Analysis and forecast of special car market based on BP neural network

Dengfeng Liu¹, Haixin Yu², Chen Zhang³

¹,²,³School of Information Science and Engineering, Northeastern University, Northeastern University, Nanhui Street, Heping District, Shenyang, Liaoning, China
2511778502@qq.com¹, 1437083606@qq.com², 764187672@qq.com³

Abstract. This paper is based on the macro environment of the special car market and its development status. Combined with relevant data, this paper forecasts the future prospects from the perspectives of the transaction scale, market recognition and the change trend of the number of special cars, we get the current situation of the car market and the future development trend. Then, the BP neural network prediction model is used to predict the demand of the special car. The grey prediction model is used to predict the number of special cars, and then the future transaction scale of the special car market is analysed. The development prospects of the special car market are analysed from the above three aspects, and the future development of the special car is predicted. It is the result that the market will increase steadily but the growth rate has slowed down, which is in line with the actual situation.

1. Introduction.
“Difficult to take a taxi” is a social hot issue that people pay attention to. With high subsidies and excellent services, the special car has become an indispensable part of the transportation industry in major cities. In recent years, more and more private cars have joined the ranks of special cars, and the special car has gradually become one of the important means of transportation for citizens. Especially with the advent of the "Internet +" era, a number of companies rely on the mobile internet to establish a car service platform to achieve information exchange between passengers and car drivers. The special car is a new thing derived from the Internet + era. It improves the travel of the citizens. However, it is caught in the whirlpool of legal disputes. Therefore, in this article, we will study the new things of the special car and make a reasonable prediction of its future development.

2. The analysis of the development status of the special car market
2.1. Macro-environmental analysis of the special car market
2.2. Development status and forecast of the special car market

Our analysis of the current status of the development of the special car market is analyzed and predicted from the following perspectives:

(1) Size of the transaction

According to the statistics of Enfodesk, this article predicts the trading scale of the special car market from 2016 to 2018, as shown below.

![Figure 2. 2015 car market trading scale and forecast for the next three years.](image)

(2) Market recognition

Through the ACM model, the drawing is as follows. As can be seen from Figure 3, the car market will gradually mature in 2017[2].

![Figure 1. Macro analysis of China's special car market](image)
(3) Trends in the number of special cars

As can be seen from Figure 4, from January to May 2015, the number of active cars in the special car market increased rapidly, from 290,000 to 920,000 in a short period of time, indicating that the first half of 2015, the car-hailing app with high subsidies and super high quality services made the special car overnight become a leading role in the city transportation stage, and the number of special cars has increased dramatically. From June 2015 to April 2016, the number of cars was basically stable, and it remained at around 1 million cars, indicating that the cars in the special car market are saturated, and there will be no sharp increase in short-term.

Based on the above data, we can see that the emergence of special cars has given passengers more choices, and its market recognition has increased year by year. It has gradually become the first choice for many people and its status in the transportation industry is irreplaceable, and its trading scale has also steadily increased. The large amount of transactions has brought economic benefits to drivers. More and more people are willing to become special car drivers.

2.3. Analysis of the situation of each platform

In order to analyse all kinds of car-hailing app platforms to provide the best advice for employment company, this article compares the order success rate and customer retention rate, the impact of relevant policies on the platform and the city coverage rate.[3]

(1) Order success rate and customer retention rate
As shown in Figure 5, due to the difference in car and order allocation mechanism, we see that the order response rate and success rate of Didi Express and Uber are higher, while Shenzhou has a higher customer retention rate.

(2) Impact of policies on various platforms
Since Didi and Uber are mainly P2P companies, the B2C model of Shenzhou special car has less policy risk and stronger resistance to policy risks, which may become a huge opportunity for Shenzhou special car to be implemented when the actual implementation of the policy.

(3) Urban coverage

As shown in Figure 6, Didi Express is the company with the shortest establishment time but the fastest strategic advancement. It was established in 2012. It expanded its market and eliminated its competitors in 2013 and 2014. In 2015, it successfully completed the merger and expansion of the business line to improve its platform. It’s coverage of city is much wider than other platforms.

