Research Article

Markus Hanisch, Jens Rommel*, and Malte Müller

The Cooperative Yardstick Revisited: Panel Evidence from the European Dairy Sectors

Abstract: Milk is an important agricultural product that has traditionally been processed by cooperatives. Across member states of the EU-27, however, large variation exists between the national market shares of cooperatives in dairy processing. Theoretical models suggest that a strong cooperative sector secures competitive regional prices for agricultural produce. Empirical studies which seek to quantify these effects are rare though. We use panel data to study the impact of cooperative strength – measured by market shares – on national farm gate milk prices in the EU-27 for the period from 2000 to 2010. Our results reveal a positive effect of cooperative market share on price that is relatively large and robust over different specifications of the econometric model. We conclude that dairy cooperatives have a pro-competitive effect and that exemptions for cooperatives from anti-trust regulation may be justified.

Keywords: EU-27, common agricultural policy, competition, cooperative yardstick, dairy farming

***Corresponding author: Jens Rommel,** Division of Resource Economics, Department of Agricultural Economics, Humboldt-Universität zu Berlin, Berlin 10099, Germany; Leibniz Institute of Agricultural Development in Central and Eastern Europe, Halle, Germany, E-mail: jens.rommel@hu-berlin.de
Markus Hanisch: E-mail: markus.hanisch@hu-berlin.de, **Malte Müller:** E-mail: mullemqd@hu-berlin.de, Division of Cooperative Sciences, Department of Agricultural Economics, Humboldt-Universität zu Berlin, Berlin 10099, Germany

1 Introduction

Milk is one of the most important agricultural commodities in the EU-27 and worldwide. In 2011, about one million European dairy farmers produced 127 million tons of milk with a value of 45 billion Euros, representing 13% of the European food and beverages industry's turnover (Euromilk 2012). Dairy cooperatives account for about 57% of the turnover in raw milk produced in the EU-27 (Hanisch, Müller, and Rommel 2011).

Concerns about market imbalances on various levels of the food chain have fueled a policy debate on how to improve competition toward benefitting farmers and consumers in the European Union. On the level of processing, imbalances in competition and irregularities have been observed, and national competition authorities have filed numerous cases against violation of anti-trust regulations in the dairy sector (European Competition Network 2012). With the ongoing reform process of the European Union's common agricultural policy (CAP) and the abolishment of the quota system, milk and dairy products have received special attention. For instance, in Germany, Europe's largest dairy producer, the national competition authority has detected severe market imperfections, especially on the level of processors (Bundeskartellamt 2012).

In this context, the role of cooperatives has also been extensively discussed. The so-called theory of the Competitive Yardstick Effect suggests that cooperatives, because they act in the interest of farmers, secure producer prices at "fair" and efficient levels, meaning here marginal cost (Cotterill 1987; Fousekis 2011; LeVay 1983; Nourse 1945; Sexton 1990; Staatz 1989). In some EU member states, these arguments have been used to justify far-reaching exemptions for cooperatives and producer organizations from anti-trust regulations (Hanisch and Rommel 2012; Zoeteweij-Turhan 2012). More recently, such exemptions have also been considered in the so-called Milk Package (European Commission 2010). However, some dairy-farmer organizations have also questioned the pro-competitive effect of large cooperatives (Hanisch and Rommel 2012).

In spite of a renewed academic interest in imperfect spatial competition (Graubner, Balmann, and Sexton 2011) and theoretical models which explain the yardstick effect of cooperative pricing (Fousekis 2011; Liang and Hendrikse 2013), empirical evidence on the effect of cooperatives on market balance and competitive prices is still relatively scarce (Cazzuffi 2012; Hanisch et al. 2012; Milford 2012; Pennerstorfer and Weiss 2013).

In this article, we seek to address this empirical gap using a unique data set to estimate the effect of cooperative market share on farm gate milk prices for the EU-27 member states. The magnitude of this effect gives us some indication of how far cooperatives fulfill yardstick functions as hypothesized by theory.

The remainder of this article is organized as follows. In the next sections, we provide some background on dairy cooperatives, dairy markets, and related agricultural policies. We then present the theoretical framework of the cooperative yardstick theory. In a subsequent section, we elaborate on our empirical approach and data. Thereafter, we present and discuss the results. In the final section, we draw conclusions from our findings and present an outlook on future research.

2 Background and theoretical framework

2.1 Cooperatives and the common agricultural policy

All around the world, cooperatives process and market large shares of the milk produced by farmers (Chaddad 2007). In the United States, cooperatives control about 83% of the dairy market (United States Department of Agriculture 2011). In the European Union, by contrast, cooperatives account for about 57% of dairy turnover and milk is by far the most important sector in the cooperative marketing of agricultural produce there (Bijman et al. 2012). Table 1 displays the largest European dairy processors by turnover.

As indicated in Table 1, among the largest European dairies, four out of ten enterprises are registered as cooperatives. Similar to their investor-oriented firm counterparts, cooperatives are very often large companies and sometimes even global players. The growing size of cooperative enterprises has induced innovations in board structures in order to (1) allow for professional management and more flexible ways of operative decision making and (2) attract additional equity for growth. Professionalization and board structure changes in some of the largest coops (e.g. DMK, Arla, FrieslandCampina) have given rise to concerns about the producer-orientation of these large cooperatives (Hanisch and Müller 2012). This tension between producers and the increasingly professionalizing management of their organizations has fuelled discussion within the EU about the role of cooperatives for agricultural markets in general and for their members in particular.

