Price Dynamics in the Fluid Milk Market: Evidence from Turkey

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Abstract

In this study, the price dynamics between retail milk price and raw milk price in Turkish Fluid Milk Market is examined. The study provides and compares empirical results by using monthly fluid milk prices between January 2003 and December 2014. The price adjustment in the fluid milk market is analyzed through an asymmetric error correction model with threshold cointegration incorporated. Our results, based on the threshold cointegration and asymmetric error-correction model, indicate the evidence of negative asymmetry in retail fluid milk prices stating that there is an oligopolistic market structure in the fluid milk sector in Turkey.

Jel codes: C24, D43, L11, Q19

Key Words: Threshold cointegration; Price asymmetry; Turkish dairy market

1. Introduction

The implication of the impact of rising food prices on households is an important issue. With quickly changing market structures, the growing concentration and centralization of processing and retail firms, the questions of how quickly farm prices are transmitted to the retail level and what the incidence of costs is on retail prices gain importance. Given the price is the primary mechanism in linked markets, the extent of adjustment and speed of shocks transmitted between producer and retailer prices is a significant factor showing the actions of actors at various market levels (Abdulai 2002). As indicated in Peltzman (2000), asymmetric price transmission is the rule rather than the exception, and much scholarly work has revealed that asymmetric price transmissions are quite common, especially in agriculture and farmers at the beginning and consumers at the end of the marketing chain often suspect that imperfect competition in processing and retailing that allows middlemen to abuse the market power.

Price transmission can be defined as the relationship between prices in two related markets. Price transmission is used to demonstrate the effects of a price change in one market over another and provides information on the extent of these markets. The special interest is whether the transmission is symmetric or asymmetric. A symmetric price transmission integrates markets vertically and horizontally and a change in prices in one market quickly reflected to another. Therefore, a change in prices in one market will have an equal and immediate effect on the other related market. But, if the price transmission between the specific stages of the supply chain is asymmetric, then the price changes at the production level are not passed to the price changes at the processing and/or retail level quickly or fully as in the case of a symmetric transmission.

There are a number of reasons for incomplete (asymmetric) price transmissions, such as asymmetric information among the firms (Bailey and Brorsen, 1989), market power and concentration at processing and retail levels (Peltzman, 2000; Meyer and Von Cramon-Taubadel, 2004; Azzam, 1999), interaction between market power and economy of scale (Lloyd et al. ,2006), adjustment and menu costs (Meyer and Von Cramon-Taubadel, 2004, Bailey and Brorsen, 1989). Also, supply shocks due to adverse weather conditions, political uncertainty can contribute to the increasing prices and the immediate impact is a fall in the real income of the households in real terms (Ghoshray 2011). Most publications on asymmetric price transmission refer to non-competitive market structures such as market power and oligopolistic behavior as an explanation for asymmetry (Vavra and Goodvin 2005). Brown and Yucel (2000) consider oligopolistic firms that engage in unspoken collusion to maintain higher profits. Ward (1982) suggests that market power can lead to negative APT if oligopolists are reluctant to risk losing market share by increasing output prices. Market power would appear to be capable of leading to long lasting asymmetries in the magnitude of adjustment (Meyer and von

Cramon-Taubadel 2004:590). An important sign of the market power is the existence of price asymmetries which indicate an unbalanced relationship between the price increases and decreases for a product through the farm gate and retail stages. More specifically, price asymmetries could be negative or positive depending on its effect. A positive (negative) price asymmetry occurs when a decrease (increase) in prices at the farm level is not fully or immediately transmitted, but an increase (decrease) passes more quickly or fully on to the final consumer (Meyer and von Cramon-Taubadel, 2004; Vavra and Goodwin, 2005). Price asymmetries are important because, usually, it negatively affects welfare (Meyer and von Cramon-Taubadel, 2004; Hahn, 1990). In case of vertical asymmetric price transmission, consumers often feel increases in farm prices are more fully and rapidly transmitted to retail levels than equivalent decreases (Kinnucan and Forker, 1987). Therefore, one can assume that in case of vertical asymmetries, the value is acquired not in the production stage but inside the supply chain, and that the real winners are not the producers or the consumers (end users), but the holders of the last stage, where the goods are sold to the final consumers.

