Forecasting the Amount of Beef Production in Turkey

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Abstract

The amount of beef production of Turkey could not reach desired level in spite of the supports. As a result, the demand of beef meat has not been sufficiently fulfilled, consumer price has continuously increased and the amount of import has also risen so as to control the demand-supply and price balance in the market. Therefore, forecasting the amount of beef production is indispensable to evaluate the structural problems of the livestock sector. The objective of this study was to forecast the amount of beef production of Turkey from the period of 2019 to 2028. The data of this study was obtained from the databases of Food and Agriculture Organization and Turkish Statistical Institute. The time series of the amount of beef production for the period 1961-2018 was used for forecasting via Box-Jenkins Model and ARIMA (2, 2, 2) was determined as the most appropriate model. The results of the study revealed that the amount of beef production would regularly rise in the next ten-year period and would be 1019754 tons in 2019 and 1163534 tons in 2028. This research concluded that the government should provide necessary supports to lessen the production costs and enhance productivity in order to produce forecasted amounts without high level of imports.

Keywords: Beef production, Time Series Analysis, ARIMA, Box-Jenkins method, Turkey.

Türkiye'de Sığır Eti Üretim Miktarının Tahmini

Öz

Türkiye'de hayvancılık sektörüne sağlanan desteklere rağmen sığır eti üretim miktarı istenen seviyede değildir. Bu nedenle, sığır eti talebi yeterli düzeyde karşılanamadığı için fiyatlar sürekli artmakta ve piyasada arz-talep ve fiyat dengesini kontrol edebilmek için ithalata başvurulmaktadır. Bu anlamda, Türkiye'de sığır eti üretim miktarının zaman serileri ile tahmin edilmesi hayvancılık sektöründeki yapısal sorunların değerlendirilmesi açısından gerekli ve önemlidir. Bu araştırmanın amacı, Türkiye'nin 2019-2028 dönemine ilişkin sığır eti üretim miktarının tahmin edilmesidir. Araştırmanın materyali Tarım ve Gıda Örgütü ile Türkiye İstatistik Kurumu veri tabanından temin edilmiştir. Araştırmada Türkiye'de 1961-2018 döneminde üretilen sığır eti miktarına ilişkin veri setinden faydalanılmış olup, Box-Jenkins yöntemi ile tahmin yapılmıştır. Araştırma sonuçlarına göre ARIMA (2, 2, 2) modelinin veri setine en uygun model olduğu belirlenmiş olup, sığır eti üretiminin gelecek on yıl içinde artacağı, 2019 yılında 1019754 ton ve 2028 yılında 1163534 tona ulaşacağı varsayılmaktadır. Araştırma ile üretim maliyetlerinin azaltılması ve verimliliğin arttırılması için hükümetin besi sığırcılığı sektörünü desteklemesi ve bu sayede ithalata önemli miktarda gereksinim duyulmaksızın tahmin edilen üretim miktarlarına ulaşılabileceği sonucuna ulaşılmıştır.

Anahtar kelimeler: Sığır Eti, Zaman Serisi Analizi, ARIMA, Box-Jenkins Yöntemi, Türkiye
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1. Introduction

The share of livestock sector in total agricultural production value of 2016 was 34.5% in Turkey (FAO, 2019a). Therefore, the sector is of great importance for economy and it has been considerably supported since 2000. While the share of livestock supports in the budget of agricultural supports was 0.5% in 2000, it has been increased 29.82% up to 2017 (MFAL, 2015; MD, 2018). During the same period, Turkish Statistical Institute (TurkStat) declared that the red meat production increased by almost 2.3 times whereas beef production increased by 2.8 times. Therefore, the share of beef production in the total red meat production had increased from 72% to 88% during this period (TurkStat, 2019a). On the other hand, real producer price of beef has decreased by 13% in the mentioned period in spite of perpetual increase of consumer prices (TurkStat, 2019b). However, in this period, the cost of production has considerably increased. The main inputs of the sector were concentrate feed and breeding material and they constituted the major part of the costs (Gözener and Sayılı, 2015; Alhas Eroğlu, 2017; Çelik and Sarıözkan, 2017). The amount of beef production has sharply decreased from 2007 to 2009 and the government has intervened in the market by means of import since 2010. Though the amount of import cattle was solely 4010 heads in 2009, it increased 895801 in 2017 and 1460705 heads in 2018 (TurkStat, 2019c). The amount of beef production and import sharply increased over the period 2010 to 2018. Besides, the government has supported the beef producers via breeding male cattle support since 2011. This support has been granted to producers whose male cattle has been slaughtered and recorded to official recording system. In the year 2011, 205607 heads cattle were supported while it has increased 1206391 heads cattle in 2014. The number of supported cattle and unit price of support decreased in the years 2015 and 2016 and the government ceased this support in 2017 (Anonymous, 2016). To sum up, the amount of production is exactly related with mentioned structural problems and it should be forecasted as much accurate as possible in order to regulate the market via accurate and efficient policies.

