Price Transmission in the Milk Portuguese Market

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Abstract

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

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

JEL classification: Q11 e Q18
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 to develop more innovative and market-oriented business models, ensuring a high quality of milk supplied and sustainability of production, at the right prices. A considerable volume of research and studies have recently been carried out on assessment of price transmission, but most research is concentrated on various product markets in the United States (Fackler and Goodwin, 2001) with few studies focused on European markets (Meyer and Cramon-Taubadel, 2004; Serra et al. 2006; Ben-Kaabia and Gil, 2008). Some authors focus their work on 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 agents’ pricing policies (COM, 2009). Most empirical studies 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. 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 tests on price transmission are conducted without regard to the overall institutional and structural characteristics of the market. Goodwin (2006) concluded that the methods and results must be treated with caution.

The first paper specifically focused on dairy product prices was presented by Kinnucan and Forker (1987). Stewart and Blayney (2011) have taken up the debate on asymmetric price transmission by 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, while Chavas and Mehta (2004) found that retail prices respond more strongly to wholesale price increases than to wholesale price decreases, their explanations being 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 adjustment constraints and costs (e.g. costs of changing prices for both producers and retailers, 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 of underlying specification, they found positive asymmetries. Additionally,
Stewart and Blayney (2011) stated that for the less processed product (whole milk) the price pass-through is greater and that the process of error correction was active in the whole spectrum of observed disequilibrium. In contrast, the more 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 wholesale 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.

Thus, the empirical evidence of statistically significant positive price asymmetries in the dairy sector is overwhelming. This paper aims to analyze the variation of milk prices along the food chain in Portugal, over time and space. The analysis will be carried out with feed prices, farm gate milk prices and with the index prices of packaged milk out of the factory.

**Methodology**

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, which 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 is Engle-Granger’s two steps based on OLS. With this method, we estimate the long-run relationships and save regression residuals, the second step being to test 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 on two statistics: maximum eigenvalues and a trace-statistic. As in Engle and Granger’s method, it is a good practice to pre-test all variables to assess their order of integration (Enders, 2010).

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 three types of statistics for determining the number of cointegration equations “r” in a VECM (Vector Error-Correction Model): Johansen’s “trace” statistic; the “maximum” eigenvalue statistic and the statistic that allows choosing the number of lags that minimizes the Akaike Information Criterion (AIC), the Schwarz Bayesian Information criterion (SBIC), Hannan and Quim information criterion (HQIC); Finite prediction error (FPE) and the 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).
The first step to test the roots analysis is the visual test; however, more rigorous tests are needed. To test the unit-root we employ the augmented Dickey-Fuller (ADF), the DF-GLS and the Phillips-Peron unit-root tests. The lags chosen have an important role in 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 price series at nominal values in logarithmic form, although the price series do not have to be expressed in logarithmic form. In this structure the parameters can be interpreted as elasticities (Thomas, 1997: 385). In the first place, we perform an analysis of the price movement at 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). The output of STATA 10 uses the pre-estimation syntax “vasrsoc” to select the lag order for VAR model of farm gate milk and feed prices.

**Results**

The objective of this study is to investigate the price transmission mechanism throughout the marketing chain in the milk sector. 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 on feed prices are from INE and those on milk prices are from SIMA (Planning and Policy Department of the Ministry of Agriculture, Rural and Fishery Development).
For feed prices we observe an increase after 2007 with a peak in the middle of 2008, as shown in Figure 1. Evolution of farm milk prices shows a peak in the same period as the feed prices (Figure 2). From then on, there is a decline of farm milk prices. The milk producer prices decline until the period of 2008, coinciding with the peak observed in the price of feeding stuff for dairy cattle. While feed prices show a decrease followed by an increase, the same does not happen with milk prices in production where the declining trend remains.