Price transmission is generally measured by price transmission elasticity. The price transmission elasticity has been estimated by regression models like unit root tests and error correction models (ECM) with threshold adjustment (see Meyer and con Crauben-Taubadel 2004, and Frey and Manera 2007, for the literature on estimating price transmission). Here, threshold adjustment analysis has particular importance because it implies that movements toward long run equilibrium do not take place at all points in time but only when the divergence from equilibrium exceeds the threshold (Ghoshrey 2011). Abdulai (2002), used a TAR model and analyzed the Swiss pork market; Ghoshray (2002), estimated the APT for wheat export prices in major wheat-producing countries with a TAR and M-TAR model; Jaffry (2004) analyzed the French hake value chain and concluded that retailers responded to positive changes in auction prices more quickly than they did to negative changes. Ghoshray test the presence of asymmetry between the rice export prices of Vietnam and Thailand with an M-TAR model (2008) and also tests how international commodity prices are transmitted to domestic prices for 13 country/commodity pairs by using a TAR/M-TAR model (2011).

The aim of the study is to test for raw milk and retail fluid milk price transmission in Turkey by employing TAR and M-TAR specifications. The focus is on vertical APT (asymmetry in price transmission between different stages of a marketing chain), therefore a final error correction model of price transmission has been estimated.

The paper is organized as follows. Section 2 provides an overview of the dairy sector in Turkey. Data, methodology and empirical results are provided in Section 3. In section 4, we discuss the relation between market structure and the asymmetric speed of price adjustment in the Turkish liquid milk market. Finally, concluding remarks are given in Section 5.

2. Characteristics of the Turkish Fluid Milk Market

In the last decade, dairy-processing industry in Turkey received a considerable investment, and the number of modern milk processing plants has increased. Many investments on the dairy processing industry become equipped with high technology, and the result was indeed an increase in the production of milk, altering the price of raw milk. Also, the industry observed new labels entering the market, with most of the retail chains producing their own brands and starting to compete with the others in the market. Parallel to this increase in the number of processing firms, the amount of milk produced and processed has also increased. In this respect, there are eight dairy processing or affiliated companies among the top 500 Turkish companies.

