Rivista di Economia Agraria, Anno LXXI, n. 1 (Supplemento), 2016

Check the Dairy Chain efficiency in Italy

R. D. Weaver - Pennsylvania State University, USA
F. Rosa - University of Udine*
M. Vasciaveo -- University of Udine

**Corresponding author: franco.rosa@uniud.it*
The authors wish to thank ISMEA for its support in providing market information.

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

Introduction

During recent decades 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) which moved the CAP toward income support through compensatory direct payment allowing a reduction in the guarantee prices. Other political interventions were included in Agenda 2000 with specific milk sector measures

DOI: 10.13128/REA-18627
ISSN (print): 0035-6190
ISSN (online): 2281-1559

(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 and accelerating the structural changes, to 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 in 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 condition 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. Being the price the primary signal of market equilibrium, the instantaneous price transmission (adjustment) is intended as an 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 have 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.

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 $vt = Pft - \mu - \beta Pwt$; $vt = \phi vt\text{-}1 + ut$ 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 · = E (vt, vt') of the residuals generated by the LR equilibrium relationship. Vt will be stationary when ··< 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 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 $\cdot X_t = \cdot \ln X_{t-I}$:

2– $\Delta X_t = \mu + \Sigma_{i=1\ldots k-1} \Gamma_i \, \Delta X_{t-i}{}^{+} + \alpha\beta' \, X_{t-k} + \phi D_t + \varepsilon_t$, t = 1…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 Λ; Γ_i· is·the matrix of the short run dynamics of price data. The vector D_t denotes seasonal dummies centered at zero, ϕ is·the seasonal coefficient. The parameters of Γ_i for i spanning from 1 to $k-1$ are short-run effects, t-k are the relevant lags, μ is the constant term, α is the p x r matrix (the

[1] In estimation of the threshold parameters, previous analyses are not yet done, and the information contained in the variance-covariance (·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 ··matrix to estimate the threshold parameter.

adjustment coefficients) and β 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 ΔX_{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 ΔX_{t-i} in deviations:

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

and the error correction term is:

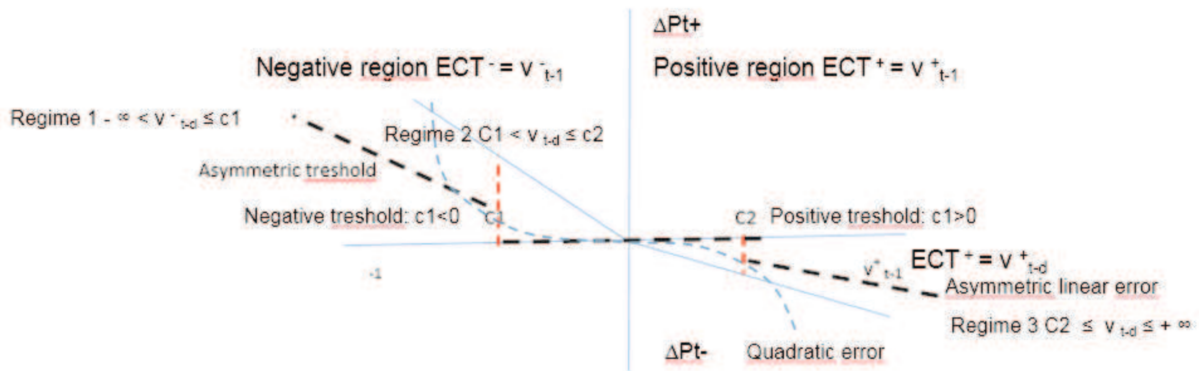
$$4 - ECT = ECT^{+} + ECT^{-}, \text{ where } ECT^{+} = \max\{ECT, 0\},\ ECT^{-} = \min\{ECT, 0\}.$$

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:

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

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).

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; · 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 $-\infty$ 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 shocks 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 that 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 and 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.

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 1, 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.
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 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%.
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.

