

# *Evaluate the Impact on the Chinese Air-traffic after the Opening of the COVID-19 Pandemic Based on ARIMA Model*

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**Abstract:** After the 3 years control of COVID-19 pandemic, all aspects of control were opened, it has many impacts in every regard. The essay uses the ARIMA model to predict the turnover and the stocking price of the aviation after the opening of the pandemic, then use these testing data to compare with the actual data, so that the difference between these data can illustrates the impact of the opening on the airline industry. The main findings are that this policy would cause the stock price boost greatly, then fluctuated, came back to the normal trend and even declined. The meaning of this research is to evaluate the counterplan and prospect of the airline industry in the future using the actual data to enhance the accuracy. There are some advice for the policy makers, investors, for policy makers and controllers, for example, the investors should sell their stock in short term after the open of the pandemic since the stock price will experience a dramatically decrease. The controllers should lead the investors to avoid the excessive invests which will disturb the aviation stock market.

**Keywords:** pandemic, ARIMA, air-traffic volume, stock price, turnover

## 1. Introduction

The COVID-19 pandemic has an unprecedented shock on the financial markets, at the same time, it brings the greatest global financial crisis during a decade [1,2]. In 2019, at the beginning of the COVID-19, US\$9.2 trillion was used in health worldwide, in 2020 and 2021, pandemic preparedness in LMICs expended \$1.8 billion of DAH contributions and health-related COVID-19 response consumed \$37.8 billion [3]. The global trade declined by 20% approximately in 2020 compared with the last year [4]. For example, the South African government payment in April 2020 was R500 million [5]. There is nearly 30% decrease in the market value of United States Standard & Poor Index (S&P 500) since the COVID-19 pandemic [6].

The aviation industry played an important role in many regions in terms of accelerating the economic growth and the social development, where a number of skilled and semi-skilled manpower were employed [7]. Many industries relied on the aviation industry such as the tourism, medical industry, food industry etc, as the air-traffic provide the fastest transportation of the tourists and cargos [6]. According to the perspective of the ai-traffic volume, Wang Yong and Liu Yi did the empirical analysis about the relation among the 10 city airports and panel data of economic growth and airport passenger throughput and cargo throughput and gross regional product [8]. The result shows that Each

unit increase in passenger throughput will increase GDP by 0.046 units; the contribution of cargo and mail throughput indicators to economic development is not significant, about 0.028 [8]. It is noticeable that the aviation industry has become an indispensable tool in the modern life. However, the COVID-19 pandemic occurred suddenly in the end of 2019, which inflicted heavy loss on the global economy as for the stable development [9]. Among this, the transportation and the tourism were significantly shocked, which are the mainstay for the aviation market [9]. The hit beard by the air-traffic was unprecedented, which means all the crisis in the history cannot be comparable to the change of aviation industry this time [9]. Because the control of the going out and many policies related to the quarantine and infection risk led many people to not have the tendance to travel, and the process of the transportation of goods was also complicated. This phenomenon remains nearly 3 years in China, causing the large change of the air-traffic industry. Following by the policy of implement “Category B Control B” in the face of the coronavirus in our country since 8<sup>th</sup> January 2023, it symbolizes that the prevention and control of the COVID-19 epidemic had entered into the new phase [10]. The three years of epidemic had a huge impact on the civil aviation industry causing approximately RMB 400 billion lost, and this period also change the people’s travel habits and consuming attitudes [10]. As a result, whether the open of the epidemic can ameliorate the aviation industry and whether the impact can sustain in a long period?

There are many researches about the recovery and the development of the aviation industry in the future. Kaitano Dube indicated that the circumstance of the recovery of the aviation in different regions had different situation due to the different geo global political and economic factors especially the inflation, the interest rates, the increasing costs of fuels, the workforce, and the Russia-Ukraine conflicts etc [11]. In terms of the Chinese aviation market, it is the first region experiencing the hit of COVID-19, and it recovered quickly as the control of the epidemic in China [12]. although the domestic market of the mainland of China has recovered to about 80% compared with the pre-crisis parameter until July 2020, the international airline recovered at a much lower pace because of the serious check and quarantine of the bilateral route and capacity control [12].

