Price transmission analysis in the Greek milk market

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Abstract

This paper examines the farm-retail price transmission mechanism in the Greek milk market by using monthly data for the period from January 1998 to June 2014. Through this period, the dairy industry underwent significant changes, resulting in increasing concentration in the market for fresh pasteurized milk. On the other hand, in the past five years, the number of dairy farms has decreased dramatically. The milk supply chain can be described as an atomized raw milk production sector confronted by a quite concentrated dairy sector. We apply an error correction model to test for asymmetric behaviour in the transmission process. The empirical results indicate that transmission between producer and consumer milk prices in Greece is asymmetric in both the short and the long run, implying that retailers exercise market power over producers.

1.   Introduction

Vertical price transmission analysis has been the subject of considerable attention in applied agricultural economics. Much of this work has concentrated on the potential for asymmetries in the adjustment of prices at different levels of the food supply chain. If the price transmission between the specific stages of the supply chain is asymmetric, then the price changes at the production level are not quickly or fully transmitted to price changes at the processing and/or retail level. Meyer and von Cramon-Taubadel (2004) observe that a possible implication of asymmetric price transmission is that consumers are not benefiting from a price reduction at the producers' level, while producers might not benefit from a price increase at the retail level. Thus, under asymmetric price transmission, the distribution of welfare effects across levels and among agents following stocks to a market will be altered relative to the case of symmetric price transmission (Vavra and Goodwin, 1995).

Peltzman (2000) argues that asymmetric price transmission is the rule, rather than the exception, and concludes that since asymmetric price transmission is prevalent in the majority of producer and consumer markets, standard economic theory that does not account for this situation must be incorrect.

There are a number of reasons for asymmetric price transmission such as market power and concentration at the processing and retail levels (Azzam, 1999; Peltzam, 2000; Meyer and von Cramon-Taubadel, 2004), product perishability (Ward, 1982), adjustment and menu costs (Bailey and Brorsen, 1989), search costs in local markets (Benson and Faminow, 1985) and public intervention in producer prices (Kinnucan and Forker, 1987).

Asymmetric price transmission has been studied by using different econometric methods, from the classical Wolffram (1971) and Houck (1977) specification to cointegration (von Cramon-Taubadel, 1998) and threshold models (Balke and Fomby, 1997).

Concerning dairy products, Kinnucan and Forker (1987) were the first to highlight that asymmetries in both magnitude and time of response are found in the retail prices of dairy products (fluid milk, cheese, butter, ice cream) in the US, with larger and speedier reactions when farm prices are increasing. Serra and Goodwin (2003) find positive asymmetries for the Spanish dairy market. The authors attribute asymmetric price behaviour in the Spanish dairy sector to menu costs, inventory management, search costs and public market intervention. Based on a dynamic reduced-form model of asymmetric price transmission, Chavas and Metha (2004) analyse the butter market in the US for the period 1980 to 2001. They find strong support for asymmetry in the adjustment of retail prices, with a stronger reaction when confronting wholesale price adjustment than when wholesale prices decrease. The authors suggest search costs, menu costs and imperfect competition as causes of asymmetry at the retail level. Lass (2005) finds evidence of short-run price asymmetries in the retail milk price in the northeast of the US and observes that retail milk prices do not return to the same level following the equivalent price increases and decreases, causing a rise in marketing margins. Capps and Sherwell (2007) test for asymmetric price transmission and calculate the elasticities of price transmission for whole milk and 2% milk for seven US cities by using the Houck and error correction model (ECM) approaches. Their results suggest that the farm-retail price transmission process is asymmetric. The European Union (2009) analyses a range of different milk products (milk, butter, cheese, skimmed milk) for a variety of EU member states. Instead of an ECM approach, a model in first differences is used to detect asymmetric price responses. In particular for Slovenia, the United Kingdom, Denmark and Lithuania, significant asymmetries are found. The Commission relates the low price transmission to several factors such as the steadily declining share of milk raw materials to the consumer price of dairy products, inefficiencies in the market structure of the chain (either linked to imbalances in bargaining power and/or anti-competitive practices) and certain specific adjustment constraints and costs (e.g. long-term contracts between economic actors) and pricing/marketing strategies in downstream sectors (European Commission, 2009). Awokuse and Wang (2009) examine the effect of nonlinear threshold dynamics on asymmetric price transmission for three US dairy products (butter, cheese, fluid milk) by using threshold ECMs. Their results suggest that the price transmission of changes between the producer and retail stages of the marketing chain is asymmetric for butter and fluid milk, but not for cheese prices. Fernandez Amador *et al.* (2010) detect positive asymmetries for milk and butter in the Austria dairy sector. Stewart and Blayney (2011) study price transmission over food crises from 2007 to 2009 in the US for whole milk and cheddar cheese. Their results indicate that price shocks at the farm level are transmitted with a delay and with asymmetry to retail prices.