[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

Figure 1. Indexes of monthly farm and retail prices for Italian dairy products

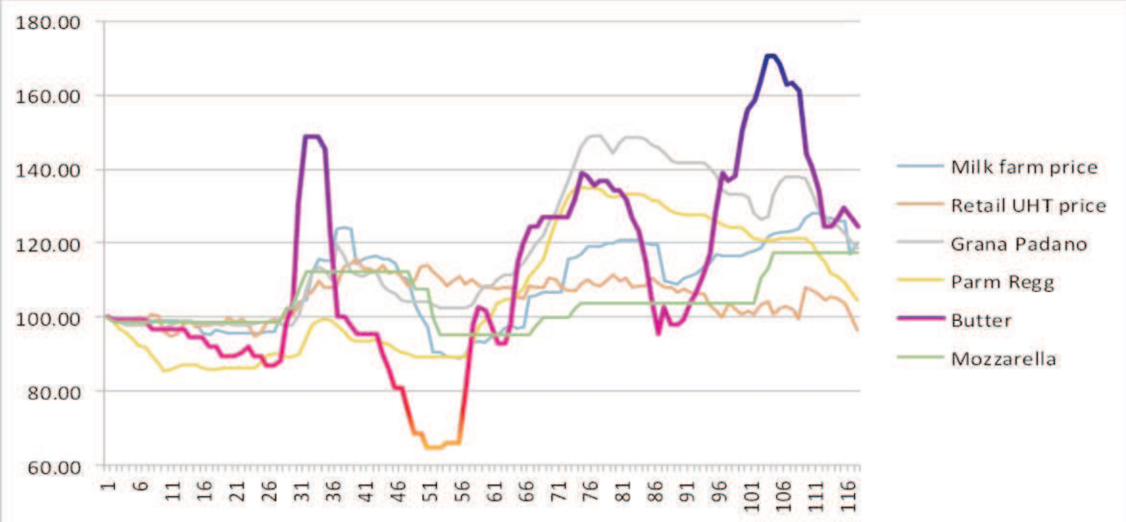


Table 1. Monthly price volatility (standard deviation of %change in price)

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	2015	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

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.

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.

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

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	Mozzarell a
Raw Milk	NA	0.816	0,191 0.117	0.916	0.101 0.598	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 0.182 0.485	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	Raw Milk	GP- W	GP- R	PR- W	PR- R UHT Butter Mozzarell a	UHT	Butter	Mozzarell a
Raw Milk	NA	0.096	0.977 0.005 NA 0.167	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).

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 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.

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

References

Azzam A., (1999). Asymmetry and Rigidity in Farm Retail Price Transmission. American Journal Agricultural Economics, 81, pp 525-533.
Balke, N. S., & Fomby, T. B. (1997). Threshold cointegration. International economic review, pp. 627-645.
Beck S. E., 1994. Cointegration and market efficiency in commodities futures markets. Applied economics 26,3, pp 249-257
Blinder A.S., (1982). Inventories and Sticky prices. AER 72, pp. 334-348.
Bonnet C., (2015). "Retail price formation in food chain: market power and vertical relationships. 52nd SIDEA conference, Viterbo, Italy.
Bonnet C., Corre T., Rèquillard V., (2015). Price transmission in food chain: the case of dairy industry. TSE Working paper 15-563.
Boyd, M.S. and Brorsen, B.W. (1988). Price Asymmetry in the U.S. Pork Marketing Channel, North Central Journal of Agricultural Economics 10, pp 103-109.
Cavicchioli, D., (2010). Detecting Market Power Along Food Supply Chains: Evidence From the Fluid Milk Sector in Italy. Paper prepared for the 116th EAAE Seminar "Spatial Dynamics in Agri-food Systems: Implications for Sustainability and Consumer Welfare.
Engle R.F. and Granger C. W. J., (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. Econometrica, 55, No. 2. pp 251-276.
Goodwin B.K., and Piggot N. (2001). Spatial market integration in presence of threshold effect. AJAE, 83, pp 302-17.
Goodwin B.K. and Holt M.T.(199). Asymmetric adjustment and price transmission in US Beef Sector. American Journal Agricultural Economics 79, pp 630-37.
Granger, C. W. J. and Newbold, P. (1974). Spurious Regressions in Econometrics. Journal of Econometrics 2, pp. 111-120.
Houck, P.J., (1977). An approach to specifying and estimating a non reversible function. American Journal Agricultural Economics 59, pp 570-572.
Kinnukan H.W., O. D. Forker, (1987), "Asymmetry in Farm-Retail Price Transmission for Major Dairy products", American Journal of Agricultural Economics 69, pp. 285-292.
Lo, M. and E. Zivot, (2001) "Threshold Cointegration and Nonlinear Adjustment to the Law of One Price," Macroeconomic Dynamics, December.
London Economics, (2003). Examination of UK Milk Prices and Financial Returns, Report prepared for The Milk Development Council, February.
London Economics, (2004). Investigation of the determinants of farm-retail price spreads, Final report to DEFRA, U.K.
Meyer J., S. von Cramon-Taubadel, (2004), "Asymmetric Price Transmission: A Survey". Journal of Agricultural Economics 55, pp. 581-611.
Minot N., (2014), Food price volatility in sub-Saharan Africa: Has it really increased? Food Policy 45, pp. 45–56.
Peltzman, S. (2000). Prices Rise Faster than they fall. Journal of Political Economy 108 pp. 466-502.

