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Stock Price Prediction with Box-Jenkins Models: Delta Airlines Application

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Abstract

The aviation industry has a great impact on the economic development of countries. This industry is effective in increasing the global gross domestic product both directly and indirectly. The share of airline companies in this economic development is important. This study, it is tried to estimate the monthly stock price of an airline company that contributes to economic growth. In the study, the monthly prices of shares of Delta Airlines, which are among the largest airline companies in America, traded in the New York Stock Exchange (NYSE), covering the period of 2010 January-2021 December, were included. Stock prices are from Box- Jenkins models; It has been tried to estimate using Autoregressive Models (AR), Moving Average Models (MA), Autoregressive and Moving Average Model (ARMA). In the study, the (AR) model was included in the prediction modelling because it provided the assumptions. The result of the study showed that the Box- Jenkins approach gave successful results in the estimation outputs.

1. Introduction

Aviation has been an industry that occupies a very important place in human history. Thanks to this industry, billions of people have gained the freedom to travel quickly, comfortably and reliably. After the Second World War, with the shift of military equipment and technology to civil aviation, different trade areas emerged in this industry. The process, which started with passenger transportation, has started to serve many sectors in cargo transportation, tourism trade and different trade areas in the later stages. Civil aviation, which contributes to the economic growth of countries on a global scale, employs the unemployed and millions of career planning through many airline companies and airports around the world. Aviation, which is a fast mode of transportation, increases the tourism industry by transporting billions of people from one country to another, and the economic growth of countries increases positively with the growth of tourism. Air transport mode takes its place as the first choice of travellers. With the increasing trend of air transport, the bond between countries is getting stronger. The aviation industry helps people understand and respect cultural and social differences by bringing people of different religions, languages and races together. In other words, it helps the manifestation of peace in the world. The coming of peace will bring economic stability to the world. The aviation industry is an important factor contributing to economic growth. Aviation has brought trade awareness with it. As can be seen in Figure 1, the growth of this sector brings many technological growths with it. The use of value-added products in the aviation industry will increase the global sales volume of these products. Many new sectors will emerge with the growth of the aviation industry. This related commercial relationship causes the valuation of airline companies.

The aviation sector has a fragile structure that is directly affected by risks arising from many different factors, such as economics, safety, and health. The fact that this sector, which is open to risks, takes important measures makes it necessary to create strong strategies that can be implemented. For this reason, new strategic approaches to the aviation sector have been developed and have started to be implemented. (Kavak and Kaygın, 2021). The aviation sector has grown, developed, and set an example for the world under the leadership of the United States of America (USA) throughout history. For this reason, the US aviation sector was subjected to examination in the study.

Figure 1 shows the air transport industry and its economic impacts. As seen in the figure, air transport is divided into two as aviation sector and the civil aviation sector. Sectors that directly affect the aviation transportation industry; airlines, airports and services, Air navigation and civil aviation-related sectors. Suppliers, the manufacturing industry, and business services indirectly affect the air transport industry. In summary, the air transport industry affects many sectors and will contribute to economic prosperity and growth. In this study, the estimation of stock prices of Delta Airlines, one of the airline companies, which is one of the parts of such an important sector, has been studied. In the literature, it is seen that the Box-Jenkins method is rarely used in the aviation sector. For this reason, the study, it was tried to estimate the stock value of an airline company in the aviation sector by using the Box-Jenkins method.