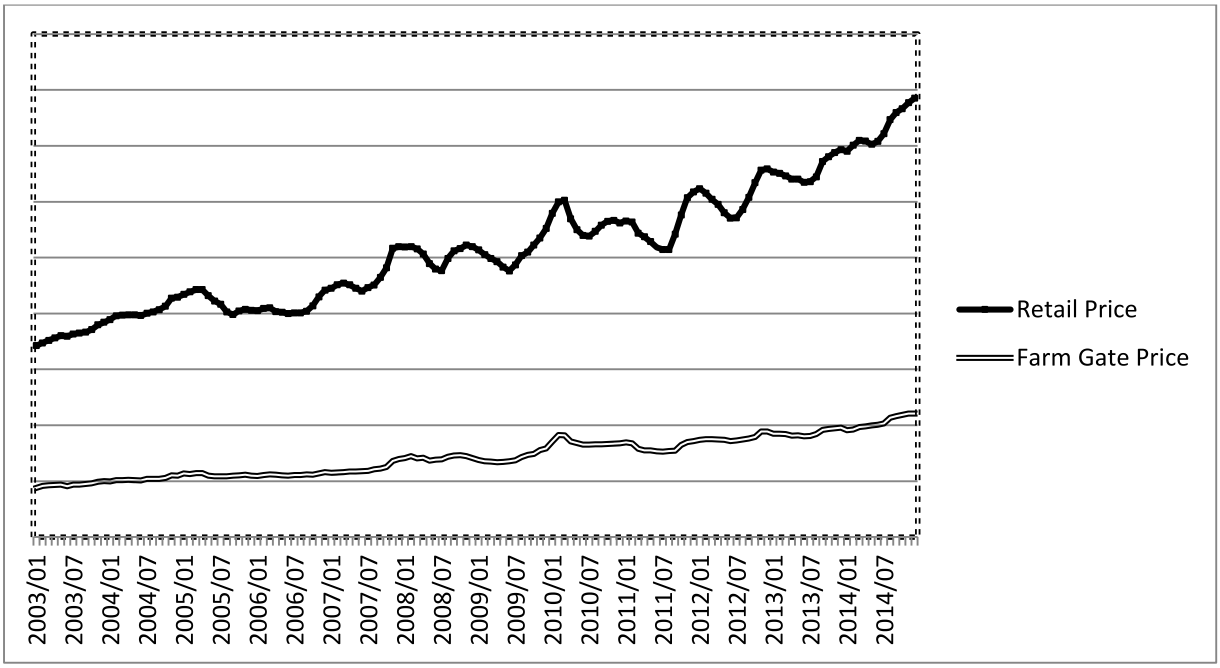
Turkey is among the 10 largest milk producers in the world (FAO 2014). The total annual milk production exceeds 18 billion liters in 2013. In 2013, of the total production, the collected milk by the industry is around 8 million tons and the registered milk production is 46.66 % of the total production in 2012 (SIS 2014). It is forecasted that 3 billion liters are used by farm families for their own consumption or processing, 1 billion liters are handled by street vendors, over 2 billion liters are processed by *mandira*s (small, simple processing establishments) and well over 3.5 billion liters are processed by medium and large-sized dairies (Dellal and Berkum, 2009).

The production costs of milk are high in Turkey and raw-milk producers work with low-profit margins due to costs mostly on feed and other services. The producer revenue primarily consists of the sales of the milk, and secondarily, the sales of the animal (most dairy farms sell the male calves born by their cows and heifers), naturally making the cost of production undoubtedly important. Therefore, the key determinant of the profit is the cost of the production (Dairy 2012). But as the initial investment and production costs are high in Turkey (see Bor, 2014), the level of the raw milk price is undoubtedly important for farmer.

Dairy products have an important role in the Turkish diet. Consumption level of liquid milk is very low; the most common form of milk consumption is yoghurt, followed by white cheese (feta type) and ayran, a liquid salted milk drink. The annual per capita consumption of milk amounts to 37.3 kg of milk equivalence that is low compared to other developed countries. In 2012 in EU-27 it is 288.3 kg and in North America it is 274 kg of milk equivalence (FAO 2014). Therefore, the final liquid milk prices on the retail shelves are important for the consumers.

The consumers argue that the retail price of milk is high and the producers argue that the raw milk price is low in Turkey. The pricing behavior in the raw milk price at the farm gate and the fluid drinking milk prices at the retailer shelves are somehow interesting in Turkey. There is a government intervention over the farm gate prices and the government uses a ceiling price of 1.15 TL (0.4356 USD) per liter for the raw milk at the farm gate prices (April 2015) and also subsidize milk by giving 0.06 TL (0.227 USD) per liter to the producer (these payments are done in every three months). But the retail prices (end user) are freely determined (average of 3.50 TL (1.325 USD) for daily fluid milk in April 2015) and there is no intervention by any authority. Even the costs of distribution, processing, packaging etc. are considered, the difference between the farm gate and retail prices could not be easily explained. This situation raise the questions of how the farm prices are transmitted to the retail levels and if there is an imperfect competition that exists in processing and retailing sectors allowing middlemen to abuse market power.

Figure 1 The Farm Gate and the Retail Price of Fluid Milk (averages of Daily and Ultra-High Temperature (UHT) milk together) between 2003/01-2014/12



Data obtained from Turkish Statistical Institute (Turkstat)

The problem in the fluid milk market may be the volatile prices of inputs for the producers and the final prices for the consumers. Figure 1 shows that there is a large marketing margin in the Turkish fluid milk market. If the daily milk sold in the markets is considered, even the margin increases. It is seen that, the retail price is being completely unrelated to the farm gate price below a certain threshold. Therefore, the two prices are related in a nonlinear manner so that increases in the farm gate price of the fluid milk are transmitted to the retail level but the decreases are transmitted slowly. So, one can assume that the retailers (as well as the processors) adjust prices partly to the changes in demand and supply freely.

