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Investigation of Production and Price Relationship in Cow Milk Production by Koyck Model Approach

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A B S T R A C T

The aim of this study was to investigate the relationship between the amount of cow milk production and its price in Turkey in the period between 1985-2015.The Koyck model that is one of the distributed lag models was used to analyse of these data. The production of cow milk was considered as dependent variable and the price series consisting of cow milk prices and lagged price series are considered as explanatory variable in the model. According to the results of Koyck model, it was determined that the production of cow milk was affected by the prices of maximum one year retrospectively and the time required to dramatically affect to production of cow milk of the change taken place in prices of cow milk was 2.9 years. Furthermore, the increase of 1 TL in price of cow milk decreases the production of cow milk by 183372.4 tonnes. On the other hand, the increase of 1 TL in prices in the previous period decreases the production of cow milk by 137345.9 tonnes. Based on these data, it can be said that the price of cow milk composed in the free market conditions is rather efficient in determination to production amount. In conclusion, economic measures such as making of production planning, constituting of efficient marketing opportunities, price policies and giving a place to stable production can be taken against to fluctutations in the price increases.

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İnek Sütü Üretiminde Üretim ve Fiyat İlişkisinin Koyck Model Yaklaşımı İle Araştırılması

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Ö Z E T

Bu çalışmanın amacı, 1985-2015 yılları arasında Türkiye'de inek sütü üretim miktarı ile fiyatı arasındaki ilişkiyi araştırmaktır. Çalışma verilerinin analizinde, gecikmesi dağıtılmış modellerinden biri olan Koyck modeli kullanılmıştır. Modelde, inek sütü üretimi bağımlı değişken, gecikmeli fiyat serileri ve inek sütü fiyatlarından oluşan fiyat serileri ise açıklayıcı değişken olarak belirlenmiştir. Koyck model sonuçlarına göre, inek sütü üretiminin geriye doğru en fazla bir yılın fiyatlarından etkilendiği ve inek sütü fiyatlarında ortaya çıkan bu değişimin, inek sütü üretimini önemli ölçüde etkilemesi için gereken zamanın 2,9 yıl olduğu belirlenmiştir. Ayrıca, inek sütü fiyatlarındaki 1 TL'lik artış, inek sütü üretimini 183372,4 ton azaltmıştır. Diğer yandan, bir dönem önceki fiyatlardaki 1 TL'lik artış da inek sütü üretimini 137345,9 ton azaltmıştır. Bu verilerden hareketle, serbest piyasa koşullarında oluşan inek sütü fiyatının, üretim miktarının belirlenmesinde oldukça etkili olduğu söylenebilir. Sonuç olarak, fiyat artışlarındaki dalgalanmalara karşı üretim planlamasının yapılması, etkin pazarlama olanaklarının oluşturulması, fiyat politikaları ve istikrârlı üretime yer verilmesi gibi ekonomik önlemler alınabilir.

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Introduction

Livestock is one of the sectors playing a significant role in socio-economic development and in nutrition of people. This sector and its products are main component of agriculture in the developing countries and moreover, it provides direct income for many farmers in Turkey and in the world (Akbay and Boz, 2005; Jabir, 2007).

Livestock sector has a considerable potential and is an important part of agriculture sector and economy in Turkey. Furthermore, dairy farming activity, which is an important part of this sector, has great importance for Turkey's agricultural production. Some animal products (meat and milk) that is obtained from this area are also an important source of income for farmers living in rural area (Jabir, 2007). Because, the substantial amount of farmer incomes are provided by sales of their animal and milk. World milk production is nearly entirely derived from cattle, buffalo, goat, sheep and camel. In Turkey, cattle, sheep, goat and buffalo are considered as dairy animals in milk production. The world cattle inventory in 2014 was 1.5 billion cattle. In 2015, there were about 13.9 million cattle (25.1%), 133 thousand buffalos (0.2%), 31.5 million sheep (56.2%) and 10.4 million goats (18.6%) (FAO, 2016; TUİK, 2016). The world milk production in 2014 was about 771.8 million tonnes. Dairy cattle accounts for 82.7% of the total world milk production. In 2015, total milk production in Turkey was about 18.6 million tonnes. Out of total milk production about 90.8% is coming from dairy cattle, 6.3% from sheep, 2.6% from goats and the remaining 0.3% from buffalos. India is the largest milk producers in the world (Bor, 2014; Yilmaz et al., 2016). Turkey is also among the 10 largest milk producers in the world.

