RESEARCH ARTICLE

Cointegration analysis of broiler meat and broiler feed prices in Turkey

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Türkiye'de piliç eti ve piliç yemi fiyatlarının kointegrasyon analizi

Öz

Amaç: Etlik piliç yetiştiriciliğinde kullanılan girdiler içerisinde yem maliyetinin yüksek oranı piliç eti fiyatının oluşumunda belirleyici olmaktadır. Türkiye'de piliç yemi sanayinde kullanılan hammaddelerin üretiminin iç piyasayı karşılamada yeterli olmaması nedeniyle talep ithalat yoluyla karşılanmaktadır. Bundan dolayı döviz kurlarında meydana gelen değişim nihai ürünün fiyatına da yansımaktadır. Bu çalışmanın amacı piliç eti ve piliç yemi fiyat serilerine ait değişkenler arasındaki ilişkilerin analiz edilmesidir.

Gereç ve Yöntem: Türkiye'de 2006-2018 arası dönemde TL ile Dolar cinsinden piliç eti ve piliç yemi fiyat serilerine ait değişkenler arasındaki ilişkiler johansen koentegrasyon analiz tekniği ile belirlenmiştir.

Bulgular: Analiz sonuçlarına göre; Türkiye'de etlik piliç yemi ve piliç eti fiyatlarının kısa dönemde eş bütünleşik olduğu, fiyatların birbirini takip ettiği tespit edilmiştir. Bu takibin yem fiyatlarındaki bir değişimin kanatlı eti fiyatlarına TL cinsinde iki dönem (2 ay) sonra, USD cinsinden ise bir dönem (1 ay) sonra etki ettiği belirlenmiştir.

Öneri: Sonuç olarak piliç eti fiyatlarının kısa dönemde girdi maliyetleri göz önünde bulundurularak belirlenmesi gerekmektedir. Ancak dolar kurlarında meydana gelen dalgalanmalar girdi fiyatlarını çok kısa bir dönemde etkilediğinden dolayı piliç eti fiyatlarında etkili bir fiyat mekanizması oluşturulamamaktadır.

Anahtar kelimeler: Fiyat, kointegrasyon, piliç eti, Türkiye, piliç yemi

Abstract

Aim: The high share of feed costs among the costs of inputs used in broiler breeding plays a significant role in the formation of broiler meat price. As the production of raw materials used in the broiler feed industry is not sufficient to meet the demand in the domestic market, the demand is met by importation. As such, the fluctuations in the exchange rates are reflected in the price of the final product. The aim of this study is to analyze the relationships between the variables of broiler meat and broiler feed price series.

Materials and Methods: In Turkey, the relations between the variables related to the price series of broiler meat and broiler feed in TL and in USD between 2006 and 2018 were determined by johansen cointegration analysis technique.

Results: The results of the analysis indicate that the broiler feed and broiler meat prices in Turkey are cointegrated in the short-term and follow each other's pattern. It was found that the change in the prices of feed had an effect on the TRY-denominated prices of poultry meat in two months and USD-denominated prices of poultry meat in one month.

Conclusion: Consequently, broiler meat prices should be set taking into account the costs of inputs in the short-term. However, since the fluctuations in the USD exchange rate affect the input prices immediately, an effective price mechanism for broiler prices cannot be developed.

Keywords: Broiler feed, broiler meat, cointegration, price, Turkey

210

Introduction

Today, the level of development in the livestock sector depends on the level of development of the industrial sectors from which the inputs of the livestock sector are procured. The mixed feed industry fulfills an exceptionally important function in the supply of mixed feed for economic and industrial livestock breeding (Denli et al 2015). Globally, consumers are demanding a higher amount of more diverse foods with each passing day. As the purchasing power has increased in many countries, consumers tend to shift their preferences toward high-value foodstuff such as meat and milk, which has resulted in increased demand for feed used in stockbreeding (Armah et al 2009; Banerjee 2011). The need for broiler feed is rising due to the increased production in the broiler industry (TPMPBA 2013).

Broiler producing companies in Turkey are vertically integrated, meaning that they breed and slaughter the broilers and have their own channels to distribute their products (Özertan et al 2014). Vertical integration has also promoted the broiler producing companies to be engaged more in the practice of producing the mixed feeds they need (Güneş et al 2010). With the development of the poultry sector, the demand for high-quality mixed feed has been on the rise. Therefore, the sector imports high-quality oil seed and cake, fish meal and other raw materials whose demand cannot be met domestically, such as corn. This has resulted in approximately 75% of the ingredients of broiler feed being composed of imported raw materials (Karakuş 2010).

