Aviation Business Volume Forecast of Xianyang International Airport Based on Multiple Prediction Models

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Abstract. With the continuous development of the strategy of the development of the western region and the gradual advancement of the “One Belt, One Road” strategy, Xianyang Airport serves as the gateway for foreign exchanges in Xi'an, and the passenger and freight traffic volume has increased year by year. This article is based on the passenger and cargo traffic that has been available from 2009 to 2015. We will use the trend extrapolation method, the econometric method and the market share method to predict the passenger and cargo transportation volume from 2016 to 2018, comparing with the actual passenger and cargo transportation volume. Then we can obtain the annual error, and find the average error. According to the average error, the weights are determined. Finally, we combine the result with its weight, comparing with accurate result, and get more exact result. Therefore, this method is applied to the forecast of aviation traffic from 2019 to 2023, and then more accurate results are obtained. According to the air passenger and cargo transportation volume in the next five years, combined with the basic economic and population conditions, it will provide reference for the future development and functional positioning of Xianyang Airport.

1. Introduction

The aviation business volume is the basic basis for the establishment of the airport in the construction, reconstruction and expansion [1]. Aviation traffic forecasting is a method of predicting near-, medium-, and long-term airport traffic based on the volume of traffic that has occurred. At present, the common traffic forecast is divided into qualitative forecasting method and quantitative forecasting method [2]. Qualitative forecasting method is divided into moving average method; brainstorming method; Delphi method; quantitative forecasting method includes moving average method, trend extrapolation method, Econometrics, market analysis, and various methods have obvious advantages and disadvantages. Because of the previous predictions for Xianyang Airport, a single prediction method is usually adopted, which leads to relatively large errors. The paper takes the aviation traffic forecast of Xi'an Xianyang International Airport as the research object, and proposes a method based on comprehensive model to predict the aviation traffic volume, so as to improve the accuracy of aviation traffic forecast. As a booster of regional economic and social development, civil aviation is an important part of the city's gateway and modern integrated transportation system. It is a symbol of efficiency, safety, speed, convenience and comfort. It is an important representative of urban business travel, investment environment and overall image. With the continuous improvement of Xi'an's strategic positioning, the rapid development of the national economy, tourism and opening up, and the deepening of the strategy of implementing the western development and the continuous development of the “One Belt, One Road” development strategy, Xi'an Xianyang International Airport serves as an open exchange for Xi'an. The role of the
window is becoming more and more prominent. [3] Xi’an Xianyang International Airport is undergoing airport expansion. In order to ensure the completion of the airport expansion, it can meet the airport traffic volume, and it is necessary to accurately predict the aviation traffic of Xianyang International Airport. Large-scale new airports will cause waste of resources, and too small will hinder the development of the local economy. [4] Aviation traffic forecasting is the basis for the preliminary work of airport planning and construction. The accuracy of forecasting plays an important role in the rationality of airport planning and the scientific nature of construction project decision-making. [5] Therefore, accurate prediction of passenger and cargo traffic at Xianyang Airport is necessary for urban development and airport development.

2. Xianyang International Airport Aviation Traffic Forecast

2.1 Influencing factors of aviation traffic forecast

The main factors affecting air transport are generally considered to include: regional economic development and structure, demographic factors and their composition, ground traffic conditions, and regional airport layout and functional positioning. [6] Regional economic development and structure include: urban GDP, total sales of social retail goods, and industrial structure. The demographic factors and their composition include: the total population of the region, the number of employees, and so on. Ground transportation conditions include: railway passenger traffic, road passenger traffic, etc.

2.2 Xianyang Airport air traffic volume and related influencing factors data

In order to be able to more accurately predict the five-year approach to aeronautical traffic selection, it needs to be representative and requires as many factors as possible to influence the airport's aviation traffic. [7] At the same time, it is necessary to ensure the selection method, which can satisfy the current period. The characteristics of aviation traffic. This paper chooses the trend extrapolation method; the econometric method; the market analysis method to predict the aviation business of Xianyang Airport in the next five years.