The marketing of the raw milk by the producers are restricted in Turkey. It means that, the producer and consumer direct relation is not available. Therefore, the small farmers could only operate through small processors (mandiras) and/or supplying their production to the big processors. The big processors collect milk by their own cooled trucks and searches for suppliers of enough daily raw milk in order to decrease the transaction cost (not willing to collect partial quantities). Therefore, only middle and big dairy farms have little bargaining ability for the price and quality.

The Turkish fluid milk market is concentrated. Only a few numbers of big and traditional brands (SEK, Danone, AOC, Yorsan, Ulker, Pinar) are competing in the market. Although there are new entrants and especially in the UHT segment there are several retailers own brands, still the market is squeezed by the conventional ones. Also, in the retail sector, a few numbers of retailers are spread to country wide although some domestic brands are operating regionally. Anyway, especially at the central/crowd cities there are a few huge retailers present and well known. So the above fluid milk brands are dominant on the shelves of these retailers.

There is a rich literature on the interactions along the dairy marketing chain, to the best of our knowledge, only a few studies investigate the farm-retail price transmission of fluid milk in Turkey. In recent paper, Bor et. al (2014) found asymmetry in the Turkish Fluid Milk market by applying a standard asymmetric ECM on the monthly price data between Jan. 2003 to Dec. 2012. The results of the paper imply that retailers as well as processors exercise significant market power in the Turkish milk market.

3. Econometric Model

The Engle and Granger two step method (1987) is employed to test for cointegration between the two prices. The test assumes symmetric adjustment. Two step methodology is used to estimate the long run equilibrium relationship. By using ordinary least squares method to estimate the long run relation is given by (1).

$$RMP_t = \alpha + \beta FGP_t + \mu_t \qquad (1)$$

Here, RMP is the retail milk price and the FGP is the farm gate price of fluid milk. RMP and RWMP are non-stationary I(1) prices, the estimated "α" is an arbitrary constant accounts for transfer costs and quality differences, the estimates "β" is the price transmission elasticity and "μ" is the error term that may be serially correlated.

Engle and Granger (1987) show that cointegration exists if $\mu_t \sim I(0)$. Residuals from equation (1) are used to estimate the following relationship:

$$\Delta\mu_t = \rho\mu_{t-1} + \varepsilon_t \qquad (2)$$

Rejection of the null hypothesis of no cointegration ($\rho \neq 0$) implies that the residuals in equation (1) are stationary.

Enders and Siklos (2001) argue that if the adjustment is asymmetric, the standard tests for cointegration and its extensions are mis-specified and consider an alternative error correction specification called the threshold autoregressive (TAR) model, in which equation (2) is replaced as:

$$\Delta\mu_t = I_t\rho_1\mu_{t-1}+(1- I_t)\rho_2\mu_{t-1} + \varepsilon_t \quad (3)$$

where I_t is the heavy side indicator function such that:

$$I_t=\begin{cases}1 & if \quad u_{t-1} \geq \tau \\ 0 & if \quad u_{t-1} < \tau\end{cases} \quad (4)$$

τ is the estimated threshold. Here, ρ_1 and ρ_2 gives the speed of adjustment coefficients RMP_t. The long run equilibrium is given by $\Delta\mu_t=\tau$. If $\rho_1 = \rho_2$, the adjustment is symmetric. If not, one can say that there is a negative asymmetry in the series. If $\rho_1 \neq \rho_2$ and $\Delta\mu_t$ is above (under) its long run equilibrium, the adjustment will be $\rho_1(\rho_2)$. Here, threshold has particular importance because it implies that movements toward long run equilibrium do not take place at all points in time but only when the divergence from equilibrium exceeds the threshold (Ghoshrey 2011).