Rosa F., Weaver, R., and Vasciaveo M. (2015). "A case of Imperfection competition in Italy: consequences for price transmission and welfare distribution System Dynamics and Innovation in Food Networks" Journal on Food System Dynamics 6, 3, pp 191-211.
Rosa F., M. Vasciaveo, R. Weaver. (2014). "Agricultural and oil commodities: price transmission and market integration between US and Italy" BAE 3, n° 2, 2014 pp. 93-117.
Santeramo F., 2015, "Price Transmission in the European Tomatoes and Cauliflowers Sectors", Agribusiness 31, 3, pages 399–413.
Serra T., and D. Zilberman, (2013). Biofuel related price transmission literature: a review, Energy Economics, pp. 141-151.
Serra T., B., and K. Goodwin (2003). Price transmission and asymmetric adjustment in the Spanish dairy sector. Applied Economics 35 pp 1889-1899.
Tomek W., and K.L. Robinson, (1972). "Agricultural Product Prices", Cornell University Press.
Tweeten, LG. and Quance, C.L (1969). Positivistic Measures of aggregate Supply Elasticities: Some new Approaches, American Journal of Agricultural Economics 51:342-352.
Vavra P., B.K. Goodwin (2005). Analysis of Price Transmission Along the Food Chain OECD Food, Agriculture and Fisheries Working Papers No. 3.
v. Cramon-Taubadel, S. (1998). Estimating Asymmetric Price Transmission with the Error Correction Representation: An Application to the German Pork Market," European Review of Agricultural Economics. 25: pp 1-18.
v. Cramon-Taubadel, S., and Fahlbusch, S. (1994). Identifying asymmetric price transmission with error correction models, Poster Session EAAE European Seminar in Reading.
Vavra P., B.K. Goodwin (2005). Analysis of Price Transmission Along the Food Chain. OECD Food, Agriculture and Fisheries Working Papers No. 3.
Ward, R.W., (1982). Asymmetry in Retail, Wholesale and Shipping Point Pricing for Fresh Vegetables. American Journal of Agricultural Economics 64 pp. 205-12.
Weaver R., and Natcher W. (1999). Price Volatility in Dairy Markets: A Story of Stocks? Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL.
Weldegebriel, H. T. (2004). Imperfect Price Transmission: Is Market Power Really to Blame? Journal of Agricultural Economics 55: 101-114.
Wohlgenant, M.K. (2001). Marketing Margins: Empirical Analysis. in Brace Gardner and Gordon Rausser, ed., Handbook of Agricultural Economics, Volume 1, Amsterdam: Elsevier Science B.V., chapter 16, pp. 934N 970.
Wolffram, R. (1971). Positivistic Measures of Aggregate Supply Elasticities. Some New Approaches. Some Critical Notes. American Journal of Agricultural Economics. 53: 356N59.
Zachariasse, V. and F. Bunte, (2003). How are farmers facing in the changing balance of power along the food supply chain?, OECD Conference: Changing Dimensions of the Food Economy: Exploring the Policy Issues, The Hague, 6N7 February 2003.

Appendix 1

1. A time series is integrated when it has a mean reverting property and a finite variance. It is only temporarily out of equilibrium and is called stationary in I(0). However, a time series, that has to be

differenced before it is stationary, has an infinite variance. The series is stationary at a higher order I(d), e.g. an I(1) series is stationary at first difference.

