can be an effective measure to reduce road traffic accidents [3]. Živković S, Nikolić V, and Markić M (2015) studied the impact of drivers’ personal characteristics on road traffic safety based on a questionnaire of 59 professional drivers. It was found that the individual characteristics of professional drivers are very important for road traffic safety [4]. Kureckova V, Gabrhel V, Zamecnik P, et al (2017) designed a 16-hour course based on experienced first-aid and compared its effects to standard 4-hour training. The results show that there are significant differences in the effects of the two sets of training, which was not only shown in the first-aid knowledge and skills, but also in the ability to cope under simulated conditions. Therefore strengthening the acquiring of first-aid knowledge and skills as well as the improvement of psychological quality should be an important part of the driving course [5].

There are relatively few studies on the driver training industry and road traffic safety in China. Most of the existing researches are targeted at single object, and are qualitative analysis. Liu Junli (2013) believes that the current training industry is ill-positioned, and driving schools should ensure the quality of training and take on their due social responsibility while pursuing business functions [6]. Zhang Luo (2013) believes that the current drivers are not skilled or even qualified, which is a major reason for the serious road safety challenges in China. Based on the current status of driving training
industry in Changsha, Zhang analyzed the five major aspects that make it difficult to improve training quality: laws and regulations, coaching quality, supply and demand, driving school system, and cost management mode, and gave relevant suggestions [7]. Liu Guangping, Ding Limin and Wang Jinfeng (2015) clarified the necessity of traffic safety publicity and education in a society with high level of automobile prevalence from the perspective of traffic safety publicity and education and believes that traffic safety education is not only conducive to road traffic safety and smoothness, but also important to the development of the national safety culture, the building of the rule consciousness among nationals, and the improvement of legal awareness [8]. Cai Yang and He Jinjiang (2016) constructed a road traffic accident probability scorecard using logistic regression analysis method based on big data analysis, analyzing the driver’s gender, age, driving age, vehicle status, driving school and other characteristic variables, so as to predict the traffic accidents.

Comparing domestic and foreign research, it can be found that foreign research has been relatively mature with diverse methods and rich results, while domestic research is still in its infancy with few results and mostly focusing on qualitative analysis. It can be said that the research on driver training industry and road traffic safety in the new stage in China is still to be fully rolled out. Especially with the issuing of the 13th Five-Year Plan on Road Traffic Safety relevant research is in urgent need.

Next, the paper studies the impact of driver training industry on road traffic safety from the perspective of the training quality. Abstractly, the industry can be regarded as the carrier of the training quality, which is the direct embodiment of the driver training industry, and connects the industry and road traffic safety as a medium. This paper follows the above ideas to study the impact of the industry on road traffic safety, as shown in Figure 1.

![Figure 1 Chart of Relations between Driving Training Industry and Road Traffic Safety](image)

### 3. Empirical Analysis of the Correlation between Driving Training Quality and Road Traffic Safety

Before the analysis, an issue that needs to be explained is that the records of road traffic accidents in various regions of China have not been standardized for a long period of time, which leads to certain difficulty in obtaining data for theoretical research. Therefore, the analysis mainly focuses on the cross-sectional data and takes into account the introduction of control variables, striving to comprehensively explore the impact of driver training quality on traffic safety.

#### 3.1. Model Introduction and Variable Selection

#### 3.1.1. Sectional Model

Based on the availability of data and the purpose of simplified analysis, this paper selects the number of traffic accidents in 100 cities in 2015 as the research object in the cross-sectional analysis, and constructs the cross-sectional model as follows:

$$ y_i = x_i \beta + z_i \delta + \epsilon_i \quad (i = 1, \ldots, n) $$

(1)
Among them, ‘y’ represents road traffic safety, ‘i’ represents individual cities, ‘n’ represents number of cities, ‘$x_i$’ represents main explanatory variables, and ‘$z_i$’ represents introduced control variables.

