Prediction of general aviation pilots in China based on supply and demand

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Abstract: This paper selects the data of civil aviation pilot licenses, flight instructors and general aviation pilot processed by HP Filtering Technology to construct the VAR equation and predict the supply of general aviation pilot in China in the next three years. Compared with the demand predicted by linear regression equation, it is found that in the next three years, the number gap of pilots in China will reach 879, 856 and 1190 respectively. Finally, this paper analyzes the results combined with the reality, and according to the VAR model, gives reasonable suggestions from the two aspects of strengthening the master's qualifications and encouraging civil aviation or military pilots to change jobs.

Keywords: General aviation pilots; HP filter technology; VAR model.

1. Introduction

Under the background of the state's strong support for the opening of low airspace, the guiding opinions on promoting the development of general aviation industry issued by the State Council in 2016 required that the number of general aviation aircraft should exceed 5000 by 2020. However, as of December 31, 2020, the number of general aviation aircraft in China was only 2461, The lack of sufficient navigation pilots is the key reason why the number of aircraft is much less than expected. Reasonable prediction of the supply and demand of general aviation pilots can not only provide a theoretical basis for the promulgation of corresponding policies, but also predict the development prospect of general aviation industry.

At present, the civil aviation industry is still the main part of the aviation industry, so scholars pay less attention to the field of general aviation, especially the research on general aviation pilots, but there are still some results for reference. Zhou Changchun (2013) predicted that in the next 5 to 15 years, the whole general aviation industry, including the number of general aviation pilots, will usher in rapid development by analyzing the resources of the flight college and the navigation flight experience of the flight college[1]. Based on the analysis of the current situation, Gao Yuanyang (2014) pointed out that the shortage of flight talents has become an important factor restricting the development of China's general aviation industry, and the shortage of educational resources and incorrect training channels are the reasons for this situation[2]. Alfonso Noriega and mark J. balas (2016) pointed out that general aviation should pay attention to the combination of facilities and flight talents. Only when the industry operates well can it fully integrate with the outside and interact internally and externally, so as to realize the smooth and efficient operation of the industry[3]. Xiao Pingfang (2017) used the number of aircraft to calculate that the number of general aviation pilots in China in 2020 is about 10000[4].

Based on the above analysis, most studies are not supported by data analysis, which is difficult to be convincing. Moreover, the prediction of general aviation pilots only obtains the possible number in the future, but it is impossible to know whether this number is large or small relative to the demand, so it is less helpful to the development of general aviation pilot scale. Through the comparison of supply and demand pre measurement, this paper observes the change law of the number gap of China's general aviation pilots in the future, clearly understands the development trend of China's general aviation pilot scale in the future, and puts forward more reliable suggestions, which can really help the development and growth of China's general aviation industry and enrich the research.

2. General aviation pilot prediction based on supply angle

At present, the supply of general aviation pilots in China mainly comes from the training of aviation schools and navigation companies and the transformation of civil aviation industry, and its supply is also affected by the number of existing general aviation pilots. A larger number gap will attract more talents to enter the industry. Therefore, based on the time series data from 2012 to 2020, this paper takes the number of teachers of aviation schools and general aviation companies, the number of pilot licenses of civil aviation routes and the number of current general aviation pilots as independent variables and the supply of future general aviation pilots as dependent variables, and uses Eviews software to construct vector autoregressive equation for prediction.

2.1 Data sources

In order to ensure the availability and reliability of data, the data of the above three indicators are derived from《the general and small transport operation overview 2012-2020》and 《the annual report on the development of civil aviation drivers 2012-2020》 published on the official website of Civil Aviation Administration of China. The original data are shown in Table 1:

Table 1 Raw data

Year	Number of general aviation pilots	Number of pilot licenses for civil aviation routes	Number of teachers of flight schools and general Airlines
2012	470	11707	481
2013	991	12470	575
2014	1651	14372	731
2015	2191	15654	910
2016	2830	17602	1253
2017	2524	19693	1308
2018	3326	22195	1547
2019	3476	24373	1986
2020	3599	26670	2267

