Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 4, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

MILK PRICE PREDICTING WITH HOLT WINTERS AND ORDINARY LEAST SQUARES

Filiz BASAGAOGLU

Turkish Statistical Institute, Department of Information Technology, Ankara, 06100, Turkey, Phone: +(90) 312 454 81 33, Email: filizbasagaoglu@gmail.com

Corresponding author: filizbasagaoglu@gmail.com

Abstract

In this research, smoothing methods and the Ordinary Least Squares (OLS) method for predicting producer milk prices in Turkey is implemented. Holt-Winters multiplicative (HWM) method and Holt-Winters additive (HWA) method are included in the exponential smoothing methods. Producer milk prices data belong to January 1st, 2010 to December 31st, 2019 period and gathered from the Turkish Statistical Institute. According to the given results, OLS method is fitted the data and has good root mean square error (RMSE) and determination coefficients (R^2).

Key words**:** *Smoothing, Ordinary Least Squares, producer milk prices, Turkey*

INTRODUCTION

The milk production in Turkey was realized 9.506.028 metric tonnes in 2019. Comparison to the years between 2018 and 2019, milk production is decreasing 5.26%. Its producer price milk ratio was up to 20.70% [23]. Especially, household's consumption for milk as packed and unpacked milk from buying producers in Turkey. The demand of milk relies on various factors for example economic factors, socio-economic and cultural factors. Moreover, buying milk from producers is cheaper than market price. For this reason, consumers prefer buying milk directly from producers.

A multivariate Tobit system of monthly wholesale dairy prices where four prices are lower censored by the dairy price support programme. Using Maximum Simulated Likelihood (MSL) the effects of simulation noise are tested/ corrected for and the relevance of estimating multivariate versus the single Tobit equations discussed [2]. The feasibility of estimating a system of demand equations in the absence of price information using the approach developed by Lewbel (1989) [4]. The double-hurdle model typically used in cross-sectional data is extended to panel data structures. In the empirical application for milk purchases, it is found that generic advertising increases the probability of market participation as well as the purchase quantity and incidence [5]. An evolution of the margin risks was performed using the relationship between excess price yield, prices of margin and conditional volatility of milk [6]. They implemented on profit level of hazelnut production [7]. On smallholder dairy farmers' risk perceptions and management strategies have still received little attention in agricultural research of developing countries [8]. Climate change is likely to affect milk production because of the sensitivity of dairy cows to excessive temperature and humidity [11]. Technical Efficiency (TE) of dairy farms is estimated and analyzed with two methodologies: Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). Two federal milk policies are considered in this research: marketing policy and milk income loss policy [14]. The long and short run relationships between oil price and food price volatility as well as the causal link between them [15]. Income, price, and cross price elasticities under six aggregated product groups were estimated within the framework of the an almost ideal demand system approach for food expenditures; and estimation of household consumers' food demand in Turkey was analyzed [19]. The evolution of the dairy farm structure of Poland during the post-socialist period. Milk projections show that under the status quo,

milk quotas will be binding and overrun, whereas under the 'soft landing' scenario they appear to be only binding after 2010 [20]. The VAR analysis to determine the relationship between the agricultural gross domestic product and agricultural supports [17].

In order to evaluate the monthly producer milk price between 2010 and 2019 years, time series analysis was applied. This paper's aim is to predict the milk prices for the next years by using the smoothing method and regression method. The data was taken from The Turkish Statistical Institute's database [23]. The EViews 10 Econometrics package program was used for the estimation and analysis procedure.

In the first section, an overview of the literature about milk price and some agricultural commodities in the Turkish agricultural sector is revised. Research methodology is given in the second and third parts. Especially, in this section smoothing methods and OLS method are emphasized. And the last section has the empirical results.

MATERIALS AND METHODS

Material

The commodity monthly prices data from January 1st, 2010 to December 31st, 2019 were taken from the Turkish Statistical Institute [23].

Methods

HWM, HWA and OLS methods are estimated in this research. The major contributions of this paper are to search the effects of the initial trend values on forecasting accuracy and to obtain the best fitting forecasting results that are obtained by comparing these methods.

Forecasting methods are smoothing methods, the Box-Jenkins model, the Grey forecasting model, Ordinary Least Squares and so on. Especially, estimation of production, prices and other variables are made by these methods. Namely, both of these methods are being contribution to these forecasting areas. These estimation methods are given in the following section.