1.1 Dickey-Fuller (DF)
A test for stationarity Dickey and Fuller (1979) referred a unit root test to us which is well established. To show the mean contents Alexander (2001) uses an AR(1) model,

$$y_t = c + ay_{t-1} + u_t$$

where ût ~ i.i.d.(0, σ^2). If |a| < 1 the model is assumed to be stationary and the characteristic polynomial of the AR(1) process lies inside the unit circle, otherwise it is nonstationary and the variance increases with time. Unfortunately it is not useful to test whether αˆ = 1 and then use a simple t-test because they are biased. It is more efficient to take the first difference of an AR(1) process,

$$\Delta y = \phi\, y_{t-1} + + u_t \quad \text{where } \phi = \alpha - 1\cdot .$$

Now one can use a one sided t-test with H0: $\phi = 0$ and Ha: $\phi < 0$ and compare it with the critical values from Dickey and Fuller, because they showed that standard t_ϕ ratios are biased and that the appropriate critical values have to be increased by an amount that depends on the sample size.

2. Linear combination and Cointegration

Consider the case of two I(1) variables, yt as dependent and xt as explanatory variable, for simplicity without a constant. Generally, if we make a linear combination out of them,

$$y_t = \alpha\, x_t + v_t \text{ or } v_t = y_t - \alpha\, x_t$$

the combination vt will normally still be I(1), since they both have infinite variance. However, if the constant α is therefore such that the bulk of the long run components of yt and xt cancel out, the linear combination could be I(0), more precisely, the difference vt would be I(0). If a linear combination of I(1) variables is stationary, (i.e vt ≈ I(0)) then the variables are said to be cointegrated.

The Engle-Granger two Step Approach (1987) suggest a cointegration test, which consists of estimating the cointegration regression by OLS, obtaining the residual vt and applying unit root test for vt . To test an equilibrium assertion, they propose testing the null that vt has a unit root against the alternative that it has a root less than unity. Since vt are themselves estimates, new critical values need to be tabulated. Thus one has to use the corrected MacKinnon critical values. We have the equation

$$vt = \rho\, v_{t-1} + \varepsilon_t \text{ with } \varepsilon_t \sim (0, \sigma^2)$$

where v_t follows an autoregressive progress and ε_t is a random variable with martingale process.
One could assume three possibilities, that ρ is smaller, equal or higher than one:
1) If | ρ | > 1: yt ~ I(1) and xt ~ I(1) then vt ~ I(2);
2) If | ρ | = 1: yt ~ I(1) and xt ~ I(1) then vt ~ I(1);
3) If | ρ | < 1: yt ~ I(1) and xt ~ I(1) then vt ~ I(0).

Only if | ρ | < 1, a cointegration relationship exists. If one wants to derive more information about the dynamic behaviour of the variables, he will have to apply an Error-Correction model. Engle and Weiß (1983) demonstrated that if a set of cointegrated variables exist, they can be regarded as being generated by an Error-Correction model, which is called the Granger Representation Theorem.

Error-Correction model (ECM): Cointegration is concerned with long run equilibrium. On the other hand, Granger causality (see below) is concerned with short run forecastability. These two different models can be considered in an error correction model. The name error-correction model is derived from the fact, that it has a self regulating mechanism. That means it returns after deviations automatically to its long run equilibrium. The ECM has a long run equilibrium and uses past disequilibrium as explanatory variables in the dynamic behaviour of current variables.1 One can estimate a Vector Autoregressive (VAR) process,

$$y_t = \alpha_{11}y_{t-1} + \alpha_{12}x_{t-1} + \varepsilon_{1,t}$$
$$x_t = \alpha_{21}y_{t-1} + \alpha_{22}x_{t-1} + \varepsilon_{2,t}$$

If one takes the differences of a VAR model, he will receive the Error-Correction model:

$$\Delta y_t = \lambda_1 z_{t-1} + \Sigma_{i=1, t-1} (c_{11} \Delta y_{t-i} + c_{12} \Delta x_{t-i}) + \varepsilon_{1,t}$$

$$\Delta x_t = \lambda_2 z_{t-1} + \Sigma_{i=1, t-1} (c_{21} \Delta y_{t-i} + c_{22} \Delta x_{t-i}) + \varepsilon_{2,t}$$

with $z_t = y_t - \alpha\ x_t$, which is exactly our residual series and with λ1 ≤ and 0 and λ2 ≥ 0. As one can easily see, if yt-1 is too high, yt will be reduced again over z_{t-i} and λ1. The same holds for xt over z_{t-i} and λ2. However, z_t regulates only the long run equilibrium, with λ1 and λ2 as adjustment speed, but if one wants to derive information about the short run adjustment, you will have to pay attention to the second part of the equation. The ECM shows how significant the lagged variables are, by using simple t-tests. If one wants to know, how strong the influences of all lagged values together are, you will have to apply a test for Granger.

