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Original Research Article

Box-Jenkins Methodology of Analysis and Forecast Prices of Peach with Prices in Turkey

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ABSTRACT

Due to global climate changes, the increasing population and some disruptions in production, the prices of products in domestic and foreign markets may vary over the years. Since the production of agricultural products is directly dependent on natural conditions, it is highly affected by these price fluctuations. In order to survive as a producer and to adapt to changing conditions, market conditions must be constantly monitored, always prepared and future situation analyzes must be made. Various methods and models have been developed to make such future time estimation analysis. One of the most widely used methods is the Box-Jenkins method. In the study; With the help of time series analysis modeling, it is aimed to analyze the export price changes of peach product by years and to predict the future price by modeling with the Box-Jenkins method, which is the most widely used modeling method. Research from the scope of the years 1967-2020 constitute rates peaches Turkey exports. ARIMA (3,1,3) model, one of the Box-Jenkins models, was used in the application. According to the results obtained; When the export prices expected to be made in 2021 after 2020 in our country are compared among themselves; Compared to 2020, export revenues expected to be achieved in 2021 are expected to increase by approximately %10. A steady increase movement is predicted for the next decade. At the end of the next decade, it is estimated that prices will increase by approximately %64 in 2030 compared to 2020.

Keywords: Peach, Price Analysis, Box-Jenkins, Future Forecast

INTRODUCTION

Despite the increase in agricultural production throughout the world, it is still not in a position to meet the current demand. The increasing population shows that this situation will continue to increase in the future. From another point of view, the fact that almost all of the arable lands have been reached in countries that can meet the demand and the reduction of the roads that can increase production further makes this production and demand meeting more important. (Tuna 2011, Gülersoy 2014). Agricultural production has a discontinuous structure as it depends on the seasons and nature. Due to the main reasons such as the risks in agricultural production, the lack of a production plan, and the inadequacy of the marketing organization, the producers; they decide by looking at the prices of the previous year when choosing the production they will make. (Mayozer and Roudart 2010, Şahin 2016, Eraktan and Açıl 2000). It causes price fluctuations for the product and affects the production amount of the product. In the long run, it causes price fluctuations and affects the market. Therefore, these decisions of the producers are effective in the formation of the prices of the product at that time. (Özçelik and Özer 2006; Bayramoğlu et al.2008).

Time series analysis is a series that provides stochastic modeling that gives the structure of the observed series about an event observed in a certain time period and that is used to make future predictions with the help of observed data from past periods. Time series analysis can be used in economics, business, statistics, finance, geophysics, meteorology, agriculture, etc. used in fields such as. The fact that a variable is in the position of independent variable in some cases and dependent variable in some cases may create a problem in determining the series internally or externally. Time series techniques allow the variable to be in both positions.
Thus, relationships are better defined and future predictions can be made in a healthier way. (Kaynar ve Taştan 2009; Bozkurt 2013).

In the first part of this study, information is given about peach production in the world and in Turkey. Then, by giving information about time series analysis, export price changes of peach product according to years were analyzed with Box-Jenkins method.

World Production

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Almost all of the commercial production in the world is made between 30-40 degrees of latitude in the north and south of the equator. Low temperatures in the middle of winter and spring frosts in temperate climate areas limit peach production. Since the production of some cultivars in subtropical areas is adversely affected by insufficient chilling, varieties with low chilling demand are used in such regions. Peach is a type of fruit that can easily adapt to different ecologies. Low winter temperatures, cooling demand of the variety, late spring frosts are the factors limiting the production economically. In places where the winter temperature drops to -18 to -20°C, the eyes and young shoots are damaged by the low temperature. If the temperature drops to -25 °C, the main branches and trunk may be damaged. (Doğanay 2000).
Our country is among the top ten in the world in peach production. (Table 1).

Table 1. Countries that produce the most peaches in the world (2019).