Seasonality is explained as a repeating behavior [12]. Holt Winters methods can be used for forecasting time series data that have both trend and seasonal patterns [9], [10], [13], [18]. Authors stressed the importance of mean absolute percentage error and computed this indicator [21], [22].

The multiple linear regression equation is as follows:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_k X_{ki} + \varepsilon_i \quad (1)$$

where: Y_i is dependent variable, $X_1, X_2, \dots, X_k$ is independent variable, ε_i error term, $\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2, \dots, \hat{\beta}_k$ are the estimated regression coefficients.

Package program. During the estimation and analysis process, Eviews 10 Econometrics package program was used.

There are some criteria to select the best model for making forecasts, such as root mean square error (RMSE) and determination coefficients (R^2). These criteria are explained as follows:

When the prediction error is a small value, the forecasted value belong to the model will be better. The RMSE statistics was used as the prediction error measure because it gives an accurate and exact statistics for comparing forecasting methods. He emphasized the RMSE [3]. There are some criteria to select the best model for making forecasts such as the mean absolute percentage error (MAPE), root mean square error (RMSE) and mean absolute deviation (MAD) [1].

$$RMSE = \frac{\sum_{t=1}^{T}(y_t - \hat{y}_t)^2}{T} \quad (2)$$

where: t is time period, T is total number of observations, y_t is actual value, and $\hat{y}_t$ is forecasted value at time t.

R^2 that is coefficient of determination shows percentage variation in y dependent variable which is explained by all the x independent variables together. Every variable added to all variables R^2 is getting high score and higher R^2 score the better value. Its score is always getting value between 0 and 1 [16].

$$R^2 = \frac{\sum(\hat{y}_i - \bar{y})^2}{\sum(y_i - \bar{y})^2} = r^2 \qquad (3)$$

$$R^2 = 1 - \frac{\sum(y_i - \hat{y}_i)^2}{\sum(y_i - \bar{y})^2} \qquad (4)$$

RESULTS AND DISCUSSIONS

Descriptive statistics for the monthly milk prices from 2010 to 2019 are given in the following Fig. 1.

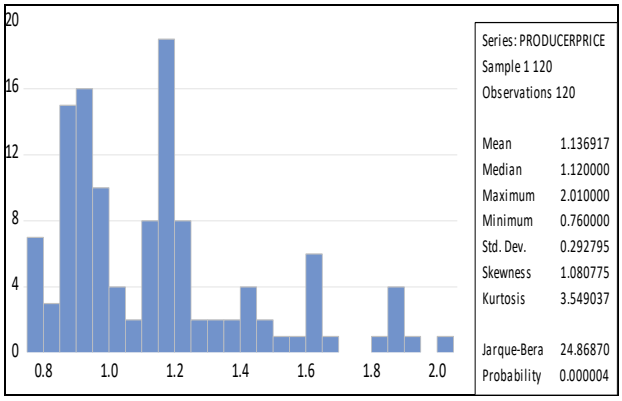

Fig. 1. Descriptive statistics for the monthly milk prices
Source: Author's calculations.

The nonstationary shape of the time series is seen in the Fig. 2. This time series will be analyzing. We can see this series' fluctuates that indicate the observation of a global trend or seasonality.

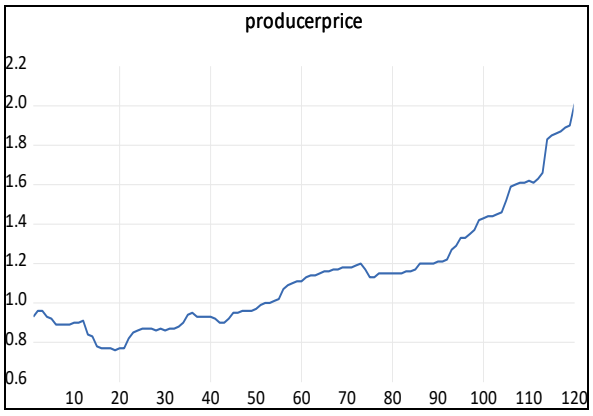

Fig. 2. The monthly producer milk prices (kg/TL) (X: month, Y: prices)
Source: Author's calculations.

The comparison of the raw data and the forecast data determined by the HWA method for producer milk prices are given in Fig. 3.

