Research on forecasting method of aviation traffic based on social and economic indicators

Xianming Zhang
China aviation international construction and investment co. ltd
Corresponding author’s e-mail: zhangxianming1314@126.com

Abstract. With the continuous deepening of the Reform and Open combining rapid growth of the national economy, China's civil aviation industry has made considerable progress in expanding the scale of transportation. According to the basic ideas and action guidelines determined by China’s economic and social development strategic planning, the overall goal is to build a safe, efficient and green mass civil aviation transportation system by 2030. The rapid development of the civil aviation industry is bound to bring a rapid increase in the passenger throughput of civil aviation. The size of the airport is closely related to the passenger throughput. Therefore, the airport passenger traffic forecast results will become an important basis for determining the future scale of the airport. This paper proposes a comprehensive forecasting method combining trend extrapolation and econometrics with economic and social indicators, and elaborates the method with examples.

1. Introduction
Aviation traffic forecasting is the key point during the process of preliminary work for civil aviation airport construction, and is the main basis for project size determination and investment estimation. The accuracy of aviation traffic forecasting is directly related to the success or failure of project decision-making. Therefore, it is extremely important to do a precise analysis in aviation traffic forecasting throughout the airport planning and construction.

The basic concept of forecasting is to assess the past trends, then design the future. The forecasting of airport air traffic volume involves many idealized assumptions as well as individual or expert judgments, which need to be understood and recognized when using forecast results.

2. Basic ideas for aviation traffic forecasting
The forecast of aviation traffic mainly includes airport passenger throughput and cargo and mail throughput forecast. Whether it is for new airports or expansion or expansion of airports, the growth of aviation traffic in a region is inseparable from the socio-economic development of the region and the aviation market demand. Therefore, scientific and reasonable forecasting of airport air traffic must be based on regional socio-economic development. Starting with the analysis of aviation market demand, we will study many factors affecting the growth of local aviation business volume, find out the key influencing factors, find out the relationship between these influencing factors and aviation traffic volume, and use various forecasting methods to make predictions. This paper mainly studies the annual passenger throughput forecast of the expansion and expansion of airport traffic.
3. Method of aviation traffic forecasting

3.1. The basic idea

The basic methods of aviation traffic forecasting can be divided into three categories: qualitative forecasting, econometrics, regression analysis and time series prediction. Qualitative prediction refers to qualitative judgment based on cognitive ability, experience and academic level, such as Delphi method (expert prediction method); econometric method and regression analysis prediction method are based on the interrelationship between objective things and dependence constraints. The internal connection and the rule of change are made, and the prediction is made according to the rule, such as multiple regression prediction method and non-linear regression prediction method. The time series prediction method is based on the regularity of the data of the prediction object, and the pattern of the data is recognized. It is the key to use time as an independent variable to fit the rules presented by the data, such as moving average method, exponential smoothing method, trend extrapolation method, and Bobkamen formula method. The prediction methods mainly used in this paper include the combination of the trend extrapolation method in the time series prediction method and the elasticity coefficient method in the econometric method.

3.2. Trend extrapolation

The air transport business volume is the same as the social economic phenomenon, and most of it is gradual in the development process. As time changes, there is a certain upward or downward trend, that is, a certain regularity. This pattern of variation can be described by a mathematical model. This is the trend extrapolation. Trend extrapolation polynomial curve model:

\[
\hat{y}_t = b_0 + b_1 t + b_2 t^2 + \ldots + b_n t^n
\]

Where: \(\hat{y}_t\) — annual passenger throughput of the airport, \(t\) — the year; \(b_0, b_1, b_2, \ldots, b_n\) — The parameters to be calibrated