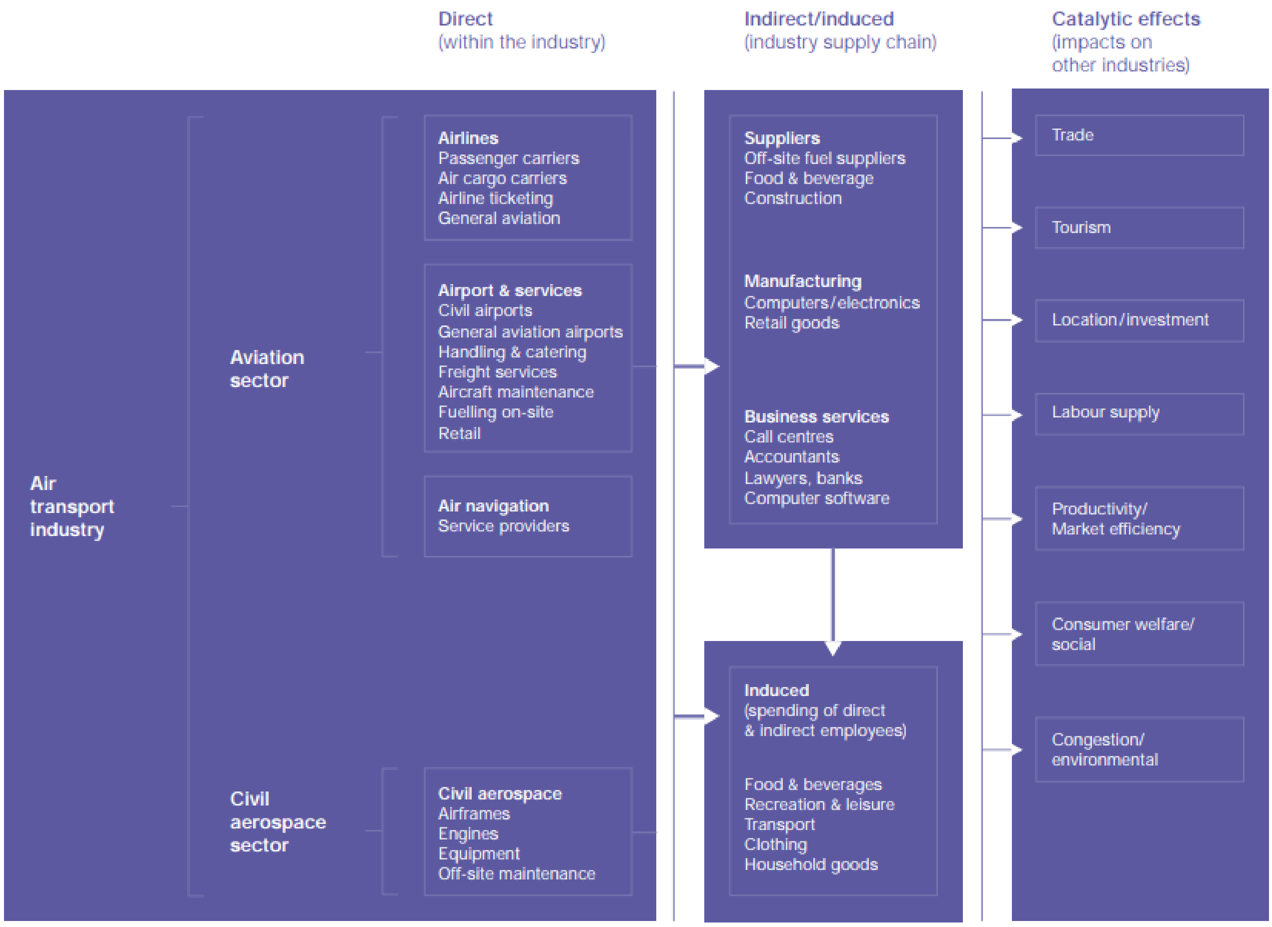

Figure 1. The Air Transport Industry Andean its Economics impacts (Icao, 2012)

2. Impact of Aviation on Global Employment and GDP

Aviation has positive effects on the growth and well-being of countries. This effect on a global scale can be seen more clearly in Figure 2. 87.7 million jobs are supported by the aviation industry. Tourism, directly and indirectly, induces this support and takes the form of a catalytic effect. Globally, 11.3 million people work in the aviation industry. 18.1 million people work in aviation-related indirect jobs. As can be seen in Table 1, 13.3 million of the 87.7 million jobs were created by European countries, while 46.7 million of them were created by European countries. It forms the Asia-Pacific region.

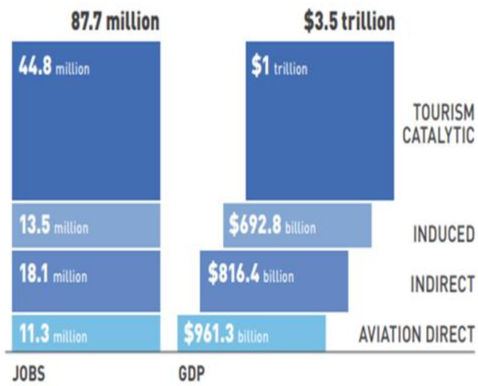

Figure 2. Impact of Aviation on Global Employment and GDP (2019), (aviationbenefits, 2020)

The global economic benefit of aviation can be seen in the gross domestic product. The aviation industry provides global economic support with a total gross domestic product of $3.5 trillion. $961.3 billion of this was directly contributed by the aviation industry, while $816.4 billion was provided by the indirect effect of aviation.

Table 1. Statistical Information of Aviation by Regional

Region	Jobs supported	GDP supported	Passengers (2019)	% of global passengers
AFRICA	7.7m	$63 bn	115m	2.5%
ASIA-PACIFIC	46.7 m	$944 bn	1.7 bn	37%
EUROPE	13.5m	$991 bn	1.2 bn	26%
LATIN AMERICA AND THE CARIBBEAN	7.6m	$187 bn	356 m	7.7%
MIDDLE EAST	3.3m	$213 bn	192 m	4.2%
NORTH AMERICA	8.8m	$1.1 tm	1 bn	22.7%

Source: (aviationbenefits, 2020)

According to the information given in Table 1, the contribution of aviation to the gross domestic product is led by North America, with $1.1 tm; then, with $991.1 bn, Europe's contribution to the economy with aviation is seen. The Asia-Pacific region holds 37% of global passenger transport, carrying 1.7 thousand passengers in 2019. Then, respectively, Europe (26%), North America (22.7%), and Latin America and the Caribbean region share 7.7% of the total in global passenger transport.

