Research Article

Economic Development Forecast of China’s General Aviation Industry

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Aiming at solving the problem of system external impact on China’s general aviation industry, combining functional theory and grey system theory, and applying Bayesian network reasoning technology, a grey Bayesian network reasoning prediction model of system impact and system control is established. Based on the dynamic deduction of the functional analysis factor of system impact evolution, the flight time of general aviation production operation is selected to predict the development trend of the system. Based on the current period information of the general aviation industry, the grey Bayesian network inference prediction model is used to predict the current and future trends, so as to predict the economic development trend of the general aviation industry in China. The prediction results are more accurate than those of other existing models.

1. Introduction

In recent years, China’s general aviation industry has been listed as a strategic emerging industry, the development of which has attached great importance by the national high level and the whole society. In November 2010, the State Council and the central military commission issued the Opinions on Deepening the Reform of China’s Low-altitude Airspace Management, which made plans for deepening the reform of China’s low-altitude airspace management. In November 2014, the National Conference on the Reform of Low-altitude Airspace Management was held, and 10 regions, including Shenyang and Xi’an flight control zone, were listed as pilot areas for airspace reform and planned to be introduced to the whole country in 2015. Therefore, China’s low-altitude airspace will gradually open up, general aviation economy will certainly become a new economic growth point to drive the development of national economy, and timely development of general aviation economy has become the general trend of research. In 2016, the State Council issued the Opinions on the Key Work of Deepening Economic Restructuring, in which it proposed to innovate the operation and supervision mode of emerging general aviation types and introduce relevant policies to promote the development of general aviation. During the 13th five-year plan period, the focus will be on promoting the development of general aviation. More than 500 general airports and more than 5,000 general aircraft will be built, the annual flight capacity will reach 2 million hours, and the overall scale of the industry will exceed 1 trillion Yuan. Although some indicators may not be achieved in the short term, it shows that the state has attached great importance to the development of general aviation, and with the issuance of state council documents, relevant ministries and commissions and local provinces and cities have issued documents, providing a good development condition for the development of China’s general aviation industry.

International experience shows that the input-output ratio of the general aviation industry is 1:10 (as a comparison, the ratio of automobile industry is only 1:4), and the employment-driven ratio is 1:12, which has a strong driving effect. In other words, it can gradually create a large market with a scale of 100 billion and employment of millions of people. In the United States, for example, there
are more than 220,000 registered general aviation aircraft, accounting for 96% of the total civil aircraft fleet in the United States. The turnover of general aviation manufacturing industry is about 20 billion US dollars, and the annual output value of related industries is about 150 billion US dollars. In 2015, the general aviation industry contributed US $219 billion dollars to the US economy, accounting for 14.5% of the aviation economy and 1.26% of US GDP. Mature general aviation and its core industry of manufacturing and operation can drive the development of the entire national economy of different industries. General aviation economy operating in research and development manufacturing and service industry chain, industry chain, and on the basis of related industrial chain to form distinctive industrial clusters promotes the area of modern manufacturing and the coordinated development of high and new technology industries and modern service industry and boost the regional economic growth and transformation and upgrading of the industrial structure.

2. Literature Review

The study of aviation economy in China started relatively late, but the empirical study of aviation economy in China is comprehensive and shows a trend of gradual enrichment. The research mainly focuses on the following three parts, that is, the formation of aviation economy, the impact of aviation economy on regional economic development, and the development of aviation economy and its theoretical research elements.

For the research on the formation of aviation economy, Ou pointed out the classification and spatial layout of aviation city [1], and Cao proposed the cobweb model of the spatial layout of the aviation industry [2]. Lian et al. believe that the aviation economic zone is connected with the central city and hinterland through the flow of production factors and commodities [3]. Kasarda and Wang analyzed the formation of aviation city, and they believed that airport was the most active area in regional development and the growth pole of economic development [4, 5]. Cao and Hu believe that the development of aviation economy has a positive feedback effect on the development of airports [6–8].