Dairy cattle stocks decreased by 18.2%, from 11.9 million head to 9.7 million head in Turkey during the period 1991-2002. During the same period, milk production decreased from 8.6 million tonnes to 7.5 million tonnes because of the decrease in the total number of cattle (Demircan et al., 2006; TUİK, 2016). Furthermore, total cattle population and milk production has been observed in recent years. But, milk production per cow is still rather low compared to that of European Union countries.

In Turkey, the dairy farming sector are negatively affected by some factors such as feed prices, natural conditions and animal diseases as well as general features such as being usually small-scale of structure of dairy cattle farms, being low of farmers' education level and inadequacy of effective marketing opportunities (Pekşen and Yardımcı, 2008; Dellal and Berkum, 2009; Doğan and Kızıloğlu 2015).Based on these comments,it can be said that farmers are confronted with price uncertainties in production and marketing of animal products because of the structural features of the dairy cattle farms. The relationship between the amount of production and price is investigated by using distributed lag models due to these features of agricultural products. Therefore, Koyck model was used to measure the lagged impact in consecutive periods of the price variable in study.

There are a number of studies examining the relationship between agricultural product and price by using distributed lag models in Turkey. Eraktan et al. (2004) used Koyck model to investigate the relationship between direct income support and financial support by government to the farmers based on their agricultural land and value added produced in Turkey. In study conducted by Erdal (2006), the relationship between tomato production and its price was investigated by using Koyck model approach in Turkey between 1975 and 2004. In another study by Doğan et al. (2014), production and price relationship for potato in 1991-2012 was analysed by using Koyck model approach. Hasan and Khalequzzaman (2015) analysed the relationship between production and price of garlic by using Koyck model in the period1974-2011.However, it can be said that studies investigating the relationship between animal products and price are limited. Çelik (2015) explained to the relationship between sheep milk production and its price by using Koyck and Almon model approaches in the period between 1994-2014. In study conducted by Çelik (2016), the relationship between red meat production and its price by using Almon model approach in the period between 1994-2014.

The aim of this study is to investigate the relationship between the production of cow milk and its price by using Koyck model approach that is one of the distributed lag model in Turkey. This study can be seen as being important in terms of determining producers' sensitivity against to prices and examination of the relationship between the amount of cow milk production and its price.

Material and Method

The post-1980 period is the term that is restructure of agricultural policies, production and capital, labour markets and social policies, especially in Turkey. It is seen that are very rapid improvements in the process from 1990 up until today when the period from 1990 to 1980 is considered as a preparatory period. Therefore, in this study, it is evaluated the amount of milk production and its price especially in the post-1985 period in Turkey. The data of the study were obtained from records of Turkish Statistical Institute (TUİK) and FAO (Food and Agriculture Organization). The data related to the amount of cow milk production and their prices were arranged yearly in 1985-2015. Real prices of cow milk according to the wholesale price index and producer price index between 1985-2015 years were used in study. The data were evaluated by using Koyck model approach that is one of the distributed lag models. In study, correlation coefficient was used to measure the relationship between the amount of cow milk production and its price. The analyses were conducted by using Eviews statistical analysis programme. In Koyck model, production of cow milk was considered as dependent variable and the price series consisting of cow milk prices and the lagged price series was considered as explanatory variable. Furthermore, the detailed information about distributed lag models and Koyck model was explained under the title of theoretical framework.

Theoretical Framework

Distributed lag models have a special place in literature of economic. Because, these models can allow the analysing the behaviours of economical units such as consumer and producer based on appropriate dynamic models (Erdal, 2006; Hasan and Khalequzzaman, 2015). This model was used for the first time by Irving Fisher. The distributed lag models take into account not only the present year value but also the previous year values of explanatory variable. According to this, it is called an infinite distributed lag model if it is not defined how long it can go back to the past for the explanatory variable(1).

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots\ldots\ldots\ldots + u_t \quad (1)$$

Furthermore, it is called a finite distributed lag modelif it is defined as *k* the number of year that go back to the past for the explanatory variable (2).

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \beta_k X_{t-k} + u_t \quad (2)$$

Unknown parameters ($\alpha, \beta_0, \ldots\ldots \beta_k$)in these models can be estimated by using least squares method. But, the model-specific estimates in these models have some drawbacks. First of all, there isn't prior knowledge about maximum length of lag period in model. Secondly, there are multiple correlation problems in variables determined as explanatory variable (Tinbergen, 1949; Gujarati, 2005). For these reasons, Koyck model that is one of the distributed lag model was developed by Koyck in order to overcome these drawbacks.