Since the introduction of the CAP, Europe's dairy sector has been subject to numerous policy changes. In 1984, milk quotas with fixed production levels at the country level were introduced. In addition, instruments such as price stabilization through intervention, export subsidies, internal subsidies to increase consumption, and private storage have been implemented since then. With the Agenda 2000 CAP reforms, intervention prices for butter and skimmed milk powder were reduced by 15%, and direct payments were introduced. In 2003, intervention prices were again reduced by 10%, and the intervention prices for butter and milk quotas were prolonged until 2015. Direct payments of 3.55 Euro cents/liter were decoupled from milk production and, since then, have become conditional on conservation and sustainability requirements listed in "cross compliance" regulations. In 2008, the "Health Check" came to the conclusion that the milk quota system had to be abolished. With a slow and stepwise increase of country quotas, a soft landing for dairy farmers on the

Table 1 Top 10 European dairies by turnover

Rank	Company name	Country	Legal form	Turnover with dairy products (in billion €) (2011)	Dairy share of total turnover (2010) (%)	Processed milk (in billion kg) (2010)
1	Nestlé	CH	IOF	18.6	19	12
2	Danone	FR	IOF	14.0	77	n.a.
3	Groupe Lactalis	FR	IOF	13.5	97	10.2
4	Friesland Campina	NL	Coop	9.7	98	10.3
5	Arla Foods Group	DK/SE/DE	Coop	9.3	100	8.7
6	Unilever	NL/UK	IOF	5.2*	–	–
7	DMK	DE	Coop	4.6	100	6.8
8	Sodiaal	FR	Coop	4.4	100	5.2
9	Bongrain	FR	IOF	4.0	100	3.1
10	Müller UG	DE	IOF	3.3	–	–

Source: Adapted from Zuvielzicht/Rabobank (2012), own data; *Estimated.

internationalizing dairy market was agreed upon. As a consequence, milk prices have become more volatile. In a period of extremely low milk prices in 2009, several "emergency market interventions" were carried out.

The European Commission's latest reform endeavors culminated in the 2009 draft Milk Package. For the time following the abolishment of the quota system, contractual relations between farmers and dairies, the EU-wide promotion of bargaining organizations, and limits to firm concentration on the basis of national market shares (30%) or market shares in the EU (3.5%) were discussed as means of leveling the playing field for producers and processors (European Commission 2009). In the debate about the objectives of EU policy reform, the role of existing cooperatives has been sometimes praised and sometimes questioned. We propose that several theoretical arguments can explain the high extent of cooperative organization in the dairy sector.

Because the production of fresh milk requires long-term initiatives in infrastructure and skills development, dairy farmers seek to protect their investments by organizing market access. Fresh milk is a perishable and comparatively heavy commodity, vulnerable to quality differentials and hygiene malpractice. Consequently, farmers benefit from collective investments in transportation, processing, and quality control. Such investments will not pay off, however, if supply or quality constraints prevail. From a Transaction Cost Economics perspective, the dominance of cooperatives in dairy can be explained by otherwise likely "holdups" in the supply chains for perishable goods (Williamson 1981). Asset specificity of site-specific dairy farming equipment or human-specific skills on the farmer side and processing equipment on the dairy side favor contractual relations with a mid-term perspective and partial integration of transactions by means of "hybrid governance" (Bonus 1986; Ménard 2007). Where cooperatives manage to provide long-term organization of producers within regions on the basis of binding price and delivery agreements, membership, and democratic control, they often achieve dominance in the dairy sector. The organization of "countervailing power" (Galbraith 1952) on the side of producers and the need to acquire a price-relevant market position for dairies are additional objectives that European cooperative farmers pursue.

2.2 The cooperative yardstick theory

Over the past century, there has developed an intensive theoretical debate regarding what cooperatives do or are supposed to do, with cooperatives often being associated with the function of leveling the playing field in the presence of power imbalances prevalent in agricultural markets (LeVay 1983). In addition, since the 1980s, scholars have increasingly viewed cooperatives from the perspective of Transaction Cost Economics (Williamson 1985, 1996). We differentiate between these two schools of cooperative thought, which have focused on countervailing power (Cotterill 1987; Nourse 1945), from a second type which views the cooperative as an organizationally superior "hybrid" form to organize certain rural transactions, opposed to coordination via hierarchies or markets (Bonus 1986; Ménard 2004, 2007; Valentinov 2007).

While contemporary contributions focus on the organization and dynamics of cooperative development (Chaddad 2007; Cook 1995; Cook and Iliopoulos 1999; Hansmann 1996; Ménard 2007; Nilsson 1999), classical theorists have mostly looked at single functions which cooperatives fulfill in the development of the overall economic system (Cotterill 1984; Marshall 1890 [1920]; Pigou 1924, 1920; Walras 1865). One function often attributed to cooperative enterprises is vertical integration into upstream or downstream positions of the supply chain and provision of higher margins and "fair pricing" for member-owners in a situation where structural imbalances would otherwise prevail (Royer 1995; Sexton 1986). Apart from the role cooperatives play in fair-trade, specialty, and organic segments of agricultural markets concentrating on particular product characteristics (Bacon 2005; Levi and Linton 2003), the question arises of how cooperatives manage to provide "fair pricing" to their members for bulk types of agricultural commodities.

A particularly interesting approach for explaining the function of cooperative enterprises where markets are riddled by structural imbalances is the competitive yardstick theory. Inspired by Chamberlin's (1933) seminal work on monopolistic competition, Shleifer (1985) developed a model of price control, based on inter-firm comparisons for public service industries such as hospitals. On this basis, Cotterill (1987) formulated a theory of cooperative prices, investment, and finance decisions under risk, explaining the pricing mechanism in a situation in which cooperatives and investor-oriented firms regionally coexist. In this situation, members of the cooperative can judge the fairness of investor-oriented firms' pricing by comparing it to the cooperative's internal pricing mechanism. Because members are at the same time firm owners, they do not have to satisfy shareholders and will not accept prices beyond average cost. Over time cooperative price information spills off into the public domain and serves market actors as a yardstick. Cooperative prices then become a disciplining factor for

the prices comparable industries offer, thereby contributing to the price development of the overall economy. Briefly put, "[in] the long run, cooperative price equals average cost" (Cotterill 1987, 196).

Cotterill's argument also works in the same manner for the provision of inputs. In a situation where cooperatives exist to supply members with cheaper inputs, *ceteris paribus* the presence of a cooperative enterprise will lower regional input prices over time. Conversely, in processing or retailing, the presence of cooperatives would lead to higher producer prices, as also proposed in LeVay's (1983) Pacemaker Theory.

Furthermore, Cotterill (1987) points out that, besides yardstick information spillovers, cooperative market power has a strong impact on price setting. The stronger the cooperative sector, the more prices head toward long-term average costs, even in unregulated cooperative monopolies, as competition between farmers and the right to deliver ensure efficiency. Empirically, this should result in higher farm gate prices for agricultural produce as compared to markets with little market power for farmers.