In terms of research on the development of aviation economy on regional economy, Kasarda first analyzed the correlation between air transport and the employment rate of the secondary and tertiary industries in the city where the airport is located, and he concluded that the employment rate of air transport and the secondary and tertiary industries showed a positive correlation [9]. On this basis, the Chinese scholar Liu used the input-output model to calculate the impact of capital airport on Beijing’s economy [10]. Air passenger linkages and employment growth in US metropolitan areas were studied by Irwin and Kasarda [11]. Goetz found in his research that the increase of urban population and employment level would lead to the increase of air passenger volume, but further empirical evidence showed that this trend would gradually weaken [12]. Ivy et al. showed that the change of urban air service connectivity would significantly affect the employment level of local core management departments and auxiliary construction [13]. By empirical analysis, Button et al. showed that the presence of hub airports can attract high-tech talents to local employment [14]. Kloukos and Fudalej analyzed the aviation demand in the southwestern United States by assessing the impact of specific economic activities on regional air passenger volume [15]. Kasarda and Green analyzed air passenger and cargo volume and regional GDP, and they pointed out that the reduction of freedom of air service, customs quality, and corruption would increase the positive impact of cargo volume on the economy [16]. Debbage studied the operation of many airports and regional economic structure in Carolina, USA, and showed that while the local economic structure had a significant impact on the operation of airports, it also had a major transformation [17].

In terms of the factors and theoretical research of aviation economy, Yin and Wang, Huang and Cheng, Jaslin et al., and Xiong studied the development status and forward suggestions on developing their own characteristic aviation industry [18–21]. Haya El Nasser and Lyon introduced the process and experience of developing aviation economy, providing references for other regions to develop aviation economy [22, 23]. Jiang used the DEA window analysis method to investigate the operational efficiency of aviation economy of seven civil airports in Jiangsu province from the perspective of regional integration of resources [24]. Cao and Ma calculated the efficiency of the aviation economic zone in Beijing, Shanghai, Guangzhou, and Zhengzhou, and they concluded that the economic efficiency of airport economy is low, and the industrial development is unbalanced [25, 26]. Moreover, there are other scholars studying general aviation from the perspective of industry chain [27–29].

Through the analysis of domestic and foreign literatures related to the development of the aviation industry, the following problems are found in the current research. At present, people’s theoretical research on aviation economy mainly focuses on the concept and connotation of aviation economy. In this paper, the future development of aviation economy is forecasted.

3. General Aviation Industry Development: A Forecast Research

An important symbol of the rapid development of the general aviation industry is the number of flight hours of the general aviation aircraft, the number of aircraft, and the number of general aviation enterprises. The most obvious change of general aviation reform policies and measures introduced in China is the number of flight hours of general aviation, which is an important indicator to remove the institutional obstacles restricting the development of general aviation in China. At the same time, the change of general aviation flight hours also reflects the development trend of the general aviation industry.
Therefore, the index of general aviation production operation flight time is used to study the future development trend of the general aviation industry through various prediction models.

3.1. Design of General Aviation Production Operation Flight Time Functional Bayesian Prediction Algorithm

The establishment of the grey Bayesian network inference prediction model with the system regulation functional analysis factor $y(t)$ can predict the future development trend of the system. The functional analysis factor of system regulation $y(t)$ can comprehensively reflect the influence of factors induced by system regulation and control factors outside the system and their related influencing factors on the development trend of the system after system regulation. In other words, the development trend of the system after system regulation should be the mapping of the generalized time $t$, and the Bayesian network reasoning technology is used to establish the Bayesian reasoning network model of the system regulation functional analysis factor $y(t)$, so as to infer and measure the system regulation functional analysis factor.

Grey system theory treats all random quantities as grey numbers, that is, all white numbers that vary within a given range. The processing of grey number is not to find the probability distribution or statistical law but to use the method of data processing to find the law between the data. The method of mining and looking for the regularity of numbers by processing the data in the sequence of numbers and generating new sequences is called generation of numbers. The following is the definition of the accumulation process.