However, there is a blank whether the open of the COVID-19 epidemic had large impact on the aviation industry in China, whether the air-traffic industry could be continuous to recovery when the control was withdrawn. It is important for the investors to predict the future trend of the aviation when they make the investment because the aviation relates to many industries. This essay aims to study and predict the future trend of the aviation industry, the turnover, the stocking prices, and prospect of other industry related.

In this essay, the time series method is applied to study these phenomena. Firstly, the three years of composite index of listed airline were collected, then find the time point of category B control B aiming to using the training data, the data before this time point, to predict the trend without the impact of the new stage [13]. We already have the data after the time point which are called the testing data, used to compared with the predicted line. The difference between these two lines can be used to research the impact of the open of the pandemic on this airline industry. During the process of the prediction, the ARIMA model is used which consist of the stationary test, determine the order using ACF and PACF, residual test and finally plot the result graph.

## **2. Data and Method**

### **2.1. Data Description**

Weekly closing price and turnover, air transport industry index, were collected from choice Financial Terminal Dataset [14]. The data were chosen from 7 Februrary,2020, to 24, April 2023, because the COVID-19 pandemic was initiated from the December 2019. These data are divided into the training data and testing data, the data before 7, December,2022 when the COVID-19 pandemic was opened,

are training data which are used to predict the trend of the air-traffic volumes without the impact of the opening of the pandemic. The data from the 5, December,2022 to 24, April 2023 are testing data which are used to compare the difference caused by the opening pandemic policy.

## 2.2. Weak Stationarity Test

Aiming to apply the ARIMA model, the first step is to test whether or not the data are stationary. According to the ADF test, P-value is the index to test the stationary firstly, if the p-value is greater than the 0.05, the null hypothesis which is that the data occurs as a small probability should be accepted, vice versa. The p-value in Table 1 for the air-traffic closing price and Turnover are 0.0150 and 0.0059 separately, being smaller than 0.05, meaning to reject the null hypothesis H0, the series is not stationary. As a result, both the time series of Closing Price and Turnover are stationary and can be used in the ARIMA model.

In spite of the stationary of raw data, the data of closing price and turnover are differences in order to strengthen the stationary of the data. In order words, the p-values of the first difference of closing price and turnover, in other words at lag 1, are 0.0000, which are statistically significant, and stationary. In this model, the return series are used aiming to get greater stability of series.

Table 1: ADF test.

Variables	t-statistic	p-value
Raw		
Closing Price	-3.832	0.0150
Turnover	-4.119	0.0059
	Difference	
Closing Price	-6.061	0.0000
Turnover	-6.186	0.0000

## 2.3. Model selection

ARIMA model is consist of three part: autoregression (AR), difference (I), moving average (MA). ARMA(p,q) is a special case of ARIMA (p, d, q), where there is no difference. During the equation (1), AR(p) model is represented by  $\phi_0 + \sum_{i=1}^p \phi_i x_{t-i} + a_t$ , describing the relationship between the current observed data and past observations.  $\phi_0$  represents the baseline level of variables;  $\phi_i$  is the coefficient related to the lagged values of variables;  $x_{t-i}$  represents the lagged values of variables when lagged values is i;  $a_t$  is the error terms of residuals at time t. The rest part of the equation represents the MA(q) which is so as to reduce the past errors as predictors.

$$x_t = \phi_0 + \sum_{i=1}^p \phi_i x_{t-i} + a_t - \sum_{i=1}^q \theta_i a_{t-i} \quad (1)$$

$$(1 - \sum_{i=1}^p \phi_i B^i)(1 - B)^d y_t = (1 + \sum_{i=1}^q \theta_i B^i) \epsilon_t \quad (2)$$

During the equation (2),  $(1 - B)$  represents the differencing operator,  $y_t$  represents the observed time series at time t. B represents the lag operator. Equation (2) is the ARIMA model, differencing the ARMA model.  $(1 - \sum_{i=1}^p \phi_i B^i)$  is AR(p) model,  $(1 + \sum_{i=1}^q \theta_i B^i)$  represents the MA(q) model.