There are few studies on forecasting livestock sector and beef. Cenan and Gürcan (2011) forecasted number of farm animals whereas Çelik (2012) and Akgül and Yıldız (2016) forecasted the amount of production and Özen et al. (2019) forecasted meat consumption. Yavuz et al. (2013) forecasted yield and price of meat sector to drive policy implications.

The meat sector is controversial because of different dynamics and policy implications have not been adequate because of structural problems in Turkey. As the beef is the main part of meat production, the forecasting of the sector is indispensable to assess the impacts of the policies in the market. Therefore, the objective of this study was to forecast the amount of beef production in Turkey for the period of 2019-2028.

The remainder of the paper is structured in four sections: In the second section the material and method of the research and in the third section model results and discussion are presented. In the fourth section, conclusion and recommendations are introduced.

2. Material and methods

In this study, the time series data of the beef production in Turkey was examined for the period 1961-2018 and it was obtained from the databases of Food and Agriculture Organization (FAO) and TurkStat (Table 1). Time series are a set of observations that are ordered sequentially through time (Chatfield, 2003). Time series are essential data to forecast and there are some methods used for this practice. Box Jenkins approach is one of the powerful methods that has been used to analyse any set of observations (Box et al., 1970). The method is called Auto-Regressive Integrated Moving Average Model (ARIMA).

Table 1. The amount of beef production in Turkey during the period 1961-2018 (tons)

Year	Production	Year	Production	Year	Production	Year	Production
1961	94767	1976	114706	1991	339478	2006	340705
1962	101432	1977	127045	1992	300605	2007	431963
1963	94722	1978	103596	1993	295995	2008	370619
1964	90634	1979	147634	1994	316654	2009	325286
1965	95203	1980	130380	1995	292447	2010	618584
1966	106336	1981	142540	1996	301828	2011	644906
1967	97880	1982	159524	1997	379541	2012	799344
1968	104335	1983	160564	1998	359273	2013	869292
1969	118383	1984	384797	1999	349681	2014	881999
1970	114493	1985	318164	2000	354636	2015	1014926
1971	103779	1986	449832	2001	331589	2016	1059195
1972	91490	1987	326020	2002	327629	2017	987482
1973	98038	1988	315403	2003	290455	2018	1 003
1974	124778	1989	367895	2004	364999		
1975	132865	1990	360704	2005	321681		

Source: TurkStat (2019a), FAO (2019b)

ARIMA models are denoted with three parameters (p, d, q). The first parameter, p, is the number of autoregressive term and indicate the dependent relationship between the observations and some number of lagged observations. The second term, d, is the difference of raw observations and has been used in order to make the time series stationary. The last term, q, is the number of moving average term and it is the dependency between an observation and residual errors.

ARIMA model can be denoted as follows:

$$Z_t=\delta+a_t-\theta_{1at-1}--\theta_{2at-2}-\ldots--\theta_{qat-q} \quad (1)$$

Here, a_t; a_{t-1}; a_{t-2}; … ; a_{t-q} are random shocks that are assumed to have been randomly selected from a normal distribution that has mean zero and constant variance. Furthermore, the random shocks are assumed to be statistically independent. θ_1; θ_2; θ_3; … ; θ_q are unknown parameters that must be estimated from sampledata. δ is a constant term and it can be proved that for the moving average model of order q, $\delta=\mu$.

The autoregressive order of p for the model is presented in equation (2):

$$Z_t=\delta+Ø_1Z_{t-1}+ Ø_2Z_{t-2}+\ldots+ Ø_pZ_{t-p}+a_t \quad (2)$$

In the equation, $Ø_1$, $Ø_2$, $Ø_3$, …, $Ø_p$ are unknown parameters and can be estimated from the sample data. On the other hand, a_t are random shocks. Lastly, δ is the constant term and can be proved that for the autoregressive model of order p, $\delta=\mu(1- Ø_1- Ø_2-\ldots- Ø_p)$.