3.1.2. Quantile Regression
The paper adds quantile regression on the basis of the above regression. The quantile regression can describe the whole situation of the conditional distribution of the explained variables in more detail, not just the expectation of the explained variables in the conventional analysis. The regression coefficient estimates are often different under different quantiles. Assume the general quantile $y_q(x)$ of the conditional distribution $y|x$ is a linear function of $x$:

$$y_q(x_i) = x'_i \beta_q$$ (2)

In the formula, ‘$x$’ represents the explanatory variable containing the control variable, $\beta_q$ is called the ‘quantile regression coefficient’, and its estimated value can be defined by the following minimization problem:

$$\min_{\beta_q} \sum^n_{i:y_i \geq x'_i \beta_q} q | y_i - x'_i \beta_q | + \sum^n_{i:y_i < x'_i \beta_q} (1-q) | y_i - x'_i \beta_q |$$ (3)

3.1.3. Variable Selection
(1) Explained Variables: Road Traffic Safety
Road traffic safety means when people carry out activities on the road, they should drive and walk safely in accordance with the provisions of traffic regulations to avoid personal casualties or property losses. This paper selects the number of traffic accidents (tranum) in 100 cities in 2015 as a proxy variable to measure the traffic safety situation in these regions. Most of the data can be found in the statistical yearbooks of different provinces in 2016, but a small amount of data still needs to be found in the statistical yearbooks of different regions.

(2) Core Explanatory Variable: Driver Training Quality
At present, there are no specific indicators to measure the quality of driving schools in China. In general, the quality of driving training is closely related to the infrastructure and teaching staff of driving schools. It measures how easy students could pass the driving test after the training and their ability to deal with emergencies on the road later on. This paper selects the average $s1$ and $s2$ passing rates of all driving schools in the region as the proxy variable to measure the training quality of the region, reflecting the training competence of the city in that year. The general logic is as follows: in the case of a certain level of difficulty of the test, the higher the passing rates of all driving school students in a certain region, the higher the average training quality of driving schools in that region is, i.e., the higher the quality of driver training in that region is. The data of the passing rates of subject 1 and subject 2 was obtained from the Traffic Safety Integrated Service and Management Platform of the Ministry of Public Security, which includes 87,768 data from 3,657 driving schools in 100 cities. The mean value was taken to obtain the regional driving quality data. Table 1 shows the number and data of driving schools in different regions used in the cross-sectional analysis in this paper.
Table 1. Source of Driving School Data

| Region         | Main Cities                                                                 | Number of Cities | Number of Driving Schools | Number of Data |
|----------------|------------------------------------------------------------------------------|------------------|---------------------------|----------------|
| East China     | Shanghai, Ningbo, Anhui Province: Hefei, Wuhu, Bengbu, Huainan, Ma’anshan, Huaibei, Tongling, Anqing, Huangshan, Chuzhou, Fuyang, Lu’an, Bozhou, Chizhou, and Xuanzeng Jiangxi Province: Nanchang, Jingdezhen, Pingxiang, Jiujiang, Xinyu, Yingtan, Ganzhou, Ji’an, Yichun, Fuzhou, and Shangrao | 15               | 367                       | 4404           |
| South China    | Guangzhou                                                                  | 1                | 88                        | 1056           |
|                | Hainan Province: Haikou and Sanya                                           | 2                | 39                        | 468            |
|                | Shandong Province: Jinan, Qingdao, Zibo, Zaozhuang, Dongying, Yantai, Weifang, Jining, Tai’an, Weihai, Rizhao, Laiwu, Linyi, Dezhou, Liaoqiang, Binzhou, and Heze Inner Mongolia Autonomous Region: Hohhot, Baotou, Wuhai, Chifeng, Tongliao, Erdos, Hulun Buir, Bayannur, Ulanqab, Hinggan League, Xilin Gol League, and Alxa League | 17               | 451                       | 5412           |
| North China    | Wuhan                                                                       | 1                | 93                        | 1116           |
| Southwest China| Chongqing, Guiyang                                                           | 1                | 366                       | 4392           |
|                | Sichuan Province: Chengdu, Zigong, Panzhihua, Luzhou, Deyang, Guangyuan, Suining, Neijiang, Leshan, Nanchong, Meishan, Yibin, Guang’an, Dazhou, Ya’an, Bazhong, Ziyang, Aba Tibetan and Qiang Autonomous Prefecture, Ganzi Tibetan Autonomous Prefecture, and Liangshan Yi Autonomous Prefecture | 20               | 320                       | 3840           |
| Northeast China| Shenyang, Harbin                                                            | 1                | 75                        | 900            |
| Northwest China| Yinchuan                                                                    | 1                | 12                        | 144            |
|                | Shaanxi Province: Xi’an, Tongchuan, Baoji, Xianyang, Weinan, Yan’an, Hanzhong, Yulin, Ankang, Shanglou, and Yangling Demonstration Zone | 11               | 255                       | 3060           |
| Total          |                                                                             | 100              | 3657                      | 43884          |
(3) Control Variables
The population factors, road factors and economic factors are considered in the selection of control variables.