3. Literature

In the literature, it is seen that the Box-Jenkins method is used for predictive modelling in many areas. In the studies, it is stated that the estimation performance of the method gives successful results. That is why the Box-Jenkins method is used quite often. In the literature, it is seen that the Box-Jenkins method is rarely used in the connection of the aviation sector with finance. It has been seen that the method is mostly used in the aviation sector for issues such as transportation demand and passenger demand. For this reason, the connection between aviation and the finance branch was dealt with in the study, and a forecast model was developed.

Bircan and Karagöz (2003) Jenkins method to predict the future of exchange rates by giving general information about time series, Box- Jenkins models are examined, and the application phases of the Box-Jenkins method are explained. The most appropriate estimation model was determined for the 132-month exchange rate series covering the period of January 1991 and December 2002.

Doğan and Ersel (2009) analyzed the export and import series using Box-Jenkins models. The monthly export and import series for the period January 2003–May 2008 were analyzed. In these analyses, calculations were made in dollar terms, and parity differences and price changes were not taken into account. Although it was thought that political and similar developments had an impact on the volume of foreign trade, such developments were not evaluated as much as possible. According to the findings, it is predicted that foreign trade deficits will continue to be an important problem in 2009 as well.

Suleman and Sarpong (2012) used the Box- Jenkins approach to model milled rice production using time-series data from 1960 to 2010 when the Ghana government called for a doubling of rice production due to the increasing rice demand in the country. The analysis revealed that ARIMA (2, 1, 0) was the best model for estimating milled rice production.

Ahmad (2012) applied the Box-Jenkins auto-regressive integrated moving average (ARIMA) modelling approach for time series analysis of monthly average prices of Omani crude oil over a period of 10 years. The identified models were then estimated and compared in terms of the significance of parameter estimates, mean square errors, and their adequacy using the Modified Box-Pierce (Ljung-Box) Chi-Square statistic. Based on these criteria, a multiplicative seasonal ARIMA (1,1,5) x (1,1,5) x (1,1,5) x (1,1,5)4 model is proposed for short-term forecasting. In his study, the author shows that the ARIMA modelling approach is an effective tool in time series analysis. Moreover, the proposed model for Oman's crude oil prices is suggested as a useful alternative for short-term forecasting.

Özer and İlkdoğan (2013), world cotton prices were analyzed with the ARIMA model using a 102-month data set covering the period of January 2004 and June 2012. ARIMA (1,1,1) (1,0,1) 12 seasonal model was determined as the most suitable model. According to this model, it is estimated that the world cotton price average will be 1.49 dollars in the 2012–2013 season, 1.57 dollars in the 2013–2014 season, and 1.55 dollars in the 2014–2015 season.

Okereke and Bernard (2014) developed a model to estimate Nigeria's GDP using the Box- Jenkins approach in their study. Autocorrelation function (ACF) and partial autocorrelation function (PACF) graphs of logarithmically transformed and differentiated series showed that the best model would be SARIMA (2, 1, 2) x (1, 0, 1). The ACF and PACF of the residuals from the constructed model behaved similarly to the white noise process, confirming the adequacy of the model. Then, using the model, Nigeria's one-year GDP is estimated.

Dritsak (2015) used econometric techniques to look into the trading habits of the Athens Stock Exchange (ASE). The serial correlation results indicate that the weak-form efficacy hypothesis of ASE should be rejected. In addition, Augmented Dickey-Fuller and Phillips-Perron tests confirm the existence of unit roots in the levels of stock prices. This shows that the future values of stock prices cannot be defined from past values, and the random walk hypothesis is compatible with the autoregressive integrated moving average (0, 1, 2) model. The findings of this study showed that the ASE may not be very efficient, and it may be difficult to predict future stock prices. Overall, this study highlights the importance of using econometric procedures to analyze the behavioral characteristics of stock market indices. The results suggest that the ASE may not be very efficient, and investors may need to consider alternative strategies to predict future stock prices.

Çelik (2017) theoretically examined the effects of the air transport industry in his study. In his study, the author also mentioned the economic dimension while explaining what purposes the air transport industry serves. In addition, the contributions of aviation have been analyzed by taking into account regional differences in the global market. As a result of the study, problems and solutions that may prevent the development of this industry, which is important for many sectors, have been proposed.

Nyoni (2019) Jenkins used the ARIMA technique to model and estimate the CPI in the UK. Diagnostic tests using annual time series data from 1960 to 2017 show that the K series is I(2). In his study, the author proposes the ARIMA (1,2) model to estimate the CPI in the UK. Diagnostic tests also show that the optimal model presented is stable and acceptable. The results of the study show that the CPI in the UK will continue its sharp upward trend over the next ten years.

Sharma and Phulli (2020) used the Box- Jenkins ARIMA model to estimate India's future military spending. The model is built on a dataset of 60 years of Indian military spending from 1960 to 2019. This research proposes an ARIMA (0, 1, 6) model for optimal estimation of India's military expenditure with an accuracy of 95.7%. The model functions as a moving average (MA) model and predicts 36.94% steady-state exponential growth in India's military spending through 2024.