**Definition.** The process of sequential accumulation of data at each time of sequence $x$ is called the accumulation generation operation, which is denoted by AGO. The new sequence of accumulation is called the cumulative generation sequence. Specifically, the assumed original number column is $x^0 = (x^{(0)}(1), x^{(0)}(2), \ldots, x^{(0)}(n))$, and the accumulated generating operation sequence is $x^{(1)} = (x^{(1)}(1), \ldots, x^{(1)}(n))$, and $x^{(0)}$ and $x^{(1)}$ satisfy

$$x^{(1)}(k) = \sum_{i=a}^{k} x^{(0)}(i), \quad k = a, \ldots, n,$$

where $a \leq n$ is a positive integer. When $a = 1$, the above AGO is named as a general accumulation generation.

Finally, the prediction data of the grey Bayesian network inference model and the Bayesian network inference data of the system regulation functional analysis factor are used to predict the future development trend of the system after the regulation of the system.

The main problems related to the algorithm step design of the grey functional prediction model are as follows:

Step 1: a prediction source data sequence with the functional analysis factor $y(t)$ is constructed based on $X(n-1) = (x(1), x(2), \ldots, x(n-1))$ and $x(n) = A(\Phi_0)$, and the functional analysis factor data sequence is $X_A^{(1)}(k) = (x(1), x(2), \ldots, x(n-1), A(\Phi))$.

Step 2: the functional analysis factor sequence of system data $X_A^{(1)}(k)$ is generated by 1-AGO accumulation of the functional analysis factor data sequence $X_A^{(0)}(k)$.

Step 3: the adjacent mean value of $X_A^{(1)}(k)$ is generated as $z_A^{(1)}(k) = 0.5X_A^{(1)}(k) + 0.5X_A^{(1)}(k-1)$.

Step 4: the least square estimation of parameters $\hat{A}(\Phi) = (B(A(\Phi))^T \cdot B(A(\Phi)))^{-1} \cdot B(A(\Phi))^T \cdot Y(A(\Phi))$ is conducted.

Step 5: the model and time response formula is determined.

Step 6: the prediction sequence of the functional analysis factor data $X_A^{(1)}(k)$ is gotten by 1-AGO accumulation.

**Theorem 1.** The functional analysis factor $y(t)$ is equal to the development coefficient of the aviation industry chain $a$.

**Proof.** Assuming that the aviation industry chain is regulated by government policies, the $n^{th}$ phase value of the aviation industry chain $x(n) = A(\Phi)$ is estimated through the model data processing method. If $x_{\min}$ and $x_{max}$ represent the most pessimistic and optimistic values of the aviation industry chain, respectively, then there is $A(\Phi) \in [x_{\min}, x_{\max}]$.

Assume that the functional analysis factor is $y(t)$, and equation (2) is obtained in the form of grey number:

$$A(\Phi) = x_{\min} + (x_{\max} - x_{\min}) \cdot y(t).$$

Assuming that the systematic development coefficient of the aviation industry chain is $c(\Delta x) = c(\Delta x_1), c(\Delta x_2), \ldots, c(\Delta x_m))$, the estimated value of the development trend of the aviation industry chain is expressed by equation (3), as is shown as follows:

$$A'(\Phi) = (1 - a)x_{\min} + ax_{\max}.$$  

It can be obtained from equation (3) that

$$A'(\Phi) = (1 - a)x_{\min} + ax_{\max} = x_{\min} + (x_{\max} - x_{\min})a.$$  

Comparing equations (2) and (4), there is

$$A'(\Phi) = A(\Phi)$$

and then, there is

$$y(t) = a.$$  

The probability of optimism and pessimism of the development of the aviation industry chain can be inferred by the Bayesian inference network. The theoretical basis for the inference of the development trend of the control system by the Bayesian inference network is obtained by the conclusion of Theorem 1 $y(t) = a$. In other words, the change of
the development coefficient of the reasoning aviation industry chain α is carried out through the Bayesian reasoning network. With the conclusion of \( \gamma(t) = \alpha \), the functional analysis factors \( \gamma(t) \) are substituted into \( X_{A(\theta)}^{(1)}(k) \), and the prediction of the future development trend value of the system after the regulation of the grey Bayesian network inference prediction model is obtained finally.

