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The Examination with the Aid of Almon Approach of Cobweb Theorem to Tomato Production in Turkey

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Abstract

The cobweb theorem is a theory which explains supply and demand disparity caused by periodic price fluctuations that emerge from increasing demand during current period due to several reasons. There are lots of econometric analyses that are used to describe this theory. One of these is the Almon Model, which is a distributed lag econometrics model. In this research, it is aimed to describe the relationship between tomato production and tomato prices in the framework of the Almon Model approach. There search period is between 1994-2013. According to the findings that are gained from the model, tomato production in Turkey is retrospectively affected by the prices two years ago at the very most. Where as the prices of "t" period and "t-1" period affect the production positively, the prices of "t-2" period have a negative effect. In the research the validation of the Cobweb Theorem has been proven. This result indicates that price stability through production planning and accordingly supply and demand balance is a necessity. In this way, both production and consumption will be defined and recorded as data and there will be the opportunity to make more reliable predictions. Besides the deficiency due to surplus and high price mechanism due to demand surplus will be avoided.

Keywords: Cobweb theory, Almon Model, Tomato, Production-Price, Turkey.

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Türkiye'de Domates Üretiminde Cobweb Teoreminin Almon Yaklaşımı ile İncelenmesi

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Öz

Cobweb Teoremi (Örümcek Ağı Teoremi), çeşitli nedenlerle artan talep karşısında oluşan fiyat dalgalanmalarının yol açtığı arz-talep dengesizliğini açıklayan bir teoridir. Bu teoriyi açıklamada kullanılan birçok ekonometrik analiz bulunmaktadır. Bunlardan biri de, gecikmesi dağıtılmış ekonometrik bir model olan Almon Modelidir. Bu araştırmada, Almon Modeli yaklaşımı ile domates üretimi ile domates fiyatları arasındaki ilişki açıklanmaya çalışılmıştır. Araştırma dönemi olarak 1994-2013 yılları arası belirlenmiştir. Modelden elde edilen bulgulara göre, Türkiye' de domates üretimi geriye dönük olarak en fazla iki yıl önceki fiyatlardan etkilenmektedir. "t" dönemi ve "t-1" dönemi fiyatları üretimi pozitif yönde etkilerken, "t-2" dönem fiyatları negatif yönlü bir etki oluşturmaktadır. Araştırmada, Cobweb Teoreminin geçerliliği ortaya çıkmıştır. Bu sonuç, üretim planlaması yoluyla fiyat istikrarı ve buna bağlı olarak da arz-talep dengesinin sağlanması gereğine işaret etmektedir. Böylece, hem üretim hem de tüketimbelirlenipveriolarakkaydedilebilecekvedahasağlıklıöngörüleryapılabilmeimkanıortayaçıkacaktır.Ayrıcaarzfazlasındandoğankayıplarvetalepfazlasındanoluşacakyüksekfiyatmekanizmasınınönünegeçilmişolacaktır.

Anahtar Kelimeler: Örümcek Ağı Teoremi, Almon Modeli, Domates, Üretim-Fiyat, Türkiye.