Countries	Production (Tonnes)	Production per Person (Kg)	Area (Hectares)	Yield (Kg/Hectares)
Chinese	15.841.928	11,33	840.919	18,83
Spain	1.545.610	32,79	77.700	19,89
Italy	1.224.940	20,31	60.430	20,27
Greece	926.620	86,46	41.410	22,37
Turkey	830.577	9,95	46.294	17,94
USA	739.900	2,25	36.380	20,33
Iranian	591.412	7,13	32.155	18,39
Egypt	358.012	3,56	15.748	22,73
Chile	330.232	17,42	15.651	21,09

Source: FAO, 2021

Turkey Production

Peach can be produced in different countries, in different geographies, in different continents. This shows that the peach can adapt to most climates. Our country ranks fifth among the countries that produce the most peaches in the world. (FAO, 2021). Thanks to its favorable climatic conditions and fertile lands, our country also has suitable areas for peach production.

While the total number of trees has increased by 41.14% in the last eighteen years, it has shown a significant increase in total production with an increase of 62.85% (Table 2).

Table 2. Peach production area and amount by years in Turkey.

Years	Production(tonnes)	Area(ha)
2005	510.000	40.300
2006	552.775	39.526
2007	539.435	41.755
2008	551.906	41.446
2009	547.219	41.534
2010	539.403	43.099
2011	545.902	41.881
2012	611.165	44.379
2013	637.543	43.831
2014	608.513	44.070
2015	642.727	44.504
2016	674.136	45.237
2017	771.459	46.299
2018	789.457	46.361
2019	830.577	46.294

Source: TUIK, 2021

The economic importance of peach farming is increasing day by day. It is of great importance for it to adapt easily to climatic changes, not to require much effort, to provide raw materials to the food industry, and to meet the new needs and demands brought by the increasing population. Like many vegetables and fruits, peach is

very important in this regard. In order to increase economic gain and ensure continuity, it is necessary to reduce losses in cultivated areas, to increase efficiency and to produce in this direction.

Foreign Trade Situation in Turkey

Turkey's peach export data for the last twenty years are shown in Table 3 below.

Table 3. Peach export in Turkey.

Years	Tonnes	Years	Tonnes
2000	14584	**2010**	41392
2001	23681	**2011**	32857
2002	27579	**2012**	43540
2003	44227	**2013**	34147
2004	20153	**2014**	39389
2005	39301	**2015**	50490
2006	39123	**2016**	50638
2007	18995	**2017**	88789
2008	42930	**2018**	126732
2009	32317	**2019**	105312

Source: FAO, 2021

When Table 3 is examined, it is seen that there has been a regular increase in Turkey's peach export figures over the years.

In the last two decades, Turkey has increased its export figures approximately seven times compared to twenty years ago. Turkey has increased its agricultural capacity, land availability and number of farmers in the last two decades (TUIK, 2021). Some factors such as increased irrigation opportunities, widespread use of mechanization and technology, increased marketing opportunities and new agricultural production techniques can be counted among the reasons for this increase.

MATERIALS and METHODS

Material

In the research, analysis was made using pre-compiled statistical data sets. The secondary data used were obtained from the database of the United Nations Agriculture and Food Organization (FAO), the Turkish Statistical Institute (TUIK), the World Bank and the Ministry of Agriculture and Forestry. The research covers the period 1967-2020. In addition, previous domestic and foreign studies and statistics related to the research subject were also used.

In this study, it is aimed to examine the main components affecting the series primarily by analyzing the time series properties. After examining the data components, suitable ARIMA models were found by following the Box-Jenkins steps. These models were used to evaluate the data in order to predict the future. With the ARIMA models, which were determined to be appropriate, the modeling of peach export prices between the years 1967-2020, which is the observation data obtained from the FAO, was made within the sample. The estimated values produced by the models were compared with the actual peach prices in the 1967-2020 period, and it was determined which model could make better predictions with the actual values. The predictive accuracy of the models was evaluated using KOHK, OHK, OMH statistics. As a result of the evaluation, ten-year peach export prices were estimated on an annual basis for the 2020-2030 period using the model that provides the highest estimation accuracy.