### 3. Results and Analysis

#### 3.1. Estimation and Test

##### 3.1.1. Order Determination

The y-axis in Figure 1 shows the values of PACF and ACF of the rate of return of the closing price and turnover, being the dependent related to the x-axis which is the lag order.

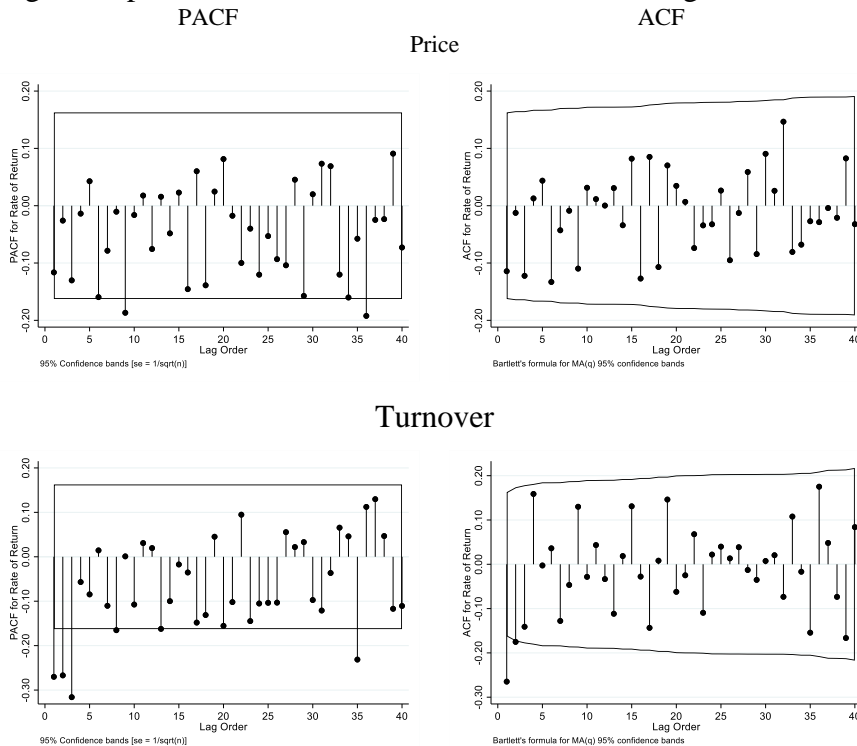


Figure 1: PACF and ACF.

Photo credit: Original

In terms of the order of the model, PACF and ACF can help to determine the value of  $p$  and  $q$ . For the price of return, the first outlier is lag order 9 in PACF graph, so the order of AR( $P$ ) is 9, so the value of  $p$  is equal to 9. All the spikes of the ACF graph are within the baseline, which means the lag could be 0 at this case, so  $q$  is equal to 0. The data experience the first difference in order to calculate the rate of returns of closing price being more stationary,  $d$  is 1. As a result, the ARIMA model for the closing price of the air-traffic volume is (9,1,0).

The 3<sup>rd</sup> and 4<sup>th</sup> graph in Figure 1 show the PACF and ACF of the turnovers of air-traffic. In the PACF graph, order 1,2,3 are all outliers which are beyond the base line. Although order 1 is the first outlier, it can only predict 1 order in the future, having the low accuracy, so  $p=3$  is choosing in order to get a greater and more accurate model. In the ACF graph, the first spikes out of the baseline is order 1, so  $q$  is equal to 1. The data experience the first difference in order to calculate the rate of returns of turnover being more stationary, so  $d$  is also 1. The ARIMA model for the turnover of the air-traffic volume is (3,1,1).

