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# Structural change and dairy chain efficiency in Italy

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# Structural change and dairy chain efficiency in Italy

Abstract – This research is an application of the econometric price series to the analysis of dairy chain efficiency in Italy. At a theoretic level, the price transmission and asymmetry in the speed of adjustment to positive and negative price changes is supported by the Industrial Organization, multi market equilibrium, food chain theories. However this does not provide a clear signal of competitiveness as many conditions may induce stickiness (curvature of demand, local cost and externalities, long term contracts. While evidences from past EU studies about the dairy sector are mixed, several studies have demonstrated the evidence of price asymmetries in different market contests. The aim of this research is to examine the price dynamics along the dairy chain and offer some empirical evidences about the cointegration and asymmetric price transmission at different market levels. The parametric test of asymmetry in a multivariate VECM (vector error correction term), suggests symmetry in co-movement. To explore in deeper whether these results are robust with respect to nonlinearity it is estimated the threshold VECM model; the results suggest to reject the hypothesis of asymmetry with exception for the raw milk and wholesale butter. While market competitiveness can not be inferred only from evidence of asymmetry, these findings support the hypothesis that the market structure and policy in the Italian dairy chain didn't affect greatly the price asymmetry. However, for the butter market, the public intervention seems to have generated speculative behavior among the operators and generated asymmetric price responses to positive/negative price changes.

Key words: dairy sector, CMO, time series analysis, asymmetric price transmission, TVECM

## 1. Introduction

A number of sector policies targeted the Milk Market Organization (CMO) in the EU; a short summary of these interventions includes the introduction of the quotas regime (1984), the Mac Sharry reform (1992) moving the CAP strategies toward income support policy with compensatory direct payment allowing a reduction of the guarantee prices. Other political interventions were included in Agenda 2000 with specific milk sector measures (May 1999), the Fischler's package reform (2003), the de-coupled single payment (2005 and 2007), the Milk Package (2009), and finally the quota release (2015). The purpose of these measures was to strengthen the dairy chain competitiveness by dismantling the CMO to accelerate the structural changes, and adapt the dairy sector to a complete market liberalization. The main structural changes were: a substantial exit of a considerable number of milk producers, leaving behind production operations with larger scale, higher yield and lower costs. At the processing level, the concentration and M&A operations were strengthening the market power of some industrial groups (i.e. Granarolo, Lactalis); at the retail level, product differentiation and private labeling increased the retailers' market power (Rosa et al., 2015). In general, these changes may have biased the power distribution along the chain with consequences for margin and profit distribution among participants (Cavicchioli, 2010). However, other factors could have been responsible of the price setting through the chain, with the increase horizontal and vertical relationships among agents across EU

countries. (Bonnet et al., 2015; Serra and Goodwin, 2003; Weaver and Natcher, 1999). These considerations suggest that the pass-through may be market specific: raw milk cost shocks are under transmitted through the dairy chain and over transmitted on the fluid market (Bonnet et al., 2015). It is our interest to evaluate how the dairy chain responded to the evolving policy and structural setting (Rosa et al, 2013), by examining the empirical evidence of vertical price transmission. Such an evaluation faces two substantial constraints: first, as the policy changes starting with the Fisher package followed throughout the ensuing decades and second the time at which such policy changes became effective is germane yet not specifiable. These premises prevent a direct evaluation on specific changes in dairy policy and their impact on market efficiency. It is asseverated that for vertically integrated and efficient markets operating under perfect information and zero transactions costs, the prices would be co-integrated by the effective arbitrage. This implies that a change on market condition at one stage of the chain would cause instantaneous adjustment along the other steps of the dairy chain. As the price is the primary indicator of market conditions the instantaneous price transmission (adjustment) is the evidence of market efficient conditions and has important consequences for the pricing practices (Bonnet, 1994). In a fast moving transparent, competitive market environment, the exogenous shocks, including policy changes are transmitted through the market chain by traditional arbitrage as suggested by the derived demand model (Tomek and Robinson, 1972). This transmission is driven by producer imperatives to seek profits and avoid losses; as this involves structural adaptation, it is useful to label its vertical structure arbitrage (Wohlgenant, 2001). Compared to intertemporal and spatial arbitrage, vertical structural arbitrage is likely to be more time intensive and requires changes in product practices, marketing relationships and other adaptive investments. Further on the impact side, such restructuring requires the establishment of a new procurement arrangements to fulfill associated changes in derived demand. Given structural differences in output and input adaptation, some authors have hypothesized that the long run relationship between prices may be asymmetric among vertical market stages. This conjecture is supported by a rather thin literature (Ward, 1982; Kinnukan and Forker, 1987; Boyd & Brorsen, 1988, Vavra and Goodwin, 2005; Weaver and Natcher, 1999; Santeramo, 2015). However, the alternative null hypothesis of market efficiency includes a number of other market conditions some consistent with competitive markets, while others are consistent with imperfect competition. Menu costs or fixed costs, inventory costs (e.g. perishability, see Ward, 1982); accounting methods (Balke et al. 1998; Blinder, 1982), production costs of adjustment (Peltzman, 2000; Bailey and Brorsen, 1989), and policy intervention (Kinnucan & Forker, 1987) have been considered to be responsible of asymmetric response to price changes under competitive conditions. Other researches suggest that price changes tend to flow from farm to wholesale and retail while the reverse is not so evident. Clearly, when the market involves oligopoly, the price transmission may also be found to be asymmetric (Rosa, 2015). Others suggest that the presence of oligopoly and oligopsony power does not necessarily reflect imperfect price transmission and noted that the functional form of the retail demand and farm input supply are the key factors in determining the extent and speed of price transmission (Weldegebriel,2004). Empirically, the problem of extracting information about market power from price time series is challenged by the complexity of the market systems. (Rosa, Weaver and Vasciaveo, 2014). At best, where price transmission takes time, is sluggish, and appears to be strongly asymmetric, we can suggest that imperfections in competition affect the