This paper calculates the passenger throughput, cargo and mail throughput and the GDP, population, social average wage, and total tourism revenue of Xianyang International Airport from 2009 to 2018. As shown in Table 1, the year after the conversion is defined as: the year of 2012 is required as the origin, and each year is used as the unit 1, and the increment and decrement are sequentially performed before and after, and the converted year is used as the independent variable, and the function model is established as the basis below.

| years | Converted year | Passenger throughput / passengers | Mail and mail throughput / tons | Xi’an GDP data/100 million yuan | Total population | Average social wage /yuan | Total tourism revenue /100 million yuan |
|-------|----------------|----------------------------------|--------------------------------|-----------------------------|-----------------|------------------------|----------------------------------------|
| 2009  | -3             | 15294948                         | 127000.2                       | 2719.1                      | 5163801         | 1474.76                | 89.6                                   |
| 2010  | -2             | 18010405                         | 158054                         | 3241.49                     | 5200899         | 1798.86                | 98                                     |
| 2011  | -1             | 21163130                         | 172567.4                       | 3864.21                     | 5265715         | 1939.35                | 115                                    |
| 2012  | 0              | 23420654                         | 174782.7                       | 4369.37                     | 5267623         | 2299.29                | 165                                    |
| 2013  | 1              | 26044673                         | 178857.5                       | 4884.13                     | 5331983         | 2638.65                | 200                                    |
| 2014  | 2              | 29260755                         | 186413                         | 5474.77                     | 5266828         | 2937.97                | 230                                    |
| 2015  | 3              | 32970215                         | 211591.5                       | 5810.03                     | 5275892         | 3039.82                | 271.6                                  |

2.3 Trend extrapolation to predict future aviation traffic

2.3.1 Characteristics of trend extrapolation

Trend extrapolation predicts what will happen in the future based on past occurrences, and believes that the main factors affecting past development are still these factors in the future, and they have not changed much. [8] It is mainly used for short-term prediction, and its most commonly used models include exponential models and linear models. Its shortcoming is that it does not consider the various
factors that influence the development trend. If the factors affecting development change, it will lead to inaccurate prediction.[9]

2.3.2 Forecast of Passenger Throughput in Recent Target Years
According to the passenger throughput and time from 2009 to 2018, the regression analysis is carried out by using the exponential and polynomial trend lines. The fitted trend line is as follows. According to the fitting effect, the largest equation of $R^2$ is used. select the linear prediction model, and the prediction equation is:

$$y=2871720x+23737800$$  \hspace{1cm} (1)

Where $x$ indicates the year after conversion, which refers to 2012 as the origin, and each year as unit 1, it is incremented and decremented in order. $y$ indicates passenger throughput unit/personal time $R^2 = 0.983$.

Figure 1 Trend graph of passenger throughput over time (linear)

The passenger throughput from 2016 to 2018 is calculated based on the predictive model and the error is calculated.

| years | Converted year | Forecast passenger throughput / person times | Actual passenger throughput / person times | deviation |
|-------|----------------|---------------------------------------------|-------------------------------------------|-----------|
| 2016  | 4              | 35224680                                    | 36994506                                  | -4.78%    |
| 2017  | 5              | 38096400                                    | 41857729                                  | -8.99%    |
| 2018  | 6              | 40968120                                    | 44650000                                  | -8.25%    |

2.3.3 Forecast of cargo and mail throughput in the target year in the near future
According to the regression analysis of cargo and mail throughput and time from 2009 to 2018, the index and polynomial trend lines are used for fitting. The fitted trend line is shown in Fig. 3. According to the fitting effect, the largest $R^2$ is used. Equation, according to the comparison, select the exponential prediction model, and the prediction equation is:

$$y=170976e^{0.068x}$$  \hspace{1cm} (2)

Where $x$ indicates the year after conversion, which refers to 2012 as the origin, and each year as unit 1, it is incremented and decremented in order. $y$ indicates the cargo and mail throughput ton $R^2 = 0.963382.$
Calculate the cargo and mail throughput from 2016 to 2018 according to the model and calculate the error, as shown in Table 3.