4. Materials and Methods

Box- Jenkins as a method in the study (Box and Jenkins, 1976) was used. Box- Jenkins, which is frequently used in predicting the future in the field of finance and gives very successful outputs, takes its place in the literature as a univariate model. In studies where this method is used, it is important to make the assumptions of the Box-Jenkins method that the series consist of data obtained at equal time intervals and that they are discrete and stationary. The Box Jenkins method was developed based on the assumption that time-dependent random events and time series related to these events are scholastic processes. For this reason, Box- Jenkins models are called linear stationary stochastic models (Bircan and Karagöz, 2003). The Box- Jenkins technique is a method used to analyze and forecast time series. This method is based on discrete, linear stochastic processes and includes different estimation models such as autoregressive, moving average, autoregressive-moving average, and integrated autoregressive-moving average. AR (p), MA (q), and ARMA (p,q) models are used for stationary processes, while ARIMA (p,d,q) models are used for non-stationary processes. These models are used to predict changes and trends in time series and are frequently used in fields such as finance, economics, and meteorology. The Box- Jenkins technique is an effective method for analyzing and estimating data in time series. This method draws attention, especially to the ARIMA model, which is used to predict changes in non-stationary processes. In this way, it is possible to make accurate predictions using time series analysis, which has an important place in fields such as finance, economics, and meteorology (Hamzaçebi and Kutay, 2004).

In the study, the monthly prices of the stocks of Delta Airlines, which are among the largest airline companies in America and trade on the New York Stock Exchange (NYSE), covering the period between January 2010 and December 2021, are included. The data is taken from the https://www.investing.com/ website.

4.1. Linear Stationary Stochastic Models

4.1.1. Autoregressive Models (AR)(p)

The observed yt series with the p-th degree autoregressive process is equal to the total value of the disruptive term with the weighted average of the yt values going backwards for the p period. The equation with an autoregressive process is written as follows.

$$y_t = m + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \cdots \ldots \ldots \alpha_p y_{t-p} + u_t \quad (1)$$

In Equation 1, "m" is a constant and relates to the mean of the stochastic process. If the autoregressive process is stationaryμ, the mean remains constant regardless of time. The higher the p-value, the shorter or longer the equation will be. In a stationary series, when the coefficients of the above equation are enclosed in parentheses, $1- \alpha_1 - \alpha_2 - \ldots\ldots \alpha_p < 1$ (Kutlar, 2017).

4.1.2. Moving Average Patterns (MA)(q)

In the MA(q) model, the Yt value is the linear function of the backward error terms of the series and its mean over q periods. The MA(q) models are generally represented as follows:

$$Y_t = \mu + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \cdots - \theta_q a_{t-q} \quad (2)$$

Here $a_t, a_{t-1}, a_{t-2}, \ldots\ldots\ a_{t-q}$ error terms, θ1,θ2,…, θq coefficients for error terms, μ a constant that is the mean of the process (Hamzaçebi and Kutay, 2004).

4.1.3. Autoregressive and Moving Average Model (ARMA)

When series are not expressed by AR or MA models alone, they are expressed by a combination of autoregressive and moving average models. Models created in this way are expressed as ARMA in the literature (Kutlar, 2017). ARMA (p, q) models are written as follows:

$$Y_t = \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \cdots + \Phi_p Y_{t-p} + \delta + a_t + \theta_1 a_{t-1} - \theta_2 a_{t-2} - \cdots - \theta_q a_{t-q} \quad (3)$$

In the ARMA equation numbered (3), $Y_{t-1}, Y_{t-2}, \ldots\ldots Y_{t-p}$ the past observation values, $\Phi_1, \Phi_2, \ldots\ldots \Phi_p$ the coefficients of the past observation values, δ the constant value, $a_t, a_{t-1}, a_{t-2} \ldots\ldots, a_{t-q}$ refers to (Hamzaçebi and Kutay, 2004).

4.1.4. Autoregressive Integrated Moving Average Model (ARIMA)

ARIMA (p, d, and q) models are a type of ARMA (p, q) models and are used frequently. Unlike ARMA models, ARIMA models are made stationary by taking the d- order difference of non-stationary series. Since some macro variables are not stationary in nature, their difference is necessary, and such series have to be differentiated. Therefore, in ARIMA models, the ARMA estimation made for the first or d'th order difference instead of the main series is actually used as the ARIMA estimation (Kutlar, 2017).

ARIMA models are widely used in time series analysis. These models are used to predict future values and are particularly useful for economic, financial, and social data. ARIMA models can predict future values by considering series trends, seasonal effects, and other factors. ARIMA models are popular because of their high predictability. These models are used to understand the causes and effects of changes in time series. Similar to ARMA models, ARIMA models use statistical analysis methods and mathematical formulas to predict future trends using the history of the data.

The Box-Jenkins method is a four-step method for predicting time series. In the first stage, model determination, the appropriate Box- Jenkins model is determined. In the second stage, parameter estimation, parameters suitable for the determined model are estimated. In the third stage, the Test of Conformity, the suitability of the determined model to the data set is tested by statistical methods. If the model is found suitable, the last stage is passed; otherwise, it is returned to the first stage to determine another model. The most suitable model selected in the last stage, estimation, is used for forecasting (Kaynar and Taştan, 2009).

