The analysis of relationship between sunflower production and its price by using Koyck model in Turkey

Reception of originals: 02/04/2017
Release for publication: 12/19/2017

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Abstract

In this study, the relationship between sunflower production and its price in Turkey were investigated. Data used were belong to 1980-2014 period. In order to determine that relationship, Koyck model were used. Production were considered as dependent and prices were independent variable as well. According to model estimations, sunflower price was effected only to prices of previous years and 0.1885 years were needed so that the change in sunflower prices could have a significant and considerable effect on sunflower production. Although supports on sunflower farming increased in last years, it still doesn't meet domestic consumption. The price of sunflower is not alone encouraging tools for increasing the amount of production. Currently, Turkey is a net importer and seems to be continue in the near future in sunflower production. Therefore, in order to increase domestic production, hybrid sunflower seed use has to be promoted and new supporting policies should be developed.

Keywords: Sunflower. Koyck model. Distributed lag model

1. Introduction

In real terms, prices for all agricultural products are expected to decrease over the next ten years, as on-trend productivity growth, helped by lower input prices, outpaces slowing demand increases. The prices of meat and dairy products are expected to be high relative to the prices of crops; while among crops the prices of coarse grains and oilseeds used for feed should rise relative to the prices of food staples (Anonymous, 2016). Marketing year 2015 oilseeds production in Turkey is expected to be 2.1 million metric tons, down about eight percent compared to a year ago. No change in production support payments and better returns of other crops adversely affected farmers' planting decisions despite the large domestic use and export of oils seeds products. Despite the efforts of the government to increase oil seed production, Turkey continues to be import-dependent due to a net deficit in oilseeds and products (Sirtioglu, 2015). Sunflower is the traditional oilseed in Turkey and it can be produced almost everywhere in the country. Since the plants contains high quality oil, it is the second biggest oilseed plant after cotton in Turkey. However, because of increase in population and consumption, current production is not meeting need of sunflower production and therefore Turkey is net importer.

There is a high correlation between the price formation and amount of production in agricultural products directly. Due to structural feature of agricultural produces, relationships between the amount of production and its price can be studied using distributed lag model. In the regression models in which time series data used, if the model uses not only the present values but also the lagged values of the defined variable, this model is known as distributed lag model (Gujarati, 2001). The geometric distributed Lag model, after application of the so called Koyck transformation is often used to establish the dynamic link and estimation in the time series data. This model used in several studies for determining the relationship between amount of production produced and its price.

In literature review, there are many studies on sunflower production in terms of production, marketing, trade and policies aspects. In addition, several studies on Kyock models used for agricultural production in Turkey. Some of them are the relationship between cotton production and its price by using Kocyk-Almon model by Yurdakul (1998), for domatos production and its price by Koyck model by Gülistan (2006) and Erdal (2006), for tobacco production and its price by Dikmen (2006), for wheat production and its price by using Koyck model by Özçelik and Özer (2006), for dry onion product and its price by Erdal and Erdal (2008), for potato production and its price by Erdal et al. (2009), for meat production and its price by using Almon model by Akgül and Yıldız (2010), for strawberry production and its price by using Koyck-Almond models by Çobanoğlu (2010), for potato production and its price by using Koyck model by Doğan et al. (2014), for hazelnuts shelled production and its price by Koyck model by Çelik (2014), for sectoral output response to fluctuations of oil exports in Algeria by using Koyck model by Yahia (2014), for sheep milk and its price by using Koyck-Almond by Çelik (2015), for watermelon production and its price by using Almon model by Özbay and Çelik (2016), for tomato production and its price by using Almon model by Doğan and Onurlubaş (2016), for wheat production and its price in Yozgat province by using Kocky model by Akgül and Yıldız (2016). For this reason, the purpose of this study was to determine the relationships between sunflower production and its price by using Kocky model.

2. Material and Method

2.1. Theoretical framework

Data used in this study on sunflower production and its prices were obtained from TurkStat data (Anonymous, 2017) and data used is belong to 1984-2014 period. In order to determine the relationship between sunflower productions and its price, dependent variable were choose as amount of sunflower production and independent variable as sunflower prices as well. In order to remove the price effects from the data, the prices were deflated to inflation and reel prices were used. Natural logarithm were taken since they provide stability over the variables.

The first-order autoregressive lag model is often called the Koyck lag in recognition of the seminal application of the model to the macroeconomic investment function by L. M. Koyck (1954). Distributed lagged models have an importance place in terms of simplicities in explaining economic theory. In such models, distributed lag models takes into account not only the present year value but also the previous year values of defining variable. If how far back will be gone for defining variable is not described, this is called an “infinite lag model” and shown as follows (Isyar, 1999; Dikmen, 2006; Kutlar, 2005);

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

On the other hand, if the number of years to go back is defined as *k* for defining variable, it is called “finite distributed lag model” and has been defined as:

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

In this model, dependent variable Y ($Y_t\ Y_{t-k}$) is not only influenced by the present value (X_t) but also by the past values ($X_{t-1} \ldots\ldots X_{t-k}$) of dependent variable. Most often, Y responds to X after some time, and the time to respond is called “lag period” (Dikmen, 2006).