The population factors include urban population density (citymidu) and number of city travellers (citytraveller). In theory, when the urban population density and number of city travellers grow, it is prone to traffic jams and the probability of traffic accidents increases, if the road area and mileage remains unchanged.

Road factors include the per capita area of city road (cityroad) and the number of road infrastructure streetlights (light). The per capita area of city road can measure the convenience of the road traffic in an area to a certain extent. The larger the per capita area of city road is, the better the traffic will be, and the lower the possibility of road traffic accidents is. Meanwhile, this paper considers the impact of the road infrastructure streetlights on traffic accidents from the perspective of the driver’s sight. Obviously, when a driver is driving at night or is affected by extreme weather, and is therefore prone to traffic accidents due to the blocked sight, the streetlights will improve the visibility of the driver so that the probability of traffic accidents will be reduced. Of course, the above variables also have the possibility leading to the increase of traffic accidents, because smooth traffic and clear sight may increase the number of passengers and vehicles, leading to more traffic accidents.

When it comes to the economic factors, the per capita GDP (agdp) is selected as a proxy variable. Generally speaking, the higher a region’s GDP, the more frequent its traffic will be, which may lead to more traffic accidents.

In terms of data sources, except for the city traveller data (citytraveller) from the statistical yearbooks of 2016 of different regions, all other data are from the China City Statistical Yearbook 2016. Table 2 shows the descriptive statistical characteristics of each variable.

| Variable                     | Observed value | Unit         | Mean Value | Standard Deviation | Minimum | Maximum |
|------------------------------|----------------|--------------|------------|--------------------|---------|---------|
| Number of Traffic Accidents  | 100            | /Year        | 706.7200   | 947.6662           | 12      | 5358    |
| (tranum)                     |                |              |            |                    |         |         |
| Passing Rate of Subject 1    | 100            | %/Year       | 78.5179    | 6.6040             | 62.71   | 93.65   |
| (S1)                         |                |              |            |                    |         |         |
| Passing Rate of Subject 2    | 100            | %/Year       | 45.7727    | 7.4146             | 26.47   | 68.99   |
| (S2)                         |                |              |            |                    |         |         |
| Urban Population Density     | 100            | persons/km²  | 3072.443   | 2162.350           | 8       | 1136    |
| (citymidu)                   |                |              |            |                    |         |         |
| Number of City Travelers     | 100            | 10,000 persons/Year | 8426.665 | 19719.76           | 15.2247 | 156957 |
| (citytraveller)              |                |              |            |                    |         |         |
| Per capita Area of City Road | 100            | m²/Year      | 19.3153    | 9.1555             | 2.8     | 56.34   |
| (cityroad)                   |                |              |            |                    |         |         |
| Number of Streetlights       | 100            | Number/Year  | 81049.14   | 96981.70           | 4280    | 532032  |
| (light)                      |                |              |            |                    |         |         |
| Per capita GDP (agdp)        | 100            | Yuan/Year    | 56471.87   | 34070.49           | 15076   | 207163  |

3.2. Cross-sectional Analysis
Before the model estimation, this paper first draws the linear trend graphs showing the correlation between the number of traffic accidents (tranum) and the passing rates of subject 1 (s1) and subject 2 (s2) according to the distribution of cross-sectional data.
As shown in the above figure, the tranum is positively correlated with s1 and negatively correlated with s2. The specific regression results are shown in Table 2.