Introduction

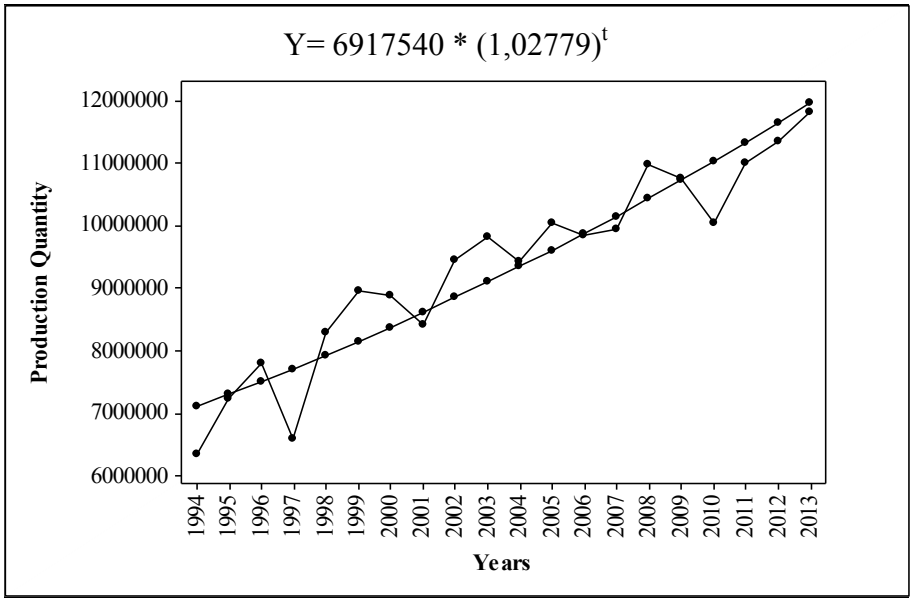
Tomato is one of the leading agricultural products that is mostly cultivated, consumed and a subject to trading. Economically it is one of the significant vegetables due to the fact that it is an important product in human nutrition and it has various usage fields in the food industry (Keskin and Gül, 2004). In 1900s it was cultivated in Adana region for the first time in Turkey and it became one of the farmers' source of income in the regions where it was cultivated (Aybak and Kaygısız, 2004).Furthermore, in today's conditions, it is believed to be an important issue that it needs to be cultivated and commercialized both because of being a direct human nutrition and providing feedstock to industry.

China was the leader in tomato production in the World in 2011 with a production of approximately 48.5 million tonnes. And China is followed respectively by India with a production of 16.8 million tonnes, the USA with 12.5 million tonnes and Turkey with 11 million tonnes. These uppermost countries in tomato production, excluding India, showed decrease in their 2011 productions. China, whose production percentage in the World was 15% in 1995, increased its percentage to 29.2% in 2009 and to 30.4% in 2011 with a heavy increase especially after 2000 (Keskin, 2013).

The tomato production in Turkey in 2009 showed 2.2% decrease compared to previous year and in 2010 6.5% decrease compared to the previous year, but in 2011 showed 9.5% increase compared to previous year and 4% increase in 2013 compared to previous year. While the tomato production in 1994 was 6.350.000 tonnes in 2013 it was around 11.820.000 tonnes. The increase of tomato production in the last 20 years in Turkey has been 1.9 times.

The trend and the relevant trend equation of Turkey's tomato production between 1994 – 2013 has been shown in Figure 1.

Figure 1. The Trend of Turkey's Tomato Production Between 1994 – 2013



Average trend of tomato production between 1994-2013was in a positive way. In Turkey tomato productionin the last 20 years has shown an exponential augmentation. When the increase trend and the relevant balance in Figure 1 are taken into consideration, it is determined that it has a 2.8% average rate of increase annually. Thus, it is thought that to study the production – price relationship of tomato, which is considered to be an important agricultural food for Turkey, is worth examining and the situation of production against the prices has been analyzed in the framework of Cobweb Theorem which mostly applied to explain whether an equilibrium exists in agricultural food markets. Annual fluctuations of production with respect to prices have been presented in this study.

Materials and Method

In the study, time series analyses have been used to examine the production – price relationship. Time series analyses are mainly on the base of forecasting due to some knowledge they contain (Tarı, 2014). In the research, the effect on the amount of production that is created by price and that is forecast to be created in the future has been tried to be explained with Almon Model, which is one of the time series analyses. The data that is

related to the model were gained from national and international resources such as (TUIK, 2014)and (FAO, 2014). The production and price series that are subject to examination include the years between 1994 – 2013 and the data set has been adapted to the Almon Model. Our theoretical model is that;

$$Q= \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \beta_3 X_{t-3} + \beta_4 X_{t-4} + \ldots\ldots\ldots + \beta_k X_{t-k} \quad (1)$$

The parameters in the research are listed below;