As in other livestock production areas in Turkey, the primary problem of the poultry industry is the feed deficit (Tandoğan 2014). Mixed feed production in Turkey increased by 145% between 2007-2017, reaching a production capacity of 22.4 million tons. 39.6% of the current production is performed by the poultry industry. The share of the broiler industry in the total production of poultry feed is 53.3% (TFIA, 2018). Several studies focusing on production costs in Turkey reported that the share of feed costs in the total cost of broiler production ranged between 64.11% and 69.97% (Sakarya 1990; Gür 1998; Tandoğan 2014). For this reason, the high share of feed in the total cost of production is reflected in the broiler meat prices in a certain period of time (Çiçek and Tandoğan 2007). Previous studies report that the changes in the broiler producer prices are symmetrically reflected in retail prices (Barahona et al 2014), that corn price is a major determinant for the formation of broiler meat price (Babula et al 1991), that the most significant factor underlying the broiler meat supply is the feed prices (Rezitis and Stavropoulos 2010), that input prices affect the wholesale and retail prices of broiler meat in the short- and long-term (Erdem et al 2011), and that fluctuations in input prices affect the regulation of the broiler market (Khiyavi et al 2012).

The purpose of this study is to identify the relationships between the time series of broiler meat and broiler feed prices in TRY and USD in Turkey for the period between 2006 and 2018 using Johansen cointegration analysis technique.

Material and Methods

Dataset

The data set of the study consists of the TRY-denominated prices of broiler feed (BFTRY in kg/TRY) and broiler meat (BMTRY in kg/TRY) as well as USD-denominated prices of broiler feed (BFUSD in kg/USD) and broiler meat (BMUSD in kg/USD) for the period between 2006 (January) and 2018 (September). The monthly broiler feed prices were taken from the Turkish Feed Industrialists Association (TFIA 2018) and the monthly broiler meat prices from the consumer prices in the TURKSTAT's database (TURKSTAT 2018). The exchange rates published by the Central Bank of Turkey were used to convert the TRY values of the variables into USD (CBRT 2018). Since monthly prices were used, each time series contained data for 153 periods.

The relationship between the price time series of broiler feed and broiler meat was tested employing Johansen cointegration analysis technique. EViews 10 Enterprise Edition was used to analyze the variables (EViews 10 Enterprise Edition 2017).

Statistical Analysis

The first difference of the monthly price series was used for the analysis of the variables. While the graphical representation of the variables may be useful to have an idea with regard to whether the variables has a unit root, formal tests should be conducted to be definite about it. For this purpose, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used.
Final Prediction Error (FPE), Hannan-Quinn (HQ), Schwarz (SW), Likelihood Ratio (LR) and Akaike Information Criteria (AIC) data were used to determine the common lag length of the variables.
Hatemi-J (2003) asserts that SW and HQ is more effective in determining the optimum lag length than the other criteria. However, SW criteria tend to give a higher lag length than HQ criteria in some cases. Taking into account such disadvantages, Hatemi-J Criteria (HJC) consists of the combination of the two criteria:

$$HJC = \ln(\det \hat{\Omega}_j) + j\left(\frac{n^2 \ h \ T + 2n^2 \ln(\ln T)}{2T}\right) \ j = 0,\ldots,K \quad [1]$$

211

The HJC, as well as other criteria, were used to determine the lag length of the cointegration system in our study. Therefore, the Johansen method was employed in this cointegration study.

The Johansen method was employed for the cointegration study. Engle and Granger (1987) method is a method that is easy to calculate and implement. However, it has some shortcomings or difficulties. When different equations are estimated for each variable in the system – e.g. in a system containing two variables – the covariance relationship is observed in the equation of the other variables, whereas the variable has cointegration relationship in one equation. This may result in an ambiguity among the variables. If there is more than one variable in the system, this ambiguity will be an issue. This method has no dedicated procedure to decompose more than one consistent.