3.2. Current Data Inferences of General Aviation Industry Development Policy Regulation. With the regards of estimation of upper bound \( x_{\text{max}} \) and lower bound of current data \( x_{\text{min}} \), under the macro-control of the government, the original development trend of the aviation industry has been greatly interfered, which may lead to a severe recession, and may lead to a rapid growth. Therefore, historical statistics from 2015 to 2018 are considered to predict the upper and lower limits of the new policies for the general aviation industry development regulation in 2019.

According to the statistics of flight duration of general aviation’s production operations from January to August 2019 (as is shown in Table 1), it should be considered that at the initial stage of the implementation of the new regulation policy in 2019, the policy effect has not yet been fully manifested during the implementation time of the hedging policy for the new regulation of the aviation industry chain. With the time going, these policy effects will be gradually released. Therefore, this paper uses the data from February to August of 2019 to estimate the upper and lower bounds of the flight time length of this year’s general aviation production operation. The valuation formulas are shown in the following equations:

\[
x_{\text{min}} = 12 \times \min(x_1, x_2, \land, x_6) = 4 \quad (100,000\, \text{hours}),
\]

\[
x_{\text{max}} = 12 \times \max(x_1, x_2, \land, x_6) = 12 \quad (100,000\, \text{hours}).
\]

On the basis of \( x_{\text{min}} = 4 \) (100,000 hours) and \( x_{\text{max}} = 12 \) (100,000 hours), the grey number representation of flight duration interval of general aviation production operation in 2019 can be obtained, as shown in equation (8):

\[
x(n = 2019) = A(\emptyset) \in [4, 12].
\]

According to equation (9), the grey number in this region is represented as a functional algebraic form, as shown in the following:

\[
A(\emptyset) = 4 + 8 \cdot \gamma(t).
\]

In this way, the prediction problem of the grey Bayesian network inference prediction model for flight duration of general aviation production operations in the development of the aviation industry can be divided into the following six steps.

Step 1: sorting out the original initialization sequence. According to Table 1 and equation (10), the sequence of predicted source data containing the system regulation functional analysis factor \( \gamma(t) \) can be sorted out, as shown in

\[
[7.4, 7.6, 8.1, 9.4, 11.2, 4 + 8 \cdot \gamma(t)].
\]

Step 2: operator design and data processing. Considering that after the new regulation of the aviation industry chain, the development mode of the aviation industry chain needs new adjustment, and the weakening buffer operator is constructed as shown in the following equation:

\[
x(k)d = \frac{1}{n - k + 1} \left[ x(k) + x(k + 1) + \cdots + x_{A(\theta)}(n) \right],
\]

\[
k = 1, 2, \cdots, n.
\]

After processing equation (11) with the weakening operator (as shown in equation (13)), the data sequence can be obtained as follows:

\[
X_{A(\theta)}^{(0)}(k) = [7.95 + 1.33\gamma(t), 8.06 + 1.6\gamma(t), 8.18 + 2\gamma(t), 8.2 + 2.67\gamma(t), 7.6 + 4\gamma(t), 4 + 8\gamma(t)].
\]

Step 3: generating \( X_{A(\theta)}^{(1)}(k) \) by 1-AGO for \( X_{A(\theta)}^{(0)}(k) \). Equation (14) can be obtained by means of 1-AGO from equation (13):

\[
X_{A(\theta)}^{(1)}(k) = [7.95 + 1.33\gamma(t), 16.01 + 2.93\gamma(t), 24.19 + 4.93\gamma(t), 32.39 + 7.6\gamma(t), 39.99 + 11.6\gamma(t), 43.99 + 19.6\gamma(t)].
\]
Step 4: the adjacent mean value is conducted on $X^{(1)}_{A(\phi)}(k)$.