Q=Tomato Production amount (Tone)

X_t=The prices that the farmers receivein current year (kg/TL)

"X_{t-1}"= The prices that the farmers had one season before

"X_{t-2}" =The prices that the farmers had two seasons before

"X_{t-i}"= The prices that the farmers had "i" seasons before

Price of tomato were not deflated. Reason to use the current prices that the farmers have in the research is because it is the income in full that the producers have after selling the products. In other words, it is the prediction that the prices that farmers have is the primary element on the decision of production. In the first stage of the study, in order to determine the production – price relationship, the ordinary least squares method have been used to analyses the variables.

According to the classical economics theory, in the conditions of free market, the solution to all economical problems is realized automatically thanks to regular price mechanisms. This means that when there is no intervention in the system of prices, it is assumed that there will be an on going supply and demand balance (Karakayalı, 2002).

From this point of view, according to economic theory the assumption that the market of agricultural products functions in the conditions of free market is prevalent. In the ongoing economic system, although the direct or indirect effect of the government on agricultural production cannot be ignored, in theoretical approaches, the assumptions of free market are accepted.

In this study, the indirect support of the government to tomato production has been ignored, too and among the factors that affect the production, only the prices that farmers have been taken into consideration. Because in the functioning of the Cobweb Theorem, the supply and demand movements dimensioning against prices come into question.

In the dynamical analysis studies, the product prices that affect the producers' production amount are examined as the prices of the previous year. Because the producer decide on the production in the current year by taking the prices of the previous year (X_{t-1}) into consideration.

This situation can appear as surplus and demand surplus in the production – price relationship and generates the phenomenon that is called as "Cobweb Theorem" in the economics literature. The first reason of the cobweb phenomenon is due to the fact that the producer cannot simultaneously increase the product supply in relation to increasing demand. Thus, the quantity supplied becomes a function of the previous season's price and the product supply is realized as$S_t=f(P_{t-1})$ (Gürler, 2012).

Due to the fact that the Cobweb Theorem examines the market fluctuation especially by predicating it on the relationships between the prices and the productions in the markets of agricultural products, there are lots of studies in the literature about the Cobweb Theorem (Ezekiel, 1937; Nerlove, 1958; Waugh, 1964; Auster, 1971; Jensen and Urban, 1984; Hommes,1991; Arifovic, 1994; Hommes,1994; Gallas and Nusse, 1996; Hommes,1998; Goeree and Hommes,2000; Onozakiet al., 2000).Some studies in the literature to introduce the Cobweb Theorem can be defined as (Yurdakul, 1998; Branch, 2002; Branch and McGoughb, 2008;Dikmen, 2005, Erdal, 2006; Özçelik and Özer, 2006; Erdal and Erdal, 2008; Erdal et al., 2009, Dieci and Westerhoff, 2009; Doğan and Gürler, 2013, Doğan et al., 2014)

In the study, an 86.7% positive correlation has been determined between production and price. This relationship carries a prior knowledge about the fact that the study can be carried out with two variables discussed.

S. Almon (1965) improved her own model by practicing on "Weierstrass Theorem" in Mathematics. In the model "β" values are described as a

function of "i"(the time lag) in a certain degree. There are two basic equations that generates the cruxes of Almon model (Gujarati, 2001);

$$Y_t=\alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \beta_3 X_{t-3} + \beta_4 X_{t-4} + \ldots\ldots\ldots + \beta_k X_{t-k} \quad (2)$$

$$\beta_i=a_0 + a_{1i} + a_{2i}^{\,2} + \ldots\ldots + a_{mi}^{\,m} \quad (3)$$

In the stage of modeling, firstly suitable time lag is acquired by using Schawarz Information Criteria(SIC) or Akaike Information Criteria (AIC). In the model, the lag that makes AIC and SIC value the minimum value is considered to be the suitable time lag (Kutlar, 2000). The notations related to AIC and SIC values are defined in Equation4and Equation5;

$$AIC= T\, ln\sigma^2 + 2n \quad (4)$$

$$SBC= T\, ln\sigma^2 + n\, ln(T) \quad (5)$$

T = Number of usable observations,

n = Number of parameters estimated,

$\sigma^2 = \frac{KKT}{Tn}$=the highest probability estimation or error variance related to the model