**Insert figure 1 and figure 2 about here**

The trend for feed prices is positive but the one for milk prices is negative. At a first sight, we can think there is no relation between feed and milk prices, and only after the cointegration process can we conclude about the relation between them. Since the weight of milking parlors is very small in milk production, the analysis will be performed between milk prices in individual producers and Azores producers and feed prices for dairy cows.

In order to test the cointegration, we will use one lag because the HQIC and SBIC methods choose one lag that minimizes those indicators. 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 factory-produced packaged whole-milk prices (UHT). The results show that, using all price series in logarithmic form, we cannot reject the null hypothesis that all price series show a unit root that is integrated to the order of one I (1). The next step is to determine the lag order for a VAR model.
The cointegration tests are based on Johansen’s model and the results show that the Ho for r=0 is not rejected at a 5% level. In other words, this trace test result does not reject the null hypothesis and therefore there is no cointegration. Table 1 shows the cointegration results between prices along the milk value chain in the mainland and in the Azores (Table 1, a). Nevertheless, we will estimate the VECM model.

The error correction term in each equation is not significant. If these two variables were cointegrated, the disequilibrium error would be a stationary process. In this case, the test shows that the error of the cointegration equation does not look like a stationary series. The results indicate strong support for no cointegration of these two variables, which means that the prices will drift far apart in the long run.

The feed and farm gate milk prices both seem to meander without any tendency to come together, without any equilibrium relationship between the two variables. We will apply the same methodology to farm gate milk prices in the Azores.

The results show that for farm gate milk prices in the Azores and feed prices, we can accept the null hypothesis that there is a cointegration equation in the bivariate model, but only one of the coefficients is statistically significant. For milk producers in the Azores, there is a long-term equilibrium between feed and milk prices (Table 1 b). This result is very interesting, mainly because in Azores production, housing systems are almost non-existent, exploration being based on extensive systems.

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

The index price of packaged whole milk (UHT) has a unit root and was tested for cointegration. First, the lag order for a VAR model was estimated. When HQIC and the SBIC were chosen, the number of lags was two, but if we decide to apply the FPE and AI criterion the number of lags are three. Given that, the Johansen trace-test is sensitive to the number of lags, and two and three lags were tested. For three lags, the results support one cointegration relationship and the VECM shows that the error correction term is not statistically significant.

The behavior of the error cointegration series shown is not typical for stationary series. The test statistic shows that the predicted value of the specified cointegrating equation is not stationary but integrated I(1). These results are consistent with no cointegration relationship (Table 1, c). If we test the cointegration between producers’ milk prices in the Azores and the whole milk packaged out of factory prices, the results show one cointegration equation. (Table 1, d).

Insert Table 1 about here

The summary statistics show there is no relation between farm gate milk prices and the prices of packaged whole milk output from the factory on the mainland, but for milk produced in the Azores, 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).

It is hard to identify the cause of the change in price transmission of milk prices along the milk chain, but Figure 2 shows the change in the price transmission pattern occurring from 2007 to 2008. It may relate to the intensity of agricultural commodity
price increase that has forced food producers to translate their increased costs to price increases. The statistical indicator for trade shows that high farm gate prices are followed by higher milk importation values.

Recent price evolution in the food supply chain in the EU, COM (2009) identifies four main phases since May 2007. We apply the same type of analysis in Table 2, but in Portugal the increase in feed prices began earlier than in the EU, that is, in January 2007. Feed prices increase sharply by 19% in 12 months, and consequently farm gate milk prices in the mainland and in the Azores increase by 38% and 25% respectively. The packaged whole milk out of the factory index price increases by 14%.

In the next period (January 2007–August 2007), the increase in feed prices continues as well as farm gate milk prices in the mainland and prices of packaged whole milk. During the food price crisis in the EU (May 2007–February 2008), feed prices increased sharply by 23% (in the EU the increase in the agricultural commodity was 16% “COM, 2009”). Farm gate milk prices rose at a high rate (41% and 49%) and the price index of packed milk increased at a lower rate (9%).