Method

Time Series Analysis

All of the numerical data obtained from the successive values of the observation data to be dealt with at certain intervals (such as day, week, month, year) is called "time series". If the considered time series is represented by Yt; The observation value is shown as Y1, Y2, Y3, ..., YT with t = 1, 2, … T. In this expression, t indicates the

time interval of the observed series, and Yt indicates the observed value of the variable in the t time interval (Akgül 2003).

The analysis of the obtained time series values for the purposes of separating, controlling, explaining the connection between them, and making predictions is called “time series analysis” (Box et al., 1994).

In other words; A time series is a sequence of values observed over time intervals.

As examples of these definitions; the weekly amount of product exported from a factory, the number of weekly accidents on a highway, the hourly water level in a lake, the monthly inflation rate in a country, the annual import and export amounts of a country, annual investment and gross national product revenues, annual unemployment rate, data series such as monthly precipitation in a city can be given. These examples are; It can be reproduced with many applications obtained by using economics, business, engineering and basic sciences (Chattfield, 1995, Akdi 2010, Akgül 2003).

Box-Jenkins Method

In the 1970s, different approaches were advocated for short-term forecasting and time series models, and there were discussions in the literature. These discussions were seen in predictions made with economic data, demo figure data and social data. Box and Jenkins also explained and defended the ARIMA model in their publications in 1970 (Mcneil, 1982).

The Box-Jenkins method is one of the methods used in the forward estimation of univariate time series. This approach, proposed by Box and Jenkins, shows a systematic approach in establishing and estimating forward forecast models with discrete time series consisting of observation values obtained at equal time intervals (Mabert 1974 Bircan and Karagöz 2003).

RESEARCH FINDINGS

Data Preparation

In order to model a time series with the Box-Jenkins method, first of all, stationarity and seasonality tests of that series should be done. If the autocorrelations of the series do not decrease rapidly and decrease with a linear movement, that is, if the series is not stationary, the degree of homogeneity d is determined by taking the difference until the series becomes stationary (Tekelioğlu and Demirer 2008).

The data to be used in this study were obtained from the FAO database. Data from 1967 to 2020 were analyzed (Table 4). Monthly and seasonally adjusted data are annual. These annual data are total peach export prices and are in thousand dollars. It is the total value obtained as a result of the direct export of the crop from the field.

The prices to be predicted will also be evaluated according to this criterion, and as a result, a forecast will be made about the ten-year export value on an annual basis. The data were analyzed in Minitab 19 and Eviews 11 package program and the figures below were obtained during the analysis of the data in this package program.

Table 4. Peach export values by years.

Years	Value (x1000$)	Years	Value (x1000$)	Years	Value (x1000$)	Years	Value (x1000$)	Years	Value (x1000$)
1967	163	**1979**	398	**1991**	2247	**2003**	24234	**2015**	38924
1968	40	**1980**	1142	**1992**	2723	**2004**	11838	**2016**	25700
1969	0	**1981**	2968	**1993**	4728	**2005**	20600	**2017**	69771
1970	58	**1982**	2372	**1994**	5436	**2006**	17960	**2018**	87105
1971	1	**1983**	2994	**1995**	4577	**2007**	11674	**2019**	89774
1972	66	**1984**	2348	**1996**	3703	**2008**	36711	**2020**	154202
1973	3	**1985**	2141	**1997**	5090	**2009**	23925		
1974	1	**1986**	1730	**1998**	0	**2010**	28852		
1975	3	**1987**	2727	**1999**	0	**2011**	21668		
1976	5	**1988**	1713	**2000**	3852	**2012**	28053		

1977	21	**1989**	1864	**2001**	6620	**2013**	27796
1978	124	**1990**	2534	**2002**	8076	**2014**	34937

Source: FAO, 2021

The graph of the data to be analyzed is shown in Figure 1. Accordingly, there are fluctuations, periodic decreases and increases in the figure over the years.