In equation (4), the heavy side indicator depends on the level of μ_{t-1} (Enders and Siklos 2001). An alternative is suggested in Enders and Granger (1998) and Ender and Siklos (2001) such that, the threshold depends on the previous periods change in μ_{t-1} and μ_t series exhibits more momentum in one direction called momentum-threshold autoregressive (M-TAR) model. Here, the heavy side indicator is set by using lagged changes in $\Delta\mu_t$.

$$I_t =\begin{cases}1 & if \quad \Delta u_{t-1} \geq \tau \\ 0 & if \quad \Delta u_{t-1} < \tau\end{cases} \quad (5)$$

The consistency of equations (1), (4) and (5) allows an error correction representation as following;

$$\Delta RMP_t = \theta + \varphi^+ ECT^+_{t-1} + \varphi^- ECT^-_{t-1} + \sum_{i=1}^{n} \alpha^+ \Delta RMP^+_{t-i} + \sum_{i=1}^{n} \alpha^- \Delta RMP^-_{t-i} + \sum_{i=1}^{n} \beta^+ \Delta FGP^+_{t-i} + + \sum_{i=1}^{n} \beta^- \Delta FGP^-_{t-i} + \vartheta_t \quad (6)$$

All the lagged prices (RMP and FGP) are split into positive and negative components as indicated by "-" and "+" superscripts. The error correction terms "ECT" are constructed from the threshold cointegration regressions in equations (3), (4) and (5).

4. Empirical Results

In order to analyze the price asymmetry in the Turkish Dairy sector, the logarithms of average monthly farm gate milk prices (FGP) and average retail milk prices (RMP) are used for the period from January 2003 to December 2014. Both prices are obtained from the Turkish Statistical Institute (TURKSTAT). Figure 1 shows the time plot of RMP and FGP. As expected these two variables seem to be non-stationary.

Table 1 Descriptive statistics and unit root test results for the retail and farm gate milk prices

Variables	Obs.	Mean	Std. Dev.	Min.	Max.	RMP	FGP
RMP	144	-0.359	0.247	-0.822	0.100	1.00	0.973
FGP	144	0.600	0.197	0.241	1.036	0.973	1.00

The descriptive statistics for the prices are reported in Table 1. The trend of the monthly milk prices is demonstrated through Figure 1. The correlation coefficient is 0.97 between the two prices over the whole study period. In recent years, the price margin between the two prices has become stable, and the two prices have evolved to be strongly correlated.

Following the Engle-Granger methodology the long-term relationship between the two milk prices is estimated, as specified in Equation(1).

$$RMP_t = \underset{(130.234)}{0.878} + \underset{(49.993)}{0.773}\ FGP_t + \mu_t \qquad (7)$$

In table 2, the residual is used to conduct a unit root test with the specification in equation (7) in the form of Engle-Granger, TAR, TAR consistent, M-TAR and M-TAR consistent model using the thresholds, $\tau = 0$ for TAR, τ=-0.043 for TAR consistent, $\tau = 0$ for M-TAR, and $\tau = -0.007$ for M-TAR consistent.

Table 2 Results of the Engle-Granger and threshold cointegration tests

Item	Engle-Granger	TAR	Consistent TAR	MTAR	Consistent MTAR
Estimate					
Threshold	NA	0	-0.043	0	-0.007
ρ_1	-0.117	-0.103	-0.052	-0.099	-0.086
	(-3.383)	(-2.017)	(-1.127)	(-1.973)	(-2.018)
ρ_2	NA	-0.127	-0.185	-0.131	-0.166
		(-2.850)	(-3.899)	(-2.887)	(-3.096)
γ_1	0.251	0.251	0.260	0.253	0.261
	(3.040)	(3.022)	(3.178)	(3.053)	(3.151)
γ_2	0.170	0.171	0.177	0.172	0.177
	(2.020)	(2.017)	(2.125)	(2.037)	(2.101)
AIC	-441.10	-439.24	-443.43	-439.34	-440.57

Φ	NA	5.756	7.998**	5.810	6.461
$\rho_1 = \rho_2$[a]	NA	0.139 (0.710)	4.280 (0.040)	0.237 (0.627)	1.440 (0.232)

Parentheses are the t statistics
Φ is the F statistic with the critical values from Enders and Siklos (2001).
[a] Entries are the sample F statistic for the null hypothesis that the adjustment coefficients are equal. Parentheses are the significance levels.