market efficient conditions. Empirically, a number of issues further challenge our ability to evaluate the impacts of policy changes on competitiveness based on time series data. First, as multiple changes in economic conditions evolve over time, a unique, exogenous treatment due to policy can not be identified. Peltzman (2000) has tested this situation by using cross section data. Second, within time series specification, a number of details are left unsolved by economic theory and results change depending on the resolution method. Given these observed structural changes following CMO reform, it is of interest to examine the evolving market condition during the last period of milk quota life. A limited, though critical topic is offered by consideration of price transmission within the vertical supply chain within the dairy sector. Specific focus on the EU vertical dairy chain has been taken by the London Economics (2003); this study has considered a group of EU countries: UK, Germany, France and Denmark and has found evidence of imperfect, asymmetric transmission in each country. OECD (2004) has considered dairy sector reform effects across the EU using the OECD Secretariat's Aglink and PEM models to evaluate the implications of individual policy measures related to quota systems and price support for production, consumption, trade, prices, income and welfare. This report suggests the reforms would lift producer prices and have only a small impact on milk supply. The U.K. Department for Environment, Food and Rural Affairs (DEFRA) has commissioned a study investigating the determinants of farm-to-retail price spreads in the UK and several other EU countries during the 1990's for about 90 products (London Economics, 2004). The report has suggested very little evidence of systematic asymmetric transmission in the EU food chains, with possible exception of certain dairy products, which have shown very low price transmission. The study also suggested no significant evidence in specific countries of systematic higher asymmetric price transmission in food chain compared to others, perhaps with the exception of France where farm gate and retail food prices did not seem to exhibit a stable relationship over the long run. This report has also investigated the impact of the increased concentration in food retailing on price transmission. A semi-structural model has been presented to capture the sensitivity of price spreads to factors such as cost distribution along the vertical supply chain (from farmers to consumers), demand and supply, EU intervention prices under the Common Agricultural Policy (GAP), exchange rates or competitive conditions at the retail market. The model has been estimated for four broad categories of products including wheat, red meat, poultry, fruit and vegetables. The result is that there are not empirical evidences of systematic widening of farm to retail price spreads as a consequence of potentially stronger buyer power due to increasing concentration in the food retail sector. In contrast to the DEFRA study, a large report on dairy supply chain margins by MDC (2004) argues that over the past ten years farm gate prices and total farm to retail margins have tended to reduce, but the dairy processor margins have remained fairly constant and retailer margins have increased across all products. However, a change in the farm-retail margins does not necessarily point to imperfect price transmission and has to be evaluated against the development of other input costs. Serra and Goodwin (2013) in revising the literature suggest evidences of asymmetries in price adjustment, although the magnitude is not usually big, the price changes tend to flow from farm to the other levels and farm prices rarely responded to wholesale or retail shocks probably because of the CMO that affect the price formation at the farm level. Our research offers a country specific study of vertical price transmission for specific products of the dairy chain, rather than an aggregation of products. Several dairy product specific chains linked to raw milk are tested at the three

vertical stage chains (farm-wholesale-retail): Parmesan reggiano, Mozzarella, and Grana Padano, and two vertical stage chains (farm-wholesale) for UHT milk and butter. The monthly price series are spanning from 2005 to 2014. This paper is structured in the following parts: a descriptive part about structural changes followed by the analysis of volatility, and application of the Granger-Engel approach to test the hypothesis of cointegration and asymmetry with TVECT. Conclusions are drawn from the evidences about market imperfections and suggestion for policy intervention in absence of CMO.

