Price Transmission on the Milk Portuguese Market[1]

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Abstract

This paper aims to analyze the milk prices transmission along the food chain in Portugal, temporally and spatially. The results show that the volatility on retail prices is small but happens after 2008. The farm gate price does not change when the price of package milk changes. In mainland, price transmission does not happen but for Azores the transmission is effective. In the intensive systems, the risk to collapse is bigger than in the extensive systems, where the volatility of prices reflects the process of markets adjustment.

Key Words: *dairy, farm-gate milk, prices, cointegration, feed prices; Portugal.*

Introduction

The reform of the Common Agricultural Policy has to respond to several challenges in general agricultural terms (climate change and European Union enlargement) and specifically in the dairy sector for developing more innovative and more market-oriented business models, ensuring high quality on milk supplied and sustainability of production, at right prices. A considerable volume of research and studies have recently been carried out on the assessment of price transmission, but most research is concentrated on various product markets in the United States (Fackler and Goodwin, 2001) and a few studies are focused in European markets (Meyer and Cramon-Taubadel, 2004; Serra *et al.* 2006; Ben-Kaabia and Gil, 2008). Some authors focus their work in developing countries (Rapsomanikis *et al.*, 2003). In the EU, food supply chain research shows that imperfect and asymmetric price transmission is linked to market imperfections, concentration and agent's pricing policies (COM, 2009). Most empirical studies

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find little evidence of systematic imperfect price adjustments along the EU food chain, although this may happen in the short run in some specific sector/country situation. The studies of vertical and spatial price transmission have been used to infer a number of conclusions regarding the behavior of market linkages across different levels of the marketing chain. Some significant criticisms have been directed toward this line of study, because it assumes that the tests on price transmission are conducted without regard to the overall institutional and structural characteristics of the market. Goodwin (2006) concluded that cautions must apply to the methods and results. The first paper, specifically focused on dairy product prices, was presented by Kinnucan and Forker (1987). Stewart and Blayney (2011) have recovered the debate on asymmetric price transmission by the using the (threshold) error correction models on milk and cheese. Meanwhile, several studies have been focused on milk, cheese and dairy products, namely Serra and Goodwin (2003); Chavas and Mehta (2004); Jensen and Moller (2007); and Baumgartner *et al.* (2009). Serra and Goodwin, (2003) found positive asymmetries for the Spanish dairy market, Chavas and Mehta (2004) found that retail prices respond more strongly to wholesale price increases than to wholesale price decreases; their explanations are consumer search costs, retailers' menu costs and also imperfect competition at the retail level. Jensen and Moller (2007) detected weak price transmission, especially for milk. In their view, asymmetric price adjustment is caused by public intervention and product differences. More value added products show a higher degree of asymmetry. The European Union analyzes a range of different milk products for a variety of EU Member States. Instead of an error correction approach, a model in first differences was used to detect asymmetric price responses. In particular for Slovenia, United Kingdom, Denmark and Lithuania significant asymmetries are found. The Commission relates the positive asymmetries to the limited share of agricultural commodities into final food prices, inefficiencies in the market structure of the chain (either linked to imbalances in bargaining power and/or anti-competitive practices), and some adjustments constraints and costs (e.g. costs of changing prices for both producers and retailers, the slow price transmission due to long-term contracts between economic actors) (EC, 2009). Baumgartner *et al*. (2009) detected positive asymmetries for milk and butter. Stewart and Blayney (2011) studied price transmission over the food crisis from 2007 to 2009 in the United States of America (USA). They analyzed the nature of price transmission for whole milk and cheddar cheese, comparing results of different model specifications. Independent from underlying specification, they found positive asymmetries. Additionally, Stewart and Blayney (2011) stated for the lower processed product (whole milk) that the price pass-through is larger and that the process of error correction was active in the whole spectrum of observed disequilibria. In contrast, the higher processed product (cheddar cheese) showed a band of no error correction. More recently, Holm *et al* (2012) analyzed weekly basis variations in vertical price adjustment (cost pass through) between retail and whole sale prices for differentiated milk and butter products (brands) for different (individual) retail outlets in the German market from 2005 to 2008. The results indicated significant asymmetric price adjustments. In dairy sector, the EU average prices continue to be largely above intervention levels and according with Quarterly report on dairy market (EC, 15/03/2011) the farm gate milk is higher than others market as United States of America (USA) and New Zealand (332 euros/tons in EU 27 against 311 and 261 euro/tons in New Zealand and