5. Result and Discussion

In the study, the monthly prices of the stocks of Delta Airlines, which are among the largest airline companies in America and trade on the New York Stock Exchange (NYSE), covering the period between January 2010 and December 2021, are included. These periods include 144 observations. In order to apply the Box- Jenkins method, the series must first be made stationary, if not already stationary. For this, the logarithm of Delta Airlines stocks was taken and the Augmented Dickey -Fuller test (ADF) applied.

Table 2. Stability Test Results

		Augmented Dickey -Fuller Unit Root Test Results					
logdelta		Intercept		Trend-Intercept		None	
		Level	l. Difference	Level	l. Difference	Level	l. Difference
ADF Test statistic	t -Static	-1.334	-11.588	-1.115	-11,591	0.681	-11,563
	prob.	0.613	0.000	0.922	0.000	0.862	0.000
MacKinnon Critical Values	1%	-3.477	-3.477	-4.024	-4.024	-2.581	-2.581
	5%	-2.882	-2.882	-3.442	-3.442	-1.943	-1.943
	10%	-2.578	-2.578	-3.145	-3.146	-1.615	-1.615
		Phillips-Perron Unit Root Test Results					
logdelta		**Intercept**		**Trend-Intercept**		**None**	
		Level	**l. Difference**	**Level**	**l. Difference**	**Level**	**l. Difference**
Phillips-Perron test statistics	t -static	-2.565	-11,642	-1.309	-11,643	0.591	-11,624
	prob.	0.587	0.000	0.882	0.000	0.843	0.000
MacKinnon Critical Values	1%	-3.477	-3.477	-4.024	-4.024	-2.582	-2.582
	5%	-2.882	-2.882	-3.442	-3.442	-1.943	-1.943
	10%	-2.578	-2.578	-3.145	-3.146	-1.615	-1.615

For determining the Box-Jenkins model suitable for the dataset, the stationarity of the series was determined by using the version Eviews 12 program. For the determination of the stationary state of the series, Dickey-Fuller and Phillips-Perron unit root tests were used. In the two tests, constant, constant, and trend were examined at level, and the first difference was for unconstant and trendless. The results are shown in Table 2. As seen in the table, According to Dickey-Fuller and Phillips-Perron unit root test results, it is seen that the series whose logarithms are taken become stationary at the first difference. At the next stage, an appropriate AR model was trying to be created. The statistical significance of the coefficients from AR (1 to 10) was investigated. As seen in Table 3, the coefficients of the AR (1) model are statistically significant, while the other AR coefficients are not. The AR (1) coefficient probe value was found to be smaller than the margin of error.

Table 3. (AR) Coefficients Statistical Results

Variable	Coefficient	Std. error	t-Statistics	prob
C	3.230733	0.452083	7.146328	0.0000
AR(1)	1.012148	0.093408	10,83583	0.0000
AR(2)	0.081026	0.138395	0.585468	0.5592
AR(3)	-0.030050	0.131089	-0.229231	0.8190
AR(4)	-0.080996	0.129549	-0.625214	0.5329
AR(5)	-0.058687	0.126034	-0.465642	0.6422
AR(6)	0.057485	0.133915	0.429264	0.6684
AR(7)	0.089810	0.123859	0.725096	0.4697
AR(8)	-0.176035	0.132744	-1.326119	0.1871
AR(9)	0.088625	0.155931	0.568356	0.5708
AR(10)	0.003249	0.111053	0.029253	0.9767
SIGMASQ	0.009905	0.001120	8.841836	0.0000
R-squared	0.977060	Mean dependent var		3.368417
Adjusted R-squared	0.975148	SD dependent var		0.659397
SE of regression	0.103950	Akaike info criterion		-1.582814
sum squared resid	1.426347	Schwarz criterion		-1.335329
log likelihood	125.9626	Hannan-Quinn criterion		-1.482250
F-statistic	511.1018	Durbin-Watson stat		1.994665
Probe(F-statistic)	0.000000			

Then, the AR(2) and AR(10) coefficients were removed because they were not significant and the calculation was performed again by leaving only the AR(1) coefficient. The calculated statistical values are shown in Table 4. For the AR(1) model, the Logdelta series is defined by its own historical values and the historical values of the errors. As seen in the table, the R^2 value is 0.9762, representing the explanatory power of the model. Logdelta explains about 98%

of the total with its autoregressive moving average time. Other criteria taken into account in explaining the power of the model are Akaike, Schwarz and Hannan-Quinn criteria. It is desirable that these criteria are close to 2.