Due to the abovementioned difficulties and shortcomings, Johansen (1988) and Stock and Watson (1993) suggested a test to compute the estimators of cointegrating vectors through Maximum Likelihood method.   [2]

The Johansen method is a generalized representation of Dickey-Fulley method.

$$X_t = \Pi_1 X_{t-1} + ... + \Pi_k X_{t-k} + e_t, t = 1,2,...,$$

Here, X denotes the vector of the variables represented by past values. This denotation refers to the variables using the past model values in the VAR model. If we express the model in moving averages, we reach the following equation.

$$A(e) = I - \Pi_1 e - ... - \Pi_k e_k \qquad [3]$$

The rank r of matrix A gives the number of matched vectors, and in equations where r<p the variable with dimension p can be at most one less than the vectors. The error term has a white noise process.

$$A(e)\big|_{e=1} = \Pi = I - \Pi_1 - ... - \Pi_k, \qquad [4]$$
$$\Pi = \alpha\beta'$$

The coefficients matrix Π is the sum of the matrices α and β' with dimension (pxr). α denotes the adjustment rate, and β' denotes the matrix obtained by the maximum likelihood method where the number of rows is equal to the number of cointegrating vectors.

This method is for evaluating the hypothesis that there is at most r cointegrating vectors through maximum likelihood estimation.

$$-2\ln(Q) = -T\sum_{i=r+1}^{p}\ln(1-\hat{\lambda_i}) \qquad [5]$$

The critical values to which the statistical values of λtrace and λmax obtained as a result of the tests are highlighted in the study by Johansen and Juselius (1990).

Deterministic components can also be included in the test when required. If the series has an increasing and decreasing trend or seasonality, the relevant components can be included in the model. The test may already contain the deterministic components introduced by the Engle-Granger method.

Results

Longitudinal price graphs of the variables are given in Figure 1. Results of the ADF and PP tests conducted to determine whether the time series of the variables were stationary are given in Table 1.

Since all of the variables have a unit root according to the results in Figure 2 and Table 1, cointegration test was conducted on the variables with I(1) process.

According to the results obtained, the test is successful in determining the optimum lag length in more than 85% of the small samples (T=40). Its success is further enhanced in large samples.

The criteria used to determine the lag length of the variables are given in Table 2.

The results in Table 2 indicate that all criteria provide the same result as the optimum lag length. Hence, a synchronization can be used as an optimal lag in a synchronicity study. The criteria used to determine the lag length of BFUSD and BMUSD are given in Table 3.

The results in Table 3 indicate that all criteria provide the same result as the optimum lag length. Hence, a synchronization can be used as an optimal lag in a synchronicity study. It was found that second lags in TRY prices and first lags in USD prices were significant.

The long-term relationship between variables is examined in a synchronous model structure. That is, it is a whole. All cooperative relationships are observed synchronously in integrity. In the Engle-Granger test, the maximum likelihood estimators of the coefficient matrix would provide consistent estimations.

Therefore, the Johansen method was employed in this cointegration study. The test results are given Table 4 and Table 5. According to the results in Table 4 and Table 5, a statistically significant cointegration relationship was found between the variables. At an error margin of 5%, there is a long-term relationship between the variables. As can be seen in Table, both eigenvalue and max-eigenvalue statistics indicate that there is a short-term relationship between the variables.

The TRY-denominated broiler feed and broiler meat prices in Turkey are cointegrated in the short-term, follow each other's pattern and are affected by the prices in the second

212
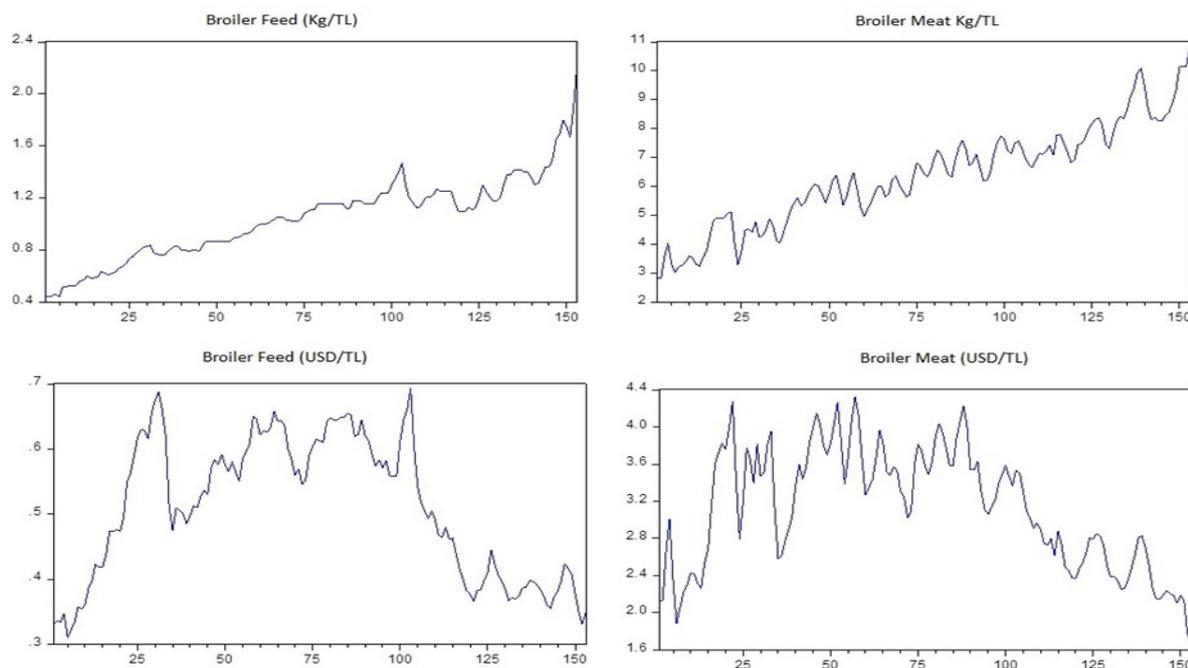
Figure 1.Longitudinal price graphs of the variables