To our knowledge, the cooperative yardstick theory[1] has not yet been tested empirically for European dairy markets. Previous work on price variation and the role of cooperatives has largely refrained from structural reasoning and, instead, has put farms as individual economic agents in the center of analysis, seeking to explain price differences from socio-economic heterogeneity and heterogeneity in transaction costs (cf. Cazzuffi 2012; Sauer, Gorton, and White 2012). Such studies refer to the literature on price dispersion in industrial organization, where the fact that "firms in the same market selling identical goods for different prices (at the same time)" (Lewis 2008, 654) is subject to a large body of theoretical and empirical work on firm-level retail price dispersion. The only recent empirical study on the effect of cooperatives on market structure and prices is Milford (2012), who finds evidence for a pro-competitive effect of the number of cooperatives within a regional market on prices farmers receive.

1 In the following, we use the terms "cooperative yardstick" or "cooperative yardstick effect" for referring to the set of theoretical contributions holding that cooperatives have a pro-competitive effect on prices in markets with imperfect competition. Most commonly, the terms "competitive yardstick", "competitive yardstick effect", or "competitive yardstick school of cooperative thought" are used in the literature (cf. Fousekis 2011; Sexton 1990; Staatz 1989; Cotterill 1984, 1987). Some authors (e.g. Fowler 1948) have also used the shorter "cooperative yardstick" when describing the phenomenon with regard to agricultural or consumer cooperatives.

3 Empirical approach and data

In the following, we develop a simple econometric model in which prices paid to producers depend, among other things, on the relative strength of cooperatives in an EU-27 member state. According to our theoretical considerations, an increase in the share of cooperatives would raise producer prices through yardstick pricing, and investor-oriented firms in the vicinity of cooperatives may have to pay price premiums to attract customers.

For our analysis, we have used Eurostat panel data on farm gate milk prices, maize fodder prices, per capita GDP, and trade balances for the years 2000 to 2010 for the EU-27. To reduce skewness, some of the variables were log-transformed. The Eurostat data on milk and maize have already been "quality-adjusted", so that the "identical good assumption" holds (Goldberg and Verboven 2004). The variable MILKPRICE is calculated as a mean on the level of a member state for one year for all milk delivered to dairies, based on its actual fat content (Eurostat Code 12112000). Super-levies are not part of the calculation, and bonuses and refunds from dairies to farmers are taken into account.[2]

In addition, we use a unique data set on the market share of cooperatives for the EU-27.[3] These data are derived from expert assessments found in country reports within the Support for Farmer's Cooperatives project of the European Commission.[4] The following Table 2 provides a brief description of the variables.

We have included prices of maize – a crucial input into dairy farming – in the analysis to control for national differences in fodder costs, because "[p]rice differences due solely to local cost differences do not create a buy-low-sell-high opportunity for arbitrageurs and so are feasible even if markets are perfectly integrated internationally" (Goldberg and Verboven 2004, 489). We have also used GDP as a proxy for labor and capital intensity of

2 The variable was calculated the same way for all member states. Additional information on calculation of this variable at the level of member states is available in the Handbook for EU Agricultural Price Statistics (Eurostat 2008). Summary statistics on variation across states and years are available from the authors on request.

3 One drawback of our approach is that these data were available only for 2010. We have thus implicitly assumed that the market share of cooperatives has been historically determined and stable over time.

4 Within this project, a national report on agricultural cooperatives was written for each of the 27 member states by academic experts. As part of these reports, experts were asked to provide information on the market shares of major agricultural sectors, including dairy, for 2010. Through discussions within the project, it turned out that for two countries – Belgium and the United Kingdom – the country experts provided very low estimates. After checking these figures with respective national cooperative umbrella organizations, they were subsequently corrected.

Table 2 Description of study variables

Variable	Description
MILKPRICE	Farm gate price in Euro for 100 kg milk
LNMAIZEPRICE	Natural logs of fodder maize price for 100 kg
LNGDP	Natural logs of per capita GDP
TRADEBAL	Percentage of imports/exports of total production
NEWMS	Dummy = 1 if country has joined European Union in 2004 or later
SOUTH	Dummy = 1 if country is located in the South of Europe
COOPSHARE	Turnover market share of cooperatives in dairy in %

Source: Own design.

agriculture. For countries with a positive trade balance, our *a priori* assumption was that their potential competitive advantage should be reflected in lower domestic prices. We added dummy variables to control for new member states and countries in Southern Europe, where dairy farming is usually more difficult due to less favorable agro-ecological conditions. Table 3 provides summary statistics for the pooled data.

Table 3 Summary statistics of pooled data

	Obs.	Mean	SD	Minimum	Maximum
MILKPRICE	241	29.68	6.38	13.83	47.50
LNMAIZEPRICE	172	2.73	0.33	2.00	3.51
LNGDP	297	9.86	0.67	8.48	11.28
TRADEBAL	210	−0.01	0.04	−0.17	0.13
NEWMS	297	0.33	0.47	0	1
SOUTH	297	0.30	0.46	0	1
COOPSHARE	297	54.50	30.85	10.00	100.00

Source: Own calculations based on Eurostat and Hanisch, Müller, and Rommel (2011).

It can be seen that the average milk price during the study period was roughly 30 Euros per 100 kg and that the average share of cooperatives was about 55%. A more detailed overview of the variation in market shares of dairy cooperatives is provided in Figure 1.

As can be seen from Figure 1, variation in the national market shares of cooperatives is relatively high, ranging from only 10% in Cyprus, Lithuania, Luxembourg, Romania, and Bulgaria up to almost 100% in Sweden. For estimating the cooperative yardstick effect, we used static panel data models. Fixed-effects models use differencing to effectively control for all time-invariant variables at the cost of efficiency. Random-effects models improve efficiency by considering additional available information from time-invariant data (cf. Greene 2011; Rabe-Hesketh and Skrondal 2008). To decide which model to use, we applied the commonly used Hausman specification test (1978) and, in addition, followed the procedure suggested by Baltagi, Bresson, and Pirotte (2003) to control for potential endogeneity bias of our main variable of interest.