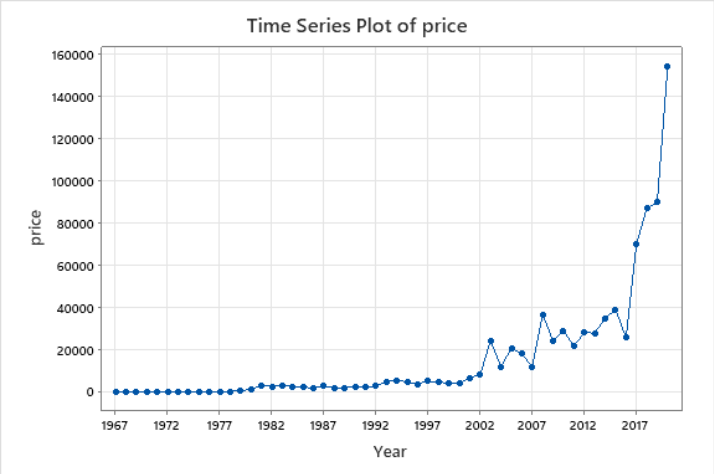

Figure 1. Change of export values by years (Source: FAO, 2021).

Stabilizing Data

The basis of time series analysis applications is that the data used is stationary. The concept of stationarity means that the process does not carry any trend, and there is no change in its mean and variance over time. In this type of series, suitable one of ARMA (p, q), and AR(p) and MA (q), which is the special case of this model, can be used. However, in practice and in reality, there may be time-dependent changes in the mean and variance of time series. In this case, the series should be made stationary and analyzed in that way.

The stationarization of the time series is done by taking the first and second differences of the series. In this case, the model is expressed as ARIMA (p,d,q) (Hamzaçebi and Kutay,2004; Topçuoğlu et al. 2005; Özdemir and Bahadır, 2010).

When the graph of the price data for the years 1967-2020 is taken, it is seen that the graph is fluctuating. This means that the series are not stationary. In order to make the data stationary, ACF and PACF tests were performed by taking their differences.

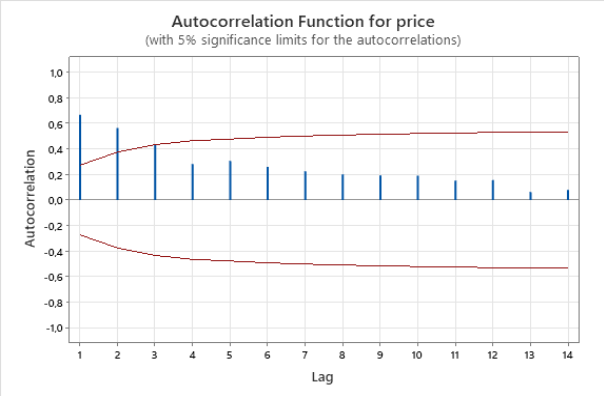

Figure 2. The autocorrelation graph of the series.

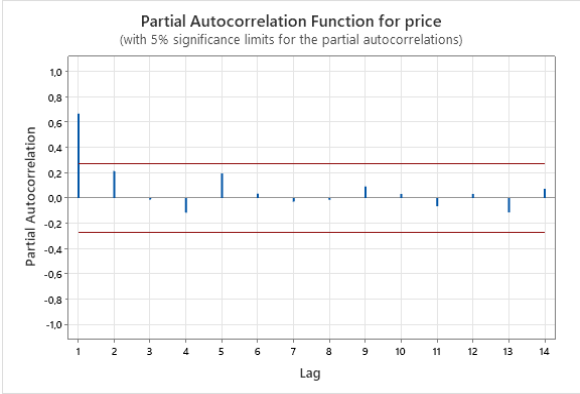

Figure 3. Partial autocorrelation plot of the series.