ARIMA (p,q) is mixed type of these two models and can be presented in equation 3:

$$Z_t=\delta+Ø_1Z_{t-1}+ Ø_2Z_{t-2}+\ldots+ Ø_pZ_{t-p}+a_t-\theta_1a_{t-1}--\theta_2a_{t-2}-\ldots--\theta_qa_{t-q} \quad (3)$$

Here a_t, a_{t-1}, a_{t-2}, …, a_{t-q} are random shocks that are assumed to have been randomly selected from a normal distribution that has mean zero and constant variance; θ_1, θ_2, θ_3, …, θ_q and $Ø_1$, $Ø_2$, $Ø_3$, …, $Ø_p$ are unknown parameters of a moving average model and autoregressive model that must be estimated from sample data. Constant term $\delta=\mu(1- Ø_1- Ø_2-\ldots- Ø_p)$ (Bowerman et al., 2005; Zaharim et al., 2009).

In this study, a 58-year period data was applied to forecast the amount of beef production in Turkey via ARIMA model. EView8 and RStudio were used in order to analyse the data and forecast the amount of beef production in Turkey for the period 2019-2028.

3. Results and discussion

Figure 1 reported two significant points about beef production of Turkey in the period 1961-2018. First of all, the amount of beef production has not considerably changed until 1984. However, there was an essential break in that year and the amount of beef production has increased almost 2.5 times in comparison with the former period. Secondly, since 1984, beef production has not significantly changed until 2010 in spite of fluctuations in time.

However, it has substantially shown increasing trend after this year. Therefore, Autocorrelation (ACF) and partial autocorrelation (PACF) graphs should be taken into consideration in order to assess the structure of the beef production.

Figure 2 reported ACF and PACF graphs of beef production in Turkey for the period 1961-2018 and indicated that time series of the amount of beef production is non-stationary at level. Therefore, Augmented Dickey-Fuller (ADF) test was applied in order to decide whether the series have unit root or not.

ADF test results reported that we cannot reject the null hypothesis of unit root in the time series of beef production and it is non-stationary (Table 2). However, it is stationary in second difference and the null of a unit root in the differenced of the series could be rejected.