In the period February to August 2008, feed prices increased slowly but farm gate prices started declining while packaged whole milk prices continued to rise. In retailers’ lags, feed prices begin to decline as does the farm gate price.

The prices of milk to the consumer appear to stabilize in February 2009-July 2009. In this period, prices of feed and of packaged whole milk stabilized but the farm gate price continued to fall. In February, feed prices rose sharply as did farm gate prices but the price of packaged whole milk remained unchanged.

Price variation analysis lets us identify several trends in price transmission mechanisms along the chain and helps to understand the result of the cointegration tests. One
important conclusion is that the price variations for milk producers appear to be greater than those of feed prices. The index prices of packaged whole milk out of the factory present signs of stickiness with only a very marginal decrease, whereas all prices upwards in the chain have a significant decline.

Insert Table 2 about here

Conclusion

In the dairy sector, average prices in the EU continue to be significantly above intervention levels and according to the Quarterly report on the dairy market (EC, 15/03/2011) the price of farm gate milk is higher than in other markets such as United States of America (USA) and New Zealand (332 euros/ton in EU 27 against 311 and 261 euros/ton 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. Portuguese farm gate prices were above average EU prices until 2005 but in recent years the Portuguese price of cow milk declined and consequently became more competitive. This fact is important for the development of international trade among neighboring countries. 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 increased feed costs is not followed by an increase in farm gate price in the mainland, but in the Azores, where the prevalent system is extensive, the relation between feed costs and milk prices exists in the long term. In intensive systems, the cow milk producer is very dependent on feed costs but stability of farm gate milk price puts dairy producer’s income at risk and the policy system does not provide protection against the increase in feed price. Some dairy stakeholders claim that
the farm gate price did not change because retail milk did not change. The results show
that the volatility of retail prices is small, but after 2008 prices outside the industry
show a real increase. Besides that evolution, the farm gate price did not change when
the price of packaged milk out of the factory did. There is no price transmission from
retail to farm price in the mainland, but in the Azores, the transmission from retail price
to farm price is effective. 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 farm milk costs to fluid milk processors. There
may be a number of reasons for this, ranging from changes in costs in processing,
distributing and retailing channels to retailers changing marketing strategies. However,
over time the published data clearly show that changes in the retail price of milk do not
tend to follow changes in the cost of farm milk. In intensive systems, the risk of system
collapse is greater than in extensive systems where the volatility of prices reflects the
process of market adjustments to changes in supply and demand. Keane and O’Connor
(2009) conclude that some degree of price volatility is necessary as it reflects changing
market conditions, but extreme price volatility results in a set of mostly negative
consequences. As a result, Portuguese raw milk can be substituted by cheaper
alternatives. Portugal is one of the Member States most 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 they 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 to improve their management skills to
lower costs and increase competitiveness. More small farmers are expected to leave the dairy production system. The slow or even lack of transmission of price increases for dairy commodities from farm gate prices to prices of packaged milk out of the factory highlights the importance of implementing policies to strengthen the functioning of the dairy supply chain.
References


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Table 1. Johansen tests for cointegration

<table>
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<tr>
<th>Maximum Rank</th>
<th>Lags</th>
<th>parms</th>
<th>LL</th>
<th>eigenvalue</th>
<th>trace statistic</th>
<th>5% critical value</th>
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<td>b) farm gate milk prices of Azores producer and feed prices</td>
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<td>* Ho: r=1 is not rejected at a 5% level (trace stat &lt;3.76)</td>
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<td>c) farm gate milk prices of Individual producer in mainland and whole milk package out of factory prices</td>
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<td>d) farm gate milk prices of Azores and whole milk package out of factory prices</td>
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### Table 2. Magnitude of price variation (nominal prices)

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<tr>
<th>Phase</th>
<th>Begin state</th>
<th>End state</th>
<th>Feed prices</th>
<th>Farm gate milk prices in mainland</th>
<th>Farm gate Milk prices in Azores</th>
<th>Whole package out</th>
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<td>19%</td>
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