Recently, Rezitis and Reziti (2011) examine the existence of a nonlinear adjustment between consumer and producer prices in the Greek milk sector, using monthly data from January 1989 to April 2009 and applying a threshold error correction autoregressive model. They show an asymmetric price adjustment, suggesting the possible market power of both the milk processing and retail sectors.

In this article, we apply the von Cramon-Taubadel and Loy (1999) error correction specification to analyse farm-retail price transmission in the Greek milk market over the period January 1989 to June 2014. This approach enables us to test for asymmetric contemporaneous and short-run responses to deviations from the unique long-run relation. The article is organized as follows. Section 2 briefly presents the milk market in Greece. Section 3 describes the empirical specification we apply. Our data and empirical results are reported and discussed in section 4, with a summary and some conclusions presented in section 5.

2. The Greek milk sector

Cow's milk production in Greece (612.532 tons in 2013–2014) represents only 0,4% of the total production in the EU-28. However, it is considered to be an essential agricultural activity, since it makes up 13% of total Greek agricultural production. Dairy farming in our country is based on a small population of dairy cows – albeit an extremely developed branch of livestock production – since its contribution to the value of livestock production adds up to 20%. The number of dairy cows in 2011 stood at 131 thous. heads, a fall of 10% (144 thous. heads) compared with 2010. The majority of dairy farms (93,4%) have up to 30 cows, 1,8% from 50 to 100 cows and only 0,7% has more than 100 cows.

Data from the Hellenic Organization of Milk and Meat (ELOGAK) show that between 2009 and 2013 milk production decreased by 10%. Specifically, in 2013/14, national production (612.532 tons) did not meet the national quota (878.298 tons). Most dairy farms (70%) are located in Makedonia and Thraki and 14% in Thessalia.

After Luxemburg, Greece is the country with fewer dairy farmers (0,6% of the total EU-25). During the period 2009–2013, the number of Greek dairy farmers decreased extensively by an average rate of 22%, as 1.000 dairy farmers abandoned farming. This was as a result of the high cost of production and low prices of producers.

The prices that milk producers receive from the dairy industries is a sensitive issue for producers as they are often affected by the low prices industries offer them with respect to the retail price of the product. The lack of agreement and organization of producers into groups as well as the agreements among dairy industries in terms of the price offered to producers aggravate the position of producers and favour the dairy industries as they increase the profit margin. There has been an interesting development in the field of livestock since 65 cattle raisers from Thesalia and Pieria proceeded to establish the first Producer Group of Cattle Farmers and Dairies in Greece with the business name "ΘΕΣγάλα", with the aim of negotiating the price of milk with dairy industries.

The dairy processing industry is the third most important in the Greek food and drink sector and represents over 17% of the total value of production. In the milk market,

there has been a noticeable increase in the concentration rate, where the three biggest dairy industries make up 64% of the market in freshly pasteurized milk. Specifically, in 2013, the market shares of Delta, Olympos and Mevgal were 37%, 16% and 11%, respectively. This year, Delta signed a preliminary agreement to acquire a 43% stake in Mevgal. The transaction is subject to the approval of the Hellenic Competition Commission. This merger would bring together the two main purchasers of raw milk in Northern Greece.

Lately, a great co-operative coalition in the milk sector has been noticed. According to the Pan-Hellenic Confederation of Unions of Agricultural Co-operatives (PASEGES) figures, in 2009 there were 10 cooperative organizations (mainly EVOL, TRIKKI and PROTO) in Greece that gathered and processed cow's milk and these accounted for 12% of total domestic production yearly. Tsakistra *et al.* (2008) provide empirical evidence that the Greek milk market operates under oligopoly conditions, which strengthens the argument for a cartel in the milk market.