USA, respectively). The EU dairy policy has helped to maintain producer price at a higher and more stable level than in an unregulated market. The Portuguese farm gate prices were above the EU average prices until 2005 but in the last years the Portuguese price of cow milk declined and in consequence became more competitive. This fact is important for the development of international trade among neighbor's countries. Thus, the empirical evidence for statistically significant positive price asymmetries in the dairy sector is overwhelming. However, despite the authors refer the importance of this asymmetric price, the aim of this work is to describe the food chain for dairy products in Portugal and to analyze the variation of prices along the food chain, temporally and spatially, and not to applying the econometric analysis to the study. To integrate the asymmetric prices analysis, would require more studies to be carried out, implying the analysis of structures of dairy farms and their structural flexibility, being or not associated with the ownership of the property and of the financing capacity, as well as an analysis of the concentration of dairy industry. This concentration will influence the market power and therefore the reaction capacity of the value chain.

This paper aims to analyze the variation of milk prices along the food chain in Portugal, temporally and spatially. The analysis will be carried out with feed prices, farm gate milk prices and with the index prices of package milk out of factory.

Methodology

Price variation analysis enables identifying several trends in price transmission mechanisms along the chain and help to understand the result of the cointegration tests.

Commodity price series have a number of common characteristics with important implications in statistical analysis. For instance, usually individual product price series contain stochastic trends and are non-stationary; moreover, tend to move together, which means that they may be cointegrated, and price series of interrelated markets are likely to contain the same stochastic trends, being the linear combination of the prices stationary. Standard unit root and cointegration tests can be made to determine whether price series are stationary and whether they are cointegrated, respectively.

Accordingly, price transmission can be studied using econometric models. The magnitude of price changes enables to identify trends in price transmission mechanisms along the chain.

The theory of cointegration developed by Engle and Granger (1987: 251) is characterized by the main idea that "equilibrium relationship is a stationary point characterized by forces which tend to push the economy back toward equilibrium whenever it moves away". The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables. Under these conditions the series are cointegrated, what is the statistical equivalent of the existence of a long-run economic relationship between the I(1) variables. If one of these variables is I(1) and the other I(0), then the linear combination of them given by the disequilibrium error could not be stationary (Thomas, 1997).

To test cointegration we can apply two methods: the first one is the Engle-Granger´s two steps based on OLS. With this method, we estimate the long-run relationships and save regression residuals, being the second step testing whether the residuals are stationary or not. A second and more powerful test is the method introduced by Johansen

(1995). This test is based on Maximum Likelihood Estimation (MLE) and in two statistics: maximum eigenvalues and a trace-statistics. As in Engle and Granger´s method, it is a good practice to pretest all variables to assess their order of integration (Enders, 2010). Both Engle-Granger and Johansen procedures are consistent for investigating bilateral cointegrating relations, which are our purpose. However, because it is condicional to short-run dynamics, Johansen's procedure may have efficiency gains, and also facilitates the inference on the cointegrating vectors using the standard distributions, which leads to our choice of this methodology.

The Johansen test is only valid when we are working with series that are known to be non-stationary and the results are sensitive to the length of the lag. The software we will apply (STATA 10) implements Johansen's "trace" statistic and "maximum eigenvalue" statistic for determining the number of cointegration equations "r" in a VECM (Vector Error-Correction Model). The number of lags is chosen previously using the following criteria: Akaike information criterion (AIC), Schwarz Bayesian information criterion (SBIC), Hannan and Quinn information criterion (HQIC), finite prediction error (FPE) and sequential likelihood-ratio (LR).