| years | Converted year | Forecast cargo throughput / ton | Actual cargo throughput / ton | deviation |
|-------|----------------|--------------------------------|-------------------------------|-----------|
| 2016  | 4              | 224420.8751                    | 233779                        | -4.00%    |
| 2017  | 5              | 240212.3192                    | 259782                        | -7.53%    |
| 2018  | 6              | 257114.9332                    | 312637.1                      | -17.76%   |

2.4 Econometrics Law predicts future aviation traffic

2.4.1 Characteristics of econometrics
Econometrics considers a relatively large number of factors. It is based on the analysis of the relationship between aviation traffic and various factors affecting it. It predicts the future. Its prediction models are mostly exponential models, multiplication models, linear logarithmic models. Therefore, when using the exponential model for forecasting, the growth is relatively fast, and the forecast is more accurate in the near future. [10]

2.4.2 Multiple regression analysis to predict passenger throughput
Taking Xi’an GDP as an independent variable model, according to the fitting results, Xi’an GDP is relatively correlated, so Xi’an GDP is adopted, but Xianyang GDP is not adopted. First, the trend extrapolation method is used to predict the passenger throughput in the next five years, and it is substituted into the function model to predict the passenger throughput in the next five years.

According to the statistical data from 2009 to 2015, using SPSS software to analyze the five factors of GDP, total population, social average wage, international tourism (foreign exchange) income, and passenger throughput, use the gradual screening to select the total GDP and passenger throughput. The amount of correlation is the largest, and the analysis results are as follows:

| Table 4 coefficient |
|---------------------|------------------|---------------|-------------|-------------|
| model               | Non-standardized coefficient | Coefficient-t | t | Sig. | B of 95.0% Confidence interval |
| GDP                 | 12728.885        | 979.095       | 0.986 | 13.001 | 10212.041 | 15245.729 |
| constant            | 3598729.300      | 1609351.569   | 2.236 | 0.076 | 538240.610 | 7735699.209 |

a. Dependent variable: passenger throughput
Table 5 removed variables

| model                      | Beta In | t   | Sig. | Partial correlation | Collinear statistic |
|----------------------------|---------|-----|------|--------------------|---------------------|
| Total population           | -0.137a | -1.142 | .317 | -0.496             | 0.377               |
| Total tourism revenue      | 0.477a  | 1.571 | .191 | 0.618              | 0.048               |
| Average social wage        | 0.462a  | 0.547 | .614 | 0.264              | 0.009               |

Table 6 Summary of model types

| equation | R2   | F    | df1 | df2 | Sig. | constant | b1          | b2          |
|----------|------|------|-----|-----|------|----------|-------------|-------------|
| Linear   | 0.971| 169.017 | 1  | 5  | 0.000 | 3598729.300 | 12728.885   |
| Quadratic term | 0.979 | 92.730 | 2  | 4  | 0.000 | 8263293.998 | 1428.653 | 0.466 |
| index             | 0.974 | 300.584 | 1  | 5  | 0.000 | 9555864.828 | 0.001       |

![Figure 5 passenger throughput fit chart](image)

From the above table, it can be concluded that the quadratic polynomial has the highest correlation, so the quadratic polynomial model is selected and its fitting function is:

\[ y = 0.466 x^2 + 1428.653 x + 8263293.998 \]  \hspace{1cm} (3)

\( x \) represents the GDP of Xi’an; \( y \) passenger throughput means R square = 0.994

Table 7 Prediction results and errors

| years | Forecast GDP / 100 million yuan | Real GDP / 100 million yuan | deviation | Passenger throughput / person times | Actual passenger throughput /tons | deviation |
|-------|---------------------------------|----------------------------|-----------|-----------------------------------|---------------------------------|-----------|
| 2016  | 6817.47525                      | 6257.18                    | 8.95%     | 39661833.92                      | 36994506                        | 7.21%     |
| 2017  | 7694.372406                     | 7469.85                    | 3.01%     | 46844651.11                      | 41857729                        | 11.91%    |
| 2018  | 8684.060383                     | 8349.86                    | 4.00%     | 55812216.52                      | 44650000                        | 25.00%    |