2.4. Analysis of the prospect of the special car platform
From the above forecast of the special car market, the comparison of various types of software, combined with the comprehensive evaluation index of various softwares, we can see that Uber, Didi Express represented the Internet and mobile Internet. The special car service quickly opened up the market, relying not only on financial subsidies, but more importantly, it bridged the gap between people's growing travel demand and lagging travel patterns. In order to promote the special car service mode, the car companies that have been established one after another have attracted a large amount of social investment, and this part of the investment is used to subsidize users and drivers to cultivate their acceptance and use of mobile application software and mobile payment methods. Therefore, the potential of China's special car market is huge, and among many companies, the prospect of Didi Express is the best, and the market share is high.$^{[4]}$
3. Forecast of the special car market

In order to predict the future of the special car market, we have selected the demand for special cars, the trading scale of the special car market, and the number of special cars.

3.1. Forecast of urban special car demand

Through the analysis of the influencing factors of the city special car market, we can know that the special car market is affected by many factors. These influencing factors make the city special car market have great complexity and non-linearity. The traditional demand forecast can't solve these problems well. The neural network model has strong nonlinear mapping ability and flexible network structure, which is suitable for this problem.

(一) The process of establishing a BP neural network prediction model is as follows:

1. Through comprehensive consideration of various data, we have developed the following factors as the influencing factors of urban special car demand: ① Urban population ② Urban road operation mileage ③ Per capita disposable income of urban residents ④ Per capita consumption expenditure of urban residents ⑤ GDP ⑥ Foreign tourist population ⑦ Private car ownership ⑧ Bus operating car

Since the special car has only emerged in recent years, its demand cannot be judged very well, and the demand for taxis can roughly reflect the demand for special cars. (The taxi software has not yet risen a lot (before 2015)). So we choose the demand of taxis for prediction and judgment.

2. Historical statistics of N-year impact factors and N-year taxi experience demand. Data from the first year to the N-th year are used as training samples for the network. Data from the (N-t)-th year to the N-th year as input vector and output vector is for training samples and test samples.

3. Construct a BP network, train the network through matlab programming, and obtain the prediction data of the network by simulating the input vector of the test sample, and analyse the error with the target vector of the test sample to meet the requirements and prove the network prediction is feasible.

4. Using the trained network and the known impact factor data of the target year to predict the demand for urban taxis in the target year.

(二) The neural network prediction flow chart is as follows:
Figure 7. Neural network prediction flow chart.

(三) Inspection and operation results of urban special car demand model

We selected the statistics of Xi'an from 2000 to 2014 as follows:

Table 1. Basic information of Xi'an City[6]

| Year | Urban population (10,000 people) | Urban road operating mileage (km) | Per capita disposable income of urban residents (yuan) | Per capita consumption expenditure of urban residents (yuan) | GDP (100 million yuan) | Foreign tourist population (10,000 people) | Private car ownership (car) | Bus operating car (car) | Taxi passenger transportation demand (10,000 people) |
|------|----------------------------------|----------------------------------|-----------------------------------------------------|-----------------------------------------------------------|------------------------|--------------------------------------------|---------------------------|--------------------------|---------------------------------------------|
| 2000 | 483.1                            | 3010                             | 6364                                               | 646.13                                                    | 31252                  | 2573                                       | 102.7                     | 2000                      | 110.6                                       |
| 2001 | 489.88                           | 3298                             | 6705                                               | 734.68                                                    | 36988                  | 2958                                       | 120.48                    | 2001                      | 110.6                                       |
| 2002 | 497.38                           | 7862                             | 7184                                               | 826.68                                                    | 454998                 | 3346                                       | 120.48                    | 2002                      | 120.48                                      |
| 2003 | 510.26                           | 8360                             | 7748                                               | 946.66                                                    | 516719                 | 3752                                       | 107.95                    | 2003                      | 120.48                                      |
| 2004 | 516.3                            | 8360                             | 8544                                               | 1102.39                                                   | 512802                 | 4351                                       | 128.96                    | 2004                      | 128.96                                      |
| 2005 | 533.21                           | 8500                             | 9628                                               | 1313.93                                                   | 544866                 | 4762                                       | 140.51                    | 2005                      | 140.51                                      |
| 2006 | 540.97                           | 9530                             | 10905                                              | 1588.94                                                   | 608155                 | 5489                                       | 153.96                    | 2006                      | 153.96                                      |
| 2007 | 549.19                           | 9672                             | 12662                                              | 1856.63                                                   | 840376                 | 5836                                       | 169.57                    | 2007                      | 169.57                                      |
| 2008 | 554.73                           | 11895                            | 15207                                              | 2138.14                                                   | 875005                 | 6121                                       | 174.51                    | 2008                      | 174.51                                      |
| 2009 | 561.58                           | 18983                            | 14251                                              | 2724.08                                                   | 1012937                | 7039                                       | 202.72                    | 2009                      | 202.72                                      |
| 2010 | 562.65                           | 12378                            | 22244                                              | 3241.69                                                   | 1253461                | 7107                                       | 210.52                    | 2010                      | 210.52                                      |
| 2011 | 568.77                           | 12599                            | 18252                                              | 3862.58                                                   | 1445811                | 7462                                       | 225.52                    | 2011                      | 225.52                                      |
| 2012 | 572.76                           | 13127                            | 29982                                              | 4366.1                                                    | 1632527                | 7695                                       | 235.46                    | 2012                      | 235.46                                      |
| 2013 | 580.6                            | 13135                            | 33100                                              | 4924.97                                                   | 1862063                | 8128                                       | 248.3                     | 2013                      | 248.3                                       |
| 2014 | 587.16                           | 13251                            | 36100                                              | 5492.64                                                   | 2139024                | 7769                                       | 240.3                     | 2014                      | 240.3                                       |