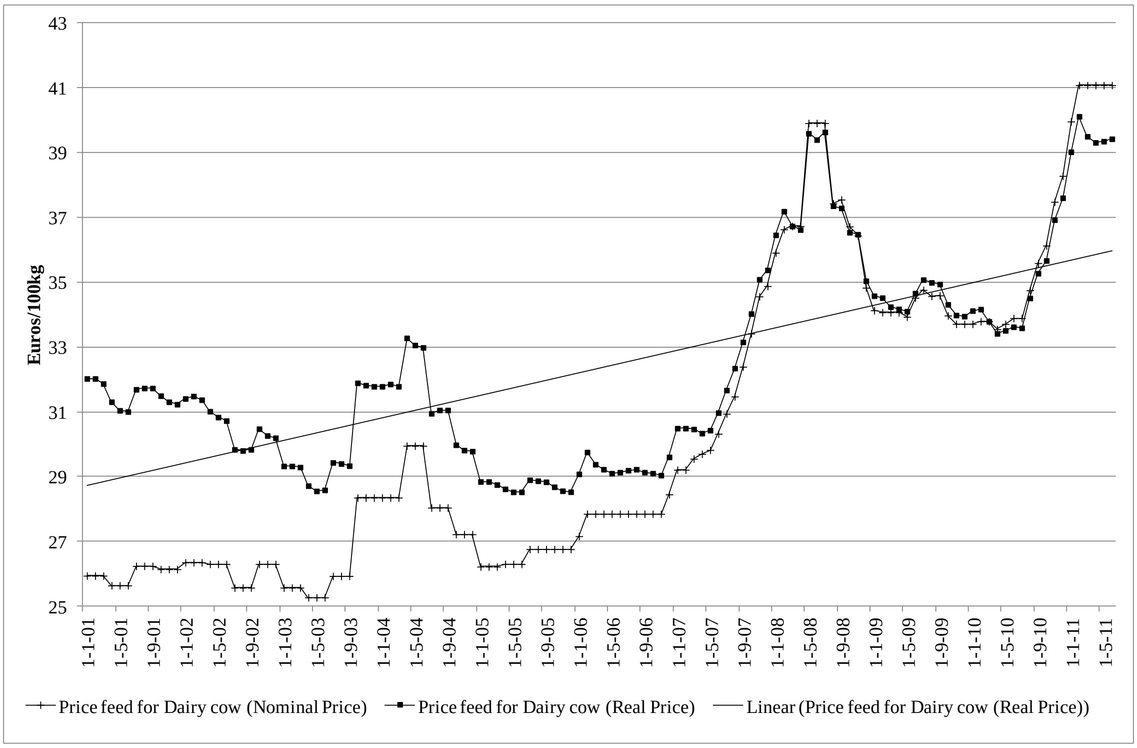
To determine the number of cointegration relations "r", we proceed sequentially from r=0 to r=k-1, and the null hypothesis is rejected if the trace statistic is greater than the critical value. We start by testing H0: r = 0, and if the null hypothesis is rejected, the process is repeated for H0: r = 1. When the null hypothesis is not rejected, we stop testing there, and we find the number of cointegrating relations (there are one or more cointegration vectors).

To test the unit-root hypothesis we employ the augmented Dickey-Fuller (ADF), the DF-GLS and the Phillips-Perron unit-root tests. The lags chosen have an important role on the test performance (Enders, 2010: 216). To select the correct number of lags we use the lags that minimize the value of the AIC and that minimize the SBIC. For the test we use the prices series at nominal values on logarithmic form, althought the prices series do not have to be expressed in logarithmic form. but in this structure the parameters can be interpreted as elasticity's (Thomas, 1997: 385). In first place, we perform an analysis of the price movement in each point of the milk chain.

To test cointegration we must specify how many lags to include. The Johansen approach can be quite sensitive to the lag length. The most regular procedure is to estimate a Vector of Auto Regression (VAR) using the "*undifferenced"* data (Enders, 2010; Lutkepohl and Kratzug, 2009). We use the software STATA through the pre-estimation syntax "varsoc" in order to select the lag order for VAR model that minimizes the majority of AIC, SBIC, HQIC,FPE and LR criteria.