Table 4. AR Model Results

Variable	Coefficient	Std. error	t-Statistics	prob
C	3.219040	0.451358	7.131893	0.0000
AR(1)	0.987668	0.013679	72,20237	0.0000
SIGMASQ	0.010270	0.000884	11.62225	0.0000
R-squared	0.976215	Mean dependent variable	3.368417	
Adjusted R-squared	0.975878	SD dependent variable	0.659397	
SE of regression	0.10413	Akaike info criterion	-1.673233	
sum squared resid	1.478876	Schwarz criterion	-1.611362	
log likelihood	123.4728	Hannan-Quinn criterion .	-1.648092	
F-statistic	2893,562	Durbin-Watson static	1.935585	
Probe (F-statistic)	0.000000			

After passing the significance criterion of the coefficients, it was investigated whether there was an autocorrelation problem among the regression error terms calculated for AR (1). The autocorrelation test results are shown in Table 5. According to the table, at all delays (probe values) H_0 The hypothesis of no autocorrelation was accepted (p>0.05).

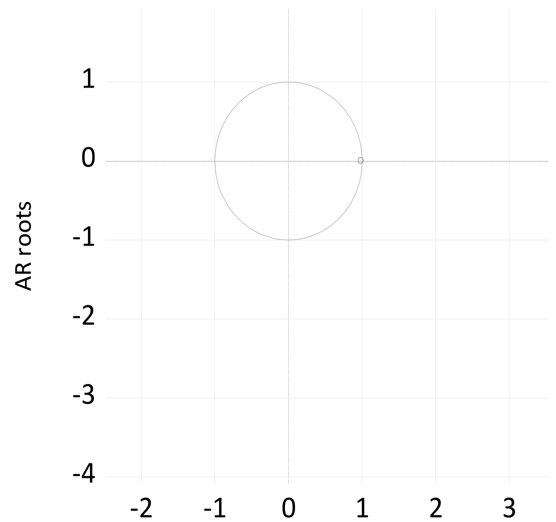

Figure 3. Inverse Roots of AR/MA Polynomial(s)

In the next step, it was checked whether the assumption of the method, that the unit roots are within the circle, was met. In Figure 3, it is tested whether the roots are within the unit circle. Since the condition of the root could not be fully diagnosed graphically, it was also analyzed tabularly. Table 6 shows that the modulus value is less than 1. In this case, it fulfills the assumption that the roots are inside the unit circle.

Table 5. Autocorrelation Test Results

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.018	0.018	0.0455	
		2	0.083	0.083	1.0616	0.303
		3	0.079	0.077	1.9973	0.368
		4	-0.004	-0.013	2.0001	0.572
		5	-0.052	-0.065	2.4060	0.662
		6	-0.023	-0.027	2.4840	0.779
		7	0.054	0.066	2.9244	0.818
		8	-0.116	-0.106	4.9989	0.660
		9	-0.027	-0.032	5.1111	0.746
		10	-0.041	-0.036	5.3770	0.800
		11	0.014	0.038	5.4093	0.862
		12	-0.011	0.004	5.4295	0.909
		13	0.056	0.048	5.9275	0.920
		14	0.120	0.107	8.2481	0.827
		15	0.081	0.083	9.3075	0.811
		16	0.069	0.035	10.078	0.815
		17	0.011	-0.023	10.097	0.862
		18	-0.056	-0.087	10.630	0.875
		19	-0.019	-0.009	10.689	0.907
		20	-0.000	0.017	10.689	0.934
		21	-0.062	-0.047	11.349	0.937
		22	0.017	0.034	11.397	0.954
		23	-0.024	-0.002	11.499	0.967
		24	0.008	0.037	11.511	0.977
		25	0.044	0.059	11.847	0.982
		26	-0.100	-0.128	13.632	0.968
		27	-0.043	-0.080	13.965	0.973
		28	-0.141	-0.164	17.550	0.917
		29	-0.056	-0.074	18.122	0.923
		30	0.037	0.065	18.380	0.936
		31	0.032	0.058	18.571	0.949
		32	-0.053	-0.035	19.097	0.953
		33	-0.064	-0.058	19.870	0.953
		34	-0.019	-0.028	19.942	0.964
		35	-0.026	0.009	20.073	0.972
		36	0.023	-0.001	20.175	0.979

Table 6. Root Test

AR Root(s)	modulus	Cycle
0.987668	0.987668	

AR (1) autocorrelation criterion phase after passing then MA model for calculations made. the appropriate AR coefficient. find of the process same in MA made. MA (1–10), all coefficients are tried, and the statistical aspect is significant (Table 7).

Table 7. (MA) Coefficients statistical Results

Variable	Coefficient	Std. error	t-Statistics	prob
C	3.354203	0.107375	31,23815	0.0000
MA(1)	1.124798	0.210174	5.351744	0.0000
MA(2)	1.188941	0.303041	3.923365	0.0001
MA(3)	1.220896	0.242030	5.044392	0.0000
MA(4)	1.176389	0.147092	7.997618	0.0000
MA(5)	1.173329	0.351344	3.339544	0.0011
MA(6)	1.287544	0.586742	2.194397	0.0300
MA(7)	1.340641	0.639562	2.096188	0.0380
MA(8)	1.054550	0.506463	2.082187	0.0393
MA(9)	0.738812	0.313844	2.354072	0.0200
MA(10)	0.301485	0.125648	2.399446	0.0178
SIGMASQ	0.012606	0.003805	3.313332	0.0012

Although all coefficients between MA (1–10) are significant, according to the Box-Jenkins assumption, there should be no autocorrelation problem among regression error terms. Then, for all models between MA (1) and MA (10), a test is applied to determine whether there is autocorrelation between regression error terms. The autocorrelation test results are shown in Table 8. According to the autocorrelation test results, the null hypothesis H_0: There is no autocorrelation in all lagged variables should be rejected. If the prob value is $p<0.05$ even with only one lag, the hypothesis cannot be rejected. As seen in the table, the P value is less than 0.05 in all lags. In this case, the hypothesis cannot be rejected. In other words, there is autocorrelation in the MA model system.