Fresh cow's milk appears to be a recession-resilient category. Although qualitative changes have occurred in the category in the context of the economic downturn, with consumers, for instance, migrating towards cheaper products or sacrificing brand loyalty, milk consumption in Greece has not declined. According to Eurostat figures, Greece is among the most expensive countries in the European Union for milk. Specifically, the average price per litre of milk in Greece is 1.50 euro, whereas it is 0.89 euro in Germany and the Netherlands, 0.99 in Austria, Belgium and Spain and 1.29 in Italy. The Ministry of Rural Development and Food and the Ministry of Economy share the opinion that that if the expiry date of milk in shops is extended from five to seven days, its price will fall by at least 5%. However, farmers' associations and milk producers support that extending the expiry date of milk and dairy products would have disastrous consequences for hundreds of thousands of small farmers and their families who support the industry.

3. Methodology

We utilize an ECM approach (Engle and Granger, 1987), which requires that the time series are cointegrated, i.e. a long-run equilibrium exists. Firstly, the long-run equilibrium relationship between consumer prices P_{ct} and producer prices P_{pt} is estimated as:

$$P_{ct} = \alpha_0 + \alpha_1 * P_{pt} + \upsilon_t \qquad \text{with t=1,....,T} \qquad (1)$$

The residual vector υ_t represents the short-run deviations from the long-run equilibrium. When P_{ct} and P_{pt} are at their long-run equilibrium levels, then u_t is expected to be zero, while when they are away from their long-run levels, then u_t could be either positive or negative. In other words, u_t is positive when P_{ct} is well above its long-run equilibrium level and/or P_{pt} is well below its long-run equilibrium level and u_t is negative in the opposite case.

The residual from equation (1) is lagged by one period and entered into the ECM as the error correction term (ECT):

$$\Delta P_{ct} = \beta_0 + \sum_{n=1}^{K} \beta_{1n} \Delta P_{pt-n+1} + \sum_{m=1}^{L} \beta_{2m} \Delta P_{ct-m} + \varphi * ECT_{t-1} + \varepsilon_t \qquad (2)$$

Where $ECT_{t-1} = P_{ct-1} - \alpha_0 - \alpha_1 * P_{pt-1}$.

Granger and Lee (1989) propose a modification to (2) that allows us to test asymmetric price transmission between cointegrated variables, in their study of inventory behaviour in US industry. They segment ECT into ECT$^+$ -and ECT$^-$ by including additional dummy variables in the model:

$$\Delta P_{rt} = \beta_0 + \sum_{n=1}^{N} \beta_{1n} \Delta P_{ft-n+1} + \sum_{m=1}^{L} \beta_{2m} \Delta P_{rt-m} + +\varphi_1 D_{1t}^+ ECT_{t-1} + \varphi_2 D_{1t}^- ECT_{t-1} + \varepsilon_t \qquad (3)$$

with $D_{1t}^+ = 1 \ if \ ECT_{t-1} > 0$ and 0 otherwise, $D_{1t}^-=1$ if $ECT_{t-1} < 0$ and 0 otherwise.

The formal test of the long-run asymmetry hypothesis using equation (3) is:

H_0: $\varphi_1 = \varphi_2$ which is detected by an F-test.

Von Cramon-Taubadel and Flahlbusch (1996) also segment the contemporaneous response term into positive and negative components following the form:

$$\Delta P_{ct} = \beta_0 + \sum_{k=1}^{N} \beta_{1\kappa}^+ \ D_{2t}^+ \Delta P_{pt-n+1} + \sum_{k=1}^{N} \beta_{1\kappa}^- \ D_{2t}^- \Delta P_{pt-n+1} + \sum_{m=1}^{L} \beta_{2m} \Delta P_{ct-m} + D_{1t}^+ ECT_{t-1} + \varphi_2 D_{1t}^- ECT_{t-1} + \varepsilon_t \qquad (4)$$

with $D_{2t}^+ = 1 \ if \ \Delta P_{p \ t-k+1} > 0$ and 0 otherwise, $D_{2t}^-=1$ if $\Delta P_{pt-l+1} < 0$ and 0 otherwise.