| Variable   | Model 1          | Model 2          | Model 3          | Model 4          | Model 5          | Model 6          | Model 7          | Model 8          |
|------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Constant   | -1993.0200       | -1993.0200       | -2112.4960       | -2112.4960       | -2807.8770       | -2807.8770       | -2114.5420       | -2114.5420       |
| Terms      | (1202.6710)      | (1204.7590)      | (1264.3450)      | (1276.7830)      | (1180.0590)      | (1095.0120)      | (975.9632)       | (1107.2266)      |
| s1         | 44.5708***       | 44.5708***       | 48.9392***       | 48.9392***       | 50.3909***       | 50.3909***       | 31.3122**        | 31.3122***       |
|            | (15.1695)        | (13.5480)        | (16.2694)        | (14.8202)        | (15.0243)        | (12.8840)        | (12.6953)        | (11.3591)        |
| s2         | -24.9975*        | -24.9975         | -26.2851*        | -26.2851*        | -20.9512*        | -20.9512*        | -8.9063          | -8.9063          |
|            | (12.8524)        | (13.7520)        | (13.3131)        | (13.9195)        | (12.3795)        | (12.6106)        | (10.4444)        | (10.0495)        |
| citytraveller | 0.0128***     | 0.0128**         | 0.0124***        | 0.0124**         | 0.0105**         | 0.0105**         | 0.0032           | 0.0032           |
|            | (0.0046)         | (0.0108)         | (0.0047)         | (0.0105)         | (0.0044)         | (0.0047)         | (0.0038)         | (0.0051)         |
| citymidu   | 0.0829*          | 0.0829           | 0.0838*          | 0.0838           | 0.0662           | 0.0662           | 0.0406           | 0.0406           |
|            | (0.0432)         | (0.0506)         | (0.0468)         | (0.0545)         | (0.0434)         | (0.0434)         | (0.0359)         | (0.0458)         |
| cityroad   | -8.9026          | -8.9026          | -19.4875*        | -19.4875*        | -2787            | -2787            | -66635           | -66635           |
|            | (10.6280)        | (7.8923)         | (10.1607)        | (10.2407)        |                 |                 |                 |                 |
| agdp       | 0.0106***        | 0.0106**         | 0.0108***        | 0.0108**         | 0.0024           | 0.0024           | 0.0024           | 0.0024           |
|            | (0.0027)         | (0.0034)         | (0.0026)         | (0.0026)         |                 |                 |                 |                 |
| light      | 0.062***         | 0.062***         | 0.062***         | 0.062***         | 0.00022          | 0.00022          | 0.00022          | 0.00022          |
|            | (0.0089)         | (0.0022)         |                 |                 |                 |                 |                 |                 |
| White-sta  | 32.4800***       | 32.4800***       | 32.6400***       | 32.6400***       | 45.5300***       | 45.5300***       | 77.2400***       | 77.2400***       |
| F-sta      | 4.8600***        | 4.8600***        | 3.7900***        | 3.7900***        | 6.3800***        | 6.3800***        | 14.1300***       | 14.1300***       |

Note: "***", "**", and "*" correspond respectively to the significance level of p<0.01, <0.05, and <0.1, and the value in the brackets are standard error.

Models 1, 3, 5, and 7 in the table show the variation of the coefficients of each variable in the equation as the control variables are introduced one by one. Considering the heteroscedasticity problem that may exist in the cross-sectional data, the model adds the heteroscedastic White test. It can be seen that the above models all reject the null hypothesis of the homoscedasticity, which means the heteroscedasticity exists. Models 2, 4, 6, and 8 show results after using heteroscedastic robust standard error estimation. It can be seen that the coefficients are unchanged, the standard errors are changed, and the significance of the relevant variables has changed to various degrees. Meanwhile, it can be seen from the F values in the table that all the models are overall significant. Observing models 1-8, one can find that the passing rate of s1 has significant positive correlation in all equations with the tranum, while the passing rate of s2 is significantly weaker, as it is negatively correlated with the tranum in models 4 and 6, and is not significant in other models. Taking Model 4 as an example, under the precondition that the control variables do not change, a 1% increase in the passing rate of s1 will lead to an increase of road traffic accidents by 48.9392 per year, and a 1% in the passing rate of s2 will reduce road traffic accidents by 26.2851 per year.
The control variables of per capita area of city road (cityroad), per capita GDP (agdp) and road infrastructure streetlights (light) are significantly positively correlated with the number of traffic accidents (tranum). The empirical results of the per capita area of city road (cityroad) are different from the theoretical expectations, probably due to the fact that the current speed of road construction in China lags behind that of vehicles’ launch in the market, which means the construction of road infrastructure lags behind the progress of motorization. The correlation between the per capita GDP (agdp) and the number of traffic accidents (tranums) meets theoretical expectations, indicating that as people's living standards improve, the increase in their travel will lead to an increase in traffic accidents to a certain extent. The number of streetlights (light) reflects the factors leading to the increase in traffic accidents as mentioned in the theory part of this paper.