Until this stage of the study, AR and MA models have been investigated. Statistically significant results were obtained for the AR model. While statistically significant results were obtained for the coefficients of MA models, the autocorrelation test, which is one of the assumptions of the model, was not passed, and autocorrelation was detected in the system. As seen in Table 9, the ARMA model was investigated in the next stage of the study.

Table 8. Autocorrelation Test Results

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.058	0.058	0.4926	
		2	0.162	0.159	4.3578	
		3	0.219	0.208	11.539	
		4	0.214	0.188	18.408	
		5	0.191	0.140	23.933	
		6	0.133	0.048	26.610	
		7	0.190	0.088	32.164	
		8	0.204	0.110	38.603	
		9	0.212	0.126	45.583	
		10	0.286	0.210	58.373	
		11	0.278	0.214	70.630	0.000
		12	0.074	-0.055	71.511	0.000
		13	0.162	-0.043	75.713	0.000
		14	0.221	0.038	83.610	0.000
		15	0.161	0.023	87.854	0.000
		16	0.161	0.044	92.137	0.000
		17	0.124	-0.017	94.688	0.000
		18	0.099	-0.119	96.335	0.000
		19	0.155	-0.070	100.38	0.000
		20	0.132	-0.055	103.35	0.000
		21	0.073	-0.109	104.25	0.000
		22	0.148	0.024	108.00	0.000
		23	0.059	-0.042	108.60	0.000
		24	0.101	-0.068	110.39	0.000
		25	0.167	0.038	115.33	0.000
		26	0.041	-0.046	115.64	0.000
		27	0.116	0.037	118.07	0.000
		28	-0.032	-0.098	118.26	0.000
		29	0.034	-0.079	118.47	0.000
		30	0.091	-0.000	119.99	0.000
		31	0.034	0.026	120.20	0.000
		32	0.018	0.003	120.27	0.000
		33	-0.010	-0.071	120.29	0.000
		34	0.039	-0.018	120.58	0.000
		35	0.039	-0.015	120.87	0.000
		36	0.038	0.030	121.16	0.000

Table 9. ARMA Model Statistical Results

Variable	Coefficient	Std. error	t-Statistics	prob
C	3.325202	0.325742	10.20808	0.0000
AR(1)	1.261006	1.933252	0.652272	0.5155
AR(2)	0.001731	2.441511	0.000709	0.9994
AR(3)	-0.216219	0.993071	-0.217728	0.8280
AR(4)	-0.036788	1.201533	-0.030618	0.9756
AR(5)	0.196291	0.472625	0.415321	0.6786
AR(6)	-0.703700	0.470290	-1.496312	0.1372
AR(7)	0.500307	1.358818	0.368193	0.7134
AR(8)	0.518601	1.043355	0.497051	0.6200
AR(9)	-0.442250	1.502167	-0.294408	0.7689
AR(10)	-0.083253	1.255334	-0.066319	0.9472
MA(1)	-0.289378	35.23554	-0.008213	0.9935
MA(2)	-0.194852	23.41657	-0.008321	0.9934
MA(3)	-0.004044	37.93141	-0.000107	0.9999
MA(4)	0.068051	56,92074	0.001196	0.9990
MA(5)	-0.255161	16.13284	-0.015816	0.9874
MA(6)	0.575987	135.2412	0.004259	0.9966
MA(7)	0.026000	46,54341	0.000559	0.9996
MA(8)	-0.770750	161.2620	-0.004779	0.9962
MA(9)	-0.065412	13,08348	-0.005000	0.9960
MA(10)	-0.090430	25.44553	-0.003554	0.9972
SIGMASQ	0.008352	0.327177	0.025529	0.9797

The model that satisfies the Box-Jenkins assumptions should be found. The coefficients between AR (1–10) and MA (1–10) were added to the equation, and it was investigated whether they were statistically significant. As seen in the table, except for the coefficient C, the other values are not statistically significant. Since the coefficients are not significant, there is no need to proceed to the other stages of the assumptions. Since the assumptions were not met, the MA and ARMA models were not constructed. Only the AR (1) model was continued to be studied. After the model was determined, the estimation phase was started.