2.2 Prediction of future number of general aviation pilots based on the VAR model

2.2.1 Processing based on the HP filtering

The number of general aviation pilots, the number of pilot licenses of civil aviation routes, and the number of teachers of flight schools and general airlines from 2012 to 2020 are respectively time series pilot, license and teacher. HP Filtering Technology in the Eviews software is used to decompose the three into trend time series and periodic time series respectively. Since they are annual data, The value of λ is 100, and the subscript 't' represents the trend part and the subscript 'c' represents the cycle part respectively. The decomposition results are shown in Table 2:

Table 2 HP filtered data

$Pilot_t$	$Pilot_c$	$License_t$	$License_c$	$Teacher_t$	$Teacher_c$
727.6345	-257.6345	10719.5	987.503	349.7439	131.2561
1145.548	-154.5484	12572.52	-102.5164	563.2209	11.7791
1560.896	90.114	14435.41	-63.4108	778.0104	-47.0104
1969.525	221.4746	16317.03	-663.03	995.5429	-85.5429
2368.246	461.754	18225.59	-623.59	1216.779	36.2214
2756.042	-232.0417	20162.68	-469.6762	1441.822	-133.8222
3136.524	189.4758	22123.64	71.362	1671.141	-124.1408
3510.985	-34.98471	24099.13	273.872	1903.863	82.1367
3862.609	-283.6091	26080.51	589.4868	2137.877	129.123

HP filtering effect diagrams are shown in Figure 1, figure 2 and figure 3 respectively:

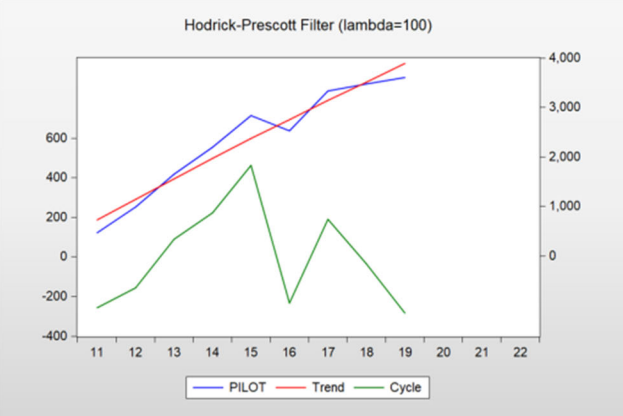

Fig1 General aviation pilot

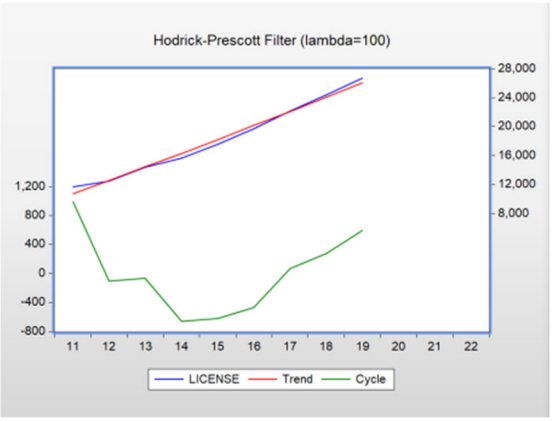

Fig2 Civil aviation routes

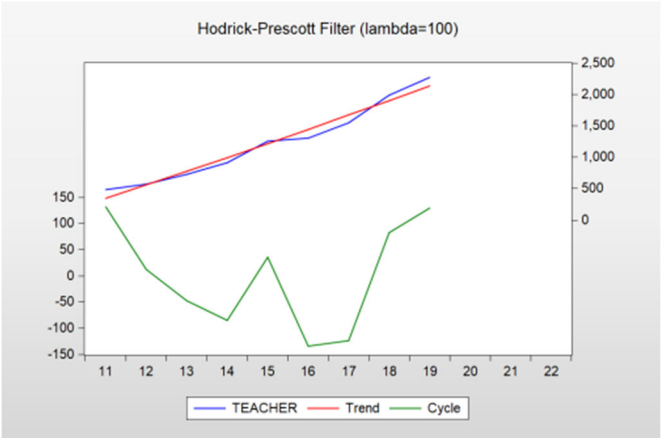

Fig 3 Flight school and general aviation instructor

2.2.2 Determine the optimal lag order

Because the selected three groups of original time series are HP filtered and divided into trend part and cycle part, this paper needs to construct VAR model for prediction by using the trend part and cycle part of the three groups of time series, and add the results to get the final prediction result. Before that, the optimal lag order of the model should be determined first. The test results of the optimal lag order of the trend part and the cycle part are shown in Fig. 4 and Fig. 5 respectively:

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-139.8009	NA	1.06e+14	40.80026	40.77708	40.51374
1	-114.0652	22.05921*	1.41e+12*	36.01862	35.92589	34.87255
2	563.6661	0.000000	NA	-155.0474*	-155.2097*	-157.0531*

Fig 4 Trend section

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-103.7963	NA	3.60e+09	30.51323	30.49005	30.22672
1	-9.136725	81.13680*	0.134621*	6.039064	5.946339	4.892995
2	339.2897	0.000000	NA	-90.93991*	-91.10218*	-92.94553*

Fig. 5 Cycle section

It can be seen from Figure 4 and figure 5 that the models built in the trend part and the cycle part are AIC, SC and HQ criteria, indicating that the optimal lag order is 2, and LR and FPE criteria indicate that the optimal lag order is 1. According to the principle of multiple criteria determination, this paper establishes VAR models with second-order lag for the trend part and the cycle part respectively.

2.2.3 Stationarity tests

After determining that the optimal lag order of the two models in the trend part and the cycle part is order 2, this paper uses AR root to test the two models, as shown in Fig. 6 and Fig. 7. In the analysis, the unit root falls in the range of unit circle, so it is a stable VAR model, and it is determined that the next research can be carried out.

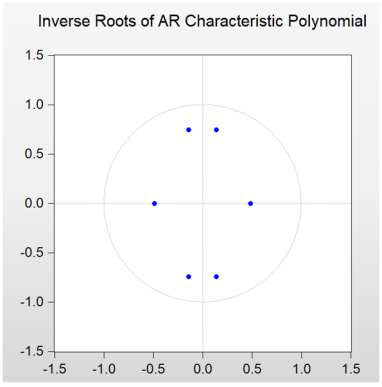

Fig 6 Trend section

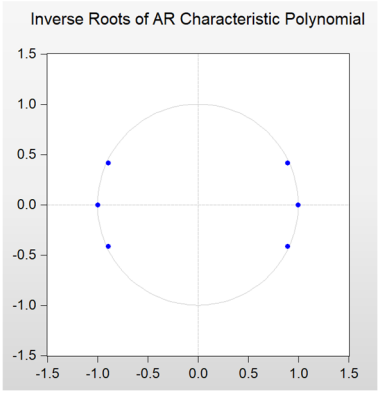

Fig 7 Cycle section

2.2.4 Data prediction

Since the stationarity of the trend part and periodic part VaR models has been verified above, and their optimal lag order is order 2, their models are used for prediction respectively.

Vector Autoregression Estimates
Date: 05/07/21 Time: 14:43
Sample (adjusted): 2013 2019
Included observations: 7 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LICENSE1	PILOT1	TEACHER1
LICENSE1(-2)	4.767192	-1.082449	0.617613
	(3.35842)	(1.31950)	(0.36378)
	[1.41948]	[-0.82035]	[1.69778]
PILOT1(-2)	-1.209930	1.341246	-0.240878
	(1.28755)	(0.50587)	(0.13946)
	[-0.93972]	[2.65137]	[-1.72716]
TEACHER1(-2)	-30.11575	8.650492	-3.861067
	(26.6645)	(10.4763)	(2.88826)
	[-1.12943]	[0.82572]	[-1.33682]
C	-25262.19	9166.404	-4317.829
	(25745.3)	(10115.2)	(2788.68)
	[-0.98124]	[0.90620]	[-1.54834]