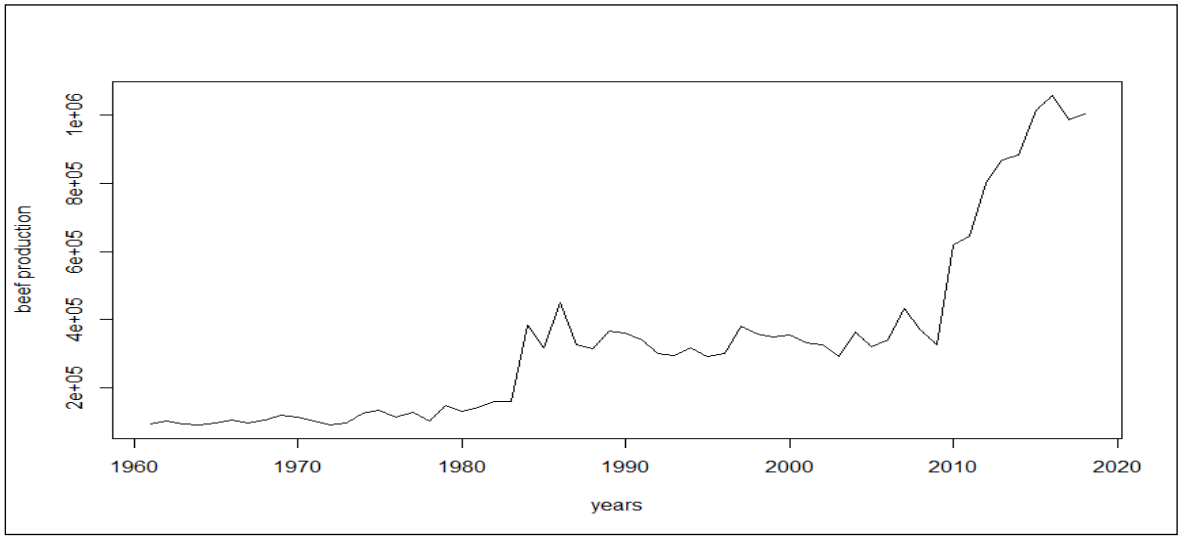

Figure 1. The amount of beef production of Turkey for 1961-2018

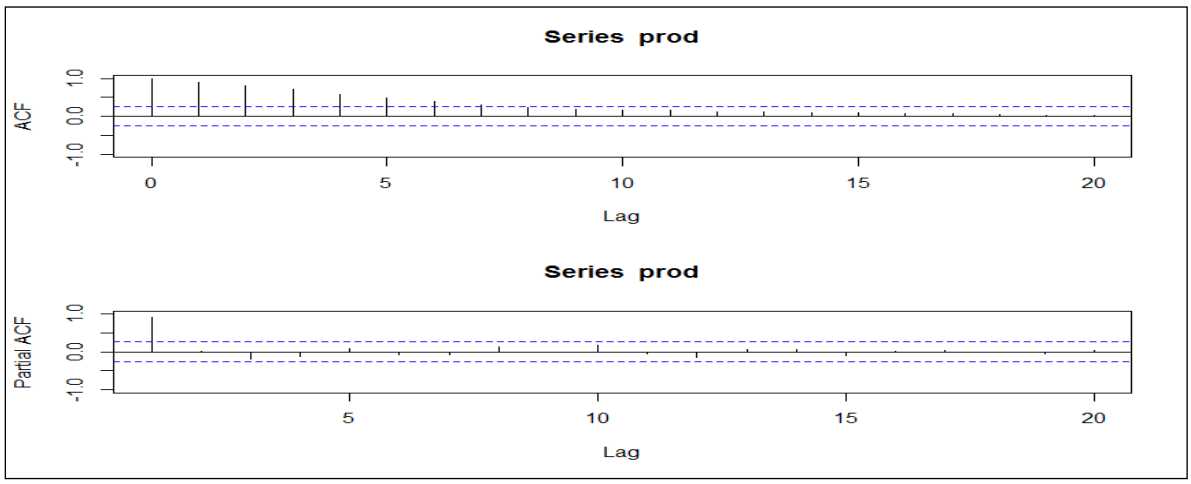

Figure 2. ACF and PACF graphs of beef production of Turkey for 1961-2018

Table 2. ADF test results for beef production

Variable	Level		Second difference	
	t-Statistic	Prob.	t-Statistic	Prob.
Beef production	1.747939	0.9795	-10.80762	0.0000

ACF and PACF graphs could also be used in order to determine the type of the model as well as the Akaike information criterion (AIC). The ACF and PACF graphs of second difference of beef production revealed that the first two lag were significant (Figure 3). RStudio model results indicated that ARIMA (2, 2, 2) best fitted and the AIC was the smallest in this model. The results of the analysis for beef model in estimating of the parameters are presented in Table 3. Accordingly, it was determined that the estimation of parameters in the model is statistically significant ($p<0.05$).

Table 4 reported the forecasted amount of beef production with lower and higher bounds of confidence intervals (80% and 95%) of Turkey for the period 2019-2028 via ARIMA (2, 2, 2) and Figure 4 reported the forecasted amount of beef production in the given period. The results of the study revealed that increasing trend in the amount of beef production especially after 2010 would continue in the next ten-year period without any interruption and beef production would reach 1019754 tons in 2019, 1083663 tons in 2023 and 1163534 tons in 2028. Çelik (2012) also concluded that while the production of meat would increase from 2014 to 2020 and Akgül and Yıldız (2016) also forecasted increasing amounts for red meat production up to 2023. However, the rise of beef meat is import based rather than production based in the mentioned period. The government imported 3 times greater cattle in 2018 in comparison with 2011 and every year the amount of imported cattle has perpetually increased except for few years. Although the producers have granted supports for beef cattle production in order to lessen the cost, one of the most essential supports has decreased in time and ceased in 2017. Therefore, the rise of production should be evaluated in this context and the government should take necessary precautions to increase the amount of production by productivity and supports rather than imports.