3.3. Elasticity coefficient method

The elasticity coefficient method is based on the interrelationship between the influence factors of the aviation business volume and its development and changes, and uses the principle of econometric rule to predict the aviation traffic volume. The method is mainly based on the correlation between the aviation business volume and its related economic development index growth rate to establish a prediction model, calculate the elasticity coefficient, and predict the aviation traffic volume according to the development trend of relevant economic indicators. The elastic coefficient calculation model is as follows:

\[
e = \frac{\Delta y}{y} \cdot \frac{\Delta x}{x} = \frac{x}{y} \cdot \frac{\Delta y}{\Delta x}
\]
Where: e — the modulus of elasticity,
Δy — the amount of aviation traffic growth
y — base year aviation business volume
Δx — the growth of relevant economic development indicators
x — the economic development indicator for the base year

4. Passenger traffic forecast of Mianyang Airport

4.1. Development of passenger traffic at Mianyang Airport
According to the latest statistics, from January to December 2018, Mianyang Airport realized a total of 176,550 aircraft movements, 3,938,882 passengers and 7,586.7 tons of cargo. The average annual passenger load factor of the flight was 79.56%.

Table 1. passenger throughput at 2008-2018 Mianyang Airport (10,000 person-times).

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|------|------|------|------|------|------|------|------|------|------|------|------|
| 2008 | 21.4 | 28.1 | 57.5 | 62.3 | 68.1 | 91.7 | 108.5 | 154.7 | 217.3 | 354.3 | 393.9 |

4.2. Analysis of Mianyang City Economic and Social Indicator System
According to the economic and social development of Mianyang City, based on the index system affecting the air transport market, statistics on the development and changes of various economic and social indicators in Mianyang in the past 10 years, then establish corresponding multi-indicator systems for impact analysis to predict the future passengers in the Mianyang aviation market. The indicator evaluation system is shown in the following table:

Table 2. Indicator comparison table.

| Indicator | Indicator content                  | Indicator | Indicator content                  |
|-----------|-----------------------------------|-----------|-----------------------------------|
| #1        | GDP                               | #11       | Investment promotion              |
| #2        | The total retail sales of social consumer goods | #12       | Total import and export trade    |
| #3        | Financial institution deposit balance | #13       | permanent residents               |
| #4        | GDP growth rate                   | #14       | Urban per capita disposable income|
| #5        | The proportion of the second industry | #15       | Number of tourists                |
| #6        | The proportion of the tertiary industry | #16       | Tourism income                    |
| #7        | Fixed asset investment            | #17       | Highway mileage                   |
| #8        | Industrial enterprises main business income | #18       | Highway passenger traffic         |
| #9        | Business revenue growth rate      | #19       | Highway freight traffic           |
| #10       | Local public revenue              |           |                                   |
The evaluation system counts a number of indicators related to the economic and social development of Mianyang City, including the GDP of the urban area, the proportion of each industry, fixed assets investment, local public finance income, total import and export trade, tourism population and income. Wait. Some of these indicators are less relevant to the airport business volume. For example, the proportion of each industry has remained stable in recent years. Therefore, this time, 7 economic and social indicators with high correlation with Mianyang civil aviation passenger traffic and Mianyang Airport's business for nearly 10 years are selected. Correlation analysis, these seven indicators include: #1 GDP、#7 Fixed asset investment、#8 Industrial enterprises main business income、#10 Local public revenue、#11 Investment promotion、#14 Urban per capita disposable income、#15 Number of tourists

The following is a correlation analysis between each indicator and aviation traffic:

![Correlation analysis between various indicators and airport passenger throughput](image)

It can be seen from the above analysis that the growth of passenger traffic in Mianyang City has a strong positive correlation with the above seven economic and social indicators, and the growth trend is basically the same. The growth rate of individual indicators in the past 10 years is also increasing with
the passenger traffic volume of the airport. The rates are similar. With the continuous development of Mianyang City’s economy and society, the continuous increase in the number of tourists will further stimulate the increase in passenger traffic.

4.3. Economic and social indicators analysis and forecast

According to the growth of the seven indicators, the future development and utilization trend extrapolation method of each indicator is predicted, and the trend is extrapolated by using a polynomial to obtain the future index values of 2020 and 2050. The x in the prediction formula below represents the year. The R in the prediction formula below represents correlation coefficient.