4 Model results and robustness checks

We estimate a static panel data model of the form

$$y_{it} = \alpha + \beta' x_{it} + \eta' z_i + u_{it} \quad [1]$$

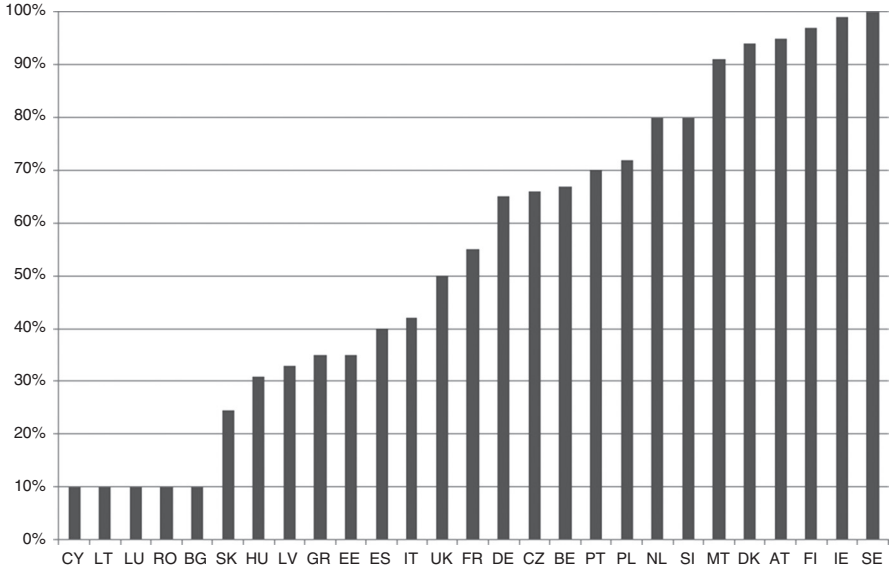

Figure 1 Market shares of cooperatives in the EU-27

where y_{it} is the milk price for country i in year t; x_{it} is a vector of time-variant variables of maize prices, GDP, and trade balance; z_i is a vector of time-invariant variables on the market share of cooperatives, dummy variables on new member state status, and location in the South of the European Union; $\alpha, \beta',$ and η' are coefficients to be estimated; and u_{it} is an error term. Assuming exogeneity of all regressors and no systematic differences in coefficients with the within-group (fixed-effects) estimator, the random-effects estimator yields efficient and consistent estimates of the model.

Table 4 presents four specifications of fixed- and random-effects models. In the fixed-effects models, the (within-group) estimator eliminates $\eta' z_i$ through using differences. The first two specifications include all variables; models 3 and 4 remove the maize price to increase the number of observations, which consequently increases the number of member states entering the analysis from 16 to 23.

Coefficients do not differ substantially between the first models, suggesting that the random-effects estimator produces unbiased estimates. A Hausman test does not reject the null hypothesis of no systematic differences in coefficients ($\chi^2 = 0.16$; $p = 0.9845$). Differences in coefficients are somewhat higher between models 3 and 4; yet, also here a Hausman test suggests using the more efficient random-effects model ($\chi^2 = 3.76$; $p = 0.1523$). Differences between the first two columns and the last two columns arise from selection effects due to the unavailability of maize price data for several member states. Models 3 and 4 include seven more countries in which maize is typically not grown or for which the data are not available, namely Sweden, Poland, Malta, Latvia, Italy, Ireland, Finland, and Estonia. It can be concluded, however, that in both samples including time-invariant variables and using the random-effects model can be justified. To explore the relationship between the market share of cooperatives and milk prices, a natural step was to investigate the data graphically. Figure 2 plots the market share of cooperatives in 2010 against the average farm gate milk price over the study period for all 23 states for which these data were available.

Figure 2 suggests a positive relationship between the strength of cooperatives and average milk price – very much in favor of a cooperative yardstick effect. We now look at this relationship in greater detail by estimating six specifications of random-effects and pooled regression models. The results are presented in Table 5.

The first two models include all variables; models 3 and 4 are reduced by the maize data; models 5 and 6 are also reduced by the trade balance, for which there were also many missing observations. Coefficients vary across models for most variables, but drastic changes are rare and only one time does a coefficient change its sign (NEWMS becomes positive in model 6).

All coefficients show the expected signs. Dairy prices increase with increasing maize prices; prices are higher in countries of the South and lower in the new member states. As one would expect, prices are also lower in exporting countries and higher in countries with a high GDP, which we can also interpret as a proxy for off-farm income opportunity costs.

Estimates for the COOPSHARE variable are relatively robust across different specifications, indicating that the

Table 4 Regression results for time-variant variables

	Model 1 (fixed effects)	Model 2 (random effects)	Model 3 (fixed effects)	Model 4 (random effects)
LNMAIZEPRICE	6.3220***	6.0694***		
	(1.6770)	(1.3740)		
LNGDP	3.2128	3.4508***	7.6821***	5.6823***
	(2.6218)	(1.1176)	(1.5906)	(1.0265)
TRADEBAL	−3.5234	−4.0928	−3.7752	−10.2606
	(9.4586)	(8.2278)	(9.0195)	(8.3368)
Constant	−19.2984	−21.3963**	−45.6682***	−25.9820**
	(23.7834)	(10.2427)	(15.7375)	(10.1408)
N	104	104	172	172
χ^2		48.5157***		33.3500***
Groups	16	16	23	23
Overall R^2	0.4825	0.4831	0.2150	0.2310
F	10.9235***		13.0507***	

Source: Eurostat; Hanisch, Müller, and Rommel (2011); own calculations.
Note: Standard errors in parentheses, ** p <0.05, *** p < 0.01.