Fig 8 Trend section

Vector Autoregression Estimates
Date: 05/07/21 Time: 14:02
Sample (adjusted): 2013 2019
Included observations: 7 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LICENSE2	PILOT2	TEACHER2
LICENSE2(-2)	0.537572	-0.174590	0.162231
	(0.63882)	(0.34765)	(0.07527)
	[0.84151]	[-0.50220]	[2.15541]
PILOT2(-2)	0.646568	-0.204142	0.019368
	(1.09990)	(0.59858)	(0.12959)
	[0.58784]	[-0.34104]	[0.14946]
TEACHER2(-2)	-3.054597	1.821469	-1.163541
	(3.17076)	(1.72558)	(0.37359)
	[-0.96336]	[1.05557]	[-3.11452]
C	-181.7392	101.6129	-36.42173
	(233.386)	(127.012)	(27.4980)
	[-0.77871]	[0.80003]	[-1.32452]

Fig 9 Cycle section

Figure 8 and Figure 9 show the model results of the trend part and the cycle part respectively. It can be seen that the formulas of the two parts of the model are equation 1 and equation 2 respectively:

$$PIOLT=-1.082449*LICENSE(-2)+1.341246*PILOT(-2)+8.650429*TEACHER(-2)+9166.4 \quad (1)$$

$$PIOLT=-0.17459*LICENSE(-2)-0.204142*PILOT(-2)+1.821469*TEACHER(-2)+101.6129 \quad (2)$$

Using the above two formulas, the data of trend part and cycle part in the next three years can be calculated. By adding the two, The data for the next three years are 4469，4902 and 4976.

2.2.5 Error test

In order to ensure the accuracy of the model prediction results, this paper uses the obtained two-order lag autoregressive equation to calculate the data from 2014 to 2020, and obtains the prediction error of the model by comparing with the real data, so as to test its accuracy. The specific results are shown in Table 6 and figure 10 (Where A represents the real data and B represents the obtained data):

Table 3 Error test

Year	Real data	Predicted data	Error
2014	1651	1786	0.08116
2015	2191	2139	0.02373
2016	2830	2374	0.16113
2017	2524	2773	0.09865
2018	3326	3323	0.0009
2019	3476	3497	0.00604
2020	3599	3706	0.02945
	Average error		0.05729

It can be seen from table 6 that the average error of the data calculated by the VAR model constructed after HP Filtering is 5.729%, and the error is small. In addition, the errors in 2016 and 2017 are relatively large, reaching 16.113% and 9.856% respectively, and the errors in other years are very small. In addition, the error in recent three years has greatly reduced compared with previous years, and the accuracy trend of the model is getting better and better. Therefore, the results predicted by the VAR model after HP filtering are more reliable and can be studied.

3. Comparative study on measurement of supply and demand

3.1 Prediction of general aviation pilots based on demand

After the supply of general aviation pilots in China is predicted by VAR model, this paper forecasts the future demand. It is more accurate to determine the general aviation pilots by the number of general aviation aircraft in the future. Since the current general aviation man-machine ratio is 4:1, in which the ratio of pilots to aircraft is 2, the prediction of the number of general aviation aircraft can obtain the approximate demand of general aviation pilots in the future.

Based on the number of general aviation aircraft in China from 2012 to 2020, this paper constructs a linear regression equation through Excel. The data and equation over the years are shown in Figure 11 (the data comes from《the general and small transportation operation overview 2012-2020》released on the official website of Civil Aviation Administration of China):