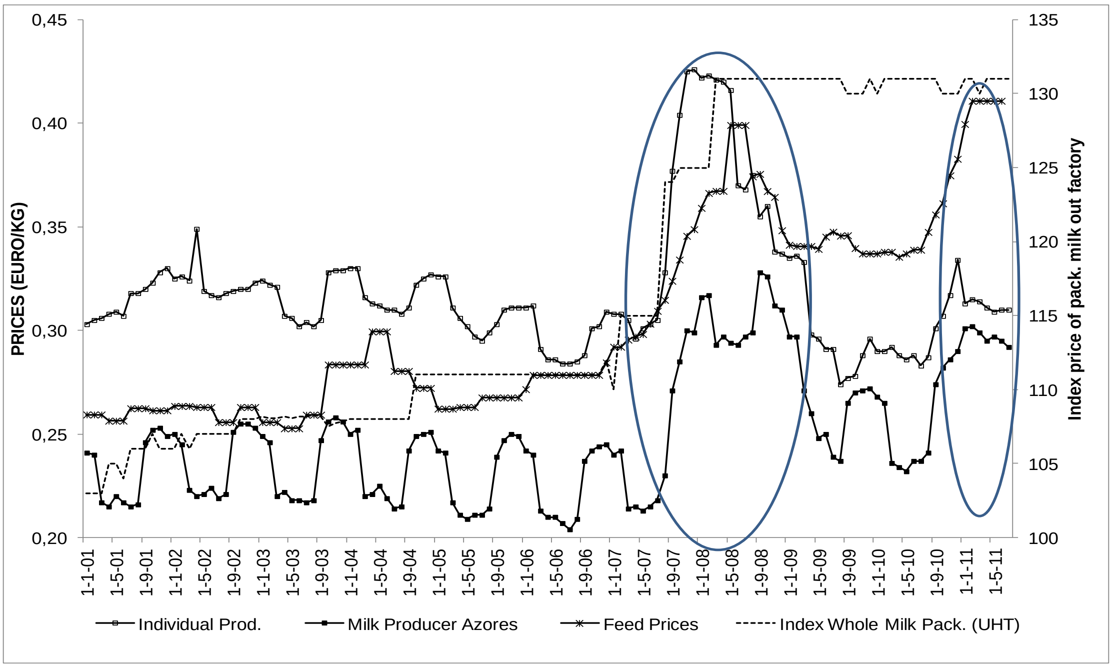
Data Analysis

The objective of this study is focused on investigate the mechanism of price transmission throughout the marketing chain in the milk sector. The price transmission will be studied between farm gate milk prices and feed prices as well as between farm gate milk prices and milk package prices. It is also possible to observe the transmission price from the producer to the consumer. The data for the feed prices are from INE and the data for the milk prices are from SIMA (Gabinete de Planeamento e Políticas do Ministério da Agricultura, Desenvolvimento Rural e Pescas). Prices and index prices are monthly



Source: Data from SIMA

Figure 1. *Feed price of dairy cows at nominal and real values*



Source: Data from SIMA

Figure 2. *Long term prices evolution within the dairy supply chain (nominal values)*

from January 2001 to July 2011. For feed prices we observe an increase after 2007 with a peak in the middle of 2008, as shown in Figure 1. The evolution of the milk farm prices shows a peak in the same period for the feed prices (figure 2). From then on, there is a decline of the milk farm prices. The producer milk prices decline until the period of 2008, coinciding with the peak observed in the prices of feeding stuffs for dairy cattle. While feed prices exhibit a decrease followed by an increase, the same does not happen with milk prices in the production where the declining trend remains.

The trend for the feed prices is positive but the trend for the milk prices is negative. In a first remark, we can think that there is not a relation between the feed and milk prices, and only after the cointegration process we can conclude about the relation between prices. Once the weight of milking parlors is very small in milk production, the analysis will be performed between milk prices on individual producers and Azores producers and feed prices for dairy cows.