As shown in the first column of Table 2, the t statistic for the coefficient of μ_{t-1} equals to -3.383. Therefore, the Engle-Granger test confirms that the two price series are cointegrated at 5 % level.

The nonlinear cointegration analysis is conducted using the threshold autoregression models. Four models (i.e., TAR, M-TAR and their consistent counterparts) are examined and the results are reported in Table 2. In estimating the threshold values for consistent TAR and M-TAR, the method by Chan (1993) is followed. 2 lags are chosen depending to AIC statistics and also it is found that different lag specifications in the models have little impact of the final threshold values selected. The estimated residuals of (7) in the form of TAR, TAR consistent, M-TAR and M-TAR consistent models are given in Table 2. The sample value of only TAR consistent model (Φ = 7.998) is significant at 5 % level. The point estimates for the TAR consistent model, ρ_1 = -0.052 and ρ_2 = -0.185 suggest the convergence. The Φ statistic indicates that the null hypothesis of no cointegration can be rejected at 5 % level. Based on the AIC, the TAR model with the consistent estimate of the threshold fits the data better than the other models with the lower statistic value. Therefore, we can state that the retail and raw milk prices are cointegrated and the adjustment is asymmetric.

Positive deviations from the long-term equilibrium resulting from increases or decreases in the prices ($\mu_{t-1} \geq -0.043$) are eliminated at 5.2 % per month. Negative deviations from the long-term equilibrium resulting from decreases or increases in the prices ($\Delta\mu_{t-1} < -0.043$) are eliminated at a rate of 18.5 % per month. In other words, positive deviations take about 19 months (1/0.052= 19.2 months) to be fully digested while negative deviations take 5.4 months. Therefore, there is substantially slower convergence for positive (above threshold) deviations from long-term equilibrium than negative (below threshold) deviations.

The model of cointegration with consistent TAR adjustment justifies estimation of the error correction model as specified in Equation (6). The Granger theorem (Engle and Granger, 1987) indicates that an error correction model can be estimated where all the variables are cointegrated with the assumption that the adjustment process due to disequilibrium among the variables is symmetric. For analyzing asymmetric price transmission, Granger and Lee (1989) decompose error correction terms and first differences on the variables into positive and negative components. In this way, it is possible to know whether positive and negative price differences have asymmetric effects on the dynamic behavior of prices. Following this, the next step is the development of threshold cointegration (Balke and Fomby, 1997; Enders and Granger, 1998). When the threshold cointegration is validated, the error correction terms are altered further. In the paper, the asymmetric error correction model with threshold cointegration is estimated and the results are reported in Table 3[1].

Table 3 Results of the asymmetric error correction model with threshold cointegration

Item	Estimate (with intercept)	Estimate (no intercept)
Θ	0.001 (-0.284)	NA
α_1^+	0.775 (13.202)***	0.772 (13.886)***
α_2^+	-0.017 (-0.222)	-0.017 (-0.018)
α_1^-	0.572 (3.383)***	0.572(3.393)***
α_2^-	-0.330 (-1.673)*	0.332(-1.670)*
β_1^+	-0.042 (-0.641)	-0.043(-0.689)
β_2^+	-0.036 (-0.635)	-0.039(-0.671)
β_1^-	-0.496 (3.291)***	0.494(3.257)***
β_2^-	-0.169 (-0.608)	-0.169(-0.689)
φ^+	- 0.021 (-0.601)	-0.027 (-0.751)
φ^-	- 0.099 (1.849)*	-0.092 (-2.022)**
R^2	0.516	0.516
D.W	2.0816	2.077
AIC	-456.00	-457.93