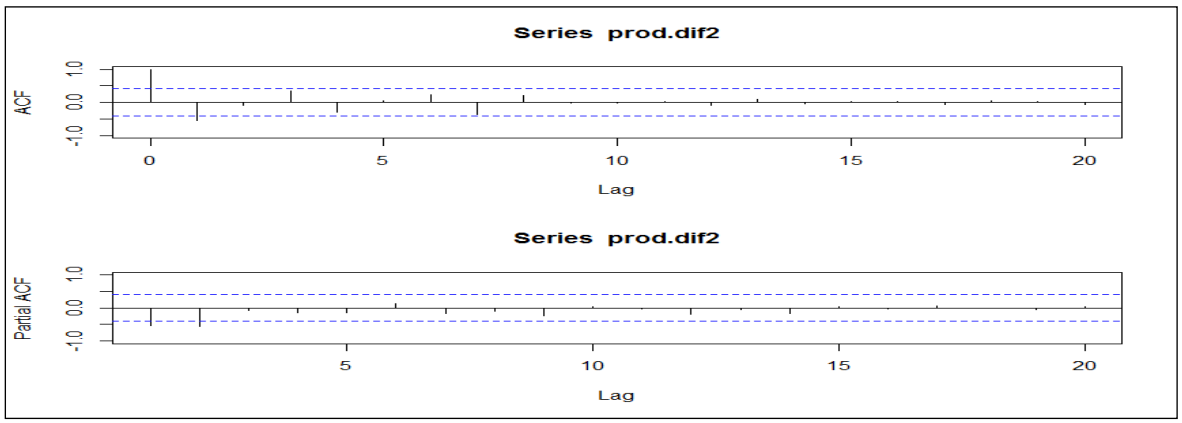

Figure 3. ACF and PACF graphs of second difference of beef production

Table 3. Final estimates of parameters

Parameters	Coefficient	Std errror	t-Statistics	Probability
AR 2	-0.923136	0.013051	-70.73447	0.000
MA 2	1.748073	0.254578	6.866547	0.000

Table 4. Forecasted amount of beef production for Turkey in 2019-2028 period

Year	Forecasted amount	Lower 80	Higher 80	Lower 95	Higher 95
2019	1019754	934160	1105348	888850	1150658
2020	1035744	925848	1145639	867673	1203814
2021	1051715	920239	1183190	850641	1252788
2022	1067689	918011	1217368	838776	1296602
2023	1083663	917714	1249612	829866	1337460
2024	1099637	918885	1280389	823201	1376073
2025	1115611	921179	1310044	818253	1412970
2026	1131586	924374	1338797	814683	1448488
2027	1147560	928313	1366806	812250	1482868
2028	1163534	932878	1394189	810777	1516290

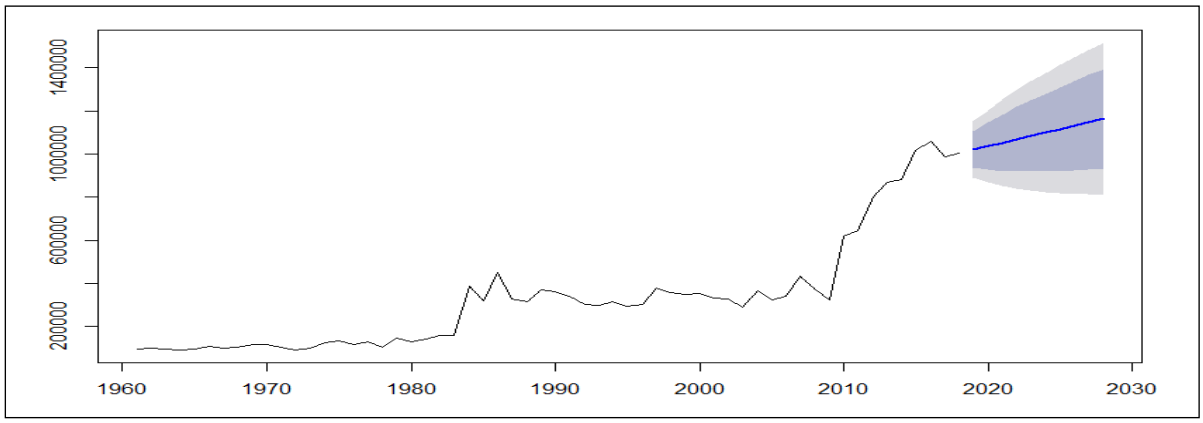

Figure 4. Forecasted amount of beef production in the period 2019-2028

4. Conclusion

In this study, beef production was forecasted for the period of 2019-2028 via Box-Jenkins method. The results of the study concluded that beef production of Turkey would increase in the next ten-year period and reach 1163534 tons in the year 2028. The imports and necessary supports were main reason for the rise of the beef production after 2010. However, the amount of supports for beef cattle production has decreased in time and ceased in 2017 but imports has substantially increased in the last three years. Therefore, import based production rise is not sustainable for the sector and government should provide producers with different supports in order to increase productivity and efficiency and decrease the costs. By this way, the forecasted amount of production could be possible without high amount of imports. In this study, only the beef production is forecasted. The model could be expanded to the forecasting of different indicators such as export and prices in order to evaluate the sector completely.

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