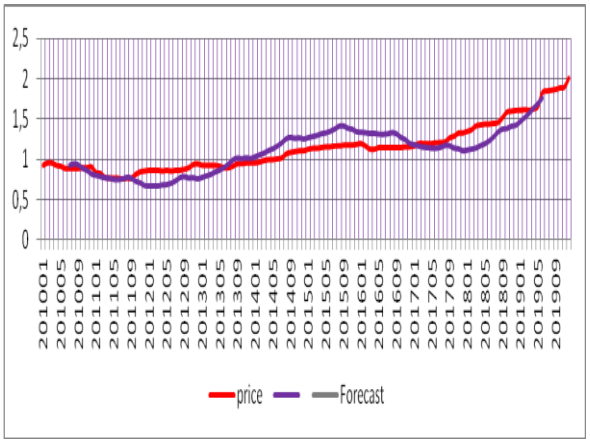

Fig. 3. The raw data and the forecast data for producer milk prices by HWA method
Source: Author's calculations.

The comparison of the raw data and the forecast data determined by the HWM method for producer milk prices are given as follows.

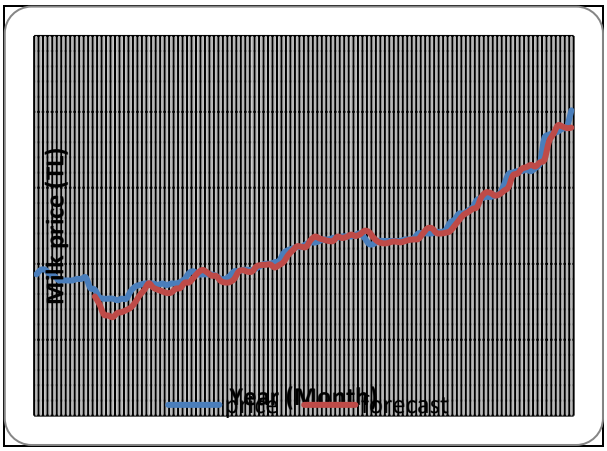

Fig. 4. The raw data and the forecast data for producer milk prices by HWM method
Source: Author's calculations.

In this paper, the weighing factors that result in the minimum RMSE were determined. The results were calculated by the HWA and HWM methods in Table 1.

Table 1. The optimal weighting factors for Jan 2010 to Dec 2019 using the HWA and HWM methods for producer milk prices

Methods	**Factors**		
	α	***β***	***γ***
HWA	0.009	1.000	0.000
HWM	0.673	0.077	1.000

Source: Author's calculations.

In this section, RMSE and R^2 belong to OLS results are given as follow in Table 2.

Table 2. RMSE and R^2 for the HWA, HWM and OLS methods for producer milk prices

Methods	**Statistics**	
	RMSE	R^2
HWA	1.994	NA
HWM	0.452	NA
OLS*	***0.124***	***0.82***

**OLS is the best model for making forecasts.*
Source: Author's calculations.

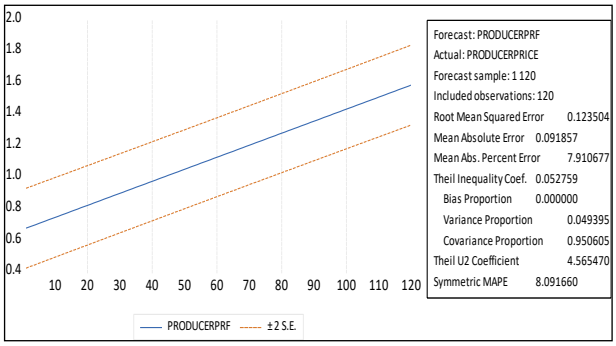

Fig. 5. Different statistics of OLS method for the monthly milk prices
Source: Author's calculations.

CONCLUSIONS

In this research, we proposed and used different initial values for the Holt Winters method to forecast producer milk prices in Turkey, and the results are deeply evaluated. The HWA and HWM methods were tested. During these tests, different initial values were tried and applied in the forecasting methods. The findings of this research revealed that the results generated by the HWA method had good accuracy for forecasting producer milk prices. To optimize the initial values, the RMSE was used in practice. For a time series, OLS method estimated in our study. Producer milk prices were taken as real values. Some statistical tests were evaluated according to the significance of the coefficients and used to test the residuals. The best indicator in this study was determined via the OLS model. The R^2 was evaluated for comparing the RMSE value. In conclusion, OLS is the best model for making forecasts according to RMSE and R^2.