Source: Xi'an 2015 Statistical Yearbook

We establish a BP neural network to predict the value of these impact factors over the next 4 years. The data of a certain influencing factor for three consecutive years before the t-th year is taken as an input sample, and the data of the t-year is used as an output sample to train the network. After the accuracy is reached, the 3 years of data before the target year can be used as the input set to obtain the predicted value of the impact factor. The predicted values are shown in the following table:
Under the influence of these eight factors, the neural network training chart of Xi’an taxis is as follows:

![Best Training Performance is 0.0064944 at epoch 81](image)

As shown in Figure 8, the training achieves a minimum mean square error during the 81st iteration, MSE = 0.0064944. At this point the training ends.

Then, we compare the neural network prediction results, as shown in the following table:

| years | Actual value | Predictive value | Relative error | Mean error |
|-------|--------------|------------------|----------------|------------|
| 2000  | 102.7        | 102.5            | -0.00195       |            |
| 2001  | 110.6        | 109.8            | -0.00723       |            |
| 2002  | 120.48       | 118.46           | -0.01677       |            |
| 2003  | 107.95       | 110.62           | 0.024734       | -0.00013   |
| 2004  | 128.96       | 132.74           | 0.029311       |            |
| 2005  | 140.51       | 138.12           | -0.01701       |            |
| 2006  | 153.96       | 151.87           | -0.01357       |            |
| 2007  | 169.57       | 170.3            | 0.004305       |            |
| 2008  | 174.51       | 176.54           | 0.011633       |            |
| 2009  | 202.72       | 200.64           | -0.01026       |            |
| 2010  | 210.52       | 214.33           | 0.018098       |            |
| 2011  | 225.52       | 224.36           | -0.00514       |            |
| 2012  | 235.46       | 234.19           | -0.00539       |            |
| 2013  | 248.30       | 246.18           | -0.00854       |            |
| 2014  | 240.30       | 239.56           | -0.00308       |            |

As can be seen from the table, the mean error is -0.013%, and the test sample data error can reach the target value.
Figure 9. Comparison of actual values and predicted values of BP neural network from 2000 to 2014.

Table 4. Forecast of Xi’an Taxi Demand in 2015-2018.

| Forecast year | 2015   | 2016   | 2017   | 2018   |
|---------------|--------|--------|--------|--------|
| Demand (/10,000) | 240.6588 | 247.3524 | 250.7324 | 252.6985 |

From the forecast data, we can see that the demand for people to take a taxi has gradually increased with time, but the growth rate has decreased, which is in line with the actual situation[7].

3.2. Forecast of the trading volume of the special car market

Through data collection and analysis, the transaction scale of the special car market in 2016-2018 is shown in Figure 2. It can be seen from the figure that the trading scale of the special car market has great potential and will increase steadily but the growth rate will slow down.

3.3. Forecast of the number of special cars

It is known that the number of special cars from January 2015 to April 2016 is shown in Figure 4. The raw data is processed by one-time accumulation method, and GM (1,1) is established by using gray prediction. The result is as follows:

Figure 10. forecast of the number of private cars from May to December 2016.

The prediction value error is 1.3182%, and the effect is good. As can be seen from the figure, the number of special cars gradually increases but the rate of increase is slow.
3.4. **Analysis of results**
As the app platforms will reduce the number and amount of vouchers and coupons in the future after the end of the customary training strategy, and the monthly “occupation fee” will be charged for the drivers, the demand for special cars, the size of the special car market and the number of special cars will gradually increase in the next few years but the growth rate will slow down. The final special car market will reach a mature and stable period in 2017.

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