As can be seen in the autocollaboration and partial autocorrelation test graphs in Figure 2 and Figure 3, the data we have is not stationary. In this way, time series analysis will not be possible and accurate results will not be obtained.

It is necessary to ensure the stationarity, which is also the basis of the Box-Jenkins method. In order to achieve this, the difference of the series was taken once and it was seen that the series became stationary.

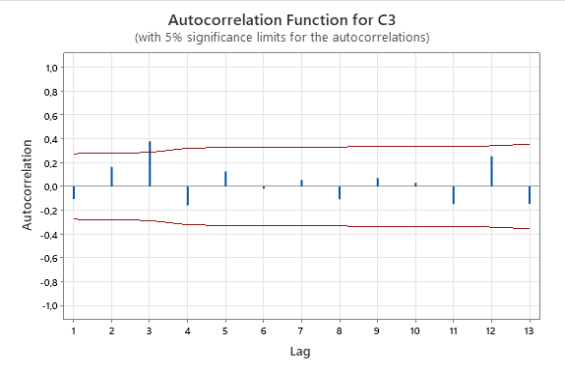

Figure 4. ACF plot of the first differenced series.

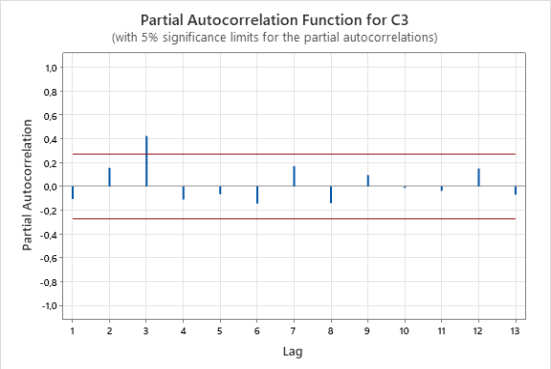

Figure 5. PACF plot of the first differenced series.

In order to eliminate the non-stationary shape of the series seen in Figure 3, Figure 5 ACF and Figure 6 PACFs with first difference of the series were created. As seen in Figure 4 and Figure 5, the observations in the ACF and PACF graphs of the series have similar significance. The stagnation of the series can be seen from the fact that it does not follow a regular trend. Modeling is now possible.

Here, the ACF test shows whether the AR model should be installed in the series, and the PACF test shows whether the MA model should be installed in the series. As can be seen from the figures seen here, the ACF and PACF test indicate that both should be applied and used together in this series. Therefore, the ARIMA Model with both models was applied to the series.

Determining the Model

In order to determine the appropriate model, the results of the significance test of the coefficients of the applied ARIMA model were examined. These results indicate which model will be applied. Various models were tried and it was decided that the most suitable model was ARIMA (3,1,3). The model is significant since the P values of AR and MA are less than 0.05. This model was chosen because it gave the most appropriate and comprehensive values among other suitable models. When the Dickey-Fuller test of the selected model is performed, it is seen that the problem, namely the p value, is less than 0.05.

RESULTS

Forecast data for the next 10 years are shown in Table 5.

Table 5. Forecast data for the next ten years.

Years	Value (x1000$)
2021	168989
2022	175713
2023	216199
2024	222242
2025	224989
2026	241533
2027	244002
2028	245125

2029	251885
2030	252894

According to the forecast results, Turkey's peach exports will increase steadily in the next ten years (Table 5).