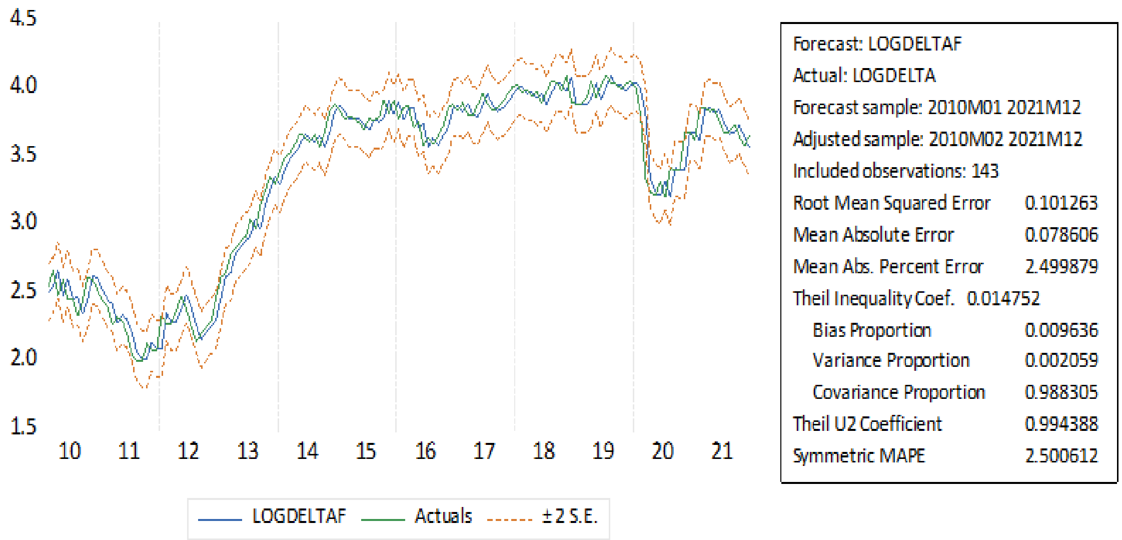

Figure 4. Forecast chart and Guess Result

Figure 4 shows the prediction performance of the AR (1) process. While the blue line graph shows the prediction graph of the model, the green line graph contains the actual sample values. It is seen that the actual values and the predicted values are close to each other. When the statistical results of the prediction results are analyzed, it is desirable that the Theil inequality coefficient value is small. Theil Inequality Coef. value in this study is 0.014752. This value is divided into three parts: bias proportion, variance proportion, and covariance proportion. Among these values, the bias proportion shows the systematic error of the model and is an important value. This value is intended to be quite small. In this study, the bias proportion value of the model was found to be 0.009636, which is a very small value. The variance proportion value indicates how much of the unpredictable part of the model is not captured. In other words, it indicates how much of the uncertainty is not captured. It is desirable that this value be small. The covariance proportion value gives information about the non-systematic error. It is also known as an innocent error. The sum of the theil inequality coefficient value is 1. It is important for the success of the forecasting model that the majority of this total value of 1 is collected in the covariance proportion value. The root mean squared error, mean absolute error, and mean abs.percent error values, which express the output performance of the forecasting model, were analyzed. In the study, the root mean squared error was 0.0101, the mean absolute error was 0.0786, and the mean absolute percent error was 2.4998. The small values of these values indicate that the prediction outputs are close to the actual values.

6. Conclusion

The airline sector has accelerated the convergence of countries, leading to an increase in the volume of trade between countries. The increase in imports and exports will result in the growth of global gross domestic product. Countries that attach importance to the aviation industry are the countries that seize the competitive edge in the world. A measure of the economic and political power of countries is the number of aircraft in their inventory. Due to this importance, the shares of the aviation industry are valued higher on the world stock markets. In this study, the monthly prices of the stocks of Delta Airlines, one of the largest airline companies in the United States, traded on the New York Stock Exchange (NYSE) for the period between January 2010 and December 2021 are estimated by the Box-Jenkins method. Financial forecasting models have an important place in the literature. By creating a strong forecasting model, decision makers can be more stable in their investment decisions. The portfolio formed by selecting appropriate financial instruments will earn more. Investors' gains will ensure the economic development of their countries. In this study, a model has been developed to predict the price of stocks. The model output gave statistically successful results. Investors will be able to be more courageous in their near-term investment decisions with financial forecasting models.

In the literature, there is no study on forecasting the stocks price of existing airline companies in the aviation sector with the Box-Jenkins method. However, there are studies on stock price forecasting with the Box-Jenkins method. Dritsak (2015) applied the Box-Jenkins method for stock price forecasting. His study fits the ARIMA (0, 1, 2) model. However, the Theil inequality coefficient could not predict ASE stocks correctly in this model. In this study, the AR (1) model met the assumptions, and the model was constructed. Dritsak (2015) stated that the Theil inequality coefficient is not suitable for accurate prediction in the model he created. When the statistical results of the estimation results are examined, it is desirable that the Theil Inequality Coef. value be small. In this study, the Theil Inequality Coef. value is 0.014752, which means that it is suitable for accurate estimation. In future studies, the forecast performance comparison can be made by adding different methods together with the Box-Jenkins method for stock price estimation of airline companies

Ethical approval

Not applicable.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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