Table 1. Results of ADF and PP tests)		
Variables	ADF	PP
ΔBFTRY	-6.72	-5.86
ΔBFUSD	-8.82	-8.67
ΔBMTRY	-12.36	-9.34
ΔBMUSD	-11.61	-8.64

First difference of Δ BFTRY, Δ BFUSD and Δ BMTRY was taken, and they were subjected to unit root test after adding a constant and trend. Critical value for ADF and PP is -3.62 at 5%. Δ BMUSD was included in the regression analysis after its first difference was taken and without any constant and trend. Critical value is -1.96 at 5%.
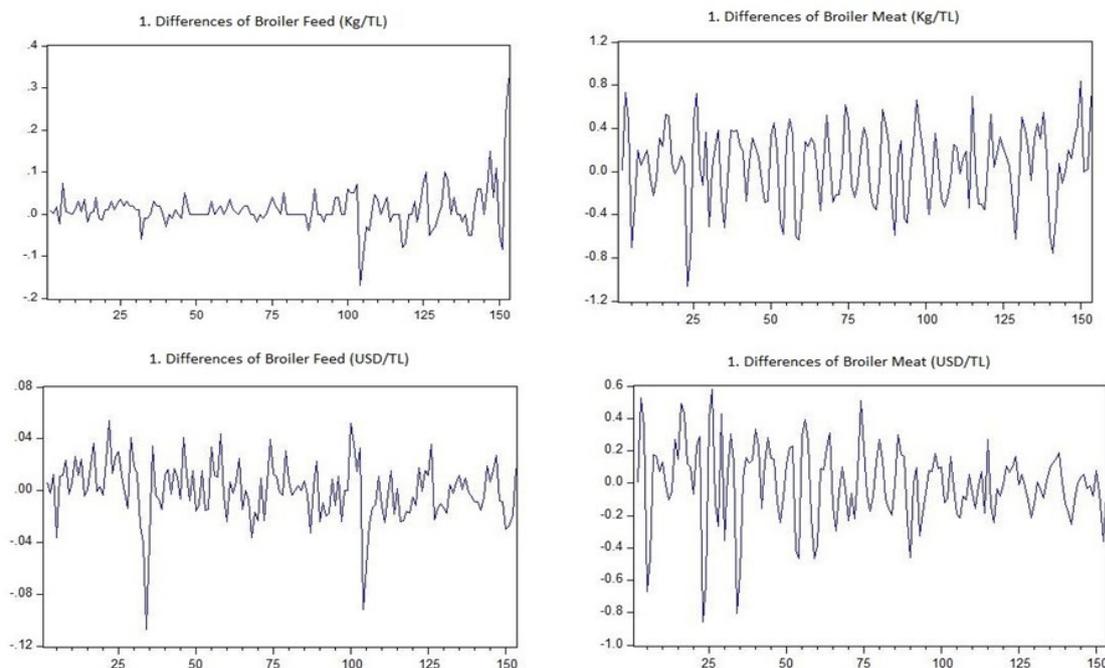
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Figure 2. First-difference of the variable prices