In this model, Koyck assumed that all β's in distributed lag model had same signs and decrease geometrically (3).

$$\beta_k = \beta_0 \lambda^k \qquad k=0,1.... \quad (3)$$

According to the model, λ $(0<\lambda<1)$ is the rate of decrease of distributed lag. β_k is the lag coefficient. The closer λ to 1, the less the decrease in β_k and the closerλ to zero, the greater the decrease in β_k (Gujarati, 2005). Mean lag number is the weighted average of all lags. This is calculated as shown in equation (4).

$$Mean\ lag\ number = \frac{\lambda}{1-\lambda} \quad (4)$$

According to these explanations, the infinite lag model is formed using ordinary least squares (OLS) method as shown in equation (5).

$$Y_t = \alpha + \beta_0 X_t + \beta_0 \lambda_1 X_{t-1} + \beta_0 \lambda_2 X_{t-2} + \ldots\ldots\ldots\ldots + u_t \quad (5)$$

But, the infinite lag and λ coefficients aren't linear. To solve this problem, the model has been taken one period back as shown in equation (6).

$$Y_{t-1} = \alpha + \beta_0 X_{t-1} + \beta_0 \lambda_1 X_{t-2} + \beta_0 \lambda_2 X_{t-3} + \ldots + u_{t-1} \quad (6)$$

New equation is obtained when the equation is multiplied by λ (7).

$$\lambda Y_{t-1} = \lambda\alpha + \lambda\beta_0 X_{t-1} + \lambda^2 \beta_0 X_{t-2} + \lambda^3 \beta_0 X_{t-3} + \ldots + \lambda u_{t-1} \quad (7)$$

The equation (8) is reached when the equation (7) is subtracted from the equation (5).

$$Y_t - \lambda Y_{t-1} = \alpha(1-\lambda) + \beta_0 X_t + \ldots\ldots\ldots\ldots + (u_t - u_{t-1}) \quad (8)$$

The equation (9) is reached when the equation (8) is reformulated.

$$Y_t = \alpha(1-\lambda) + \beta_0 X_t + \lambda Y_{t-1} + v_t \quad (9)$$

In equation $v_t=(u_t-\lambda u_{t-1})$ is the moving average of u_t and u_{t-1}.According to the above definition, the equation (9) is defined as Koyck model. Thus, the multiple correlation problems are also solved.

Results and Discussion

Turkey's production of cow milk showed a fluctuation both increasing and decreasing between 1985 and 2015. There wasn't noticeable change in current prices of cow milk between 1985 and 1994. Furthermore, prices of cow milk significantly increased in Turkey from 1995 until 2008 and reached the highest value in 2015 during the period 1985-2015(Figure 1).

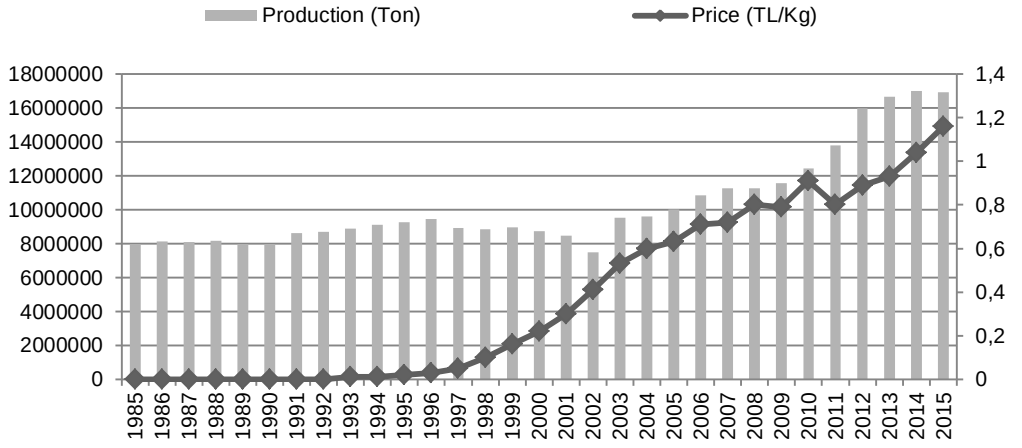

Figure 1Turkey's production of cow's milk and its price by years.