As seen from the Table 3, estimates and their t-ratios do not differ regardless of whether the model contains an intercept or not. The AIC is better for the without intercept model although the difference is small. The significant short run coefficients α^* and β^*suggest the presence of price asymmetries. The φ^- is significant at 5% level and φ^+ is insignificant. φ^+ and φ^- are statistically different, therefore this implies asymmetric long run adjustment of the retail milk price to the raw milk price. The significant φ^- and insignificant φ^+ suggest that only decreases in raw milk prices adjust in the long run but the price increases do not adjust.

5. Conclusions

In this study, the price dynamics between raw milk and retail milk markets in Turkey is examined using the threshold cointegration. The price adjustment in the short term is also analyzed through an asymmetric error correction model with a threshold cointegration incorporated. The result from this study discloses in detail the price relationship between these two fluid milk markets over the last ten years.

[1] Furthermore, the hypotheses of Granger causality between the two prices are assessed with F-tests (not reported in the paper). The F-statistic of 2.660 and the p-value of 0.00003 reveal that the price of raw milk does Granger cause the price of retail milk.

The transmission between the two prices has been asymmetric in both the long term and short term. The threshold cointegration analysis reveals that in the long term positive deviations of the price spread between the two markets take about 19 months to be fully digested, while negative deviations take 5 months.

Differences between the farm and retail milk prices could be tied to marketing costs across the supply chain and pricing policies associated with the market structure. But, when the long-run relationship between farm gate and retail prices are analyzed (Equation 7), 1 % increase in the farm gate price increases the retail milk price by 0.77 %. This figure shows that the difference cannot be explained by marketing costs and may indicate a significant market power in the fluid milk market. Therefore, in this asymmetric case, the deviations can be the reason of the market power of the processors/retailers and the oligopolistic market structure in the sector.

As explained in section 2, because marketing of the raw milk by the producers are restricted in Turkey and there is a government intervention to raw milk prices, the processors/retailers have unequal bargaining power over the producers. Also producers keep their raw milk in the cooling tanks, where it stays fresh only a few days, thus need to be sold within a short period of time. As the processing industry is concentrated and the structure of unions and cooperatives are ineffective, the producers of raw milk work under contracts and, inevitably they have little bargaining over the processors. This implies that the farm price of milk is mainly determined by the industry, due to the little market power of the farmers. On the consumption side, the milk can stay fresh for several months on the shelves in UHT (Ultra-High Treatment) packets causing processors/retailers to benefit from a greater elasticity than producers. Also, there is no intervention to the fluid milk on the consumption side by the government and the prices on the shelves are freely determined.

There are only a few numbers of big and traditional brands (SEK, Danone, AOC, Yorsan, Ulker, Pinar) in the market and the market structure is highly competitive. The improvements in the UHT technology enables firms to operate with stocks. Therefore, there is a high level of competition in the retailers' shelves. Also, as stated above, there is a big mark-up in pricing the fluid milk. Therefore, the firms/brands react quickly to price decreases in raw milk and easily transmit the price decreases to their final products. But it is not the case for price increases. The profit margin is high enough to compensate the increases in raw milk prices so the deviation is much slower. This result is consistent with Ward (1982) that market power can lead to negative APT if oligopolists are reluctant to risk losing market share by increasing output prices.

In summary, Turkey has the opportunity to improve the dairy sector and to achieve modern standards in the means of production and structure of dairy farms. But the problem arises firstly from the high cost of production/low farm gate prices and secondly from the high fluid milk prices on the shelves. As the small structure of dairy farms in Turkey are considered, because the capital requirements of building or improving a dairy farm are hard to reach for small farmers, a system of effective marketing and production agricultural cooperatives could be organized in the longer term. By that way the producers could gain bargaining power over processors and also could reach to final consumer directly. This can help to depreciate the power of the processors and the retailers over producers and consumers.

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