Formula (15) can be obtained by generating adjacent to the mean value of equation (14),

$$z^{(1)}_{A(\phi)}(k) = 0.5x^{(1)}_{A(\phi)}(k) + 0.5x^{(1)}_{A(\phi)}(k - 1).$$

$$z^{(1)}_{A(\phi)}(k) = [11.98 + 2.13y(t), 20.1 + 3.93y(t), 28.29 + 6.27y(t), 36.19 + 9.6y(t), 41.99 + 15.6y(t)].$$

Step 5: perform the least square estimation of parameters for $a(A(\phi)) = (B(A(\phi))^T \cdot B(A(\phi)))^{-1}$. $B(A(\phi))^T \cdot Y(A(\phi))$:

$$a(A(\phi)) = \frac{5.66 \cdot y(t)^2 + 24.45 \cdot y(t) + 29.08}{2.73 \cdot y(t)^2 + 3.76y(t) - 3.14}.$$

$$b(B(\phi)) = \frac{0.17 \cdot y(t)^3 + 26.20 \cdot y(t)^2 + 201.79 \cdot y(t) + 296.46}{5.66 \cdot y(t)^2 + 24.45 \cdot y(t) + 29.08}.$$

Step 6: conduct prediction by means of the grey Bayesian network inference prediction model.

The predicted values of general aviation production flight duration from 2019 to 2021 with the system control functional analysis factor $y(t)$ are shown in equations (17)–(19), respectively.

The functional representation of the transaction value of the aviation industry chain in 2019 is as follows:

$$x(2019) = e^{-(-2.73 \cdot y(t)^3 - 3.76 \cdot y(t) - 3.14/5.66 \cdot y(t)^2 + 24.45 \cdot y(t) + 29.08)} \cdot \left(1 - e^{-(-2.73 \cdot y(t)^3 - 3.76 \cdot y(t) + 3.14/5.66 \cdot y(t)^2 + 24.45 \cdot y(t) + 29.08)}\right) \cdot \left(\frac{3.8y(t)^3 + 52.9y(t)^2 + 227.5y(t) + 271.5}{2.73y(t)^2 + 3.76y(t) - 3.14}\right).$$

The functional representation of the transaction value of the aviation industry chain in 2020 is as follows:

$$x(2020) = e^{-(-5.46 \cdot y(t)^2 - 7.52 \cdot y(t) - 6.28/5.66 \cdot y(t)^2 + 24.45 \cdot y(t) + 29.08)} \cdot \left(1 - e^{-(-2.73 \cdot y(t)^3 - 3.76 \cdot y(t) + 3.14/5.66 \cdot y(t)^2 + 24.45 \cdot y(t) + 29.08)}\right) \cdot \left(\frac{3.8y(t)^3 + 52.9y(t)^2 + 227.5y(t) + 271.5}{2.73y(t)^2 + 3.76y(t) - 3.14}\right).$$

The functional representation of the transaction value of the aviation industry chain in 2021 is as follows:

$$x(2021) = e^{-(-8.19 \cdot y(t)^2 - 11.28 \cdot y(t) - 9.42/5.66 \cdot y(t)^2 + 24.45 \cdot y(t) + 29.08)} \cdot \left(1 - e^{-(-2.73 \cdot y(t)^3 - 3.76 \cdot y(t) + 3.14/5.66 \cdot y(t)^2 + 24.45 \cdot y(t) + 29.08)}\right) \cdot \left(\frac{3.8y(t)^3 + 52.9y(t)^2 + 227.5y(t) + 271.5}{2.73y(t)^2 + 3.76y(t) - 3.14}\right).$$
3.3. Dynamic Prediction Effect Analysis of the Grey Bayesian Network Inference Prediction Model. Under the influence of the government’s macro-control policies and other factors in the development of the aviation industry, they influence each other on the flight duration of general aviation production operations, and a grey Bayesian network reasoning model is established, as shown in Figure 1.

