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Factors affecting the price of raw milk in Turkey using panel data analysis

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ABSTRACT: *The high costs of feed among the total costs of raw milk production and an unfavorable milk-feed ratio directly affect the profitability of milk producers. To understand how the market in Turkey can be equilibrated, an exploration of the factors affecting milk prices is essential. This study determined the effects of the basic and the economic indicators on the price of raw milk between 2010 and 2019, by analyzing the monthly panel data. Since time series data are used, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are conducted to find out whether the series is stationary. In order to see the individual effects, the parameters are estimated using the fixed and random-effects models. The Hausman test is conducted to decide which of the two models is valid. The basic indicators for milk price, namely, prices of barley, soybean meal, wheat and distillers dried grains with soluble (DDGS), and the economic indicators, namely, dollar exchange rate and agricultural producer price index* **(***PPI) had significant (P < 0.05; P < 0.01) effects on the milk price. In conclusion, it is reported that the raw milk prices in Turkey are considerably affected by the prices of feed ingredients as well as the general economic conditions.*

Key words: *economics, feed price, milk price, panel data, Turkey.*

Fatores que afetam o preço do leite cru na Turquia usando análise de dados em painel

RESUMO: *Os elevados custos da ração entre os custos totais para a produção de leite cru e uma relação leite-ração desfavorável afetam diretamente a lucratividade dos produtores de leite. Para entender como o mercado na Turquia pode ser equilibrado, é essencial explorar os fatores que afetam os preços do leite. Este estudo pretende determinar os efeitos dos indicadores básicos e econômicos sobre o preço do leite cru entre 2010 e 2019, por meio da análise de dados em painel mensal. Como os dados de série temporal são usados, os testes de Dickey-Fuller Aumentado (ADF) e Phillips-Perron (PP) são conduzidos para descobrir se a série é estacionária. Para ver os efeitos individuais, os parâmetros são estimados usando os modelos de efeitos fixos e aleatórios. O teste de Hausman é realizado para decidir qual dos dois modelos é válido. Encontram-se os indicadores básicos do preço do leite.Os preços da cevada, farelo de soja, trigo e grãos secos de destilaria com solúveis (DDGS), e os indicadores econômicos. A taxa de câmbio do dólar e o índice de preços ao produtor agrícola (PPI), ter efeitos significativos (P < 0,05; P < 0,01) no preço do leite. Em conclusão, verifica-se que os preços do leite cru na Turquia são consideravelmente afetados pelos preços dos ingredientes para rações, bem como pelas condições económicas gerais.*

Palavras-chave: *economia, preço da ração, preço do leite, painel de dados, Turquia.*

INTRODUCTION

In Turkey, 90.5% of the 22,960,894 tons of raw milk produced in 2019 was cow milk, 6.7% sheep milk, 2.5% goat milk, and 0.3% water buffalo milk (MAFT, 2020). In 2019 the amount of imported raw milk industry in Turkey was realized as 45.74% (TÜİK, 2020). Turkey in 2019 was exported 208 151 tons of dairy products revenue was US $ 356 850 975. Conversely, 19,479 tons of dairy products were imported and US $ 80,339,409 was spent (SETBİR, 2020). Of the 1,382,080 dairy farming businesses, 81.1% have 1–10 head of livestock and 18.9% have more than 10 head of livestock. The vast majority of the businesses are engaged in traditional, non-specialized, small-scale, distributed production, which increases their production costs (SAKARAYA & ARIKAN, 2014).