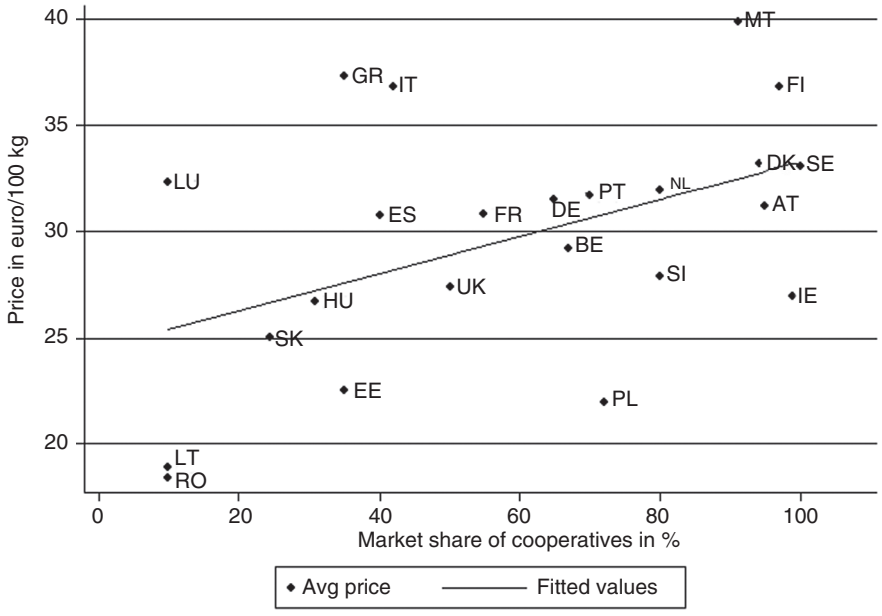

Figure 2 Cooperative market share vs. average milk price 2000–2010

Table 5 Regression results for all variables

	Model 1 (pooled)	Model 2 (random effects)	Model 3 (pooled)	Model 4 (random effects)	Model 5 (pooled)	Model 6 (random effects)
LNMAIZEPRICE	3.9369***	6.4254***				
	(1.4073)	(1.5445)				
LNGDP	2.4365**	2.8285*	3.0476***	5.6053***	4.1068***	7.0595***
	(0.9578)	(1.5840)	(0.8258)	(1.3274)	(0.5999)	(0.7803)
TRADEBAL	−0.2175**	−0.0880	−0.2699***	−0.1579		
	(0.0973)	(0.1037)	(0.0785)	(0.0982)		
SOUTH	2.7542**	1.8641	5.3693***	6.1942***	5.8416***	7.3864***
	(1.0598)	(1.9199)	(0.8793)	(1.7222)	(0.6962)	(1.6858)
NEWMS	−4.0681***	−2.5522	−3.3374**	−0.0407	−2.4616**	1.2930
	(1.5095)	(2.8617)	(1.3666)	(2.4683)	(1.0157)	(2.0117)
COOPSHARE	0.0417**	0.0250	0.0438***	0.0443*	0.0440***	0.0369
	(0.0200)	(0.0345)	(0.0127)	(0.0263)	(0.0099)	(0.0260)
Constant	−7.2927	−17.1404	−3.4373	−29.4178**	−14.0445**	−43.8919***
	(8.7243)	(15.0847)	(8.5290)	(13.7158)	(6.1286)	(8.1782)
N	91	91	154	154	241	241
χ^2		59.1656		59.6145		128.1768
Adj. R^2	0.6141		0.5550		0.6057	
Groups		15.0000		22.0000		23.0000
Overall R^2		0.6121		0.5320		0.5845
F	24.8715		39.1577		93.1698	

Source: Eurostat; Hanisch, Müller, and Rommel (2011); own calculations.
Note: Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

size of the cooperative yardstick effect is not very sensitive to changes in sample or variables and remains relatively stable under a range of specifications. The smallest estimated coefficient is 0.0250 in model 2, as compared to the high estimate of 0.0443 in model 4. Using 0.0250 as a conservative estimate suggests that a one percent increase in the market share of cooperatives leads to a rise in farm gate milk price of 2.5 Euro cents. For a country like Germany, where cooperatives control roughly two thirds of the market, this means that about

1.66 Euros of an assumed farm gate milk price of 25 Euros/100 kg – that is, 6.7% – can be attributed to the existence of cooperatives. Note that these estimates are rather conservative and that the cooperative yardstick effect would be substantially higher for a coefficient of about 0.04.

The estimates of η' may suffer from bias if there are country-specific factors that *cause* the market share of cooperatives. A potential way to overcome such bias would be to implement the Hausman–Taylor estimator (Hausman and Taylor 1981), which would require exogenous instruments to substitute COOPSHARE. Unfortunately, our limited data did not include instrumental variables (IV) which would have been good enough to provide reliable estimates of the respective IV estimator. Available instruments (GDP, NEWMS, and SOUTH) were not sufficiently correlated with the potentially endogenous variable and the resulting Hausman–Taylor estimates suffered from small-sample and weak-instrument bias: a commonly known problem of IV estimators (Verbeek 2004, 147). It is likely that a country's legal framework – for instance differences in taxation of cooperatives – would influence the strength of the cooperative sector. However, a recent large-scale research project did not find support for such an impact in the EU-27 (Bijman et al. 2012). In other words, even if data on the legal framework were available, they most probably would not have reduced the problem of weak instruments. Summing up, the presented random-effects estimates are the best the available data allow. However, the issue of potential endogeneity should be kept in mind.

In the end, we cannot rule out that the effect of COOPSHARE on milk prices is driven by other time-invariant country-specific effects. As it stands now, our approach here cannot disentangle the two. A country's cooperative or competition laws, or even its culture, could all drive cooperative strength and, hence, milk prices. In future work, these limitations could be overcome in three ways. Firstly, more and stronger instruments at the country level may be used to substitute for COOPSHARE. Weak-instrument and small-sample bias may nonetheless prevail, however. Secondly, and perhaps more promising, time-variant data on cooperative strength, for instance yearly variation in market shares of cooperative dairies according to country, would enable identification of presently unobserved effects. Regrettably, such data are currently unavailable for the European dairy sector. This may be different in other sectors or other parts of the world. Thirdly, one may look at variation of cooperative strength within regions of a country. This would eliminate potentially important country-specific effects, such as the legal system. On the other hand, cultural particularities of a region may still be found to drive membership and strength at the regional level.

Farm gate prices could also be driven by the level of value addition in the sector. If member states with higher market shares of cooperatives are also dominated by higher value products, it could be that higher prices are a result of value addition and not of cooperatives as such. In spite of this, on the national level, for instance in Germany, often the opposite is argued: As a consequence of bulk orientation and a lack of brand orientation, cooperatives are often accused of realizing *less* value addition as compared to investor-oriented firms (Schramm, Spiller, and Staack 2005). Sometimes, the ratio of turnover derived from dairy products by processed amounts of milk is used as an indicator of value addition (Fahlbusch et al. 2009, 41). Such data were unfortunately not available for the entire study period for EU-27 member states, though the Eurostat data did include turnover for the dairy processing industry for 2008. The following Table 6 presents these data, milk output, a value addition index as the ratio of turnover by output, farm gate milk prices, and cooperative market shares by member states.