213

Table 2. Criteria used to determine the lag length of the variables BFTRY and BMTRY						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	185.32	NA	0.000288	-2.47	-2.43	-2.46
1	211.32	50.95	0.000214	-2.77	-2.65	-2.72
2	236.48	48.61*	0.000161*	-3.06*	-2.85*	-2.97*
3	238.52	3.88	0.000165	-3.03	-2.75	-2.91
4	239.92	2.63	0.000171	-2.99	-2.63	-2.85

Table 3. Criteria used to determine the lag length of the variables BFUSD and BMUSD					
Lag	LogL	LR	FPE	AIC	SC
0	367.07	NA	2.47e-05	-4.93	-4.89
1	385.67	36.43*	2.03e-05*	-5.13*	-5.00*
2	411.95	50.78	1.50e-05	-5.43	-5.22
3	414.91	5.62	1.52e-05	-5.41	-5.13
4	419.26	8.18	1.51e-05	-5.42	-5.05

Table 4. Results of BFTRY and BMTRY variables Johansen cointegration test				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen/ Statistic	(0.05) Critical Value	Prob.**
None *	0.39	74.32	15.89	0.0000
At most 1 *	0.15	24.33	9.164	0.0000

Table 5. Results of BFUSD and BMUSD variables Johansen cointegration test				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen/ Statistic	(0.05) Critical Value	Prob.**
None *	0.37	70.23	11.22	0.0001
At most 1 *	0.20	33.52	4.12	0.0000

broiler feed and broiler meat prices in Turkey are cointegrated in the short-term, follow each other's pattern and are affected by the prices in the previous period.

Discussion

A growing trend in red meat consumption is predicted in Turkey (Özen et al 2019), but the high prices of red meat and the efforts to meet the resulting animal protein gap are causing an increase in broiler meat production (Çiçek and Tandoğan 2007; Cinar and Keskin 2018). Particularly, the consumers in developing countries meet their need for protein of animal origin by consuming poultry meat without having to allocate a significant share of their consumption budget (Özertan et al 2014). Previous research calculated the share of broiler meat in the food expenditures of households in Turkey at 3.66% (Akbay et al 2008).

Price plays an important role in determining the volume of the inputs demanded and supplied in the market (Kotler 1982). As feed costs compose a significant portion of broiler meat production costs and a large part of the raw materials used in broiler feed are imported, they are affected by fluctuations in the exchange rate in the short-term. This suggests the need for setting the broiler meat prices in a short period of time, taking into account the demand for broiler meat in the market (Njoroge et al 2015). Indeed, it is reported that when the price of soybean, the main imported input among the feed raw materials, rose by 10%, the price of broiler meat increased by 3.84% (Cinar and Keskin 2018).

In this study focusing on the time series of the TRY- and USD-denominated prices of broiler meat and broiler feed in Turkey for the period between 2006 and 2018, it was found that the time series were not stationary, but after taking their first difference the trend in the variables was eliminated using ADF and PP unit root tests and they became stationary (Figure 2). Hence, a cointegration analysis was conducted to identify the relationship between the variables.

According to the results of the analysis, broiler meat prices and broiler feed prices in Turkey are cointegrated. This distinct characteristic distinguishes the broiler industry from other livestock industries. In other livestock industries (e.g. dairy, egg, etc.), increases in feed prices result in decreased feed production. However, since a large portion of broiler feed production is performed by broiler producing companies because of the vertical integration in the sector, any increase in broiler meat prices results in increased production of broiler feed in the next year (Güneş et al 2010). During the period under consideration (2006-2018), the price of broiler meat rose by 3.84 times and the price of broiler feed by 5.07 times (Figure 1). In other words, while the price of broiler meat increased by 2.5% monthly on average, the price of feed increased by 3.3%.

Conclusion

In conclusion, a short-term relationship was found between the TRY- and USD-denominated prices of broiler feed and broiler meat. An analysis of the TRY-denominated prices that follow each other's pattern showed that broiler feed and broiler meat prices were affected by the prices in the second previous period (2 months). Therefore, broiler meat prices should be set taking into account the costs of inputs in the short-term so that production planning and stock management can be carried out properly. However, as it is not possible to reduce the costs in the short-term, the increases in the price of inputs are reflected in the price of the final product.

An analysis of the USD-denominated prices showed that broiler feed and broiler meat prices were affected by the prices in the previous period (1 month). Since the raw materials of the feed used in broiler meat production are imported, the price of broiler meat is affected by the fluctuations in the exchange rate in the very short-term. This makes the broiler industry even more dependent on global markets and reduces its competitive power in the international arena.

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215

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