Therefore, equation (4) can be used to test both the short-run and the long-run symmetry hypotheses by applying a joint F-test under the null that:

H_0: $\sum_{k=1}^{N} \beta_{1\kappa}^+ = \sum_{k=1}^{N} \beta_{1k}^-$ and : $\varphi_1 = \varphi_2$

According to von Cramon-Taubadel (1998), valid inference requires P_{pt} to be weakly exogenous with respect to the parameters of interest in (1) or (4). For this reason, they follow the testing procedure of Boswijk and Urban (1997). In the first step, the following marginal model for P_{pt} is estimated:

$$\Delta P_{pt} = \gamma_0 + \gamma_1(L)\Delta P_{pt-1} + \gamma_2(L)\Delta P_{pt-1} + e_t \qquad (5)$$

In the second step, a variable addition test is applied to the fitted residuals e_t from the marginal model (5) in the structural model (2) and (4). If the fitted residuals are not significant in the structural model, then the ECM is rightly conditioned on the short-run weakly exogenous variable. Similarly, the test for weak exogeneity with respect to the long-run parameters is applied by adding ECT$_{t-1}$ from equation (1) to equation (5) and testing its significance.

4. Data

The data used in this paper are monthly nominal prices on producers and consumers of cow's milk. The sample contains 306 observations running from January 1989 to June 2014. Data on producer prices for cow's milk are obtained from the Hellenic Milk and Meat Organization (ELOGAK) and data on consumer prices are obtained from the Hellenic Statistical Authority (EL.STAT). In this application, P_{rt} and P_{ft} correspond to the natural logarithms of consumer and producer milk prices respectively. The descriptive statistics associated with these respective price series are exhibited in Table 1. In addition, the prices are presented graphically in Figure 1.

Figure 1 shows that the consumer price is stationary with a shift that should be taken into account when we test for unit roots. Therefore, both series are tested for unit roots with the Augmented Dickey–Fuller (ADF) procedure and the KPSS test introduced by Kwiatkowski *et al.* (1992). The test results are reported in Table 2. Both tests indicate that producer/consumer prices contain a unit root, i.e. price series are I(1), while first differences are trend stationary.

Table 1: Descriptive statistics January 1989 – June 2014

	P_{rt}	P_{ft}
Mean	-0.082	-1.163
STD	0.357	0.279
Skewness	-1.098	-0.965
Kurtosis	3.284	3.410

Note: P_{rt} stands for the natural logarithm of consumer prices, while P_{ft} stands for the natural logarithm of producer prices. STD stands for standard deviation.

Table 2: Unit root tests

Variable	*ADF with trend*	
	Level	*First difference*
P_{ct}	-2.858 (1) [0.178]	-14.972 (0) [0.000]
P_{pt}	-2.853 (2) [0.180]	-8.803(1) [0.000]
	KPSS with trend	
	Level	*First difference*
P_{rt}	0.436	0.148
P_{ft}	0.346	0.125

Notes: Figures in parentheses denote the number of lags in the augmented term of the ADF test that ensures white-noise residuals. Figures in brackets denote *p*-values. The null hypothesis of the ADF test is that 'there is a unit root', while the null hypothesis of the KPSS test is that 'there is not a unit root, i.e. a stationary series'.
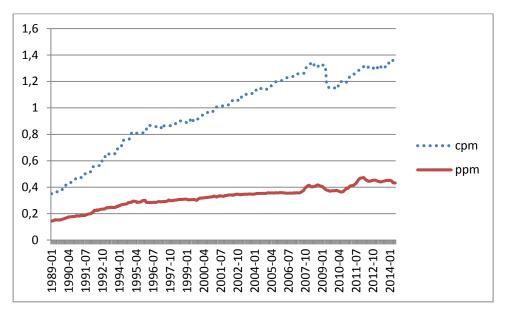
Figure 1: Consumer (CPM) and Producer (PPM) prices in Euros.

5. Empirical results

We now proceed to the cointegration analysis using Johansen's multivariate procedure (Johansen, 1988). The results of both the trace and the λ-max tests are presented in Table 3, suggesting that the null hypothesis of zero cointegrating vectors is rejected and one long-run relationship exists.

Table 3. Johansen's test for the cointegration between P_{rt} and P_{ft}

H₁: Testing the number of cointegrating vectors				
No. of cointegrating vectors	λ - max	95% λ - max	Trace statistic	95% trace
r=0	41.62	15.89	50.62	20.26
r≤1	9.00	9.16	9.00	9.16

Thus, the long-run price relation between the consumer and producer prices for the January 1990 to June 2014 period is (standard errors in parentheses):

$$P_{rt} = 1.509 + 1.351 * P_{ft} - 0.148 * D_t \tag{6}$$
$$(0.013) \quad (0.010) \quad \quad (0.008)$$

where, D_t is a dummy variable, where $D_t = 0$ if t< January 2011 and $D_t = 1$ if t≧ January 2011, indicating an increase in consumer prices after having kept on declining since May 2009.