At least for 2008, the index of value addition does not seem to be correlated with the market share of cooperatives. The Pearson correlation coefficient is 0.0153 and is not statistically significantly different from zero ($p = 0.9460$). Given this relatively small sample, we cannot fully rule out that such correlation exists for other years of the study period or other sub-samples. However, at this stage, we do not find strong support for a price effect driven by value addition.

5 Discussion

The extent to which dairy sectors are cooperatively organized widely differs among member states of the European Union. In some cases, farmers have criticized the growth and professionalization strategies of their cooperatives. With dairy farming being hardly profitable in many parts of Europe, even a small yardstick effect could make a difference to farmers. We find that cooperatives can best play their roles if they possess a relevant (aggregate) market position. Figures about rapid concentration in the sector, together with the limited role other types of producer organizations play in the dairy sector, underpin this claim. EU policy makers have argued that strengthening the role of new bargaining cooperatives or

Table 6 Value addition and industry turnover statistics by member states

Country	Milk production in 1,000 tons in 2008	Industry turnover in million Euro in 2008	Index of value addition turnover/milk produced in Euro/kg	Farm gate milk price in Euro/100 kg in 2008	Market share cooperatives in % in 2010
AT	2,705	1,987.9	0.7349	38.9	95
BE	2,849	4,238.8	1.4878	32.12	66
BG	681	330.0	0.4846	.	10
CY	150	197.3	1.3153	.	10
CZ	2,433	1,634.5	0.6718	.	66
DE	27,466	23,889.8	0.8698	35.01	65
DK	4,586	.	.	37.82	94
EE	606	307.0	0.5066	29.67	35.1
ES	5,849	10,305.2	1.7619	37.94	40
FI	2,254	2,051.2	0.9100	43.49	97
FR	23,815	25,098.5	1.0539	.	55
GR	690	.	.	43.2	35
HU	1,425	916.6	0.6432	32.81	30.8
IE	5,090	3,172.0	0.6232	31.25	99
IT	10,489	15,233.9	1.4524	41.47	42
LT	1,382	822.0	0.5948	.	10
LU	265	.	.	38.13	10
LV	635	324.4	0.5109	24.96	33
MT	.	.	.	47.5	91
NL	10,936	8,913.1	0.8150	36.35	80
PL	9,112	5,464.5	0.5997	29.12	72
PT	1,890	1,679.2	0.8885	36.22	70
RO	1,053	816.0	0.7749	23.93	10
SE	2,955	2,279.1	0.7713	37.23	100
SI	524	.	.	32.79	80
SK	946	516.1	0.5456	34.13	24.5
UK	13,350	8,497.1	0.6365	31.62	50

Source: Eurostat (2012); Hanisch, Müller, and Rommel (2011); own calculations.

producer organizations may improve the situation for dairy producers. In our view, producers have to decide the extent and type of organization they want to control. In any case, large shares of the market will have to be organized. As long as producers are still the legal owners of dairy cooperatives which control 57% of the European market, it seems reasonable to assume that investments in the internal control and management of their cooperative may achieve better results than investments in the organization of new bargaining groups. More recent trends toward growth and concentration, organization in holding structures, or international acquisitions, may, however, partly divert interest alignment between farmers and cooperative managers. Eventually, this may even erode the cooperative yardstick effect. These concerns give further credibility to the importance of research on the role of internal governance in agricultural cooperatives.

In the past, quota limits may have reduced the amounts of surplus milk and overall quality of milk processed by dairies, particularly so in countries with high quota rents such as Denmark or the Netherlands. Consequently, quotas have been very influential in shaping the institutional environment for milk producers and dairies. The abolition of quotas, reduced price intervention, and expected future increases in production may result in heavy price fluctuations similar to those observed in the past few years. In this situation, it is important to understand both the nature of milk producing firms and their processors. Our findings suggest that an alternative policy option may be to support cooperatives for their positive effects on price. Initial results also point toward a positive effect of cooperatives on price stabilization (Hanisch et al. 2012). Exemptions from bundling restrictions are one possible way to ensure that cooperatives can achieve large market shares. Farmers may have to accept that this comes at the cost of larger, increasingly internationally-oriented and professionalized cooperatives, which is usually accompanied by the transformation of internal governance models.

Ensuring that cooperatives can grow while still acting in the interests of their farmer-owners is a challenge that should not be underestimated in this regard.

6 Conclusions and outlook

In this article, we have conducted a panel-data analysis to estimate the yardstick pricing effect of cooperatives in European dairy farming. Our results show that this effect exists, it is relatively large, and it is fairly robust regarding sample and variable selection. A drawback, however, is the limited data we needed to rely on, which do not allow us to distinguish the effect of cooperative strength on milk prices from other country-specific effects. Keeping this limitation in mind, the findings, at this stage, are in line with theoretical predictions from the literature.

Ironically, the yardstick effect is observed on the level of national markets, implying that *all* farmers, not only farmer-members, benefit from the pro-competitive effect of cooperatives. A recently carried out analysis of pricing behavior on the level of processors even suggests that, in some regions, members of cooperatives receive somewhat *lower* prices (Hanisch, Müller, and Rommel 2011), because competing dairy processors had to pay price premiums. To look at the pricing behavior of cooperatives and individual enterprises nested within national market structures in greater detail would, thus, be an important task for future research. It would, we believe, also be worthwhile to explore the temporal dynamics of yardstick pricing. Over the last decade or so, farmer complaints about prices received for their produce have also increased vis-à-vis cooperatives. It would be interesting to see whether recent professionalization, growth, and changes in internal governance have also had an effect on yardstick pricing. Are there expectable price declines in countries like Denmark, Germany, or the Netherlands, which are characterized by very large multi-billion Euro cooperatives? Further analysis may also focus on other aspects of market structure, such as price volatility, or extend the analysis to different sectors. Different sectors may show various levels of market integration and transportation costs, and it would be interesting to see whether such differences are also reflected in the yardstick effect of cooperatives.

Acknowledgments: The research presented in this article is based on results from the project Support for Farmers' Cooperatives which was financed by the European Union and managed by the European Commission, DG Agriculture, and Rural Development. The authors gratefully acknowledge financial support received under contract number 30-CE-0395921/00-42. We are thankful for helpful comments received from Jos Bijman, Silke Hüttel, Martin Odening, Krijn Poppe, and Perttu Pyykkönen on earlier drafts of the article. We would also like to thank an anonymous referee for helpful and constructive comments. The views expressed in this article are solely those of the authors. The usual disclaimer applies.