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The fact that these businesses are unable to achieve economies of scale in the production of forage crops as their land shares are small and distributed boosts their feed cost, which, in turn, is a significant share of their total milk production costs (NUMANOĞLU et al., 2014). There are not enough meadows and pastures in Turkey, and existing fields are declining with each passing day (SIMSEK, 2020). Therefore, the feed requirement of the producers is constantly increasing (GÖKHAN, 2003). In the study conducted, the use of pasture is important in increasing farm productivity (BOZOGLU et al., 2017). In the current literature, the share of feed cost in operating costs has been calculated to be between 48.65-65.30% (SANTOS et al., 2018; ÖRS & OĞUZ, 2019; TAPKI, 2019). Furthermore, the feedstuff prices are adversely affected by erratic exchange rate fluctuations, dependence on foreign raw materials, and additives used in feed production (CBRT, 2020). According to the 2019 Turkish feed industry report, imports of feed raw materials and feed additives amounted to 4,818 million dollars. The amount of these imports accounted for about one-third of Turkey's total agricultural imports (TÜRKİYEM-BİR, 2020). Previous studies indicated that food industry price indices, oil prices, international food prices, and foreign exchange rates significantly affect the producer prices of agricultural products (HARRİ et al., 2009; BAYRAMOĞLU & YURTKUR, 2015). A change in the price of livestock products is affected by the dollar exchange rate and PPI in the short term (MAT et al., 2020). In other words, dairy cattle feed prices and oil prices have huge impacts on the wholesale price of milk (NUMANOĞLI et al., 2016).

Feed costs have the highest share of the total costs of raw milk production and play a key role in the profitability of the businesses. One of the essential factors for the profitable and efficient operation of a dairy farming business is the proportional relationship between the milk and the feed prices. The amount of feed that can be purchased by selling a unit of raw milk is a very important indicator (WOLF, 2010). For ensuring sustainability in milk production, the milk-feed ratio should be 1,5: 2, as adopted in the developed countries (KOÇ et al., 2001).

However, recently, the main problem of dairy farming in Turkey has been that increasing input costs are not reflected in the producer prices of milk (GÜNDÜZ & DAĞDEVIREN, 2011). Since the milk production in Turkey is carried out in an oligopsony market structure where there are many sellers but a few buyers, the producers are forced to accept the milk purchase prices that are formed under these circumstances (TANDOĞAN, 2006). When the production structures and product ranges produced by the enterprises operating in the milk and dairy products sector were examined, it was understood that a small number of milk buyers dominated the market. It is seen that the rest of the enterprises are small-scale producers who only produce certain products (cheese varieties) and that they work periodically (AKIN & CEVGER, 2019). This leads to a high concentration ratio in the marketing of raw milk (GÜNLÜ, 2011) as well as to complaints that the producer price of raw milk is set low because of the milk-processing firms (CA, 2018; CA, 2020).

Previous studies have also reported that the macro determinants of milk prices in Turkey are the consumer price index and the foreign exchange rate (GÖKTÜRK & YALÇINKAYA, 2016). It has also been reported that the prices of feed raw materials used in concentrate feed are cointegrated (YALÇINKAYA, 2016), and the reduction in the value-added tax (VAT) rate of the feed does not reflect in the milk prices (YALÇINKAYA & AKTAŞ, 2019).

Considering the factors affecting raw milk prices in econometric studies has revealed the need for a holistic evaluation of these effects. The change in the prices of animal products is another significant economic risk that affects the level of production. Thus, an exploration of the factors affecting the milk prices in Turkey is important to understand how to equilibrate the market. This study determined the holistic effects of basic and economic indicators on raw milk price with panel data analysis.

MATERIALS AND METHODS

Dataset

In order to explore the factors affecting the dependent variable in the study, that is, the milk price (TSI, 2020), the monthly data of the period from January 2010 to December 2019 are analyzed using the panel data method. The independent variables in the dataset of the study are addressed under two groups, namely, the basic indicators and the economic indicators. The basic indicators included the prices of dairy cattle feed, maize, barley, soybean meal, wheat, sunflower meal, and distillers dried grains with soluble (DDGS) (TFIA, 2020), and the economic indicators include the USD exchange rate (CBTR, 2020), producer price index (PPI), and the agricultural PPI (TSI, 2020). Since monthly prices are used, each time series contains the data for 120 periods. E Views 8 Enterprise Edition is employed in the analysis of the data (EVIEWS, 2016).

Model of the study

The panel data, which are defined as time series of cross-sections or cross-sectional data of the time series (GREENEE, 2003), can also be interpreted as the expression of cross-sectional observations consisting of the units, such as the firms, countries, or households with the dimension of time (BALTAGI, 2001).

One-way and two-way fixed effects and random effects models, dynamic panel analysis, Generalized Least Squares (GLS), etc., are the panel regression models used when the datasets contain a combination of cross-section and time series. Among the above-mentioned models, the one-way fixed effects and random effects models are used in this study.