##### 3.1.2. White Noise Test

The residual test is applied to check whether the residual of the model is white noise. Table 2 shows the Ljung-Box test of the air-traffic closing price and turnover, the  $p$ -values of the two parameters are

separately 0.9737 and 0.8147, which are both greater than 0.05, hence the null hypothesis being the white noise cannot be rejected. In this case, ARIMA (9,1,0) and ARIMA (3,1,1) can be accepted since the time series law are followed by this model.

Table 2: Residual test.

Model	Portmanteau (Q) statistic	Prob > chi2
Price	24.5723	0.9737
Turnover	31.9303	0.8147

### 3.2. Prediction

Figure 2 shows the actual value (blue line) and fitted value (orange line) of the stocking price of air-traffic, the time point 2022-12-07 divides the trend in two parts, the data before the time point are training data and those after the time point is the testing data which is predicted trend. During the first 15 days after the time when the COVID-19 epidemic was opened, the actual air-traffic stock price was much higher than the predicted. After 23rd December 2022, the actual line fluctuated being similar as the line of fitted value. Therefore, there is only a short period impact on the air-traffic stock price after the open of the epidemic. In addition, although there is a change after the open of the epidemic, the trend of the stock price shows a downward trend.

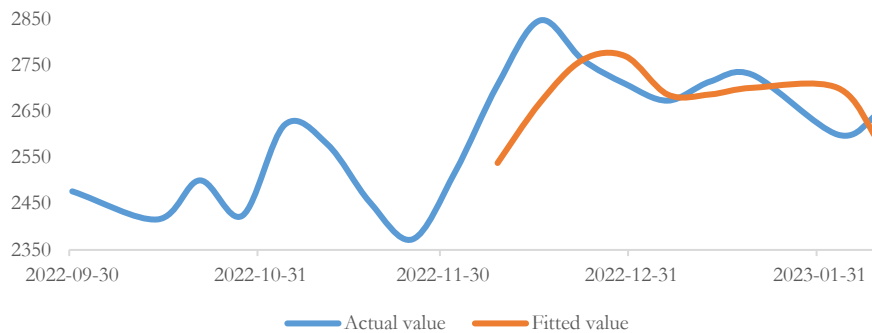


Figure 2: Stock price, actual and fitted value.  
 Photo credit: Original

Figure 3 shows the actual value (blue line) and fitted value (orange line) of the turnover of air-traffic. After the 9th December, it was apparently that the actual turnover was greater than the fitted value. At the beginning of the open of epidemic, the actual turnover was significantly larger than the fitted amount of turnover, being about 7000 million, which means the change of the epidemic have enormous impact on the air-traffic. Whereas the difference between the actual value and the fitted value lessened until the 22nd December, 2022 when the fitted value overcome the actual turnover. It shows that there was a huge effect on the air-traffic turnover in short term. The actual value was about 700 million higher than the fitted value at the beginning of the open of the pandemic. And the actual turnover showed a downward trend which would be lower than the fitted value, falling to approximately 1700 million until 22 Decemeber,2022.