## 2. Methodology

The econometric modelling of the price asymmetries has been extensively discussed by Wolffram (1971), Houck (1977) and Ward (1982). Tweeten and Quance (1969) examined asymmetric linear response of prices and Wolffram (1971) extended the linear model to include asymmetric response to the magnitude of accumulated magnitudes of past change. Variations of the Wolffram method have been criticized because ignoring the properties of time series: when price series are non stationary, the autoregressive model may suffer from specification and would give spurious results (Granger and Newbold, 1974). To avoid such problem von Cramon and Taubadel (1998) propose to modify the Wolffram approach by allowing the error correction term and Goodwin and Holt (1999) propose to use the threshold vector error correction term (TVECM) a multivariate version of the simplest class, the univariate Threshold Autoregression or TAR, developed by Tong (1983,1990). Balke and Fomby (1997) extended the TVECM to a cointegration framework. The TVECM investigates about the adjustment of individual process and provides more information about short run price dynamics. Balke and Fomby (1997) use the threshold cointegration and the error correction models with a grid search procedure and threshold parameters selected by minimizing the sum squared errors (SSE). In this research the price transmission is examined in the Italian Dairy market contest, motivated by a total differential of partial reduced form of the downstream prices in terms of upstream prices using a three regime TVECM to explore the asymmetric price adjustment and vertical price dynamics. For the simplest case of two prices Pft and Pwt: the linear cointegration condition is tested with the following equation:

1 - $Pft = \mu + \beta Pwt + vt$ or $vt = Pft - \mu - \beta Pwt$; $vt = \phi v_{t-1} + ut$ and $vt \approx N(0, \sigma 2)$ i.e. I(0); [1]

Pft and Pwt are two prices at two market levels, the error term vt is the deviation from the LR equilibrium distributed as a martingale difference sequence with finite covariance matrix $\Sigma = E(vt, vt')$ of the residuals generated by the LR equilibrium relationship. Vt will be stationary when $\phi < 1$ meaning a non explosive error trend; then the hypothesis of cointegration is accepted when vt is I(0). The optimal lag length may be determined

[1] In estimation of the threshold parameters, previous analyses are not yet done, and the information contained in the variance-covariance ($\Sigma$matrix) of the residual vt used in TVECT to take into account of possible relations among the markets to be considered. Assuming a cross sectional independence among residuals, the analysis requires to elaborate a grid search to minimize the the trace test of the $\Sigma$ matrix to estimate the threshold parameter.

empirically or by test (correlation, portmanteau), however, results will be sample specific. Boyd and Brorsen (1988) examined both a model in levels and one in changes allowing for consideration of both response to change in levels and consideration of response to magnitude and speed of adjustment to change in prices. Considering a full linear price system through the vertical chain, Meyer and von Cramon-Taubadel, (2004) review alternative specifications for such a system. If price time series are stationary, the system is represented by VAR that would show the linear responses to change in level of price. In case of asymmetric price response the VECM must be estimated. The error correction model is motivated by the concept of cointegration: assuming there exists a long run dynamic relationship between two variables Pft and Pwt a portion of disequilibrium in SR from one period to the next one is corrected with the error vt (Engle and Granger, 1987; Cramon-Taubedel and Fahlbusch, 1994). Threshold models are based on the principle that the data generation process for a time series is characterized by separate regimes, each one with its own independent behavior. Goodwin and Holt (1999) use the threshold vector error correction model (TVECM) to investigate the adjustment process and provide more information about short run price dynamics.

In general notation, the VECM is a vector of first differences in log prices $\Delta X_t = \Delta\,(\ln X_{t-1})$:

$$2-\quad \Delta X_t = \mu + \Sigma_{i=1\ldots k-1}\,\Gamma_i\,\Delta X_{t-i}{}^{+} + \alpha\beta'\,X_{t-k} + \phi D_t + \varepsilon_t,\ t = 1\ldots T$$

where $X_{k+1},..,X_0$ are determined and $e_1, \ldots, e_T$ for t = 1..T are independent p-dimensional Gaussian variables with mean zero and covariance matrix $\Lambda$; $\Gamma_i$ is the matrix of the short run dynamics of price data. The vector $D_t$ denotes seasonal dummies centered at zero, $\phi$ is the seasonal coefficient. The parameters of $\Gamma_i$ for i spanning from 1 to $k-1$ are short-run effects, t-k are the relevant lags, $\mu$ is the constant term, $\alpha$ is the p x r matrix (the adjustment coefficients) and $\beta$ is the cointegrating coefficient. Note such model is symmetric so that the effect of $|\Delta X_{t-i}|$ in absolute value is the same regardless of its sign. The deviation from the long run equilibrium, is the error correction term ECT = $\beta' X_{t-k}$. The model above also assumes that the effect of $|ECT|$ is the same regardless of the sign of *ECT (symmetry condition). F*or the agricultural commodity prices, Von Cramon-Taubadel and Fahlbusch (1994) were among the firsts to incorporate the concept of cointegration into models of asymmetric price transmission for agricultural commodity prices. Indeed, as Granger and Lee (1989) pointed out, within the general VECM notation above, it may be important whether the variable $\Delta X$ t - i is positive or negative or whether ECT is positive or negative. Following the notation for a general (random) variable x, let $x^+ = \max\{x, 0\}$ and $x^- = \min\{x, 0\} = -\max\{-x, 0\}$, then we can write $x = x^+ + x^-$. In this way, we can write $\Delta X_{t-i}$ in deviations:

$$3-\quad \Delta X_{t-i} = \Delta X_{t-i}{}^{+} + \Delta X_{t-i}{}^{-},\ \text{where } \Delta X_{t-i}{}^{+} = \max\{\Delta X_{t-i}, 0\},\ \Delta X_{t-i}{}^{-} = \min\{\Delta X_{t-i}, 0\}$$

and the error correction term is:

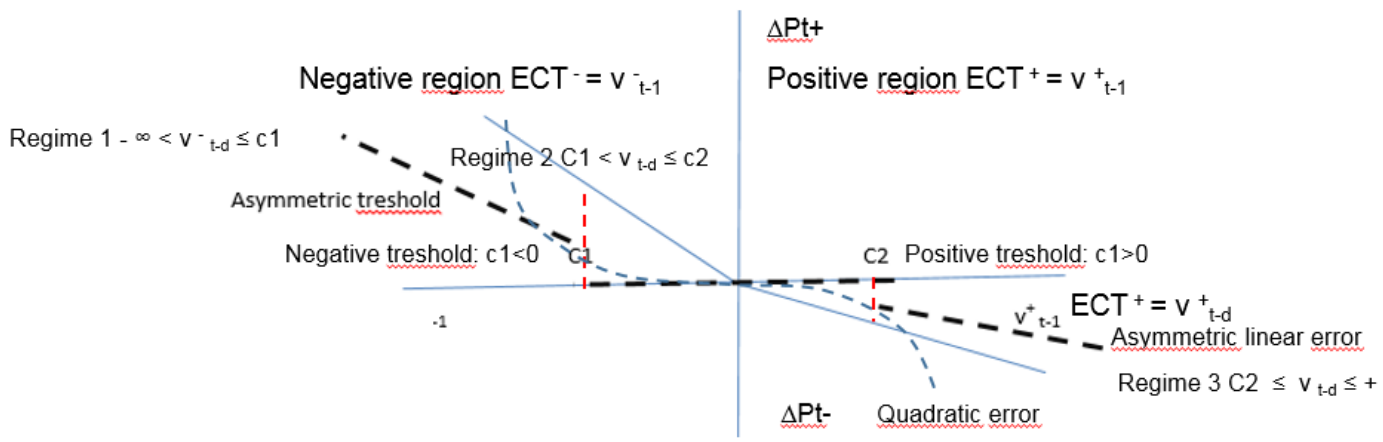
$$4 - \mathrm{ECT} = \mathrm{ECT}^{+} + \mathrm{ECT}^{-},\ \text{where } \mathrm{ECT}^{+} = \max\{\mathrm{ECT}, 0\},\ \mathrm{ECT}^{-} = \min\{\mathrm{ECT}, 0\}.$$

It is noticed that in the context of a VECM, specification is left unsolved by the theory as either or both short-run and long run asymmetric response to change in prices could be allowed. Balke and Fomby (1997) argued for the latter case. To proceed, we consider the general case allowing for both types of effects so the original VECM can be written as:

5 - $\Delta X_t = \mu + \Sigma_{i=1...s} \Gamma_i^+ \Delta X_{t-i}^+ + \Sigma_{i=1...q} \Gamma_i^- \Delta X_{t-i}^- + \alpha^+ ECT^+ + \alpha^- ECT^- + \phi D_t + \varepsilon_t$, t = 1…T

In figure 1 is reported the three regimes of the error vt following the TVECM linear and non linear pattern caused by non linear positive and negative price responses within the threshold interval. (see appendix 2). Fig 1 - Three regimes TVECM are hypothesized to explain the asymmetric price transmission and Vt.

Figure 1. Description of the price adjustment with three regimes error correction




Source: our elaboration

Referring to equation 5 and figure 1, three different types of asymmetries are observed depending on: reaction time, equilibrium adjustment, simultaneous impact and distributed lag:

1 – Asymmetric price transmission outside the symmetric interval c1 = c2;
2 – Asymmetric Price transmission outside the asymmetric interval: c1≠c2 causing different price responses in positive-negative directions (slope of the errors (t);
3 – Price shocks at different chain level are different and depend on the level at which the initial shocks start (Vavra and Goodwin; Goodwin &Holt).