Panel unit root test

To test the stationarity of the variables, initially, the panel unit root test is conducted, and then the panel unit root test, as suggested by Im, Peseran, and Shin (IM et al., 2003) is applied.

In the panel unit root test, Im, Peseran, and Shin used the Augmented Dickey-Fuller (ADF) test statistic. They calculated the ADF for each unit in the panel and looked at the mean ADF value (SARAÇOĞLU & DOĞAN, 2005).

In applying the panel unit root test, y_{it} is defined as follows in the first-order autoregressive process, where N is cross-section and T is the time series:

$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + e_{it}$, $i = 1,\ldots\ldots\ldots,N$, $t = 1,\ldots\ldots\ldots,T$,[24].

In this test,

H_0: $\beta i = 0$, for all i values,

H_1: $\beta i < 0$, $i = 1, 2,\ldots\ldots\ldots N1$, $\beta i = 0$, $i = N1 + 1, N1 + 2, \ldots\ldots\ldots N$.

H_0 suggests the presence of panel unit root, whereas the alternative hypothesis suggests no presence of a panel unit root. Im, Pesaran, and Shin (IM et al., 2003) tested the “no unit root” hypothesis using the t-bar statistic.

One-way fixed effects model

In the panel data model, the variables are shown with two sub-indices representing both the time and the cross-section, unlike the time series and the cross-sectional data. Among the sub-indices, i represents the cross-sections, and t represents the time. So, the fixed effects model is $Y_{it} = \alpha_i + X'_{it} \beta + e_{it}$. The fixed effects models that meet the basic assumptions below are estimated using the intra-group estimator and the least squares dummy variable (LSDV) estimator (GREENEE, 2003).

$$Y_{it} = \alpha_i + X'_{it} \beta + e_{it} \qquad (1)$$

$i = 1, \ldots\ldots\ldots\ldots N$

$t = 1,\ldots\ldots\ldots\ldots\ldots T$

$$E(e_{it}) = 0,\ Cov(e_{it}, e_{jt}) = 0,\ Var(e_{it}) = \sigma_e^2 \text{ ve } E(X_{it}, e_{it}) = 0$$

In the model, X_{it} is the explanatory variables vector, $Y_{it,}$ is the dependent variable, β is the slope coefficient, e_{it} is the error term, and α_i is the constant term that shows the unit effect. In the present study, the effects of time and units are analyzed assuming that the constant term is constant over time, but might vary for each unit; and that the constant term is constant for each unit, but might vary over time. In order to determine the coefficients of the model ($Y_{it} = \alpha_i + X'_{it} \beta + e_{it}$), using the intra-group estimator, the average values of the individual observations need to be subtracted from the individual observations. Then, the estimation is carried out by the GLS method using the converted data (KENNEDY, 2006).

The model is analyzed according to the group effect, which assumes that the constant term is constant over time, but might vary for each unit. Furthermore, according to the time effect, the constant term is constant for each unit but might vary over time.

An alternative method is to use a GLS estimator containing a dummy variable for each unit with a view to expressing the differences among the constant terms in the model. The method known as LSDV may result in multicollinearity as well as a fall in the degree of freedom because it requires too many dummy variables (KENNEDY, 2006). When a dummy variable is used for each unit, the fixed effects model shown in equation (1) can be written as follows (PAZARLIOĞLU & GÜRLER, 2007):

$$Y_{it} = \alpha_1 D_1 + \ldots + \alpha_N D_N + X'_{it} \beta + e_{it} \qquad (2)$$

In both models, the differences between the units or the times are assumed to arise out of the differences among the constant terms (IM et al., 2003). Therefore, it is assumed that the variable coefficients do not vary among the units or the times. Furthermore, in order to explore the group effect in this study, it is assumed that the constant term remains constant over time, but might vary for each unit. For exploring the time effect, it is assumed that the constant time is constant for the units, but might vary over time (Equation 2 instead of Equation 1).