2.4.3 Multiple regression analysis to predict cargo and mail throughput

According to the statistical data of 2009-2018, using SPSS software to analyze the five factors of GDP, total population, social average wage, international tourism (foreign exchange) income, and passenger throughput, use the gradual screening to select the total tourism revenue and cargo and mail. The throughput is the most relevant, and the analysis results are as follows:
Table 8 Coefficient

| model | Non-standardized coefficient | Coefficient-t | t | Sig. | B of 95.0% Confidence interval |
|-------|-----------------------------|--------------|---|------|--------------------------------|
|       | B                           | Standard deviation |               |      | Lower limit                   |
| 1     | constant                    | 94459.543    | 15798.736      | 5.979| 0.002                         |
| GDP   | 49.485                      | 9.612        | 0.917          | 5.148| 0.004                         |

Dependent variable: cargo and mail throughput

Table 9 Excluded Variables

| model | Beta In | t | Sig. | Partial correlation | Collinear statistic |
|-------|---------|---|------|---------------------|---------------------|
| Total tourism revenue | -0.158a | -0.175 | .870 | -0.087 | 0.048 |
| Average social wage | -0.076a | -0.037 | .972 | -0.018 | 0.009 |

a. Predictors in the model: (constant), GDP data.
b. Dependent variable: cargo and mail throughput

Table 10 Model summary

| equation | Model summary | Parameter estimate |
|----------|---------------|--------------------|
| Linear   | R square      | F                  | df1 | df2 | Sig. | Constant | b1   | b2   |
| Quadratic term | 0.853 | 11.631 | 2 | 4 | 0.022 | 55631.402 | 104.265 | -0.018 |
| index    | 0.894 | 23.398 | 1 | 5 | 0.005 | 98062.5 | 0.000139126 | 0 |

Figure 6 cargo and mail throughput fit chart

From the above table, it can be concluded that the index has the highest correlation, so the exponential model is selected, and the fitting function is the fitting function.

\[ y = 98062.5e^{0.000139126x} \]  

x represents the total amount of GDP, y represents the cargo and mail throughput; R square = 0.894
Table 11 Prediction results and errors

| years | GDP / 100 million yuan | Real GDP / 100 million yuan | deviation | Mail and mail throughput / tons | Actual cargo and mail throughput / tons | deviation |
|-------|------------------------|-----------------------------|-----------|---------------------------------|----------------------------------------|-----------|
| 2016  | 6817.47525             | 6257.18                     | 8.95%     | 253178.0743                     | 233779                                 | 8.30%     |
| 2017  | 7694.372406            | 7469.85                     | 3.01%     | 290764.0393                     | 259782                                 | 11.93%    |
| 2018  | 8684.060383            | 8349.86                     | 4.00%     | 334392.4824                     | 312637.1                               | 6.96%     |

2.5 Market analysis method to predict future aviation traffic

2.5.1 Characteristics of market analysis
The market analysis method is mainly to predict the proportion of aviation traffic within a country or region to a small area or an airport. It needs to ensure the proportion of possession and can stably reflect the airport's business volume and occupy the national airport business. The proportion of the amount.

2.5.2 Market Analysis Method to Forecast Passenger Throughput
According to the proportion of passenger throughput and cargo throughput of Xianyang Airport since 2009-2018, we have found a relatively stable proportion, and forecast the passenger throughput and cargo throughput of Xianyang Airport through the total airport traffic volume.