The long-term equilibrium mark-up as a percentage of the consumer price is obtained from equation (1) when $u_t=0$ and it is given by:
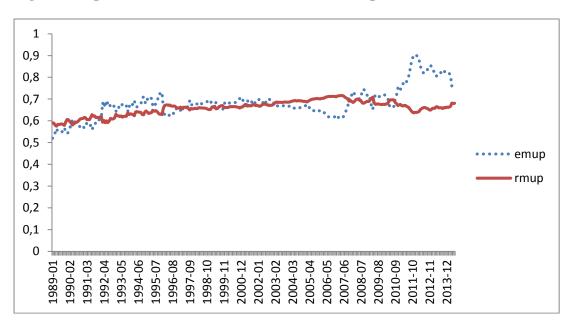
$$EMUP = \frac{e^{\alpha_0} * P_{ft}^{\alpha_1} - P_{ft}}{P_{rt}} \tag{7}$$

where $\alpha_0=1.509$ and $\alpha_1=1.351$. Note that when vt is different to zero, then equation (7) becomes

$$MUP = \frac{e^{\alpha_0 + ut} * P_{ft}^{\alpha_1} - P_{ft}}{P_{rt}} \tag{8}$$

Equation (8) indicates that when ut>0, then MUP is less that EMUP, while the opposite happens when ut<0. As indicated in our discussion of the long-run cointegrating vector in equation (1), vt is greater than zero when Pr is well above its long-run equilibrium level and/or Pf is well below its long-run equilibrium level and vt is negative in the opposite case.

The equilibrium mark-up (emup) and observed relative mark-up (rmup) for the observed period are depicted in Figure 2. In the past five years, the equilibrium mark-up is well above the observed mark-up. However, the observed mark-up is increasing towards the equilibrium mark-up.

Figure 2. Equilibrium and observed relative mark-ups.

Before proceeding to interpret the estimation results of equation (4) presented in Table 5, a test of weak exogeneity is carried out by estimating the marginal model for P_{ft} specified by equation (5). Equation (5) is first estimated by using six lagged differences of both P_{ft} and P_{rt} on the RHS, and subsequently reduced to the more parsimonious model presented in Table 4.
The results in Table 5 indicate that v_t is not significant in either equation and hence, the null hypothesis that producer prices are weakly exogenous with respect to the short-run parameters in (2) and (4) cannot be rejected. Variable addition tests are then used to test the significance of the ECT (both segmented and unsegmented) in the marginal model (5), and the results in Table 4 suggest that the weak exogeneity of the producer price with respect to the long-run parameters cannot be rejected.
Next, the test on short-run asymmetry (Table 5) indicates that price increases are transmitted differently to price decreases. In fact, contemporaneous price decreases are insignificant in the asymmetric ECM and only producer price increases are significantly different from zero. Therefore, a unit increase in P_{ft} induces a contemporaneous increase of 0.267 units in P_{rt}. This short-run adjustment is greater than the long-run adjustment. The lagged variables of segmented ΔP_{ft}^+ and ΔP_{ft}^- are

not statistically significant and are not included in the estimation of equation (4). However, as we can see, the lagged one of the dependent variable is significant.

The coefficients of the positive and negative ECTs have the correct sign. The coefficient of ECT$^-$ is significantly different from zero and has a negative sign, indicating that negative deviations from the long-run equilibrium will positively affect the dependent variable (change in consumer prices). This means that when producer prices increase, retailers must react fast in response to the changes in producer prices in order to return to the equilibrium (deviations equal to zero). Additionally, within one month, retail prices adjust to eliminate approximately 8.3% of a unit negative change in the deviation from the equilibrium relationship caused by changes in producer prices. This implies that retailers must increase their marketing margin by 8.3% in order to respond completely to a unit negative change in producer prices.

By contrast, the coefficient of ECT$^+$ is not significantly different from zero, indicating that positive deviations from the long-run equilibrium do not affect consumer price changes and that retailers will not react. Therefore, the asymmetric price transmission process is obvious from the parameter estimates of the segmented ECT and it is not essential to perform an F test; however, the results of the long-run asymmetry test are reported in Table 5.