✓ Urban GDP forecast

\[ y = 145.68x - 291812 \]

R = 0.9958, where y is the GDP value of Mianyang City, the unit is 100 million yuan.

✓ Forecast of total investment in fixed assets

\[ y = 92.969x - 186127 \]

R = 0.9487, where y is the total investment amount of fixed assets in Mianyang City, the unit is 100 million yuan.

✓ Local public fiscal revenue forecast

\[ y = 10.291x - 20633 \]

R = 0.9698, where y is the local public finance income of Mianyang City, the unit is 100 million yuan.

✓ Investment promotion forecast

\[ y = 36.357x - 72689 \]

The correlation coefficient is R=0.8167, where y is the investment amount of Mianyang City, and the unit is 100 million yuan.

✓ Industrial enterprises above designated size realize main income forecast

\[ y = 213.93x - 428679 \]

R = 0.9908, where y is the main business income of industrial enterprises above designated size in Mianyang City, the unit is 100 million yuan.

✓ Forecast of tourist population

\[ y = 481.62x - 966813 \]

R = 0.9739, where y is the number of tourists in Mianyang City.

✓ Urban per capita disposable income forecast

\[ y = 2237.5x - 4481225.06 \]

R = 0.9987, where y is the per capita disposable income of Mianyang City, the unit is yuan.

According to the above calculation, the target year indicators and corresponding growth rates are determined.

| Years  | \#1  | \#7  | \#8  | \#10 | \#11 | \#14 | \#15  |
|--------|------|------|------|------|------|------|------|
| 2030   | 0.04 | 0.04 | 0.04 | 0.03 | 0.04 | 0.04 | 0.05 |
| 2035   | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 |
| 2040   | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| 2045   | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 |
| 2050   | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |

4.4. Passenger throughput growth rate forecast

At the same time, according to the growth of various indicators, the relationship between their growth rate and the growth rate of passenger traffic in Mianyang City is determined. The elasticity coefficient method is used to determine the growth rate of passenger traffic in Mianyang City in the target year, and the passenger traffic between 2030 and 2050 is obtained.
Table 5. Statistical Table of Elasticity Coefficients between Indicators and Passenger Traffic Growth

|     | 2009  | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | average |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| #1  | 3.36  | 6.18  | 0.33  | 0.71  | 4.29  | 2.13  | 5.59  | 5.28  | 4.73  | 1.24  | 3.38    |
| #7  | 0.28  | 44.77 | 1.08  | 1.61  | 4.70  | 2.30  | 6.25  | 4.02  | 4.81  | 0.71  | 7.05    |
| #8  | 1.29  | 3.25  | 0.28  | 1.17  | 4.25  | 1.77  | 4.08  | 7.81  | 8.78  | 0.83  | 3.35    |
| #10 | 1.06  | 3.09  | 0.18  | 0.41  | 2.76  | 1.47  | 18.23 | 12.06 | 22.85 | 0.89  | 6.30    |
| #11 | 1.44  | 4.70  | 0.29  | 0.30  | -1.33 | 2.44  | -13.94| 3.75  | 2.47  | 1.04  | 0.12    |
| #14 | 1.88  | 2.95  | 0.24  | 0.44  | 1.23  | 1.25  | 2.13  | 1.67  | 2.44  | 0.54  | 1.48    |
| #15 | 2.83  | 7.96  | 0.49  | 0.61  | 3.07  | 1.88  | 5.91  | 4.91  | 7.68  | 1.38  | 3.67    |

It can be seen from the above table that the elasticity coefficient of the six indicators except the investment attraction index, the passenger traffic growth rate of the seven indicators are both greater than 1. This situation is called strong effect elasticity, indicating that the change in passenger traffic is affected by this. The 5 indicators have a greater impact, in other words, they are more sensitive to changes in these indicators. Among the 6 indicators, the local public fiscal revenue index fluctuated greatly, and the impact on the results fluctuated greatly. Therefore, the two indicators of attracting investment and local public finance income were excluded, and the elastic coefficients of the other five indicators were analyzed and calculated.