The population factors including the urban population density (citymidu) and number of city travellers (citytraveller) are significant in the models with heteroscedasticity and are not significant after being adjusted. Therefore, it can be said that the population factors are not the main factors causing traffic accidents during this period.

3.3. Quantile Regression

The data of traffic accidents cited in the paper are those of different cities in China, including large cities such as Beijing, Shanghai and Guangzhou, medium-sized cities such as Ningbo, Jinan, Hefei and Wuhan, as well as a larger number of small-sized cities. Therefore, the distributions of number of traffic accidents vary. Figure 3 shows the distribution of tranum of the 100 cities in the sampled data.

![Figure 3 Number of Traffic Accidents (tranum)](image)

The horizontal axis of the above figure represents the number of traffic accidents (tranums), and the vertical axis represents the frequency, i.e. the number of cases falling within the range of number of traffic accidents. It can be seen from the figure that the distribution of number of traffic accidents is extremely uneven. There are about 60 cities whose tranum is no more than 500, about 20 cities whose tranum is within the range of 500-1000, and a few cities 1000-3000. Outliers exist around 5000. Meanwhile, combined with the linear trend graphs of s1, s2 and tranum in Figure 2, the existence of outliers can also be found. Therefore, it is necessary to use quantile regression, which can avoid the impact of outliers on the regression results and bring the more robust conclusion. Considering the fact that it is found in the previous cross-sectional analysis of the paper that the population factors are not significant during this period, the control variables of quantile regression here do not include the urban population density (citymidu) and the number of city travellers (citytraveller). The specific results are shown in Table 4.

| Variables       | Model 1 1/10 Quantile | Model 2 3/10 Quantile | Model 3 1/2 Quantile | Model 4 7/10 Quantile | Model 5 9/10 Quantile |
|-----------------|------------------------|------------------------|-----------------------|------------------------|------------------------|
| Constant Terms  | -184.3458*** (512.7731) | -835.5702 (924.9161) | -1147.6740 (720.6238) | -1686.6100** (831.8178) | -3148.5030* (1612.2360) |
Secondly, the earliest records of traffic accidents in China started around 2013. Therefore, considering the above objective conditions, this paper selects the panel data of 18 cities from 2013 to 2016 for analysis, namely, Beijing, Tianjin, Taiyuan, Hohhot, Baotou, Shenyang, Harbin, Shanghai, Hefei, Nanchang, Jinan, Wuhan, Guangzhou, Haikou, Chongqing, Chengdu, Xi’an and Yinchuan, including provincial capitals, municipalities directly under the Central Government, and first-tier cities. The data is representative to some extent.

The variable section is consistent with the previous ones cited in this paper to make sure the conclusions are comparable. Since tranum data of 2016 has not been published, this paper uses linear interpolation\(^2\) to seek the data. Meanwhile, the data of the passing rates of s1 and s2 of the above-mentioned cities are reached by calculating the mean values of all the driving schools in the targeted regions in different years. For cities with no records of the passing rate of 2013, the linear

\[^2\text{Assuming the time series a}_1\text{, a}_2\text{, a}_3\text{ represents from the past to the present, as a}_1\text{ and a}_3\text{ are known, then the estimated value of a}_2\text{ can be expressed as (a}_1\text{+a}_3)/2.}\]

|   | s1       | s2       | cityroad | agdp    | light    |
|---|----------|----------|----------|---------|----------|
|   | (4.5479,) | (6.5429,) | (5.7787,) | (0.0002,) | (0.0020,) |
|   | (15.2396,* | (8.8867,) | (6.6738,) | (0.0021,) | (0.0027,) |
|   | (21.6746**) | (8.7983,) | (7.1846,) | (0.0004,) | (0.0086*** |
|   | (24.2232**) | (9.5092,) | (8.3244,) | (0.0009,) | (0.0090*** |
|   | (22.8664,) | (18.4232,) | (22.8293,) | (0.0037,) | (0.0145**** |