This model simply;

$$Y = \propto + \sum_{i=0}^{k} \beta x_{t-1} + u \quad (3)$$

Unknown parameters in distributed lag models (α , α 0, …, α k) can be estimated using the classical least squares method (Alt, 1942; Tinbergen, 1949; Gujarati, 2001). Model-specific estimates in distributed lag models have certain drawbacks (Gujarati, 2001;Erdal et al., 2009). Based on the assumption that lags in independent variable affect the dependent variable to some extent and the weight of these lags decrease geometrically, model is reduced and thus made to estimate the regression equation (Dikmen, 2006).

The Koyck model is a model used to measure the lagged effects of successive independent variables. In the Koyck model, as the number of lag increases, the coefficients of the lag variables (lag values of the independent variable) is gradually decline. This shows that the effect of the variable over time is reduced (Özçelik and Özer, 2006). In order to obtain the reduced model, Koyck assumed that in an infinitely distributed lag model all *β*'s had the same signs and geometrically decrease. This assumption can be shown below;

$\beta_k = \beta_0 \lambda^k$ k=0,1,2…………………………………....(4)

In this equation, β_k is the lag coefficient, which varies by λ as well as by β_0. The closer λ to 1, the less decline in β_k. On the other hand, the closer λ to zero, the greater the decline in β_k (Gujarati, 2001; Erdal et al., 2009). If we estimate λ we know rate of decline and speed of adjustment. λ∈ (0,1) is the rate of decline and (1–λ) is speed of adjustment. Mean lag coefficient gives the weighted average of all lag and calculated for Koyck model as shown

$$Mean\ lag = \frac{\lambda}{1/(1-\lambda)} \qquad (5)$$

Mean lag number shows the time period necessary for a unit change in X independent variable to have a noticeable effect on the dependent variable Y (Dikmen, 2006). In view of these explanations, infinite lag model is formed using OLS method as shown in Equation (6);

$$Y_t = \alpha + \beta_0 X_t + \beta_0 \lambda X_{t-1} + \beta_0 \lambda^2 X_{t-2} + \cdots + u_t \qquad (6)$$

Linear regression solution cannot be applied to regression Equation (6) since it has infinite lag and λ coefficients are not linear. In order to solve this problem, the model has been taken one period back and the following regression model has been developed:

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

When the equation (7) is multiplied by λ, the Equation (8) is obtained

$$\lambda Y_{t-1} = \lambda\alpha + \lambda\beta_0 X_{t-1} + \lambda^2 \beta_0 \lambda X_{t-2} + \lambda^3 \beta_0 \lambda^2 X_{t-3} + \cdots + \lambda u_{t-1} \quad (8)$$

When the Equation (7), whose lag is taken one period back, is subtracted from Equation (5), whose lag is infinite, the following Equation is reached:

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

If the Equation (9) is reorganized, Equation (10) is obtained;

$$Y_t = \alpha(1-\lambda) + \lambda Y_{t-1} + v_t \quad (10)$$

$v_t = (u_t - u_{t-1})$ and moving average of u_t and u_{t-1}

By Kocky model, lagged values of explanatory variable were removed, multicollinearity problem were automatically solved due to only k=1 is in the model. While in infinitely distributed lag model it is necessary to predict infinite number of β using α, in Koyck model distributed lag model can be resolved only through estimating α, β_0 and λ.

2.2. Sunflower production in Turkey

The harvested area of sunflower seed in the world is 25.203.554 hectare and 41.422.310 tonnes in 2014. When the shares of countries in production in the world examined, half of total production is provided from two countries (Ukraine and Russian Federation). Turkey is eighth rank with 1.637.900 tonnes in 2014 (Anonymous, 2017b). Total sunflower sown area in Turkey is 6.853.174 decares and the amount of production is 1.680.700 tonnes in 2005. The most of sunflower sown area (83.03% of total area) in Turkey are occupied for oilseed production (Anonymous, 2017a). Although there is decreasing trends (from 589.577.000 to 237.984.000 USD in 2011-2015 period) in importation last years, Turkey is still net importer (Anonymous, 2017c). The sunflower is one of the most important crops for oilseed and mostly grown in the Marmara Region and Thrace Region in Turkey. In general, it is sold at sunflower seeds are processed in factories. According to distribution of amount of production by provinces, the biggest 5 provinces in Turkey production (1.680.700 tonnes) come from Tekirdağ, Edirne, Konya, Kırklareli and Adana provinces with 267.012, 226.573, 217.634, 188.998 and 134.361 tonnes, respectively (Anonymous, 2017a). Sunflower production and prices have increasing trend in last years which shown in Figure 1 and 2. This augmentations can be explained due to government supports to oilseed production.