Assuming Pit, Pjt and Pkt, referred to three prices of the dairy chain: retail, wholesale and farm-levels; $\mu$ is the constant signaling the market level; bj is the estimated cointegration coefficient between Pjt and Pit; bk is the estimated cointegration coefficient between Pkt and Pjt and vt is the positive or negative residual vector of the LR equilibrium relationship (i.e the positive or negative deviation from the LR equilibrium) modelled as: $V_t = \phi\, v_{(t-d)} + e_t$, with $v_{t-d}$ ranging

in the interval between $-\infty$ to $+\infty$. It is possible to define the following types of asymmetries:

i) If $\Gamma_i^+ = \Gamma_i^-$; $s = q$; $\alpha^+ = \alpha^-$ the VECM is symmetric;
ii) If $\Gamma_i^+ = \Gamma_i^-$; $s = q$; $\alpha^+ \neq \alpha^-$ the VECM shows the asymmetry in reaction time (ART) to positive and negative price shoks and equilibrium adjustment path (AEAP);
iii) If $\Gamma_i^+ \neq \Gamma_i^-$ the VECM shows the asymmetry in simultaneous (cumulated) impact (ACUI);
iv) If $\Gamma_i^+ \neq \Gamma_i^-$ and $s \neq q$ then the presence of asymmetry in distributed lag effect and cumulated impact (ALE and ACUI). Note only simultaneous impact asymmetry is short-run asymmetry, while other types of asymmetries are long-run asymmetries. Assuming the X as a vector of prices our notation presents a general VECM as considered for the bivariate case by Meyer & von Cramon Taubadel. A final notation on specification that deserves consideration follows from the possibility of nonlinearity in the relationships. While the VECM in linear form rules out such nonlinearity, variation in its specification can accommodate nonlinearity by allowing for regime change either exogenously by specification of a parameter shift at point in time or endogenously by specification of threshold condition at which a parameter shift occurs. In this latter case, the threshold could be specified as an exogenous value, e.g. von Cramon Taubadel (1996), estimated as a parameter, or smoothly based on further modeling of parameter evolution, e.g. Serra and Zilberman (2013). Azzam (1999) and Goodwin and Piggot (2001) provide theoretic motivation for such threshold adjustment mechanisms. Granger and Lee (1989) presented an approach for the former type of an asymmetric error correction model that was further developed by Enders and Granger (1998), who also noted that standard unit root tests are mis-specified if adjustment is asymmetric and presented new critical values for unit root tests for use when asymmetry is possible. Clearly, when the threshold is zero, the TVECM provides a direct alternative approach to estimation of asymmetric VECM. As the TVECM provides a basis for differentiation of price level response to change in price level, such impulse responses are typically not examined. Further, an important limitation of the TVECM is the need to specify or estimate exogenous threshold values. From this perspective, the TVECM provides little other than a regime switching mechanism and, thereby, is most useful when treatment periods are ex ante observable by the researcher at least in number of thresholds that might be relevant. In our application, we consider only one threshold and estimate its value in the context of estimation of the TVECM.

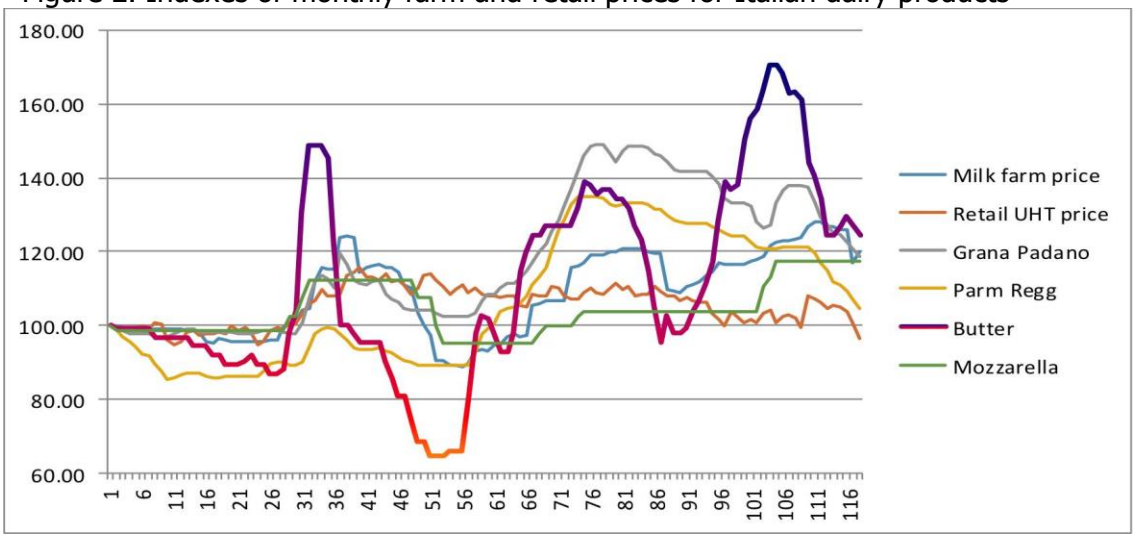
## 3. Empirical analysis of the dairy chains prices in Italy