Based on these data, the correlation coefficient was calculated to determine whether or not it is appropriate to distributed lag models of the relationship between the amount of cow milk production and its price. According to result of the correlation analysis that was made based on these data between 1985-2015, the correlation coefficient was found to be 0.85. This value shows that there is a strong relationship between two variables and can be examined by using Koyck model approach of the relationship between the amount and the price in cow milk production. But, it needs to be determined lag length of price series for cow milk in order to form Koyck model in the study. Therefore, the Bayesian information criterion (BIC), also known as Schwarz's Bayesian criterion, was used for the determination of the lag length in the distributed lag model. The lag length in the BIC is found by determining value making the smallest to Schwarz value (Acquah, 2010). At this stage, it is started with a very great k value (lag length) without making any restriction for the form of distributed lag. Then, it is observed to whether or not going wrong of model when duration of lag length is shortened (Davidson and Mackinnon, 1993; Hasan and Khalequzzaman, 2015). According to this, schwarz criterion values determined for different lag lengths are given in Table 1.

Table 1. Lag length values (Schwarz criterion)

Lag length	Schwarz criterion
k=1	30.58
k=2	30.67
k=3	30.80
k=4	30.92
k=5	31.01
k=6	31.14

Table 2.The results of Koyck model

Q_t=7669578 - 183372.4P_t + 0.749 Q_{t-1}			
Variable			
	Constant	P_t	Q_{t-1}
Coefficient	(α)7669578	(β)183372.4	(λ) 0.749
t-statistic	3.944	-3.909	9.502
Probability L.	0.0005	0.0006	0.0000

R-squared (R^2)= 0.94, F-statistic=201.95 Prob(F-statistic)=0.000, Mean lag value= λ /(1- λ) = 0.749/0.251=2.9

As can be seen in the Table 1, the lowest Schwarz value was obtained from lag length k=1.The effects of its price to production of cowmilk is zero after one year.Lag length values in some studies made by using Koyck model for different agricultural products are 3 years for tobacco, tomato and wheat, respectively (Dikmen, 2005; Erdal, 2006; Özçelik and Özer, 2006), 5 years for dry onion (Erdal and Erdal, 2008), 4 years for hazelnut (Çelik, 2014), 2 years for potato (Doğan et al., 2014), 1 year for garlic (Hasan and Khalequzzaman, 2015), 8 years for watermelon (Özbay and Çelik, 2016), 9 years for sheep milk (Çelik, 2015) and 6 years for red meat (Çelik, 2015). All these values are shown that there are similar and close results between findings of in the present study and the previous researches that were made for determining of lag length. On the other hand, it can be seen that cow milk is affected by the prices in shorter time than products such as dry onion, hazelnut, watermelon and sheep milk and red meat. In addition to these, effects of this time are longer than potato and garlic and are also same for tobacco, tomato and wheat. But, it must be taken into consideration that increasing of production amount in annual crops is related to one production period and increasing of milk production amount is related to taking new animals to dairy cattle farms in a few days when comparing plant and animal products.

According to lag length that is determined in the period 1985-2015, the relationship between production of cow milk and its price was estimated with Koyck model. The Koyck model equation can be written as follows;

$$Q_t=\alpha+\beta_0 P_t+\lambda Q_{t-1}+u_t \quad (10)$$

In equation, Q_t is production of cow milk in period t, P_t is price of cow milk and Q_{t-1} is production of cow milk in the previous period than in period t. The results of Koyck model that is formed with equation (10) are given Table 2.

According to results of Koyck model in Table 2, the model was found to be statistically significant according to t-test ($P<0.05$). The multiple coefficient of determination of the model was also found to be 0.94. It is indicated that 94% of change occurred in production of cow milk will be explained with prices of cow milk. Based on this result, it can be said to be a very high interaction between these variables. The multiple coefficient of determination for model was found to be 0.71 in study conducted by Erdal (2006). This value was found to be 0.90 in study conducted by Erdal and Erdal (2008), 0.70 in study conducted by Doğan et al. (2014), 0.99 in study conducted by Çelik (2015) and 0.81 in study conducted by Özbay and Çelik (2016).According to these results, it can be said that an explainable of the relationship between production and price belonging to crops and animal products by high specificity coefficient when considered findings in the present study conjunction with results of the previous researches.

According to model results in Table 2., it can be said that the increase of 1 tonne in the production of cow milk in the previous period on production of cow milk causes a increasing by 0.749 tonnes when increase of 1 TL in price of cow milk decreases production of cow milk by 183372.4 tonnes.