The group significance test should be conducted to determine whether there is any difference between the units in the fixed-effects model. Under the null hypothesis that the constant term remains the same for each unit, the following F-statistic is obtained (IM et al., 2003).

$$F_{(N-1,NT-N-K)} = \frac{(R^2_{LSDV} - R^2_{Pooled})/(N-1)}{(1-R^2_{LSDV})/(NT-N-K)} \qquad (3)$$

In the F-statistic (3), R^2_{LSDV} is the coefficient of determination of the LSDV model, R^2_{Pooled} is the coefficient of determination obtained from the estimation of the panel data using the GLS method, T is the value of observation for each unit, N is the number of units (groups), and K is the number of the explanatory variables. When the calculated F value is higher than the F-statistic table value, the null hypothesis is rejected; it is accepted that the group effect exists, i.e., there are differences among the units.

In order to determine whether there is any difference over time, the same test statistic is used. In this case; however, the model where the constant term varies by time is used, and a null hypothesis suggests that the constant term does not vary by time.

One-way random effects model

Another model used in the study is the random-effects model. If individual effects are not related to the explanatory variables in the model, and the constant terms of the units are randomly distributed across the units, the structuring of the model should be made suitable accordingly (GREENEE, 2003).

In random-effects models, the variations occurring throughout the cross-sections and/or time are included as a component of the error term in the model. The reason is that the loss of the degree of freedom encountered in the fixed effects models is eliminated when using the random effects models (BALTAGI, 2001).

A one-way random effects model is used in this study. The model [4] below, which indicates that the variation among the cross-sections is a component of the error terms in the model, is estimated with i denoting the cross-sections and t denoting the time.

$$Y_{it} = \alpha + X'_{it}\beta + (\mu_i + v_{it})$$
$$i = 1, \ldots\ldots\ldots\ldots N \qquad t = 1, \ldots\ldots\ldots\ldots\ldots T$$
$$E(u_i) = (v_{it}) = 0,\ Cov(u_t, v_{jt}) = \sigma_{u,v},\ Var(u_i) = \sigma^2_u \text{ ve } E(X_{it}, u_t) = 0 \qquad (4)$$

In the model, X_{it} is the explanatory variable vector, Y_{it} is the dependent variable, β is the variable coefficient, and α_i is the constant term. Here, it is assumed that the error terms are distributed independently and identically, such that their variances equal to zero. µi is the error term containing the unobserved random variations that occur across the units, and v_{it} is the term containing the remaining errors. Under the assumption of the normal distribution, the following model (5), which consists of the combination of the two error terms, is obtained from the model.

$$Y_{it} = \alpha_i + X'_{it}\,\beta + e_{it} \qquad (5)$$
$$e_{it} = \mu_i + v_{it}, \qquad (6)$$

In this model, the error terms consist of two components, and the variance of the error terms (6) does not exhibit the constant variance and the zero variance properties.

Therefore, the GLS estimator cannot be applied to this model, as the error terms do not have the desired properties; however; methods such as Generalized Least Squares and Feasible Generalized Least Squares can be implemented. In order to implement the Generalized Least Squares method, the variance components of the error terms should be known. The methods of SWAMY & ARORA (1972) and WALLACE & HUSSAIN (1969) were employed to determine the variance components in the present study. Swamy and Arora (1972) suggested that the variance components could be obtained using intra-group and inter-group regression models (BALTAGI, 2001). In the present study, the unit effect is estimated using the method suggested by Swamy & Arora (1972), and the time effect is estimated using the method suggested by WALLACE & HUSSAIN (1969).

Hausman test

In panel data analysis, the fixed effects model is a frequently used model with statistically desired properties. However, the random effects model should be preferred if it gives more efficient results than the fixed effects model. Therefore, one may need to determine which of the two models, which are both consistent but have varying efficiency levels, is more efficient. In the relevant literature, the efficiency of the models is tested using the Hausman test with chi-squared distribution and k degrees of freedom (BALTAGI, 2001).

In the Hausman test, the rejection of the null hypothesis suggests that the coefficients obtained from both the models are the same; the failure to reject the fixed effects model indicates that the random-effects model gives more efficient results.

RESULTS AND DISCUSSION

The Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests are conducted to test whether the time series that constitutes the dataset of the study has a unit root (stationarity). The results of the unit root test are given in table 1.