References

Bacon, C. M. 2005. "Confronting the Coffee Crisis: Can Fair Trade, Organic, and Specialty Coffees Reduce Small-Scale Farmer Vulnerability in Northern Nicaragua?" *World Development* 33 (3):497–511.

Baltagi, B. H., G. Bresson, and A. Pirotte. 2003. "Fixed Effects, Random Effects, or Hausman–Taylor? A Pretest Estimator." *Economics Letters* 79:361–9.

Bijman, J., C. Iliopoulos, K. J. Poppe, C. Gijselinckx, K. Hagedorn, M. Hanisch, G. W. J. Hendrikse, R. Kühl, P. Ollila, and P. Pyykkönen. 2012. "Support for Farmers' Cooperatives Final Report." *Support for Farmers' Cooperatives*. Wageningen: Wageningen UR. Accessed June 6, 2013. http://edepot.wur.nl/245008.

Bonus, H. 1986. "The Cooperative Association as a Business Enterprise: A Study in the Economics of Transactions." *Journal of Institutional and Theoretical Economics* 142:310–39.

Bundeskartellamt. 2012. "Sektoruntersuchung Milch: Endbericht Januar 2012." Bonn. Accessed June 6, 2013. http://www.bundeskartellamt.de/wDeutsch/download/pdf/Stellungnahmen/2012_01_Sektoruntersuchung_Milch_Endbericht_final.pdf

Cazzuffi, C. 2012. "Prices Paid and Value for Members: Dairy Processing and Marketing Cooperatives in Three Italian Provinces." Paper presented at the international conference "Cooperative Responses to Global Challenges," Humboldt-Universität zu Berlin, Germany, March 21–23.

Chaddad, F. 2007. "The Evolution of Brazilian Dairy Cooperatives: A Life Cycle Approach." Paper presented at the meeting of the Brazilian Economic Society, Londrina, Brazil, July 22–25.

Chamberlin, E. H. 1933. *Theory of Monopolistic Competition*. Cambridge, MA: Harvard University Press.

Cook, M. L. 1995. "The Future of U.S. Agricultural Cooperatives: A Neo-Institutional Approach." *American Journal of Agricultural Economics* 77 (5):1153–9.

Cook, M. L., and C. Iliopoulos. 1999. "Beginning to Inform the Theory of the Cooperative Firm: Emergence of the New Generation Cooperative." *LTA (Finnish Journal of Business Economics)* 4:525–35.

Cotterill, R. W. 1984. "The Competitive Yardstick School of Cooperative Thought." In *American Cooperation 1984*, edited by American Institute of Cooperation, 41–53. Washington, DC: American Institute of Cooperation.

Cotterill, R. W. 1987. "Agricultural Cooperatives: A Unified Theory of Pricing, Finance, and Investment." In *ASC Service Reports: Vol. 18. Cooperative Theory. New Approaches*, edited by J. S. Royer, 171–258. Washington, DC: US Department of Agriculture.

Euromilk. 2012. "About the European Dairy Industry: General Overview." *Euromilk*. Accessed April 2, 2012. http://www.euromilk.org/eda/content_html.aspx?cid=426

European Commission. 2010. *Proposal for a Regulation of the European Parliament and of the Council Amending Council Regulation (EC) No 1234/2007 as Regards Contractual Relations in the Milk and Milk Products Sector*. Brussels: DG Agriculture, European Commission. Accessed June 6, 2013. http://ec.europa.eu/agriculture/milk/proposal-12-2010/com-2010-728_en.pdf

European Competition Network, Subgroup Food. 2012. *ECN Activities in the Food Sector: Report on Competition Law Enforcement and Market Monitoring Activities by European Competition Authorities in the Food Sector*. Brussels: European Commission Accessed June 6, 2013. http://ec.europa.eu/ competition/ecn/food_report_en.pdf

Eurostat. 2008. "Handbook for EU Agricultural Price Statistics, Version 2.0." Accessed September 8, 2013. http://unstats.un.org/unsd/EconStatKB/Attachment502.aspx

Eurostat. 2012. *Data tables: Maize – Prices per 100 kg [Code: 01500000)]*; *Raw cows' Milk Actual Fat Content – Prices per 100 kg [Code: 12112000]*; *Gross Domestic Product at Market Prices [Code: B1GM/EUR_HAB]; External Balance of Goods and Services [Code: B11/PC_GDP]; Manufacture of Dairy Products [Table: sbs_turn_ind_r2 Code: C105]; Cow's Milk Collected [Table: apro_mk_cola Code: MM001]*. Accessed October 6, 2013. http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

Fahlbusch, M., A. Bahr, B. Brümmer, and A. Spiller. 2009. "Der Markt Für Milch Und Milcherzeugnisse." *German Journal of Agricultural Economics* 58 (1):36–52.

Fousekis, P. 2011. "Free-on-Board and Uniform Delivery Pricing Strategies in a Mixed Duopsony." *European Review of Agricultural Economics* 40 (2):119–39.

Fowler, B. B. 1948. "The Cooperative Yardstick." *Law and Contemporary Problems* 13 (3):445–57.

Galbraith, J. K. 1952. *American Capitalism: The Concept of Countervailing Power*. Boston, MA: Houghton Mifflin.

Goldberg, P. K., and F. Verboven. 2004. "Cross-Country Price Dispersion in the Euro Era: A Case Study of the European Car Market." *Economic Policy* 19 (40):483–521.

Graubner, M., A. Balmann, and R. J. Sexton. 2011. "Spatial Price Discrimination in Agricultural Product Procurement Markets: A Computational Economics Approach." *American Journal of Agricultural Economics* 93 (4):949–67.

Greene, W. H. 2011. *Econometric Analysis*. Essex, England: Pearson Education.