Note: "***", "**", and "*" correspond respectively to the significance level of p<0.01, <0.05, and <0.1, and the value in the brackets are standard error of bootstrap method.
interpolation method is also used. The following table shows the regression results of the panel fixed effect model for the impact of driver training quality on the road traffic safety.

Table 5. Results of the Panel Fixed Effect Model

| Variables | Model 1       | Model 2       | Model 3       | Model 4       |
|-----------|---------------|---------------|---------------|---------------|
| Constant  | 5481.2930***  | 7403.1670***  | 7384.5590***  | 7468.5780***  |
| Terms     | (771.6312)    | (1593.2910)   | (1612.2250)   | (1583.0880)   |
| s1        | -29.5081***   | -35.6933***   | -35.4123***   | -34.2640***   |
|          | (8.7274)      | (9.7527)      | (9.9788)      | (9.8168)      |
| s2        | -15.6556      | -17.8641*     | -17.6464*     | -11.0542      |
|          | (9.3857)      | (9.4438)      | (9.6170)      | (10.1997)     |
| agdp      | -0.0135       | -0.0128       | -0.0012       | -0.0012       |
|          | (0.0098)      | (0.0106)      | (0.0104)      | (0.0104)      |
| light     | -0.0003       | -0.0003       | -0.0007       | -0.0007       |
|          | (0.0019)      | (0.0019)      | (0.0019)      | (0.0019)      |
| cityroad  | -47.3078*     |                |               | (27.7433)     |
| city-effect | 33.0700***    | 33.7500***    | 26.6700***    | 24.7700***    |
| F-sta     | 30.2000***    | 29.2800***    | 27.3500***    | 27.2400***    |

Note: "***", "**", and "*" correspond respectively to the significance level of p<0.01, <0.05, and <0.1, and the value in the brackets are standard error.

It can be seen from Table 5 that in the period from 2013 to 2016, the passing rate of s1 had significantly negative correlation with the number traffic accidents (tranum). It indicates that from the perspective of dynamic characteristics of the data, as the s1 increases, the occurrence of road traffic accidents will decrease. The passing rate of s2 was also negatively correlated with tranum, but the overall significance was weak. The model tests the individual city effect (city-effect) and the overall significance of the equation (F-sta), which turn out to be good.

The control variables per capita GDP (agdp) and the number of streetlights (light) were not significant during this period, probably due to the short time span. Considering it not the focus of the research, the paper will not give much analysis of it. The per capita road area (cityroad) was negatively correlated with the tranum, indicating that the increase of the per capita road area can help improve road traffic, thereby reducing traffic accidents.

However, why is the conclusion from s1 passing rate of Table 5 opposite to that of the cross-sectional analysis? From a common point of view, the conclusions of the panel analysis are more reasonable, i.e., the higher the s1 passing rate (indicating better quality of the driving schools and the drivers’ better knowledge of road traffic) would indicate less probability of traffic accidents. The conclusions of the cross-sectional analysis show that the higher s1 (i.e. the higher training quality) would indicate the growth in traffic accidents. The reason is that as the paper analyzes the variable characteristics of the panel data and the cross-sectional data, the former accommodates the time span of the cross-sectional data and explores the changes of the cross-sectional individuals from the dynamic perspective, while the latter explores the commonalities among different individual behaviors in the same period of time at the static level.