Table 12 Xianyang Airport Data

| years | Passenger throughput / passengers | National passenger throughput / passengers | Percentage of the country | Mail and mail throughput / tons | National cargo and mail throughput / passengers | Percentage of the country |
|-------|-----------------------------------|-------------------------------------------|---------------------------|---------------------------------|-----------------------------------------------|---------------------------|
| 2009  | 15294948                          | 486063435                                  | 0.031466979               | 127000.2                        | 9455645                                       | 1.34%                     |
| 2010  | 18010405                          | 564312300                                  | 0.03191567                | 158054                          | 11289872                                      | 1.40%                     |
| 2011  | 21163130                          | 620536534                                  | 0.034104567               | 172567.4                        | 11577677                                      | 1.49%                     |
| 2012  | 23420654                          | 679772088                                  | 0.034453686               | 174782.7                        | 11993970.85                                   | 1.46%                     |
| 2013  | 26044673                          | 754308682                                  | 0.034527871               | 178857.5                        | 12585175.15                                   | 1.42%                     |
| 2014  | 29260755                          | 831533051                                  | 0.035188926               | 186413                          | 13560841.03                                   | 1.37%                     |
| 2015  | 32970215                          | 914773311                                  | 0.036041951               | 211591.5                        | 14094002.69                                   | 1.50%                     |
| 2016  | 36994506                          | 1016357068                                 | 0.036399123               | 233779                          | 15104056.72                                   | 1.55%                     |
| 2017  | 41857729                          | 1147866788                                 | 0.036463668               | 259782                          | 16177345.42                                   | 1.61%                     |
| 2018  | 44650000                          | 1264688737                                 | 0.03530513                | 312637.1                        | 16740229.09                                   | 1.87%                     |

From the data in the table, according to the trend extrapolation method, the fitting function of the national passenger throughput can be obtained.

\[
y = 69797974.21x + 693042771.6
\]  
(5)

x indicates the year after conversion, meaning as above. y indicates passenger throughput unit/personal number R square = 0.98

x indicates the year after the conversion, the same as above. The above function model is used to predict the national passenger throughput. According to the passenger throughput of Xianyang Airport, the proportion of passenger throughput in the national airport has been stable in recent years, which is 0.03588, thus predicting the passengers of Xianyang in 2016-2018 year.

Table 13 Prediction results and errors

| years | Converted year | National passenger throughput / passengers | Actual national passenger throughput / passengers | deviation | Xianyang passenger throughput / passengers | Actual passenger throughput / passengers | deviation |
|-------|----------------|-------------------------------------------|-----------------------------------------------|-----------|-------------------------------------------|-----------------------------------------|-----------|
| 2016  | 4              | 972234668.4                                | 1016357068                                    | 4.34%     | 34883935.46                               | 36994506                                | 5.71%     |
| 2017  | 5              | 1042032643                                 | 1147866788                                    | 9.22%     | 37388297.94                               | 41857729                                | 10.68%    |
| 2018  | 6              | 1111830617                                 | 1264688737                                    | 12.09%    | 39892660.43                               | 44650000                                | 10.65%    |
### 2.5.3 Market Analysis Method to Forecast Freight and Mail Throughput

From the data in the table, according to the trend extrapolation method, the fitting function of the national cargo and mail throughput can be obtained.

\[ y = 11991619.33e^{0.05884x} \]  

(6)

\( x \) indicates the year after conversion, meaning as above. \( y \) indicates the cargo and mail throughput unit (ton) \( R^2 = 0.98 \)

Using the above functional model to predict the national passenger throughput, according to the passenger throughput of Xianyang Airport in recent years, the proportion of passenger throughput in the national airport is stable at 0.0173, thus forecasting the passenger throughput of Xianyang in 2016-2018 year.

#### Table 14 Prediction results and errors

| Years | Converted year | National cargo and mail throughput/tons | Actual national cargo and mail throughput/tons | Deviation | Xianyang cargo and mail throughput/tons | Actual cargo and mail throughput/tons | Deviation |
|-------|----------------|-----------------------------------------|-----------------------------------------------|-----------|----------------------------------------|--------------------------------------|-----------|
| 2016  | 4              | 15173766.01                            | 15104056.72                                   | 0.46%     | 262506.15                             | 233779                              | 12.29%    |
| 2017  | 5              | 16093380.15                            | 16177345.42                                   | 0.52%     | 278415.476                           | 259782                              | 7.17%     |
| 2018  | 6              | 17068727.99                            | 16740229.09                                   | 1.96%     | 295288.994                            | 312637.1                           | -5.55%    |

#### 2.6 Using the weighted combination to obtain the air traffic of Xianyang Airport

Based on the above three methods, the calculated passenger throughput and cargo and mail throughput are summarized and compared. It can be seen that the results of different methods are different. To ensure the reliability of the data, the prediction results of different methods are weighted according to each prediction. The method predicts the results obtained in 2016-2018 and compares the actual business volume, obtains the relative error, and averages the errors obtained each year to obtain the average error. The principle that the larger the error is, the smaller the weight is.

\[ a_1, a_2, a_3 \] represent trend extrapolation to predict traffic weight, \( a_2 \) represent the econometric method to predict the weight of business volume, \( a_3 \) represent the econometric method to predict the weight of business volume.