The results of the ADF and PP unit root tests, one of the prerequisites to the panel data analysis, indicate that the panel data are stationary ($P < 0.05$).

In order to see the individual effects in the panel data, the parameters are estimated using the fixed effects and the random-effects models. To begin with, the Hausman test is conducted to decide which of the two models (fixed effects and random effects) is statistically valid. The results are given in table 2.

In the Hausman test, the null hypothesis suggests that the random-effects model should be used, whereas the alternative hypothesis suggests that the fixed effects model should be used. In table 2, the probability (level of significance) and the table value (α) are compared, and since Prob. = 0.002 < 0.050, H_0 is rejected; that is, the fixed effects model should be used. This pointed out the necessity of estimating the model with fixed effects. The fixed effect estimation results of the model are given in table 3.

The basic indicators included the prices of dairy cattle feed, maize, barley, soybean meal, wheat, sunflower meal, and DDGS. An R^2 value of 0.89, as shown in table 3, indicates that the prices of the dairy cattle feed and the feedstuff raw materials can explain 79% of the changes in the price of the milk. The result of the F-statistic suggests that the model is significant.

According to the non-cyclical, fixed-effect panel data analysis, the prices of barley (TRY/ton), soybean meal (TRY/ton), wheat (TRY/ton), and DDGS (TRY/ton) have a significant effect on the milk prices (TRY/l) ($P < 0.05$; $P < 0.01$).

The following estimation equation can be constructed in the model developed for the basic indicators:

Milk Price=–1.91976064675e–16+ 0.503520875729 + 0.000838494929898*Milk Feed–8.46506391791e–05*Corn–3.10434121841e–05*Barley +0.000251529284134*Soybean Meal+2.6925775474e–05*Wheat–0.000166394097907*Sunflower Seed Meal – 0.000548192505742*DDGS.

In the Hausman test, the null hypothesis suggests that the random-effects model should be used, whereas the alternative hypothesis suggests that the fixed effects model should be used. According to

Table 1 - The results of ADF and PP unit root tests on Newey-West and Bartlett kernel panel data of the variables.

Parameters (n=120)	Unit root	χ2	p
Milk Price (TL/lt)	ADF	34.60	0.0001
	PP	36.06	0.0001
Milk Feed (TL/ton)	ADF	37.91	0.0001
	PP	37.53	0.0001
Corn (TL/ton)	ADF	34.58	0.0001
	PP	32.53	0.0001
Barley (TL/ton)	ADF	32.83	0.0001
	PP	31.80	0.0001
Soybean Meal (TL/ton)	ADF	34.79	0.0001
	PP	32.84	0.0001
Wheat (TL/ton)	ADF	25.90	0.0001
	PP	26.03	0.0001
Sunflower Seed Meal (TL/ton)	ADF	35.15	0.0001
	PP	31.12	0.0001
DDGS (TL/ton)	ADF	31.40	0.0001
	PP	29.81	0.0001
Dolar (TL)	ADF	33.93	0.0001
	PP	33.12	0.0001
PPI	ADF	23.75	0.0001
	PP	22.25	0.0001
Agricultural PPI	ADF	36.68	0.0001
	PP	27.40	0.0001

ADF: Augmented Dickey-Fuller unit root test.
PP: Phillips Perron unit root test.

Table 2 - Panel data analysis between milk price (TRY/l) and basic indicators (independent variables) — Hausman Test.

Test Summary	χ^2	s.d	p
Hausman Test	11.27	10	0.003

table 4, the probability (level of significance) and the table value (α) are compared. Since Prob. = 0.0001 < 0.050, H_0 is rejected.

Accordingly, the fixed effects model should be used. In this case, the model should be estimated with fixed effects. The results of the estimation with fixed effects are given below:

The economic indicators include the USD exchange rate, PPI and agricultural PPI. The non-cyclical, random-effects panel data analysis in table 5 illustrates that the variables, dollar exchange rate, and the agricultural PPI have a significant effect on the dependent variable, which is the milk price (TRY/l) (P<0.05; P<0.01). The non-cyclical explanation power was reported to be 84.61%. The independent variables, dollar exchange rate, and the agricultural PPI can explain the dependent variable, that is, the milk price (TRY/l) at a rate of 84.61%.