The monthly price series [2]of some dairy products from 1st Jan 2005 to June 2014[3] are examined to observe their evolution, interactions and transmission. In Figure 2, the dynamics of monthly prices in the Italian dairy chain are illustrated; for the purpose to facilitate the cross price analysis the series are indexed to 100 in the first period. The sample covers the period running from 1st Jan 2005 to June 2014. The measure of variability, often used in financial market analysis, is the standard deviation of returns, where the return is defined as the proportional change in price from one period to the next. The return are the log difference of prices from one period to the next and measure the unconditional volatility, expressed as follows:

$$\text{st dev } (r) = \Sigma\, 1/n\text{-}1\, ((rt - rm)^2)^{1/2} \quad \text{with } rt = \ln(Pt) - \ln(Pt\text{-}1) \text{ and } rm = \Sigma\, 1/n * rt$$

If prices follow a unit-root process with a multiplicative error term, r will be stationary and its standard deviation will not depend on the size of the sample. This unconditional concept does not take into account any prior information and is based only on observed variation in returns (Minot, 2014). Two general patterns of co-movement exist that appear to be consistent with cross-product arbitrage to move milk ingredients into more storable forms. The prices of butter, GP, PR, and milk appear to co-move, however the intertemporal timing of their co-movement appears to change over time. For example, butter price appears to lead changes in milk, GP, and PR price. The extended shelf life of retail UHT and Mozzarella relative to other products is reflected in greater stability in their prices.

Figure 2. Indexes of monthly farm and retail prices for Italian dairy products




Evidence of the extent of price volatility at various stages of the dairy chain follows from consideration of intra-year price variation. In Table 1, it is reported the intra-year

[2] As reported by Serra et al., the prices of milk are constant through the month with adjustment being made at the beginning of each month.

[3] Data provided by ISMEA

standard deviation of the percentage change in price. While this is based only 12 monthly observations each year, results suggest the extent of price variation experienced. As is clear from this table, price variation experienced varied across the products and stages, in some cases reaching as high as 8% for retail butter in 2009, though more typically falling the range of 1-2%.

Table 1. Monthly price volatility (standard deviation of %change in price)

| Period | year | Milk farm price | GP-W-14-16 | GP-R-14-16 | PR-W-24 | PR-R-24 | UHT-R | Butter-R | Mozzarella - R |
|---|---|---|---|---|---|---|---|---|---|
| jan-dec | 2005 | 0.0022 | 0.01 | 0.00 | 0.0109 | 0.0058 | 0.0164 | 0.0078 | 0.0037 |
| jan-dec | 2006 | 0.0094 | 0.00 | 0.01 | 0.0035 | 0.0025 | 0.0163 | 0.0155 | 0 |
| jan-dec | 2007 | 0.0222 | 0.0254 | 0.0081 | 0.017 | 0.0035 | 0.0163 | 0.1039 | 0.0202 |
| jan-dec | 2008 | 0.0255 | 0.0141 | 0.0054 | 0.0089 | 0.0026 | 0.02 | 0.0328 | 0 |
| jan-dec | 2009 | 0.0281 | 0.012 | 0.0095 | 0.0186 | 0.0038 | 0.0177 | 0.0827 | 0.0251 |
| jan-dec | 2010 | 0.0243 | 0.0089 | 0.0055 | 0.0135 | 0.007 | 0.0158 | 0.0536 | 0.0102 |
| jan-dec | 2011 | 0.0056 | 0.0166 | 0.0119 | 0.0074 | 0.0324 | 0.0129 | 0.0277 | 0.0079 |
| jan-dec | 2012 | 0.0287 | 0.0066 | 0.0038 | 0.0042 | 0.0146 | 0.0128 | 0.0634 | 0 |
| jan-dec | 2013 | 0.0071 | 0.0205 | 0.0017 | 0.0055 | 0.0201 | 0.0198 | 0.0332 | 0.0213 |
| jan-dec | 2014 | 0.029 | 0.009 | 0.008 | 0.0084 | 0.008 | 0.0347 | 0.0434 | 0 |
| jan-oct | 05-14 | 0.0237 | 0.0181 | 0.008 | 0.0151 | 0.0144 | 0.0181 | 0.0587 | 0.0141 |
| Average month | | 0.0182 | 0.0124 | 0.0064 | 0.0098 | 0.01 | 0.0183 | 0.0464 | 0.0089 |

The analysis of price proceeds with the following operations:
First the stationary condition of the series will be checked using the Augmented Dickey Fuller test; second the linear co-integration will be verified using the Johansen co-integration test and third the asymmetry will be verified and commented.