Hanisch, M., and M. Müller. 2012. "Ownership and Control Rights Transformations: The Evolution of the Deutsches Milchkontor GmbH." *Support for Farmers' Cooperatives*. Wageningen: Wageningen UR. Accessed June 6, 2013. http://edepot.wur.nl/244991

Hanisch, M., M. Müller, and J. Rommel. 2011. "Support for Farmers' Cooperatives in the Dairy Sector: EU Sector Report." *Support for Farmer's Cooperatives*. Wageningen: Wageningen UR. Accessed June 6, 2013. http://edepot.wur.nl/244940

Hanisch, M., M. Müller, J. Rommel, J. Sagebiel, H. Karikallio, S. Pakarinen, and P. Pyykkönen. 2012. "The Effect of Farmers' Cooperatives on Price Stabilization in the Dairy Sector." *Support for Farmers' Cooperatives*. Wageningen: Wageningen UR. Accessed June 6, 2013. http://edepot.wur.nl/244841

Hanisch, M., and J. Rommel. 2012. "Producer Organizations in European Dairy Farming." *Support for Farmers' Cooperatives*. Wageningen: Wageningen UR. Accessed June 6, 2013. http://edepot.wur.nl/245003

Hansmann, H. B. 1996. *The Ownership of Enterprise*. Cambridge, MA: The Belknap Press of Harvard University Press.

Hausman, J. A. 1978. "Specification Tests in Econometrics." *Econometrica* 46 (6):1251–71.

Hausman, J. A., and W. E. Taylor. 1981. "Panel Data and Unobservable Individual Effects." *Econometrica* 49 (6):1377–98.

LeVay, C. 1983. "Agricultural Cooperative Theory: A Review." *Journal of Agricultural Economics* 34 (1):1–44.

Levi, M., and A. Linton. 2003. "Fair Trade: A Cup at a Time?" *Politics & Society* 31 (3):407–32.

Lewis, M. 2008. "Price Dispersion and Competition with Differentiated Sellers." *The Journal of Industrial Economics* 56 (3):654–78.

Liang, Q., and G. W. J. Hendrikse. 2013. "Pooling and the Yardstick Effect of Cooperatives." Paper presented at the 17th annual conference of The International Society for New Institutional Economics, Florence, Italy, June 20–22.

Marshall, A. 1890 [1920]. *Principles of Economics*. London: Macmillan.

Milford, A. B. 2012. "The Pro-Competitive Effect of Coffee Cooperatives in Chiapas, Mexico." *Journal of Agricultural & Food Industrial Organization* 10 (1):1–27, Art.2.

Ménard, C. 2004. "The Economics of Hybrid Organizations." *Journal of Institutional and Theoretical Economics* 160 (3):345–76.

Ménard, C. 2007. "Cooperatives: Hierarchies or Hybrids?" In *Vertical Markets and Cooperative Hierarchies: The Role of Cooperatives in the Agri-Food Industry*, edited by K. Karantininis and J. Nilsson, 1–17. Dordrecht: Springer.

Nilsson, J. 1999. "Co-Operative Organisational Models as Reflections of the Business Environments." *LTA (Finnish Journal of Business Economics)* 4:449–70.

Nourse, E. G. 1945. "The Place of the Cooperative in Our National Economy." In *American Cooperation 1942 to 1945*, 33–9. Washington, DC: American Institute of Cooperation.

Pennerstorfer, D., and C. R. Weiss. 2013. "Product Quality in the Agri-Food Chain: Do Cooperatives Offer High-Quality Wine?" *European Review of Agricultural Economics* 40 (1):143–62.

Pigou, A. C. 1920. *The Economics of Welfare*. London: Macmillan.

Pigou, A. C. 1924. "Income Tax and Co-Operative Societies." In *Essays in Applied Economics*, edited by A. C. Pigou, 141–8. New York: Staples Press.

Rabe-Hesketh, S., and A. Skrondal. 2008. *Multilevel and Longitudinal Modeling Using Stata*. 2nd ed. College Station, TX: Stata Press Publication.

Royer, J. S. 1995. "Potential for Cooperative Involvement in Vertical Coordination and Value-Added Activities." *Agribusiness* 11(5):473–81.

Sauer, J., M. Gorton, and J. White. 2012. "Marketing, Cooperatives and Price Heterogeneity: Evidence from the CIS Dairy Sector." *Agricultural Economics* 43(2):165–77.

Schramm, M., A. Spiller, and T. Staack. 2005. "Zur Brand Orientation Genossenschaftlicher Unternehmen Der Ernährungsindustrie." In *Jahrbuch Der Österreichischen Gesellschaft Für Agrarökonomie*, edited by D. I. S. Pöchtrager and E. Schmid, 141–52. Vienna: Österreichische Gesellschaft für Agrarökonomie.

Sexton, R. J. 1986. "Cooperatives and the Forces Shaping Agricultural Marketing." *American Journal of Agricultural Economics* 68 (5):1167–72.

Sexton, R. J. 1990. "Imperfect Competition in Agricultural Markets and the Role of Cooperatives: A Spatial Analysis." *American Journal of Agricultural Economics* 72 (3):709–20.

Shleifer, A. 1985. "A Theory of Yardstick Competition." *RAND Journal of Economics* 16 (3):319–27.

Staatz, J. M. 1989. *Farmer Cooperative Theory: Recent Developments*. Washington, DC: United States Department of Agriculture.

United States Department of Agriculture (USDA). 2011. "Marketing Operations of Dairy Cooperatives – Historical Summaries." Accessed June 6, 2013. http://www.rurdev.usda.gov/BCP_Coop_Data_DairyMarketing.html

Valentinov, V. 2007. "Why Are Cooperatives Important in Agriculture? An Organizational Economics Perspective." *Journal of Institutional Economics* 3 (1):55–69.

Verbeek, M. 2004. *A Guide to Modern Econometrics*. Chichester: John Wiley & Sons.

Walras, L. 1865. *Les Associations Populaires De Consommation, De Production Et De Crédit*. Paris: Dentu.

Williamson, O. E. 1981. "The Economics of Organization: The Transaction Cost Approach." *American Journal of Sociology* 87 (3):548–77.

Williamson, O. E. 1985. *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*. New York: Free Press.

Williamson, O. E. 1996. *The Mechanisms of Governance*. New York: Oxford University Press.

Zoeteweij-Turhan, M. H. 2012. *The Role of Producer Organizations on the Dairy Market*. Baden-Baden: Nomos.

Zuvielzicht/Rabobank/MI, V. 2012. "TOP 10 Molkereien in Europa 2012." *Rabobank* Accessed June 6, 2013. http://www.milchindustrie.de/uploads/tx_news/TOP_Molkereien_EU_Homepage_01.pdf