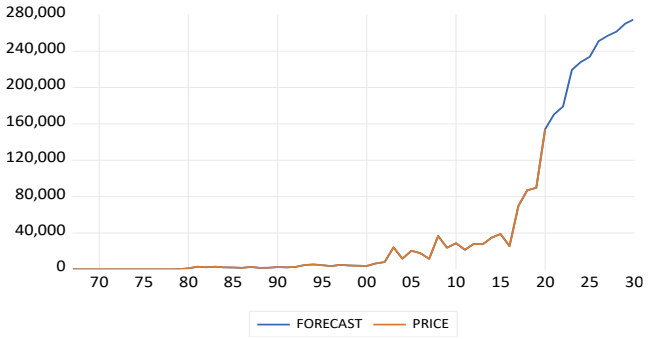

Figure 5. Combination of predictive data and observed data.

As can be seen in Figure 5, the values of the next ten years are increasing compared to the previous years. At the end of the next decade, it is predicted that the value of peach exports to be made in Turkey will increase by approximately 64% compared to today. From 2020 to 2021, the first increase is predicted to be approximately 10%.

CONCLUSIONS

Peach product has an important place for Turkey and the world. It is observed that the need for production is increasing day by day as a result of increasing population and increasing demands. In order to respond to this need, the right production activities should be increased and the efficiency obtained from the production areas should be at the highest level.

Export activities are one of the most important income tools for the development of a country. Income from export activities is primarily used for the development of the country. Every foreign currency that the country will obtain is both very useful and very important for the country's economy. Therefore, it is important to ensure continuity in exports and to increase export items. While the subject is so important for the state, it has the same importance for the producer of the country. When considered on this basis, it is also beneficial for the producer to export a product with added value. Because the producer knows that the income to be obtained from the sales to the domestic market will be less than the income to be obtained from the export. For this reason, he will want to choose the product he will choose in order to produce it from products that are easy to export and have a high return. Since countries will also benefit in general, they will encourage and support their producers in this regard. Seeing the future of a product to be produced, being able to make predictions about its prices and production values, and being able to calculate them will provide an advantage to everyone who is aware of global competition in today's world. Foresight of the future; According to the findings obtained as a result of the foresight, it provides the person with an idea about the subject and results of the planned production activity before starting the work, and provides the opportunity to make results and evaluations at the decision-making stage. From this point of view, various methods have been developed over time in order to predict the future. One of the most widely used of these methods is the Box-Jenkins method.

In this study, Turkey's peach export values announced by FAO in the 54-year period between 1967-2020 are discussed.

These data were processed in Minitab 19 and Eviews 11 package programs, and as a result of the evaluations and tests, it was found appropriate to use the ARIMA (3,1,3) model, one of the Box-Jenkins models. With the results obtained, estimations were made about the export prices of the next 10 years. These estimates

were tested at 95% confidence intervals and the model with the closest accuracy to the truth was used. Data from FAO is in thousand dollars ($) and forecast data is given as such.

As a result; Turkey's annual peach export value is expected to increase by approximately 64% in ten years compared to 2020. From 2020 to 2021, the first increase is predicted to be approximately 10%. It is estimated that this increase will continue on a regular basis over the years. It is seen that the export and economic return potential of peach fruit is high. All this information shows that producers can produce more peaches, export more from this production, provided that they are of good quality, and thus earn more income. In order to understand this, it will be enough to look at the figures of the last five years. Looking at only the last five years; The number of trees increased by 8.42%, the production amount increased by 32.32% and the export value increased 6 times. The potential of peach is high and necessary attention should be paid from production to harvest, from harvest to sale. The state also has some responsibilities in this regard. For example, along with activities to ensure agricultural sustainability, producers should increase their support as in other fruits and vegetables, assist the producer in terms of export, provide facilities and take necessary activities to create more production areas. To this end, policies should be developed and implemented. In the coming period, the issue of water problem and the importance of the yield to be obtained from agricultural areas will become more serious. Necessary measures should be taken already and policies should be produced in a protective scope. Peach fruit also has a bright future in terms of exports and a very high potential in terms of income. With the right production model and marketing, these predicted figures can be achieved.

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