REFERENCES

[1]Ahmad, W., Ariffin, W. K., Sabri, A., 2013, Arima model and exponential smoothing method: A comparison. AIP Conference Proceedings 1522, 1312; https://doi.org/10.1063/1.4801282.
[2]Arias, C., Cox, T.L., 2001, Estimation of a US dairy sector model by maximum simulated likelihood, Applied Economics, 33:9, 1201-1211, DOI: 10.1080/00036840010005797.
[3]Barnston, A., 1992, Correspondence among the Correlation root mean square error] and Heidke Verification Measures; Refinement of the Heidke Score. Notes and Correspondence. Climate Analysis Center.
[4]Castellón, C.E., Boonsaeng, T., Carpio, C.E., 2015, Demand system estimation in the absence of price data: an application of Stone-Lewbel price indices, Applied Economics, 47:6, 553-568, DOI: 10.1080/00036846.2014.975332.
[5]Dong, D., Chung, C., Kaiser, H.M., 2004, Modelling milk purchasing behaviour with a panel data double-hurdle model, Applied Economics, 36:8, 769-779, DOI: 10.1080/0003684042000229505.
[6]Fidan, H., Şahinli, M.A., 2008, The margin risk and price effects in the Turkish milk market. Journal of Animal and Veterinary Advances. 7: 1374-1382.
[7]Fidan, H., Şahinli, M.A., 2010, Profit level and price fixing in hazelnut production. The Journal of Animal and Plant Sciences, 20(2): 117-122.
[8]Gebreegziabher, K., Tadesse, T., 2014, Risk perception and management in smallholder dairy farming in Tigray, Northern Ethiopia, Journal of Risk Research, 17:3, 367-381, DOI: 10.1080/13669877.2013.815648.
[9]Holt, C. C., 2004, Forecasting seasonals and trends by exponentially weighted moving averages. International Journal of Forecasting. 20(1): 5-10.
[10]Kalekar, P. S., 2004, Time series forecasting using Holt-Winters exponential smoothing. Kanwak Rekhi School of Information Technology. 1-13.
[11]Mauger, G., Bauman, Y., Nennich, T., Salathé, E., 2015, Impacts of Climate Change on Milk Production in the United States, The Professional Geographer, 67:1, 121-131, DOI: 10.1080/00330124.2014.921017.
[12]Mladenović, J., Lepojević, V., Janković-Milić, V., 2016, Modelling and prognosis of the export of the republic of Serbia by using seasonal holt-winters and arıma method. Economic Themes. 54(2): 233-260.
[13]Montgomery, D. C., Jennings, C. L., Kulahci, M., 2008, Introduction to time series analysis and forecasting. New Jersey: Wiley-Interscience.
[14]Murova, O., Chidmi, B., 2013, Technical efficiency of US dairy farms and federal government programs, Applied Economics, 45:7, 839-847, DOI: 10.1080/00036846.2011.613772.
[15]Nwoko, I.C., Aye, G.C., Asogwa, B.C., 2016, Oil price and food price volatility dynamics: The case of Nigeria, Cogent Food & Agriculture, 2:1, 1142413, DOI: 10.1080/23311932.2016.1142413.
[16]Özçelik, A., Şahinli, M.A., 2019, Statistics of Agricultural Economics. Ankara University printing press. 651.

[17]Şahinli, M.A., 2019, Effects of agricultural supports: the case of Turkey. Journal of Environmental Protection And Ecology. 20:1, 515–525.
[18]Şahinli, M.A., 2020, Potato price forecasting with holt-winters and ARIMA methods: a case study. American Journal of Potato Research, 97:336–346. https://doi.org/10.1007/s12230-020-09788-y.
[19]Şahinli, M.A., Fidan, H., 2012, Estimation of food demand in Turkey: method of an almost ideal demand system. Quality & Quantity, 46:653–663, DOI 10.1007/s11135-010-9419-4.
[20]Tonini, A., Jongeneel, R., 2009, The distribution of dairy farm size in Poland: a Markov approach based on information theory, Applied Economics, 41:1, 55-69, DOI: 10.1080/00036840701704394.
[21]Tratar, L. F., Mojskerc, B., Toman, A., 2016, Demand forecasting with four parameter exponential smoothing. International Journal Production Economics, 181: 162-173.
[22]Tratar, L. F., Srmenik, E., 2016, The comparison of Holt-Winters Method and regression methods: a case study. Energy, 109: 266-276.
[23]Turkstat, 2020, http:www.turkstat.gov.tr. Accessed 03 August 2020.