Results

The first step is to test the presence of unit roots in the series that we will use: feed prices; farm gate milk and indices of prices of milk whole package output of factory (UHT). The results show that, using all prices series in logarithmic form, we cannot reject the null hypothesis that all prices series exhibits a unit roots that is integrated of order one I (1). The next step is to determine the lag order for a VAR model. For farm gate milk prices and feed prices we use one lag in the VAR because that choice minimizes HQIC and SBIC. The tests for cointegration are based on Johansen's model and the results show that the Ho for r=0 is not rejected at a 5% level (see Table 1a). In other words, this trace test result does not reject the null hypothesis and therefore there is no cointegration. We also use a lag order of 4, which minimizes two other criteria (FPE and AIC), but still with no cointegration was found. The feed and farm gate milk prices, both seem to meander without any tendency to come together, there is not an equilibrium relationship between the two variables.

Since no VECM applies here, we proceed to estimate a VAR in differences of order 3 (assuming order 4 for the levels) and used it to test for Granger causality. The results are shown in Table 2. From Table 2a we can conclude that the growth rate of milk prices Granger causes the growth rate of feed prices, and the reverse is not true. This is not the direction we would expect in causality. However, we note that Granger causality is only about the past of one variable helping forecasting the present value of another variable, and is not economic causality.

We apply the same methodology for farm gate milk prices in Azores.

The results from Table 1b) showed that for the farm gate milk prices in Azores and feed prices, we cannot reject the null hypothesis that there is a cointegration equation in the bivariate model,. For milk producers in Azores, there is long-run equilibrium between feed and milk prices. This result is a very interesting one, mainly because in Azores the housing systems are almost non-existent, and the exploitation performs extensive systems. The normalized cointegrating vector is displayed in Table 3b), from which we find an estimated long run elasticity of feed prices of 0.63%.

The estimation of VECM shows that the cointegrating vector is significant in the

Table 1. *Johansen tests for cointegration*

Maximum Rank	**Lags**	**parms**	**LL**	**Eigen-value**	**trace statistic**	**5% critical value**
a) farm gate milk prices of Individual producer in mainland and feed prices						
	1					
0		2	570.89		6.22*	15.41
1		5	573.69	0.05	0.02	3.76
2		6	573.97	0.00		
	4					
0		14	568.99	.	11.37*	
1		17	574.66	0.09	0.03	
2		17	574.68	0.03		
Ho: r=0 is not rejected at a 5% level (trace stat <15.41)						
b) farm gate milk prices of Azores producer and feed prices						
	3					
0		10	511.95		27.95	15.41
1		13	525.87	0.20	0.12*	3.76
2		14	525.93	0.00		
* Ho: r=1 is not reject at 5% level (trace stat <3.76)						
c) farm gate milk prices of Individual producer in mainland and whole milk package out of factory prices						
	3					
0		10	653.48		16.67	15.41
1		13	661.53	0.12	0.58*	3.76
2		14	666.82	0.01		
* Ho: r=1 is not rejected at a 5% level (trace stat <3.76)						
d) farm gate milk prices of Azores and whole milk package out of factory prices						
	2					
0		**6**	595.08		18.55	15.41
1		**9**	604.16	0.14	0.37*	3.76
2		**10**	604.35	0.00		
* Ho: r=1 is not rejected at a 5% level (trace stat <3.76)						

equation of Azores milk price (with coefficient -0.31), but not in the feed prices equation. From Table 2b) we do not find evidence of Granger causality in either direction.

The figure 2 illustrates the evolution of the index price of whole milk in package out of factory, showing a break on 2007, that is consistent with the increased on feed and farm gate milk prices, however the prices did not decrease as happened with the farm gate milk prices. Figure 2 shows that for a long period the indices of price remain stable, but suddenly the price out factory increased illustrating the differences in market situation along the dairy supply chain. However the farm gate price dropped and the milk price out of factory did not respond at same level.