Table 6. Statistical indicator of target annual elasticity coefficient

|     | 2009  | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | average |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| #1  | 3.36  | 6.18  | 0.33  | 0.71  | 4.29  | 2.13  | 5.59  | 5.28  | 4.73  | 1.24  | 3.38    |
| #7  | 0.28  | 44.77 | 1.08  | 1.61  | 4.70  | 2.30  | 6.25  | 4.02  | 4.81  | 0.71  | 7.05    |
| #8  | 1.29  | 3.25  | 0.28  | 1.17  | 4.25  | 1.77  | 4.08  | 7.81  | 8.78  | 0.83  | 3.35    |
| #14 | 1.88  | 2.95  | 0.24  | 0.44  | 1.23  | 1.25  | 2.13  | 1.67  | 2.44  | 0.54  | 1.48    |
| #15 | 2.83  | 7.96  | 0.49  | 0.61  | 3.07  | 1.88  | 5.91  | 4.91  | 7.68  | 1.38  | 3.67    |

Therefore, the elasticity coefficients of the target years of the 5 indicators are 3.88, 4.59, 1.54, 4.14, and 3.80, respectively. The target annual passenger volume is calculated according to the target year growth rate of each indicator and the relevant elasticity coefficient, thereby calculating the target annual passenger volume.

Table 7. Statistics on the annual growth rate of passenger traffic target based on various indicators

|     | 2030  | 2035  | 2040  | 2045  | 2050  |
|-----|-------|-------|-------|-------|-------|
| #1  | 14.98%| 14.09%| 18.23%| 15.79%| 7.14% |
| #7  | 12.56%| 11.89%| 15.21%| 13.26%| 5.79% |
| #8  | 10.81%| 10.28%| 13.05%| 11.43%| 4.88% |
| #14 | 9.49% | 9.05% | 11.43%| 10.04%| 4.21% |
| #15 | 8.45% | 8.09% | 10.16%| 8.96% | 3.70% |

4.5. Analysis of prediction results

The growth of air passenger traffic in Mianyang City is divided into five stages, namely 2019~2030, 2031~2035, 2036~2040, 2041~2045, 2046~2050, combined with the national airport development rule, with the development of the civil aviation transportation market, the future passenger traffic growth rate and GDP growth rate tend to be consistent, combined with civil aviation development growth curve, future civil aviation The growth rate of the market is becoming more and more gradual. According to this rule, the growth rate of aviation business in the future will gradually become flat. Therefore, for the long-term passenger traffic forecast, the reference GDP growth is determined to increase the passenger traffic volume rate by 8% from 2030 to 2035, the passenger traffic volume growth rate from 2020 to
2040 is 6%, and the passenger traffic volume growth rate from 2040 to 2045 is 4%. From 2045 to 2050, the passenger traffic volume is 3%, so the final target passenger traffic is shown in the following table:

| Years | Mianyang aviation business demand |
|-------|----------------------------------|
| 2030  | 1700                             |
| 2035  | 2500                             |
| 2040  | 3400                             |
| 2045  | 4100                             |
| 2050  | 4700                             |

Table 8. Target year passenger traffic forecast summary (10,000 person-times)

5. Conclusion

This paper makes a reasonable judgment on the future passenger traffic of the airport based on the trend extrapolation method and econometric method commonly used in aviation traffic, combined with the growth of indicators related to passenger traffic in the economic society.

From the above-mentioned Mianyang Airport air traffic forecasting and analysis process, it is clear to see that most of the national socio-economic indicators are closely related to airport passenger traffic. Economic development and social stability will further promote the growth of airport passenger traffic. Different from the traditional logic deduction algorithm, the method adopted in this paper is based on the economic and social development trend as the main basis for prediction, and the result is consistent with expectations.

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