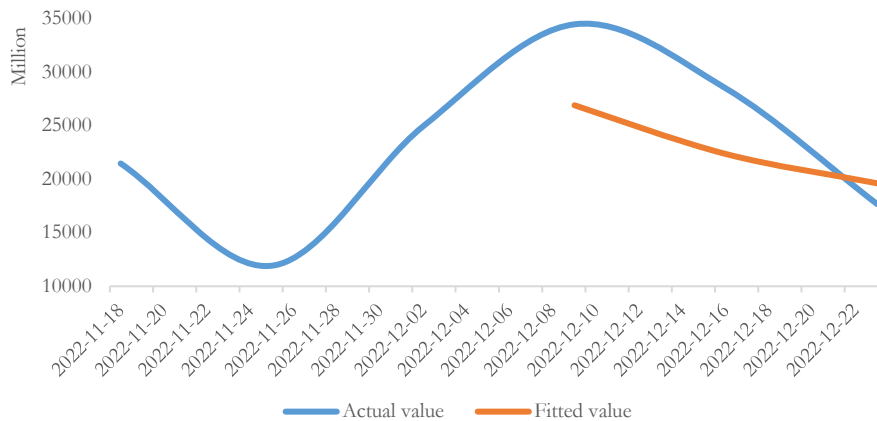


Figure 3: Turnover, actual and fitted value.

Photo credit: Original

### 3.3. Analysis

Figure 3 shows the air-traffic stocking price, reflecting the state of the overall tock market, recovery a little then it was fluctuated which the open of the epidemic has little impact on, because opening of the pandemic was benefit to the stock market, the prospect of the stock market is better which means the price of the stock price will rise. However, the stock price illustrates the downwards trend because the public was infected with the coronavirus at a large extend, causing the demand for a journey decreased. Moreover, there was a reversal effect of the overreaction, the phenomenon, the investors were excessively bullish on the stock who had performed previously well and were overly pessimistic on th stock who had been gloomy previously, cause these stocks markets price had deviation to their basic value [15]. with the time being, the market will repair automatically which means the stock performing bullish will become the worse stock after the negative risk adjustment, vice versa [15]. In this case, the stock raised exaggeratively because of the opening of the policy of the pandemic, which contributed to the excess estimate of the true value of the stock. The stock price would return to the normal value after a short period.

Figure 3 illustrates the turnover of the air-traffic stock market. the turnover depends on the quantity and the price of the stock. Firstly, the open of the pandemic provide the confidence of the aviation market, this is the reason why more investors purchase the airline stock, at the same time, as the development of the aviation will be better, the stock price also increases, so the turnover enlarged a lot. While this phenomenon continues a short period, then shows a dramatically downward trend. On the one hand, the stock price will return to the origin and even decline further due to the reversal effect and the increased number of the people infected the coronavirus. On the other hand, as the stock price took a bad turn and many people infected the virus, the investors did not have the positive attitude to the stock market of the aviation, so there are less investors purchasing the stock, thus the turnover show a downward trend.

### 4. Conclusion

This paper was studied under the circumstance that the COVID-19 pandemic was opened, there exist already the turnover and the stocking price of the airline industry after and before the open of the pandemic. This paper is concentrated to use the training data during the COVID-19 to predict the turnover and the stock price after the open of the epidemic to obtain the compare data. According to this method, the opening policy have a huge impact on both the turnover and stock price in the short term, it shows a suddenly increase due to the overreaction, whereas the stock price will return to the

normal trend after a period, and the turnover shows even a lower trend after this policy. This illustrates that the opening of the pandemic actually brings the benefits for the airline industry, while the interest just remains a short period, then there will be a severe rebound. There are some advice for the policy makers, investors, for policy makers and controllers, they should make the relevant policy to give the treatment to the patient od COVID-19 pandemic in order to make the markets such as the airline market recovery to normal quickly. for investors, it should be prudent if they want to invest during the beginning of the open of the pandemic. Because the trend of the increase of the stock price does not remain a long term, it will experience a large decrease after a short period of this rise. What's more, if the investors want to gain some profit from the aviation stock, it is recommended to purchase the stock, then sell it in a short period before there is the decline. For the controllers, it is urgent to lead these investors to the right way to invest, avoid the excessive invest of the future market, avoid the substantial change of the stock market causing the market value is far from their actual value. There is a risk when the stock market experiencing the large policy change, usually, the stock price will not rise for a long time. Finally, whether this stock market will have a warming, and the extent of the stock market future change is still a problem which can be evaluated.

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