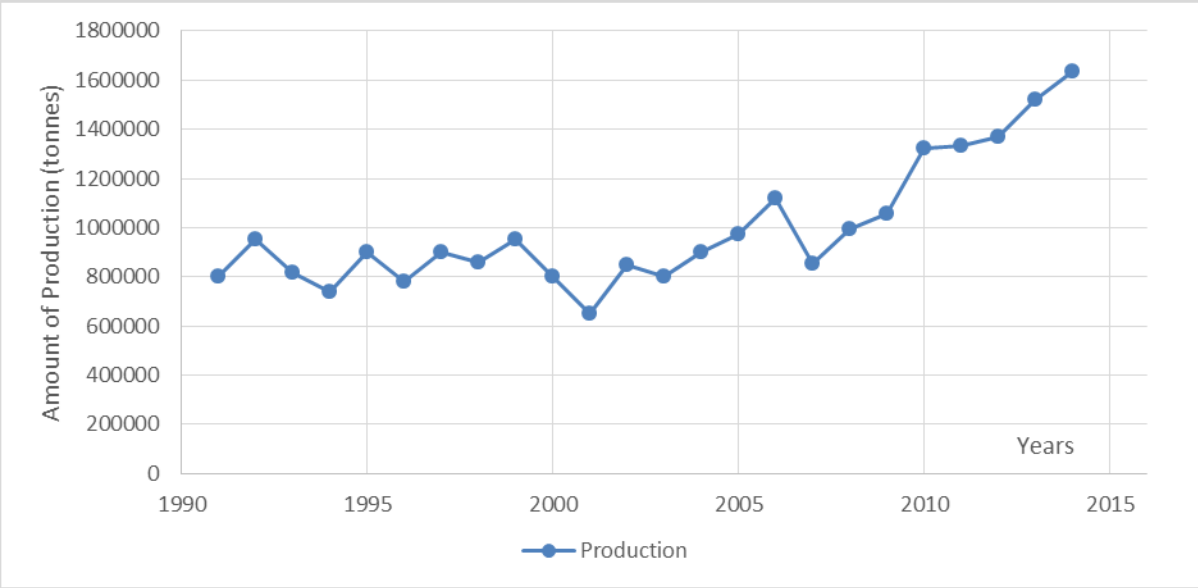

Figure 1: Developments in Sunflower Production in Turkey (www.fao.org)

Figure 2: Developments in Sunflower Seed Prices in Turkey (www.fao.org)

Sunflower having high adaptation capability is growing mainly under dry conditions in Turkey and the world. However, sunflower could not produce in large areas due to getting low income and could not compete with other more profitable crops such as wheat, corn, soybean, cotton etc. in both dry and irrigated conditions (Anonymous, 2017d).

3. Research Findings and Discussion

In this study, the relationship between amount of sunflower and sunflower price were analyzed by using Koyck model. Correlation coefficient between two variable was found as 0.504. It was accepted as sufficient.

Distributed lag model in this study was formed as follow

$$Q_t = \alpha + \beta_0 + \beta_1 P_t + \beta_2 P_{t-1} + \cdots \ldots \ldots \ldots \ldots + \beta_n P_{t-k} + u_t$$

In this equation, Q_t is sunflower production in period t (tonnes), P_t is sunflower price (TL/kg)

To estimate Koyck model, lag value of sunflower prices series lag length was determined. One difficulty that is common to all distributed-lag models is choice of lag length. In order to do this, Schwarz criterion was used (Yurdakul, 1998; Dikmen, 2006). Values for Schwarz criterion determined at different lag lengths is given in Table 1.

Table 1: Lag Lengths Based on Schwarz Values

Lag weight	Schwarz values
k=1	**1.881369**
k=2	2.242160
k=3	2.501150
k=4	2.452680
k=5	2.896393

According to the Schwartz criterion, the lowest Schwartz value was obtained from lag length k=1 value. That means, effect of sunflower price on sunflower production will converge to zero (0) after 1 year.

According to the lag lengths, the relationship between sunflower production and price were estimated using the classical least squares method as follow;

$$Q_t = 0.8727 + 0.1208 P_t + 0.0066 P_{t-1} + u_t$$

(14.135) (2.178) (0.112)

All coefficients in model was found not statistically significant at 1% level of probability. The coefficient of determination (R^2=0.236234) and S.E of regression (0.219246) were found low. Although F statistic of model is significant (4.175572) at 1% level of probability, regression equation was estimated by using Koyck model in order to cope with the negative effects of distributed lag models such as multicollinearity and observation losses. The estimation of regression equation results was given in Table 2.