This article extended the data period of the Rezitis and Reziti (2011) article and used an alternative approach to detect asymmetric price transmission. However, both studies support the view that consumer prices increase faster than producer prices in order to restore the long-run equilibrium between consumer and producer milk prices. Additionally, these results are in accordance with those of Lass (2005), Capps and Sherwell (2007) and Bakucs and Ferto (2008) where asymmetric price transmission was supported in both the long run and the short run. By contrast, Tekguc (2013) finds asymmetric price transmission for Turkey's fluid milk, suggesting faster convergence in response to positive deviations from the equilibrium (i.e. when the gross profit margin is extended).

Table 4. Estimates of the marginal model (5) for producer prices (dependent variable ΔP_{ft})

Independent variable	Equation (5)
Constant	0.002 (0.000)
ΔP_{rt-1}	0.124 (0.055)
ΔP_{rt-2}	0.273 (0.555)
ΔP_{rt-5}	0.105 (0.050)
R^2	0.13
D-W	1.964
η_1	0.472[~F(4,292)]
η_2	2.035[~F(1,297)]
η_3	145.76*[~χ^2(2)]
η_4	4.234[F(1,295)]
φ_{ECT}	1.654[F(1,295)]
φ_{ECT}^+ and φ_{ECT}^-	1.729[F(2,294)]

Notes: *= significant at 5%; ***= significant at 1%. Standard errors in parentheses. η_1=LM test for autocorrelation for up to and including 4 lags; η_2=ARCH test for up to 4 lags; η_3=Normality test; η_4=RESET test; φ=Variable addition test for the residuals ECT$_t$ in the marginal model (5) (test for weak exogeneity of P$_f$ with respect to the short-run parameters).

Table 5. Estimates of the symmetric and asymmetric ECMs

Independent variable	Equation (4): Asymmetric ECM	Equation (2): Symmetric ECM
constant	0.0001 (0.001)	0.001 (0.0008)
ΔP_{ft}	-	0.233** (0.058)
ΔP_{ft}^{+}	0.281** (0.079)	-
ΔP_{ft}^{-}	0.147 (0.132)	-
ECT_{t-1}	-	-0.055** (0.016)
ECT_{t-1}^{+}	-0.028 (0.029)	-
ECT_{t-1}^{-}	-0.083* (0.034)	-
ΔP_{rt-1}	0.202** (0.054)	0.203** (0.054)
D_1	0.008** (0.002)	0.009** (0.002)
D_4	0.009** (0.002)	0.008** (0.002)
R^2	0.17	0.17
D-W	1.92	1.93
η_1	0.966[~F(4,291)]	1.141[~F(4,293)]
η_2	0.098[~F(1,301)]	0.092[~F(1,301)]
η_3	23.69*[~x^2(2)]	21.39*[~x^2(2)]
η_4	0.284[~F(1,294)]	0.472[~F(1,296)]
Φ	0.036[~F(1,289)]	0.062[~F(1,293)]
F test for long-run symmetry	10.291[~F(1,295)]	
F test for short-run symmetry	8.751[~F(1,295)]	

Notes: * = significant at 5%; ** = significant at 1%. Standard errors in parentheses, D_1, and D_4 are seasonal dummies for January and April respectively.
η_1=LM test for autocorrelation for up to and including 4 lags; η_2=ARCH test for up to 4 lags; η_3=Normality test; η_4=RESET test; φ=Variable addition test for the residuals v_t of the marginal model (5) (test for weak exogeneity of P_f with respect to the short-run parameters).

6. Conclusions

This article examines the mechanism of price transmission in the Greek milk market. We perform our analysis by using von Cramon-Taubadel and Loy's (1996) ECM approach for monthly consumer and producer prices covering the period from January 1989 to June 2014. During this period, the Greek dairy industry went through major mergers (Delta-Vivartia), exits from the pasteurized milk market (Fage, 2007) and, lately, the proposed acquisition of Mevgal by Vivartia, implying that concentration will increase further. We identified a structural break in the long-run equilibrium relationship in January 2011, after which consumer prices increased, thereby explaining the sudden increase in the equilibrium mark-up. Price transmission analysis revealed that the Greek milk sector is characterized by long-run and short-run asymmetries. This is supported by the finding that in the short run, retail prices adjust

instantaneously only if the producer price increases, not decreases. While in the long run, retailers will react to negative deviations from the long-run equilibrium, positive deviations do not affect retail prices. Furthermore, tests of the exogeneity conditions regarding producer prices that are necessary for the valid inference of asymmetry were carried out.

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