In Figure 1, each node has two states, namely, good (G) and bad (B), and the probabilities of each state are expressed as $P(G)$ and $P(B)$. According to the actual economic development, the experts calculated the conditional probability table, as shown in Tables 2–4.

The chain rule and conditional independence rule of Bayesian network reasoning are used to calculate the relative conditional probability, as follows:

$$P(x_3 = G) = P(x_3 = G | x_1 = G, x_2 = G)$$

$$= P(x_1 = G) \cdot P(x_2 = G)$$

$$+ P(x_3 = G | x_1 = B, x_2 = G)$$

$$\cdot P(x_1 = B) \cdot P(x_2 = G)$$

$$+ P(x_3 = G | x_1 = G, x_2 = B) \cdot P(x_1 = G)$$

$$\cdot P(x_2 = G)$$

$$P(x_3 = B) = 0.732, P(x_4 = G) = 0.254, P(x_4 = B) = 0.746$$

$$P(x_5 = G) = P(x_5 = G | x_3 = G, x_4 = G) \cdot P(x_3 = G)$$

$$\cdot P(x_4 = G)$$

$$+ P(x_5 = G | x_3 = B, x_4 = G) \cdot P(x_3 = B)$$

$$\cdot P(x_4 = G)$$

$$+ P(x_5 = G | x_3 = G, x_4 = B) \cdot P(x_3 = G)$$

$$\cdot P(x_4 = B)$$

$$+ P(x_5 = G | x_3 = B, x_4 = B) \cdot P(x_3 = B)$$

$$\cdot P(x_4 = B) = 0.34.$$  

(20)

![Figure 1: Schematic diagram of the Bayesian network correction process of the aviation industry development.](image)

Table 2: Expert prediction probability table of the economic development and government regulation effect in September 2019.

<table>
<thead>
<tr>
<th>Bubble situation</th>
<th>Government macro-control</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p(x_1) = G$</td>
<td>$p(x_1) = B$</td>
</tr>
<tr>
<td>$p(x_2) = G$</td>
<td>$p(x_2) = B$</td>
</tr>
<tr>
<td>0.2</td>
<td>0.8</td>
</tr>
<tr>
<td>0.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 3: Probability table of expert forecast conditions for industrial development and the aviation industry development in September 2019.

<table>
<thead>
<tr>
<th>Bubble situation $x_1$</th>
<th>Government macro-control $x_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p(x_1) = G$</td>
<td>$G$</td>
</tr>
<tr>
<td>$p(x_1) = B$</td>
<td>$B$</td>
</tr>
<tr>
<td>$p(x_2) = G$</td>
<td>$G$</td>
</tr>
<tr>
<td>$p(x_2) = B$</td>
<td>$B$</td>
</tr>
<tr>
<td>$p(x_1) = G$</td>
<td>$1$</td>
</tr>
<tr>
<td>$p(x_1) = B$</td>
<td>$0$</td>
</tr>
<tr>
<td>$p(x_2) = G$</td>
<td>$0.8$</td>
</tr>
<tr>
<td>$p(x_2) = B$</td>
<td>$0.2$</td>
</tr>
<tr>
<td>$p(x_1) = G$</td>
<td>$0.7$</td>
</tr>
<tr>
<td>$p(x_1) = B$</td>
<td>$0.6$</td>
</tr>
</tbody>
</table>

Table 4: Probability table of national economic development experts’ forecast conditions in September 2019.

<table>
<thead>
<tr>
<th>Industrial development situation $x_3$</th>
<th>$G$</th>
<th>$G$</th>
<th>$B$</th>
<th>$B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p(x_3) = G$</td>
<td>1</td>
<td>0.8</td>
<td>0.6</td>
<td>0</td>
</tr>
<tr>
<td>$p(x_3) = B$</td>
<td>0</td>
<td>0.2</td>
<td>0.4</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5: Flight time forecast of the aviation industry production (unit: 10,000 hours).