Table 2: The Results of Koyck Model

Dependent Variable: PRODUCTION
Method: Least Squares
Date: 01/30/17 Time: 01:43
Sample (adjusted): 1985 2014
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.159461	0.133962	1.190351	0.2443
PRICE	0.025041	0.034351	0.728991	0.4723
PRODUCTION(-1)	0.841438	0.150382	5.595335	0.0000

R-squared	0.646167	Mean dependent var	0.999233
Adjusted R-squared	0.619957	S.D. dependent var	0.242066
S.E. of regression	0.149228	Akaike info criterion	-0.872043
Sum squared resid	0.601263	Schwarz criterion	-0.731923
Log likelihood	16.08064	Hannan-Quinn criter.	-0.827217
F-statistic	24.65355	Durbin-Watson stat	2.080082
Prob(F-statistic)	0.000001		

And Koyck model are given as follow;

$$Q_t = 0.159461 + 0.0250P_t + 0.8414Q_{t-1} + u_t$$

(1.190351) (0.728991) (5.595335)

R-squared: 0.646167 F-statistic:24.654 S.E.:149.228

When model results analyzed, Koyck model was statistically significant at 1% level of probability. With reference to model results, a 1 TL increase in sunflower price increased the sunflower production by 0.025 tonnes. An increase of 1 tonnes of sunflower production in the previous period increased the sunflower production by 0.8414 tonnes.

According to information in equation $Mean\ lag = \frac{\lambda}{1/(1-\lambda)}$ $\frac{0.8414}{1/(1-0.8414)}$=0.1885

According to mean lag number, the time required for changes in sunflower prices to have a significant and detectable effect on sunflower production was 0.1885 years.

If we write Koyck model again;

$$Q_t = \alpha + \beta_0 P_1 + \lambda Q_{t-1} + u_t \quad ve \quad b_k = \lambda^k \beta_0$$

Because 0<λ<1 first equation is reached as follows;

$$\beta_k = \lambda^k \beta_0$$

$$\beta_0 = (\lambda^0 \beta_0) = (0.8414)^0 (0.0250) = 0.0250$$

$$\beta_1 = (\lambda^1 \beta_0) = (0.8414)^1 (0.0250) = 0.0210$$

$$Q_t = \alpha + \beta_0 + \beta_1 P_1 + \beta_2 P_{t-1} + \beta_2 P_{t-2} + \beta_3 P_{t-3} + \beta_4 P_{t-4} + u_t$$

$$Q_t = \alpha + \beta_0 P_t + (\lambda\beta_0) P_{t-1} + (\lambda^2\beta_0) P_{t-2} + (\lambda^3\beta_0)\beta_3 P_{t-3} + (\lambda^4\beta_0)\beta_4 P_{t-4} + u_t$$

$$\alpha_0 = \frac{\alpha}{1-\lambda} = \frac{0.159461}{0.1586} = 1.005429$$

When the equation formula derived from Koyck model is rewritten by using this results, equation is obtained as;

$$Q_t = 1.005429 + 0.0250 P_t + 0.0210 P_{t-1} + u_t$$

This distributed lag model derived from Koyck model, it is seen that lag sunflower prices have a decreasing effects on sunflower production since 0<λ<1. Decreasing effects of lag price parameters result from the fact that λ exert an affect was limited in the model. According to the equation, a unit increase in sunflower prices, increased the production 0.0250 tonnes in that year, while one unit increase in the previous year increased the production 0.0210 tonnes. As it can be seen, each lag value has smaller effects on sunflower production As Unakıtan and Miran (2006) indicated, sunflower prices do not encourage the production in Turkey and low price parity between oil seeds and the other agricultural products and price fluctuation have negative effects to oil seeds production.

4. Conclusions and Recommendations

In this study, relationship between sunflower production and price were investigated. In order to determine this relationship, Koyck model were used. While amount of production was dependent variable, its price and lag value of production were independent variable for 1984-2014 time period.

Correlation coefficient was found normal (0.504) and lag length by using Schwarz criterion were determined as 1. This mean that sunflower production is influenced from the prices of only previous year according to annual data used. According to Koyck model results, the time required for the changes in sunflower prices were not estimated insignificant, only 0.1885 years.

As a results, since production cost of sunflower in Turkey is high, world price is lower than Turkey. Because of unproductive farm structure in Turkey, sunflower farming hasn't competitive power in the world market. In addition, there is also lack of competitiveness problems with alternative crops in country and therefore, Turkey is net importer in sunflower production. Despite increased government support in last year, production does not meet for both as sunflower oil consumption and agroindustry.

In order to use natural resources more efficient and decrease lack of production and importation of sunflower, price support should be continued and increased. Increasing the hybrid sunflower seeds usage, making a short and long term planning on sunflower production can be a solution for lack of supply.

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