Specifically, the cross-sectional analysis in the paper examines the impact of driver training quality on road traffic safety in 100 cities across the country in 2015 alone. It is a relatively static analysis. The positive correlation between s1 and tranum in the year can be explained by the fact that currently some students failing to meet the requirements can still pass the s1 test (many just log in and remain online without actually studying the contents on the required website or do not give much attention to studying), which leads to the phenomenon that with the increase of s1, the probability of traffic accidents increases due to drivers’ poor command of traffic rules and lack of safety awareness. When exploring the correlation between s1 and tranum dynamically based on the panel data, the negative
correlation between the two shows that with the country's growing attention to the driver training industry, especially the quality of training, the true level of s1 has risen, thereby reducing the probability of traffic accidents.

4. Conclusion and Policy Recommendations
The paper first analyzes the impact of the driver training quality of the industry on road traffic safety based on the panel data of 100 cities across the country in 2015. In the analysis, it is found that the existence of outliers in the data is likely to affect the analysis results. Therefore, the quantile model analysis is adopted and then enriches the conclusions of this paper from the perspective of panel data. It can be said that the difference of samples is a necessary condition for ensuring the results of significant analysis, and an important guarantee for comprehensively exploring the correlation among variables. It is concluded that the correlation between the passing rate of s2 and road traffic safety is relatively robust, as the improvement of s2 can indeed reduce the occurrence of traffic accidents. The passing rate of s1 and road traffic safety shows a positive correlation in the relatively static cross-sectional period, and a negative correlation in the panel analysis with time series characteristics, reflecting that the true level of s1 is steadily increasing, but some mismatch between the s1 and the true practice still exists.

At present, there are few empirical studies on the correlation between the driver training industry and road traffic safety. One of the causes is that the related road traffic data is difficult to obtain, which also indicates the people used to neglect the industry and road traffic safety. The successive issuing of the 12th Five-Year Plan on Road Traffic Safety and the 13th Five-Year Plan on Road Traffic Safety demonstrates the determination of the CPC Central Committee and the State Council on promoting road traffic safety. But we need to be aware of the fact that the improvement of road traffic takes time and requires unremitting efforts.

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References
[1] O'Malley P M, Johnston L D. Drinking and driving among US high school seniors, 1984-1997. [J]. American Journal of Public Health, 1999, 89(5):678-684.
[2] Eensoo D, Paaver M, Harro J. Drunk Driving Among Novice Drivers, Possible Prevention with Additional Psychological Module in Driving School Curriculum[J]. Association for the Advancement of Automotive Medicine, 2011:283-291.
[3] Chakrabarty, Neelima Shukla, Anuradha Singh, H. Shokeen, Nancy Driver Training: An Effective Tool for Improving Road Safety in India[J]. Journal of Engineering & Technology. 2012, 2(2):113-117.
[4] Živković S, Nikolić V, Markić M. Influence of professional drivers' personality traits on road traffic safety: case study[J]. International Journal of Injury Control & Safety Promotion, 2015, 22(2):100
[5] Kureckova V, Gabrhel V, Zamecnik P, et al. First aid as an important traffic safety factor –, evaluation of the experience – based training[J]. European Transport Research Review, 2017, 9(1):5.
[6] Liu Junli, Poor Function of Driving Schools and Mismatch between Driving Practice and Exam[J]. Transport Business China, 2013, (06):63-65.
[7] Zhang Luo, Study on the Efforts of A Driving School of Changsha to Improve Training Quality[D]. Journal of Changsha University of Science & Technology, 2013
[8] Liu Guangping, Ding Limin, Wang Jinfeng, Views on the Campaign to Promote Traffic Safety Awareness[J]. Journal of People’s Public Security of China Science and Technology, 2015, 21(04):50-54. [2017-09-11].

[9] Cai Yang, He Jinjiang, Big Data Models and Analysis of Motor Vehicle Road Traffic Accidents[J]. Statistics and Management, 2016, (10):32-34.

[10] Luo Jiexiong, Suggestions on Enhancing Drivers’ Education on Safety[J]. Road Traffic Management, 2017, (07):47. [2017-09-11].

[11] Zhang Chunyi, “Letting the Pedestrians Cross the Road First” Should be Incorporated in the Driving Exam[N]. Changchun Daily, 2017-07-04(006).

[12] Yang Kaixin, Problems and Solutions in the Cost Management of Driving Schools[J]. Assets and Finances in Administration and Institution, 2015, (30):29-30. [2017-09-11].