The following estimation equation can be constructed in the model developed for the economic indicators.

Milk Price = –4.70688303148e–16 + 0.125649 - 0.002323*Dollar + 0.001594*PPI + 0.005934*Agricultural PPI

Among the feed raw materials, the soybean meal is used as a rich protein source with a high biological value in the dairy cattle feed; barley and wheat are the other key sources of energy. However, as the domestic supply of soybean and barley does not meet the demand, the deficit is met by imports (GÜLER, 2013; TAŞCI, 2018). Of the meal products, 40% imported as feed raw material in 2019 was soybean meal, and 13.5% of the vegetative sources of energy was barley (TFIA, 2020).

The changes in the price of feed directly affect the costs of dairy farm businesses. The price changes of barley, soybean meal, wheat, and DDGS affected the price of raw milk between 2010 and 2019.

The value of feed prices against raw milk directly affects the activities of producers. Short-term

Table 3 - Fixed-effect panel data analysis between milk price (TRY/l) and basic indicators (independent variables).

Variable	Coefficient	Std. Error	t-Statistic	p
C	0.503521	0.059197	8.505797	0.0001**
Milk Feed (TL/ton)	0.000838	0.0000445	18.83032	0.0001**
Corn (TL/ton)	–0.0000847	0.0000909	–0.931063	0.3538
Barley (TL/ton)	–3.10E–05	0.000119	–0.260085	0.7953
Soybean Meal (TL/ton)	0.000252	0.0000703	3.575423	0.0005*
Wheat (TL/ton)	–0.0000269	0.0000966	–0.278641	0.7810
Sunflower Seed Meal (TL/ton)	0.000166	0.0000515	3.232002	0.0016
DDGS (TL/ton)	–0.000548	0.000122	–4.485066	0.0001**
----------Fixed Effects (Cross)----------				
_1—C	---------- –0.0000001----------			
----------Effects Specification----------				
----------Cross-section fixed (dummy variables)----------				
R-squared	0.896341	Mean dependent var		1.136917
Adjusted R-squared	0.889863	S.D. dependent var		0.292795
S.E. of regression	0.097170	Akaike info criterion		–1.760374
Sum squared resid	1.057499	Schwarz criterion		–1.574542
Log likelihood	113.6225	Hannan-Quinn criteria.		–1.684907
F-statistic	138.3530	Durbin-Watson stat		0.381415
Prob(F-statistic)	----------0.000001----------			

*p<0,05 **p<0,01 C: Constant, 1-C: 1-Constant, DDGS: dried grains with soluble.

Table 4 - Panel data analysis between milk price (TRY/l) and economic indicators (independent variables) — Hausman Test.

Test Summary	χ^2	s.d	p
	16.225	10	0.0001

fluctuations in income in dairy farms are entirely the result of changes in input prices (BOWDEN & ZHU, 2007). In the short term, producers can respond to the increase in milk prices by changing their feed regime. Although, such adaptation takes less time, it can reduce production. Considering the long production chain, it is not surprising that it takes some time to transfer the increase in milk price to feed price (HANSEN & LI, 2017). Knowing the interaction between milk price and input prices can provide an advantage as a risk management tool for milk producers in making decisions against fluctuations in the market. A study exploring the financial relationship among the cost items of milk production between 2010 and 2015 reported that a structural break had occurred in the sector between December 2011 and August 2013 during which the milk-feed ratio plummeted (YALÇINKAYA, 2016).

To reduce the costs incurred by the producers in Turkey, the VAT rates imposed on the feed and the feed raw materials were reduced from 8% to 1% in early 2016 (TOG, 2016). However, the reduction of the VAT rate has no effect on the prices of the dairy cattle feed and the milk in the short- and long-terms (YALÇINKAYA & AKTAŞ, 2019).

A study analyzing the causal relationship between the products and the input prices in farming found that there existed a unidirectional causal relationship between the prices of feed for ovine/bovine animals and the price of maize ($P < 0.01$) (ÇOBANOĞLU et al., 2012); another study reported that the prices of barley and soybean were the unidirectional cause of the price formation of the concentrate feed (YALÇINKAYA, 2016).