Mean lag number was calculated to be 2.9 according to the information in the equation. It is shown that the time required to dramatically affect to production of cow milk of the change taken place in prices of cow milk was 2.9 years. Average lag value in similar studies made for different agricultural products by using Koyck model was found to be 18.2 years for tomato (Erdal, 2006). This value was found to be 1.2 years for dry onion in study

conducted by Erdal and Erdal (2008), 1.4 years for potato in study conducted by Doğan et al. (2014), 32.3 years for garlic in study conducted by Hasan and Khalequzzaman (2015), 8.7 years for sheep milk in study conducted by Çelik (2015) and 6 years for red meat by Çelik (2016). According to these results, it can be said that the effect on the amount of production of change in cow milk prices is shorter than effect on the amount of production of change in sheep milk and red meat prices, respectively. Forecasts known as β_0, β_1, β_2, β_3 and α_0 with regression equation derived from the Koyck model can be reached with following calculations since they are defined in form $\beta_k=\beta_0\lambda^k$ and $\lambda= 0<\lambda<1$ in the Koyck model.

$$\beta_k= \beta_0\lambda^k$$
$$\beta_0= \beta_0\lambda^0=(-183372.4)(0.749)^0=-183372.4$$
$$\beta_1= \beta_1\lambda^1=(-183372.4)(0.749)^1= -137345.9$$
$$\alpha_0= \alpha/(1- \lambda)=7669578/(1-0.749)=30556088$$

The equation (11) is obtained when the regression equation derived from the Koyck model is rewritten with these findings.

$$Q_t= \alpha+ \beta_0P_t+ \beta_1P_{t-1}+u_t \quad (11)$$
$$Q_t=30556088-183372.4P_t-137345.9P_{t-1}$$

It can be said that lagged prices of cow milk have gradually decreasing effect on production of cow milk due to the fact that λ coefficient is between 0 and 1 in the Koyck model. According to the regression equation (11), the amount of milk production is 30556088 tonnes when there isn't any changes in prices. The increase of 1 TL in price of cow milk decreases the production of cow milk by 183372.4 tonnes. Otherwise, the increase of 1 TL in prices of the previous period decreases the production of cow milk by 137345.9 tonnes. According to these results, the lagged values of cow milk prices have a negative effect on production and this effect follows gradually decreasing course. According to these results, it can be said that there is a negative relationship between the amount of milk production and its price. On the other hand, increase in milk production will decrease milk prices. Thus, it can be positive development in terms of purchasing power of consumers as the increase in milk production decreases its price. Based on these data, it can be said that price of cow milk composed in the free market conditions is rather efficient in determination to the production amount. For this reason, it can be said to be an important of setting up a good the balance between the amount of cow milk production and its price. Because, price increases in previous years are caused a decline in the amount of milk production. Therefore, dairy farming activity should be encouraged and subsidized to cope with problems like these. Furthermore, the price stability can be provided through positively effect to milk production by increasing of the number of dairy cattle in dairy cattle farms. Thus, problems encountered against to the price increases can decrease with increasing of cow milk production.

Conclusions

In this study, it was aimed to determine the relationship between production of cow milk and its price by using Koyck model approach. The data set covers in the period between 1985 and 2015.The lagged values of price and price that had effect on production of cow milk were determined. The correlation relationship between the amount of cow milk production and its price was found to be %94. This result shows that is a very high interaction between these variables. The time required to affect positively to production of cow milk of the change in prices of cow milk was determined to be 2.9 years. On the other hand, the findings regarding the lag length indicate that production of cow milk is impressed by price of backwards maximum one year. According to this, the increase of 1 TL in prices of the previous period decreases the production of cow milk by 137345.9 tonnes when the increase of 1 TL in price of cow milk decreases the production of cow milk by 183372.4 tonnes. The changes in their lagged values for periods of cow milk prices have affected negatively on production. These effects follow gradually decreasing course. According to this results, it can be seen that the price of cow milk composed in the free market conditions is rather efficient in determination to the production amount in this study.

In conclusion, cow milk is one of the most important animal products in Turkey. But, many farmers are confronted with price uncertainties because of some problems such as risks and uncertainties in livestock activity, unplanned production and lack of efficient marketing. Price uncertainties are also caused fluctuations in the amount of production. Based on these assessments, firstly it can be said that it is an important of setting up powerful producer unions in terms of turn into a profitable position to farmers' dairy farming activities. Also, government grants to form powerful producer unions are needed. In this context, it can be said to be an important of determining of efficient marketing opportunities and making of production planning for cow milk production by producer unions. Milk has compound that requires obligation fast and efficient marketing. But, it can be said that market prices is to be disadvantageous to producers due to the lack of organization of milk producers in the face of farms in dairy industry. Therefore, it should be attach importance to providing stable production and price policies by establishing supply-demand balance on the market. Thus, the setting up of these objectives oriented agricultural policies are needed. Furthermore, one of the most important problems in dairy cattle farms is the lack of efficient production planning work. Dairy cattle farms generally do not benefit from scientific research methods and studies and so make their plans manually.

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