## 4. Univariate time series properties

The first step is the exam of the univariate properties of the price series. The Augmented Dickey Fuller tests suggests that the series are non-stationary in levels, but stationary in first differences then the series are first order integrated I(1).

Table 2. ADF test for stationarity

| | Milk Farm | GP-Wholesale 14-16 mon. | GP-Retail 14-16 mon. | PaRe-Wh 24 mon. | PaRe-Ret 24 mon | UHT-R | Butter-R | Mozz- R |
|---|---|---|---|---|---|---|---|---|
| ADF test | -9.1605 | -6.3368 | --1.9213 | -4.1194 | -8.5466 | -5.2504 | -10.3415 | -12.4015 |
| level 1% | -3.4876 | -3.4876 | -2.5856 | -2.5850 | -2.5851 | -2.5872 | -2.5854 | -2.5854 |
| level 5% | -2.8865 | -2.8865 | -1.9437 | -1.9436 | -1.9436 | -1.9439 | -1.9437 | -1.9437 |
| level 10% | -2.5802 | -2.5802 | -1.6149 | -1.6149 | -1.6149 | -1.6147 | -1.6149 | -1.6149 |

Exceptions may include GP_R where the hypothesis of non-stationary can be rejected only at the 10% level. Then we estimate the rank of the cointegrating vector for bivariate pairs of prices. In table 2, the estimated rank is one for raw milk and butter, GP_W and GP_R; GP_W and PR_R; GP_R and PR_W; GP-R and PR_R; Butter with Mozzarella; of 29 pairs only six appear to be cointegrated. When the series aren't cointegrated, the price transmission between price pairs is not significant. In terms of market efficiency this result appears quite surprising given the previous hypothesis that the various steps of the dairy chain are co-integrated. The lack of co-integration between raw milk and other products can be explained with the presence of the OCM, influencing the price formation quite stable at the farm level and not affected by marked conditions; this justifies the separation from the industrial or retail level markets where the price setting is made in competitive conditions. The other cointegration between GP_W and GP_R or PR_W and PR_R appear quite plausible due to the interactions among these markets.

Table 3. Rank of cointegration vector

| | Raw milk | GP-W | GP-R | PR-W | PR-R | UHT | Butter | Mozzzarella |
|---|---|---|---|---|---|---|---|---|
| Raw milk | NA | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| GP-W | | NA | 1 | 0 | 1 | 0 | 0 | 0 |
| GP-R | | | NA | 1 | 1 | 0 | 0 | 0 |
| PR-W | | | | NA | 0 | 0 | 0 | 0 |
| PR-R | | | | | NA | 0 | 0 | 0 |
| UHT | | | | | | NA | 0 | 0 |
| Butter | | | | | | | NA | 1 |
| Mozzzarella | | | | | | | | NA |

The results about the linear cointegration, suggest to continue to check for non linear cointegration using the asymmetric VECM and testing for asymmetry in the long run deviation ECT,. It is typical that interest focuses on price asymmetry as the deviations from long run equilibrium. It is estimated the later as $ECT_t$ in the first step of Granger's two step method. It is reported in the first block (Tables 4.1), results for the case where asymmetry occurs only with respect to $ECT_t$ and in the lower block (table 4.2) for the case of asymmetry allowed for each of the independent variables, both short run and long run indicators. Results provide strong support for rejecting the null hypothesis of asymmetry for all bivariate pairs, except GP_W and GP_R. For most pairs, the estimated parameters in the asymmetric VECM are statistically significant, though the point

estimates are close in values leading to rejection of the null. Thus, in general, we infer from available data that price transmission within the Italian dairy chain is symmetric.

Table 4.1. Asymmetry in ECT with the assumption that only ECT could be asymmetric

| | Raw Milk | GP-W | GP- R | PR-W | PR-R | UHT | Butter | Mozzarella |
|---|---|---|---|---|---|---|---|---|
| Raw Milk | NA | 0.816 | 0,191 | 0.916 | 0.101 | 0.346 | 0.130 | 0.151 |
| GP W | 0.760 | NA | 0,026 | 0.320 | 0,371 | 0.133 | 0.543 | 0.885 |
| GP R | 0.851 | 0.455 | NA | 0.959 | 0,134 | 0.404 | 0.580 | 0.976 |
| PR W | 0.816 | 0.014 | 0,117 | NA | 0,598 | 0.202 | 0.734 | 0.969 |
| PR R | 0.804 | 0.553 | 0,000 | 0.895 | NA | 0.451 | 0.492 | 0.93 |
| UHT | 0.461 | 0.492 | 0,000 | 0.713 | 0,000 | NA | 0.800 | 0.977 |
| Butter | 0.265 | 0.215 | 0,182 | 0.960 | 0,190 | 0.926 | NA | 0.592 |
| Mozzarella | 0.389 | 0.649 | 0,485 | 0.425 | 0,064 | 0.621 | 0.587 | NA |

Note: The table above uses Granger two step method.