KKT = Residual sum of squares (RSS)

After the determination of the suitable time lag, the polynomial degree needs to be determined. Polynomial degree is at least one more than the number of each flection (maximum or minimum points). The determination of the polynomial degree is mostly subjective. Thus to determine these criteria is up to the researcher's forecasting (Akın, 2002). In this study, on the basis of AIC the most suitable time lag has been determined as "X-2" season and polynomial degree has been determined as second degree polynom by forecasting. After the determination of the polynomial degree, the suitable "Z" values are acquired. In the acquisition of "Z" values, The Equations 6, 7 and 8 can be used;

$$Z_{0t} = \sum_{i=0}^{k} X_{t-i} \quad (6) \qquad Z_{1t} = \sum_{i=0}^{k} i\, X_{t-i} \quad (7) \qquad Z_{2t} = \sum_{i=0}^{k} i^2 X_{t-i} \quad (8)$$

In the Almon sequence that is created, the regression of Y is acquired according to "Z" variables that have been generated, not according to "X". The equation above can be forecast with OLS method. So, the forecast ofα

and a_i would provide all the statistical conditions required, on condition that possibility disturbance term fulfills the forecast of classical linear regression model(Gujarati, 2009)

$$Y_t=\alpha+a_0Z_{0t}+a_1Z_{1t}+a_2Z_{2t}+u_t \qquad (9)$$

After the transferal to Equation 8, in the schema of second degree polynomial time lag, when the model is forecast with OLS method, a_0, a_1 and a_2 coefficients are acquired. And when the "a" coefficients acquired are put into their places, "β" coefficients are acquired (Tarı, 2005). "a" type values of"β_i"s are acquired as in the Equations10,11,12,13.

$$\beta_0 = a_0 \qquad (10)$$

$$\beta_1 = a_0+ a_1 + a_2 \qquad (11)$$

$$\beta_2 = a_0+ 2a_1+ 4a_2 \qquad (12)$$

$$\beta_3 = a_0+ 3a_1+9a_2 \qquad (13)$$

When the estimated $\beta_i$values are put into their places, it can be interpreted as an equation that has been solved with the classical OLS method.

Research Findings

In the research, AIC values in different time lags have been examined in order to determine that howlong ago at the very most do the tomato producers consider the prices retrospectively in tomato production. The value that makes the AIC value in time lags minimum expresses the maximum lag. The AIC value in different time lags is shown in Table 1.

Table 1.Time Lags and AIC values

Time Lag	"t"	"t-1"	*"t-2"*	"t-3"
AIC Value	30,08	29,75	*29,71*	29,86

The time lag that makes the AIC value minimum is acquired as the prices in "t-2" season. In this time lag the relationship between the production amount and the price has been analyzed with the Ordinary Least Squares (OLS) method and the results have been shown in Table 2.

Table 2.The OLS Analysis of Tomato Production in Turkey in Different Time Lags

$Q_t=16,23-0,18X_t-0,04X_{t-1}+0,2575X_{t-2}$ (14)			
	Coefficient	**Standard error**	**t statistics**
$\mathbf{X_t}$	-0,1822	0,0842	-2,1627**
$\mathbf{X_{t-1}}$	-0,0422	0,0715	-0,5904**
$\mathbf{X_{t-2}}$	0,2575	0,0591	4,3535*
Constant	16,2306	0,0168	964,3800**
R^2=0,92 Adj. R^2 =0,90 F=52,89 P=0,0000			

*found in % 1 level significance **found in %5 level significance

According to the results of the model, it is determined that whereas the prices of tomato in the current year and "t-1" period affect the production negatively, the prices of "t-2" period has a negative effect. When the acquired statistical results have been evaluated, whereas the coefficients of "t" period and constant term have been found 1% important, the coefficient of "t-2" period has been found 5% important. In terms of partial regression coefficients all the parameters excluding "t-1" period have been found statistically meaningful. When the model is wholly considered, it has been found 1% meaningful and the adjustment determination coefficient is 90%. In other words, 90% of the tomato production can be explained by the prices in "t", "t-1" and "t-2" periods.