Appendix 2

APT – TVECT in presence of threshold: three market levels: Pit $\alpha - \beta_j P_{jt} - \beta_k P_{kt} = v_t$
Assuming Pit, Pjt and Pkt are three vertically related prices: retail, wholesale and farm-levels;
a is the constant signaling the market level;
βj is the estimated coefficient between Pjt and Pit; βk is the coefficient between Pkt and Pit;
vt is the positive or negative residual vector of the LR equilibrium relationship (i.e the + or - deviation from the LR equilibrium) modelled as:
vt = (ϕ)vt-1 + ut, ranging in the interval between - °° to + °°;
The co-integration condition among the prices requires Vt, to be stationary, i.e I(0) or |ϕ |< 1 implying. (Balke and Fomby, 1997).
This analysis is extended to the case of three regime with Vt following a threshold auto-regression:

$V_{t-d} = \phi\ v_{(t-d)}$ + et, with v_{t-d} ranging

$$\phi^{(i)} \begin{cases} \phi^{(1)} & \text{if } -\infty < v_{(t-d)} \le c_1 \\ \phi^{(2)} & \text{if } c_1 < v_{(t-d)} \le c_2 \\ \phi^{(3)} & \text{if } c_2 < v_{(t-d)} \le +\infty \end{cases}$$

ci and c2 are the threshold parameter values that indicate the different regimes;

Vt-d is the variable relevant to the threshold behaviour (often referred the "forcing variable"). In most empirical applications, d is = 1 (see fig. before), though this is a restriction can be empirically tested within the threshold model estimation procedure.

The vector error correction representation of the threshold model is the following:

$$\Sigma_{i=1}^{l} B_i^1 \Delta P_{t-i} + \gamma^{(1)} v_{t-1} + e_t^{(1)} \quad \text{if } -\infty < v_{(t-d)} \le c_1$$

$$\Delta Pt \quad \begin{cases} \Sigma_{i=1}^{l} B_i^2 \, \Delta P_{t-i} + \gamma^{(2)} v_{t-1} + e_t^{(2)} & \text{if } c_1 < v_{(t-d)} \leq c_2 \\ \Sigma_{i=1}^{l} B_i^3 \, \Delta P_{t-i} + \gamma^{(3)} v_{t-1} + e_t^{(3)} & \text{if } c_2 < v_{(t-d)} \leq +\infty \end{cases}$$

where Pt, is the vector of prices being analyzed and Bi and γ are vectors of parameters to be estimated. The threshold vector error correction model (TVECM) can be compactly expressed as:

$$\Delta Pt \quad \begin{cases} B^1 X_{t-l} + e_t^{(1)} & \text{if } -\infty < v_{(t-d)} \leq c_1 \\ B^2 X_{t-l} + e_t^{(2)} & \text{if } c_1 < v_{(t-d)} \leq c_2 \\ B^3 X_{t-l} + e_t^{(3)} & \text{if } c_2 < v_{(t-d)} \leq +\infty \end{cases} \qquad \text{Range } Xt-l \text{ for } l=1..l \qquad X_{t-l} \quad \begin{pmatrix} \Delta P_{t-1} \\ \Delta P_{t-2} \\ \cdots\cdots \\ \Delta P_{t-l} \end{pmatrix}$$

B is the matrix of parameters that can be written as:

$$\Delta P_t = \beta^{(1)} X_{t-l} \, d_{1t} (c1, c2, d) + \beta^{(2)} X_{t-l} \, d_{2t} (c1, c2, d) + \beta^{(3)} X_{t-l} \, d_{3t} (c1, c2, d) + e_t$$

Where the d terms are indicator variables defining each regime

d_{1t} (c1, c2, d) = $-\infty < v_{(t-d)} \leq c_1$

d_{2t} (c1, c2, d) = $c_1 < v_{(t-d)} \leq c_2$

d_{3t} (c1, c2, d) = $c_2 < v_{(t-d)} \leq +\infty$