Table 2. *Cointegrating equations*

Variable	Coefficient	Std. Error	z	p-value
b) farm gate milk prices of Azores producer and feed prices				
lnmilk_azo	1	…	…	…
lnfeed	-0.63	0.09	-6.8**	0.00
constant	3.53	…	…	…
c) farm gate milk prices of mainland producer and whole milk package out of factory prices				
lnmilk_prod	1	…	…	…
lnwhole_milk constant	-0.02 1.27	0.26 …	-0.08 …	0.94 …
d) farm gate milk prices of Azores producer and whole milk package out of factory prices				
lnmilk_azo	1	**…**	**…**	**…**
lnwhole_milk constant	-1.02 …	0.23 …	-4.52** …	0.00 …
* * Significant a 5% level				

The index price for whole milk package (UHT) has a unit root, and we proceed to test whether it is cointegrated with farm gate milk prices in the mainland. Three out of our five criteria choose a lag order of 3 for the VAR model. The results (Table 1c) support one cointegration relationship, displayed at Table 3c). The estimated long run elasticity of whole milk price is, however, very low (0.02%), and not statistically significant by the asymptotic normal significance test (z). Thus the evidence of long run relationship is not strong for these variables. We also use the VECM to test for Granger causality, finding (Table 2c) that the growth rate of whole milk price Granger causes the growth rate of farm gate milk prices, and reverse is not true, which again is somehow counterintuitive.

Finally we test for cointegration between the producer milk prices of Azores and the whole milk package out of factory prices The results find one cointegration equation (Table 1, d).

Thus, the results show that there is no relation between the farm gate milk prices and the prices of package whole milk output of factory on mainland, but, for milk produced in Azores, the farm gate prices and the price of whole milk are cointegrated "*their time paths are influenced by the extent of any deviation from long-run term equilibrium*" (Enders, 2010, pp. 365). The cointegrating vector is shown in Table 3d). This reveals a near unit long run elasticity of whole milk prices regarding farm gate prices in Azores. The corresponding VECM was estimated, and Granger causality tests performed (Table 2d), but no evidence of that was found in either direction.

It is hard to identify the cause of the change in price transmission of milk prices along the milk chain, however Figure 2 shows the change in price transmission pattern occurring from 2007 to 2008. It may relate to the intensity of agricultural commodity price increase that has forced food producer to translate his increase in costs to price

Table 3. *Granger causality Wald tests*

Equation	Excluded (all lags)	Chi-square	df	p-value
a) farm gate milk prices of mainland producer and feed prices (VAR in differences)				
D.lnmilk_prod	D.lnfeed	5.191	3	0.158
D.lnfeed	Dlnmilk_prod	11.313**	3	0.010
b) farm gate milk prices of Azores producer and feed prices (VECM)				
D_lnmilk_azo	D.lnfeed	1.22	2	0.54
D.lnfeed	D_lnmilk_azo	2.03	2	0.36
c) farm gate milk prices of mainland producer and whole milk package out of factory prices (VECM)				
D.lnmilk_prod	D_lnwhole_milk	9.88**	2	0.01
D_lnwhole_milk	D.lnmilk_prod	0.82	2	0.67
d) farm gate milk prices of Azores producer and whole milk package out of factory prices (VECM)				
D_lnmilk_azo	D_lnwhole_milk	0.79	1	0.37
D_lnwhole_milk	D_lnmilk_azo	0.16	1	0.69
** Significant at 5% level				

increases. Statistical indicator for trade shows that high farm gate prices are followed by higher milk importation values.

Recent price evolution in food supply chain in EU, COM (2009) identifies four main phases since May 2007. We apply the same type of analysis in Table 4, but in Portugal the increases of feed prices began earlier than in EU, that is in January 2007. Feed prices sharply increase by 19% in 12 months, consequently farm gate milk prices in mainland and in Azores increase by respectively 38% and 25%.The whole milk package out of factory index price increases 14%.

In the next period (January 2007–August 2007), feed prices increase continue as well as the farm gate milk prices in mainland and the prices of whole milk package. In food prices crisis on EU (May 2007–February 2008), the feed prices sharply increased 23% (in EU the increasing of agricultural commodity was of 16% "COM, 2009"). The farm gate milk prices grew at a high rate (41% and 49%) and index of price packed milk increased even at lower rate (9%). In the period February to August 2008, feed prices increased slowly but the farm gate prices started declining while the whole milk package prices are still raising. On retailers' lags, the feed prices begin to decline as well the farm gate price. The prices of milk on consumer appear to stabilize in February 2009-July 2009. In this period, prices of feed and of whole milk package stabilized but the farm gate price continues declining. In February, feed prices sharply increased as well the farm gate prices but the whole milk package price remained unchanged.