Table 4.2. Asymmetry in ECT with the assumption that all rhs terms could be asymmetric

| | Raw Milk | GP- W | GP- R | PR- W | PR- R | UHT | Butter | Mozzarella |
|---|---|---|---|---|---|---|---|---|
| Raw Milk | NA | 0.096 | 0.977 | 0.266 | 0.150. | 0.978 | 0.842 | 0.485 |
| GP W | 0.785 | NA | 0,005 | 0.828 | 0,390 | 0.783 | 0.200 | 0.569 |
| GP R | 0.451 | 0.346 | NA | 0.964 | 0,053 | 0.795 | 0.092 | 0.520 |
| PR W | 0.679 | 0.978 | 0,167 | NA | 0,022 | 0.397 | 0.233 | 0.684 |
| PR R | 0.404 | 0.322 | 0.173 | 0.692 | NA | 0.612 | 0.940 | 0.429 |
| UHT | 0.181 | 0.837 | 0,109 | 0.792 | 0.752 | NA | 0.928 | 0.947 |
| Butter | 0.955 | 0.231 | 0,960 | 0.057 | 0,398 | 0.911 | NA | 0.876 |
| Mozzarella | 0.869 | 0.183 | 0,944 | 0.799 | 0,217 | 0.953 | 0.544 | NA |

Note: The table above uses mtar method.

The results reported in tables 4.1 ans 4.2 are consistent with a linear VECM then our analysis stop at this point. If the relationships were nonlinear, one approach to test for nonlinearity is to estimate a threshold VECM where the parameters shift to different values, depending on the magnitude of the error relative to a threshold. Tsay non parametric test and sequential conditional iterative SUR in two steps of which: first step a two dimensional grid search is carried out to estimate the threshold parameter (c1 and c2 see fig 1 ) by finding the values of the threshold ((Serra and Goodwin, 2003).

## 5. Conclusions

In this paper, it has been examined the efficiency of dairy chain markets in Italy with evidences of price transmission using the econometric approach based on monthly time series data. As suggested by Granger and Engel it was estimated the stationarity condition and the cointegration among all pair of prices, it was used the lagged errors vt-1 resulting from OLS estimates of the first step for the threshold vector error correction term with three regimes and finally the dynamics of long run equilibrium were analyzed. The results do not support the hypothesis of asymmetries in shocks transmission in the dairy sector, [4] and from the parameter values the transmission occurs rapidly with very limited delays. The Italian liquid milk industry is characterized by lower value added to factor costs, limited margins on manufactured products, a relatively higher competition among the most relevant retail chains due to the number of private labels. These sector features may have influenced the transmission from farm to retail prices reducing the asymmetric price adjustment. In addition the relative weakness of dairy farm contractual organization may have reduced the strength of farm price transmission. The CMO regulation of the farm prices doesn't seems to have caused asymmetric vertical price transmission as the lack of cointegrations among the pair of prices tested and the reverse, the retail price movement is not reflected in the pass- through to dairy farmer prices. The contract bargained with the intervention of farmers and industry association has limited as well the asymmetric power between farmers and industry. Some asymmetries can be explained with the Ward's suggestion that asymmetries may be related to highly perishable products, in our case it is more reliable the hypothesis that the asymmetry could be generated by speculative actions causing overreaction to increasing prices. Price shocks induce permanent adjustments in most of the markets however the pass through doesn't seems to be affected by the presence of oligopoly conditions at some dairy chain level. The tendency to price reduction at the farm level seems to be caused by internal market conditions (growing supply and increasing size seeking for scale economies). The CMO protection has probably affected the dairy farms integrated in dairy coops countervailing the market power at higher levels. Consequences for policy analysis can be summarized as it follows: if the price transmission is working and evidences of asymmetries are limited to few dairy products, the market conditions can be considered quite efficient for almost all the dairy products. The decline in price at the farm level are due to a substantial increase in market competition that has accelerated the need for structural changes to obtain scale economies at farm level accompanied by better integration at different chain level to participate to the redistribution of value added of the dairy chain. The milk

[4] These results are in line with those found by Serra and Goodwin for the Spanish dairy market.

package is offering the measures to substitute the quota market protection with the increased effectiveness of more bargaining power through representative dairy associations and cooperatives

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