As it can be remembered from the method section, it is necessary to get "Z" values. Based on the notations to get "Z" values that have been described before;

$$Z_0 = \sum_{i=2}^{2} X_{t-i} = -236187,32$$

$$Z_1 = \sum_{i=2}^{2} iX_{t-i} = 3649582,14$$

$$Z_2 = \sum_{i=2}^{2} i^2 X_{t-i} = -1218351,14$$

the results above have been found. Based on the new equation generated and by using the "Z" parameters, we can reach to the ultimate Almon model. In

this case;

$$Q_t = 8135154{,}25 - 236187{,}22\ Z_0 + 3649582{,}14\ Z_1 - 1219351{,}14\ Z_2 \quad (15)$$

And the "β" parameters that are acquired have been defined in the equations below.

$$\beta_0 = a_0 = -236187{,}32$$

$$\beta_1 = a_0 + a_1 + a_2 = 2195043{,}68$$

$$\beta_2 = a_0 + 2a_1 + 4a_2 = 2425759{,}72$$

$$\beta_3 = a_0 + 3a_1 + 9a_2 = -16413{,}84$$

After the acquisition of "β" parameters, the ultimate Almon model would be written as the equation below;

$$Q_t = 236187{,}32 + 2195043{,}68\ X + 2425759{,}72\ X_{t-1} - 16413{,}84\ X_{t-2} \quad (16)$$

The results of Almon model can be explained in this way. One unit increase in the prices of "t" period ramps up the amount of production by 2195044 units and one unit increase in the prices of "t-1" period increases the tomato production in current year by 2425760 units. Similarly, one unit increase in the prices two periods before decreases the production in the current year by 16414 units. As it can be interpreted from the results that the prices of "t-1" period is more effective on the decisions of the producers production as the dynamic analysis has forecast. Besides, it is possible to see the cobweb's existence by the positively and negatively change of the coefficients in these findings.

Conclusion

The fluctuations in the output market, which is named as Cobweb Theorem in the literature of Economics and which can be identified with some econometric analyses, can come up as a result of an unsteady production. The market of agricultural products, which is assumed to function in the conditions of free market, can cause increase in the prices as a result of short supply in return for the demand that increases all of a sudden. In parallel with this, negative results such as surplus and demand surplus occur. Therefore, balanced product prices and correspondingly the demand and the product supply like in a two- handed seesaw are the desired result. In this research, the interaction between the production and the prices was examined with Almon approach which is one of the distributed lag econometrics models. Tomato production has been used as dependent variable and the tomato prices that the farmers had have been used as

explanatory variable. The model, which has been generated with the annual data, covers the years between 1994–2013. It is found that in Turkey's conditions, tomato production is retrospectively affected by the prices two years ago at the very most. Whereas the prices in the current year and "t-1" period affect the production positively, the prices "t-2" period ago has a negative effect. As it is known, "t-1" period prices are effective in dimensioning the decisions of the producers. In the findings of this research, it is also observed that the effect of "t-1" period is more than the other periods. The result that the prices of different periods cause fluctuations on tomato production can be considered as an indication that there is still not a planned production mechanism in Turkey. This situation both creates negative effects on producers' incomes and in some certain periods causes the consumers to purchase products that price out the market. In order to prevent the price fluctuations and accordingly the supply and demand disparity, without direct intervention, balancing the production and consumption through the ways such asorganizing the producers, contract producing, specialization and improving the effectiveness of the lobbyist organizations can be considered as a solution to resolve the problems in question.

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