Price variation analysis enables identifying several trends in price transmission mechanisms along the chain and help to understand the result of the cointegration tests. The analysis of price variations since 2007, in table 4, enables to identify several trends in price transmission mechanisms along the chain. In January, when the portuguese

Table 4. *Magnitude of price variation (nominal prices)*

Phase	Begin state	End state	Feed prices	Farm gate milk prices in mainland	Farm gate Milk prices in Azores	Whole milk package out factory
	Jan-01	Dec-01	1%	9%	3%	3%
	Jan-02	Dec-02	0%	-1%	1%	2%
	Jan-03	Dec-03	11%	2%	3%	0%
	Jan-04	Dec-04	-4%	-1%	0%	3%
	Jan-05	Dec-05	2%	-5%	3%	0%
	Jan-06	Dec-06	5%	-1%	1%	1%
Portuguese Food crises	Jan-07	Dec-07	19%	38%	25%	14%
	Jan-07	**Aug-07**	8%	6%	-4%	13%
Food crisis (EU)	**May-07**	**Feb-08**	23%	41%	49%	9%
producer lags	**Feb-08**	**Aug-08**	2%	-11%	-6%	5%
Retailers' lag	**Aug-08**	**Feb-09**	2%	-10%	-1%	0%
stabilisation	**Feb-09**	**Jul-09**	2%	-13%	-20%	0%
	July-09	**Feb-10**	-3%	0%	11%	0%
	Feb-10	**Aug-10**	3%	-1%	-9%	0%
	Aug-10	**Feb-11**	18%	10%	25%	0%

food crises begins, the variations in consumer prices appear to be of a lesser magnitude than variations of feed prices and variations of milk farm prices. The index prices of whole milk package out of factory present signs of stickiness having only very marginally decreased whereas all prices upwards in the chain have significant decline.

Conclusion

Farmers' perceptions of the milk market situation appear to differ and the feeling is a gap between the price paid for milk and the costs of producing The results showed that the increased on feed costs is not followed, in the long run, by an increase on farm gate price, in mainland, but in Azores, where the prevalent systems are extensive systems, the long term relation between feed costs and milk prices exists. In intensive systems, the producer of cow milk is very dependent on feed costs but stability on farm gate milk price put in risk the income of dairy producer and the policy systems does not provide protection against the increased of feed price. Some dairy stakeholders claim that the farm gate price did not change because milk on retail did not change. The results show that the volatility on retail prices is small, but after 2008 the prices outside industry show a real increase. Beside that evolution, the farm gate price does not change when the price of package milk out factory did change. The evidence of long run price transmission from retail to farm price in mainland is weak. But, as for Azores is concerned, the transmission of retail prices and farm prices is effective and proportional, as the unit long run elasticity indicates. Going back further, there were a few periods where the retail milk price did not change as much as farm milk costs, but there were also periods when the retail milk price changed more than did farm milk costs to fluid milk processors. There may be a number of reasons for this, ranging from changes in costs in the processing, distributing and retailing channels to changing marketing strategies by retailers. However, over time the published data clearly show that changes in the retail price of milk do not tend to track with changes in the cost of farm milk. In the intensive systems, the risk to collapse of the system is bigger than in the extensive systems where the volatility of prices reflects the process of market adjustments to changes in supply and demand conditions. As a consequence, Portuguese raw milk can be replaced by cheaper alternatives. Portugal is one of the Member States more affected by the "Soft landing" policy (increasing raw milk production quotas by 1% a year until 2015). It is expected to be subject to more imports from more competitive countries as this increase their production capacity. The dairy sector was not defined as strategic in the Rural Development Program (PRODER) that runs from 2007 to 2013 and therefore support for investment in the sector was not considered a priority. Without the guarantee of funds for structural reform, farmers can only aim at improving their management skills to lower costs and gaining competitiveness. More small farmers are expected to leave the dairy production system. The slow or even the lack of transmission of price increases for dairy commodities from farm gate prices to milk highlights the importance of implementing policies to strengthen the functioning of the dairy supply chain.

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