According to the above data, it can be calculated \( a_1 = 0.432, a_2 = 0.216, a_3 = 0.352 \)

#### Table 15 Prediction results and errors

| Years | Xianyang Airport passenger throughput / passengers | Deviation | Xianyang Airport cargo and mail throughput / tons | Deviation |
|-------|---------------------------------------------------|-----------|-----------------------------------------------|-----------|
| 2016  | 36063163.17                                       | 2.52%     | 247609.8036                                   | 5.92%     |
| 2017  | 39736770.32                                       | 5.07%     | 270397.0798                                   | 4.09%     |
| 2018  | 43795883.08                                       | 1.91%     | 295814.5258                                   | 5.38%     |

Similarly, using the above three methods, the passenger throughput for forecasting 2019-2023 is as follows:
Table 16 Prediction results and errors

| method              | 2019      | 2020      | 2021      | 2022      | 2023      |
|---------------------|-----------|-----------|-----------|-----------|-----------|
| Trend extrapolation  | 43839840  | 46711560  | 49583280  | 52455000  | 55326720  |
| Econometric law      | 67029791.41 | 81087014.03 | 98731566.33 | 120912008.5 | 148832285.5 |
| Market share method  | 42397022.91 | 44901385.39 | 47405747.87 | 49910110.36 | 52414472.84 |

In the same way, using the above three methods, the cargo and mail throughput for forecasting 2019-2023 is as follows:

Table 17 Prediction results and errors

| method              | 2019      | 2020      | 2021      | 2022      | 2023      |
|---------------------|-----------|-----------|-----------|-----------|-----------|
| Trend extrapolation  | 275206.9048 | 294571.9235 | 315299.5678 | 337485.7191 | 361233.0059 |
| Econometric law      | 391545.1811 | 467865.8341 | 572016.5055 | 717667.2055 | 927062.6108 |
| Market share method  | 313185.1403 | 332165.8918 | 352296.9818 | 373648.1272 | 396293.2701 |

From the above data, according to the weight $a_1=0.313$, $a_2 = 0.319$, $a_3 = 0.368$. From this, the results of the aviation traffic forecast for 2019-2023 can be obtained.

Table 18 Forecast results of air traffic at Xianyang Airport

| year | 2019      | 2020      | 2021      | 2022      | 2023      |
|------|-----------|-----------|-----------|-----------|-----------|
| Passenger throughput/ passengers | 48340997.89 | 53499476.61 | 59432818.54 | 66345912.69 | 74498811.15 |
| Mail and mail throughput /tons | 308886.7144 | 340383.1833 | 380730.6586 | 434315.5294 | 508261.0582 |

3. Conclusion
By selecting models such as trend extrapolation and econometrics, we will conduct a certain analysis of the aviation business volume of Xianyang Airport in the next five years. Using trend extrapolation model to predict airport passenger cargo throughput is a simple and efficient forecasting method, but it cannot take into account other relevant factors affecting airport aviation traffic; When using multiple regression models for forecasting, it is necessary to accurately identify the impact throughput. The factors are determined by determining regional GDP, total population, social average wage and tourism foreign exchange income as the main influencing factors, but using the model will often lead to a larger forecast, and the market analysis method is based on the national airport traffic. The development trend is to predict the passenger and cargo transportation volume of Xianyang Airport. However, the prediction result of Xi‘an Airport as a fast-developing city tends to be small. By weighting the results predicted by the three methods, it can be more accurate. As a result, from the prediction of the forecast from 2016 to 2018, the error is controlled within 6% compared with the actual situation, and the error is greatly reduced as a whole. Therefore, according to this method, the forecast will be carried out to obtain the business volume of Xianyang International Airport in the next five years.Providing development basis for the future development and positioning of Xianyang Airport, so that it can improve the various supporting facilities and improve the corresponding management mode.

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