<table>
<thead>
<tr>
<th>Methods</th>
<th>Grey Bayesian network inference model</th>
<th>GM (1, 1)</th>
<th>Exponential smoothing model</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>106.07</td>
<td>103.38</td>
<td>98.62</td>
</tr>
<tr>
<td>2020</td>
<td>120.08</td>
<td>114.17</td>
<td>105.68</td>
</tr>
<tr>
<td>2021</td>
<td>136.13</td>
<td>126.11</td>
<td>112.75</td>
</tr>
</tbody>
</table>

The system development coefficient of the system is $\alpha = P(x_3 = G)$. According to Theorem 1 $\gamma(t) = \alpha$, the functional analysis factor of system regulation can be obtained, $\gamma(t) = 0.34$. 
By substituting the system control functional analysis factor $y(t) = 0.34$ into the prediction equation, the predicted flight duration of production operations in the aviation industry from 2019 to 2021 is obtained as follows: $x(2019) = 106.07 (10,000$ hours$), x(2020) = 120.08 (10,000$ hours$), and $x(2021) = 136.13 (10,000$ hours$).

In this paper, the GM (1, 1) model and exponential smoothing model are selected as comparison models. Without considering the impact of the new policies on the production and operation flight time of the aviation industry and according to the statistical data of the production and operation flight time of the aviation industry from 2015 to 2018, the GM (1, 1) model can be used to predict the production and operation flight time of the aviation industry from 2019 to 2020. An exponential smooth regression model was established based on the flight time statistics of the aviation industry from 2015 to 2018. The three models are used to predict the flight time of production operations in the aviation industry in 2019, 2020, and 2021, as shown in Table 5.

These three models are used to compare and analyze the predicted values of flight time in 2019 and their errors in the aviation industry, as shown in Table 6.

According to the above predicted results, the following main conclusions can be drawn:

1. **Prediction Effect Analysis.** The state shall implement airline industry regulations and control policies, which lead to transformation in the airline industry situation. Forecasting models relying on historical data to predict the future value, and the GM (1, 1) model and the exponential regression model in this case will result in the deviation of the real and estimated values. That is, GM (1, 1) was 8.34%, and exponential regression was 13.57%. The grey forecasting of the Bayesian network inference model based on the current period of economic information to modify the historical trend predicts only 5.59% of the deviation with the actual result, which means the predicted results are more accurate.

2. **Model Selection Analysis.** The classical GM (1, 1) and exponential regression models are suitable for developing and utilizing the data of the past period to predict the future trend. The grey Bayesian network inference model emphasizes the development and utilization of the recent data, which is suitable for the prediction of the recent development trend of the system.

3. **Dynamic Prediction Effect Analysis of the Grey Bayesian Network Inference Prediction Model.** Based on the analysis of the current situation of system regulation, the functional analysis factor of system regulation is determined by the expert group using the Bayesian network reasoning technology. The introduction of the system control functional analysis factor can be sensitive to the current situation of system control and the system development trend of dynamic prediction.

### 4. Conclusion

The prediction model of grey Bayesian network reasoning was established after the aviation policy was regulated. The model provided a better solution for the prediction problem under the policy control. In theory, a new post-regulation prediction model framework is established, which builds a bridge between social science and system regulation theory. The model inherits the graphical display technology of the system regulation theory, which makes the complex process of economic system regulation and prediction be displayed dynamically and intuitively. This paper, based on the grey system and Bayesian network inference technology, created a grey Bayesian network inference prediction model, which makes full use of the information revealed before and after the system regulation and realizes scientific reasoning and predication under the external regulation environment.

### Data Availability

The data used to support the findings of this study are included within the article.

### Conflicts of Interest

The authors declare that they have no conflicts of interest.

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### References