Previous studies have also underlined that the feed prices do not only affect the prices of the animal products but also the prices of the ovine and bovine animals used in the production (ARSLAN, 2017).

The present study also finds that the changes in the dollar exchange rate and the agricultural PPI affect the price of raw milk. The changes in the dollar exchange rate are important in that they show the effect of world prices on the feed raw materials. As a matter of fact, changes in the dollar exchange rate are the main reason for the volatility in the prices of grains used as feed raw materials (OTT, 2014). The cost of maize import rose by $83/ton to $357/ton in 2011 compared to the previous year, which resulted in a 35% increase in the domestic feed prices. When the world feed prices fell below $175/ton in 2016, a

Table 5 - Fixed-effect panel data analysis between milk price (TRY/l) and economic indicators (independent variables).

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.125649	0.056444	2.226073	0.0279
Dolar	–0.002323	0.030754	–0.075527	0.9399
PPI	0.001594	0.000575	2.770681	0.0065*
Agricultural PPI	0.005934	0.001148	5.170150	0.0001**
---Fixed Effects (Cross)---				
_1—C	---- –0,00000004----			
---Effects Specification---				
---Cross-section fixed (dummy variables)---				
R-squared	0.945357	Mean dependent var		1.136917
Adjusted R-squared	0.943944	S.D. dependent var		0.292795
S.E. of regression	0.069323	Akaike info criterion		–2.467321
Sum squared resid	0.557456	Schwarz criterion		–2.374404
Log likelihood	152.0392	Hannan-Quinn criteria.		–2.429587
F-statistic	668.9558	Durbin-Watson stat		0.206950
Prob(F-statistic)	----0.000001----			

*p<0.05 **p<0.01 C: Constant, 1-C: 1-Constant, PPI: Producer Price Index.

similar trend was observed in Turkey as well, and the domestic feed prices fell below $250/ton (TGB, 2018).

The increase in the prices of the final products affects the input goods as well, resulting in price hikes for agricultural products. A study dealing with the international variables affecting producer prices of agricultural products notes that the most important factors are the food industry price indices, oil price, international food prices, and the dollar and euro exchange rates (BAYRAMOĞLU & YURTKUR, 2015).

Another study reports that agricultural inflation is significantly reflected in food inflation and aggregate CPI inflation, confirming the presence of a positive relationship (ÇIPLAK & YÜCEL, 2004; ERDAL et al., 2008).

Knowing the factors and variables that affect raw milk prices is important in predicting prices of milk and dairy products used by the final consumer (AWOKUSE & WANG, 2009). For example in the Turkish dairy market, it is reported that, against the 10% increase in raw milk prices, yoghurt prices increased by 11.46% and cheese prices by 12.06% (ÇINAR 2017).

The degree and timing of fluctuations in feed and milk market prices around the world are different. At this point, it is important to have an idea about how feed and milk prices will move for countries that export dairy products or aim to increase their exports. Import countries such as China, Russia, Mexico and Japan closely monitor world feed and milk prices to make an ideal purchasing decision. It is also important to predict the future prices of different feed ingredients to achieve an economic optimum in sustainable animal nutrition (HANSEN & LI 2017).

CONCLUSION

In conclusion, the fact that the producers have to accept low purchase prices due to the market structure and their lack of organization, along with the price hikes of the input goods used in the production, particularly the feed, and the unstable market conditions, all result in the dairy farming businesses being not profitable. This, in turn, causes the producers to give up production and send their cows to slaughter, which leads to a decline in the total milk output, as is the case in the Turkish dairy sector today.

To ensure the stability of the market, it is essential that the basic variables used in the study, including the raw milk-feed ratio and the costs, be followed carefully, that the purchase prices of milk collected from producers be updated according to this ratio, and that incentives be granted for the production of feed raw materials for which the domestic market relies heavily on foreign markets. Besides, the effect of the economic indicators on the price of raw milk, as evident from the study, indicating that this product is largely affected by the general economic policies implemented in Turkey.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

All authors contributed equally for the conception and writing of the manuscript. All authors critically revised the manuscript and approved of the final version.

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