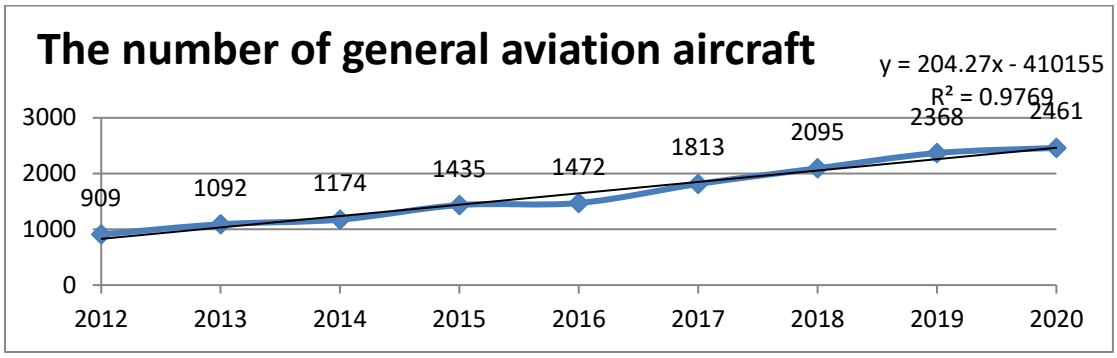

Fig 10 Number of aircraft

It can be seen from Figure 11 that R^2 of the linear equation is 0.9769, which is a value very close to 1, which also shows that the regression degree of this model is good and can be used for prediction. According to the formula, the number of aircraft in China from 2021 to 2023 is 2674, 2879 and 3083 respectively. It can be seen that the demand for navigation pilots in China in the next three years will be 5348, 5758 and 6166 respectively.

3.2 The comparison of supply and demand

After calculating the supply and demand of the number of general aviation pilots in China from 2021 to 2023, in order to analyze the predicted data more intuitively, the predicted data are compared with the existing data. The demand of general aviation pilots from 2012 to 2020 is calculated according to the 2:1 ratio of pilots to man-machine. The results are shown in Figure 12:

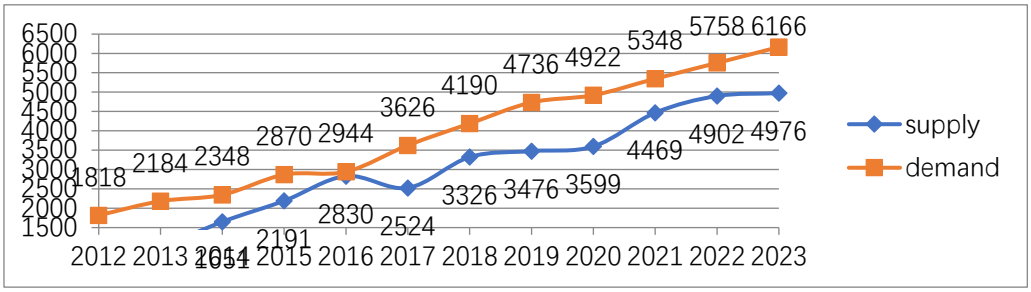

Fig 11 Supply and demand comparison

As can be seen from Figure 11, Compared with 2020, which is seriously affected by the epidemic, the difference between the number of general aviation pilots and demand from 2021 to 2023 predicted from the perspective of supply has been greatly reduced, which shows that China's general aviation industry can meet various flight needs more than before in the next three years, which is very beneficial to the development of the whole general aviation industry. However, it can not be ignored that in the next three years, there will still be about 1000 aviation pilots in China. Especially in 2023, the demand gap will reach 1190, accounting for almost one fifth of the number in that year. It can be seen that in the future, we still need to take various measures to vigorously develop the training of general aviation talents.

4. Relevant suggestions

By observing the vector autoregressive equation constructed above, it can be found that the coefficient before the index of the number of flight instructors is far greater than the coefficient of the other two indexes in both the trend part and the cycle part. It can be seen that the number of flight instructors is very important for the development of the scale of general aviation pilots. The aviation school can provide students with more opportunities for practical operation through cooperation with foreign countries. In addition, the salary of flight instructors can be appropriately increased to increase the number of flight instructors. In addition, pilots transferred from civil aviation or military also play an important role. The state can attract more talents to join the field of general aviation by reducing the difficulty and threshold of transfer procedures.

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