Econometric Analysis of the Performance of Cooperatives and Investor Owned Firms in the European Dairy Industry

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في سبيل الحق
For the path of righteousness

Abstract

In this study we measure the performance of cooperatives and investor-owned firms in the European dairy processing industry. Comparing the performance between cooperatives and investor-owned firms requires accounting for differences in their mission and objectives. Traditionally, cooperatives were established by farmers to gain access to markets, balance market powers and have a secured and sustainable income. Generally, there is a consensus in the economic literature that a cooperative can be defined as a (members)user-owned and (members)user-controlled organization that aims to benefit its (members)user. Cooperatives are transaction oriented, the members provide themselves with services they could not secure otherwise. In addition member are owners and determine the mission and strategy of cooperatives equally as the owners of the cooperative enterprise. Our study takes into account the consequences of members' strategies for the cooperatives' organizational structure and subsequently the significance of structure on (technical and economical) efficiencies. Although the theoretical literature emphasizes the difference in economic behavior between cooperatives and IOFs, the empirical studies have failed to follow up with theoretical approaches. The failure of the empirical studies to apply the models proposed by the theoretical literature seems to be due to either the inaccessibility of data, the inability to take into account the interests of all the various types of members and stakeholders of the cooperative, or the difficulty in testing the various hypotheses in practice. An empirical analysis of differences in financial indicators between IOFs and cooperatives in six European countries shows that cooperatives are less profitable but operationally more efficient, they have higher material costs and lower debts than IOFs. Furthermore, cooperatives display a substantially greater variation in financial indicators than IOFs. Stochastic Frontier Analysis is used to measure and compare the efficiency and production technology of cooperatives and IOFs. Cooperatives are found to have a more productive technology than IOFs, but they use their production potential less efficiently. A further empirical analysis of technical efficiency using Data Envelopment Analysis shows that explicit accounting for the objectives of cooperatives generates different outcomes compared with treating cooperatives as if they were IOFs. The results of the empirical analyses in this study promote the conclusion that measuring the performance of cooperatives as if they were IOFs produces misleading insights about the cooperatives' performance suggesting performance suggesting that cooperatives' performance is influenced by their organizational characteristics and members objectives.

Keywords: *Cooperatives, IOFs, European dairy industry, logistic regression, stochastic frontier analysis, inter- and intra-firm efficiency, catch-up component, data envelopment analysis, hyperbolic technical efficiency, overall efficiency, scale efficiency, bootstrapping.*

Preface

After agreeing with my supervisors on the terms of my PhD and a few weeks before I moved to Wageningen, I joined a discussion with a young French professor at the University of Amsterdam. This professor, who teaches Financial Economics, was proudly saying how he has learned from his students in many issues he thought were trivial. He mentioned a few examples where he had to rethink certain approaches, which he always believed to be obvious, to certain research questions. At this point, while attempting to take part in this discussion, I talked about the difference between cooperative firms (considering their relations to their members) and the investor-owned firms (IOFs). I was enthusiastic to explain to this professor the complexity of members' role in their cooperative and how the economical literature lacks a proper tool to measure the performance of the cooperatives. He reacted instantly saying that members at the cooperatives and owners of the IOFs are the exact same thing and that there is nothing special about being a member of a cooperative. He argued conclusively that there is no need for different tools or treatment to measure the performance of the cooperatives. And so he left the discussion. I felt annoyed to be honest. On one hand, this individual seemed not to be as open-minded as he claimed in order to rethink common approaches to this issue that appears obvious to him. On the other hand, I sensed the difficulty that I am facing to defend an uncommon idea to main stream economists who are not familiar with cooperatives or their added-value to members. This incident raised alarms to me about my PhD project, but it also indicated the potential level of people's tolerance to different views than the common ones. I recall how the work of John Nash was ignored for years before being recognized as substantial to Game Theory. Of course, the cooperatives' performance is not comparable to Nash's *non-cooperative equilibrium* but the instant reaction, by those who work with main stream school of thoughts to certain non-traditional ideas, is very similar. And this is exactly what this thesis encountered, especially in the last chapters. With the support of my supervisors we started this PhD about the performance of cooperatives. This thesis would never come true without the contribution of many. Some contributed to the content of the research, while others contributed implicitly in words and sometimes by listening to me and provide me some directions and moral support. The idea to conduct a PhD on this subject came few years before the actual start of the PhD in June 2005. Thanks to Prof. Gert van Dijk, who provided me with all possible support during my master thesis in 2003 and then during my PhD. He contributed to my knowledge of cooperatives businesses in this part of the world and provided me with the opportunity to talk with him

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Chapter 1

General Introduction

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1.1 Introduction

Throughout the world cooperatives play an important role in the agricultural sector in general and in the dairy sector in particular. In the EU, in particular the northwestern members' states, cooperatives account for a large proportion of the market. In the Netherlands and Denmark, for instance, the dairy cooperatives are the market leaders. Providing relevant and accurate evaluation of the financial performance of the agricultural cooperatives is not only of relevance to the owners of the cooperatives and other stakeholders, but also to policy makers, the general public, local communities and academia. Recently, the concern to provide a proper evaluation of any firm's performance in the agri-food sector has intensified due to reasons such as the current financial crises, ongoing globalization, changes of environmental and food safety requirements, EU enlargement and WTO negotiations on the liberalization of the agricultural trade. One of the concerns raised in providing relevant and accurate performance measurement, is the comparison of the performance of cooperatives with investor-owned firms (IOFs). Providing a relevant comparison of the performance of the two types of firms requires an in-depth understanding of their core business objectives. Their mission and key objectives explain the differences of their performance. Performance measurement in this study refers to the ongoing process of assessing progress towards achieving pre-determined objectives (Bourne *et al.*, 2003).

In the economic literature, studies on the performance of cooperatives and IOFs are extensive. However, there is a big gap between the theoretical findings and their empirical implementation into performance measurement of cooperatives. When empirically evaluating the performance of cooperatives and IOFs, economists tend to accommodate the cooperatives by imposing behavioral assumptions (profit maximizing or cost minimizing) that are assumed for shareholders-value oriented firms and use tools commonly developed to measure the performance of IOFs. When the behavioral assumptions are not valid, imposing them while studying and comparing the performance of the cooperatives (as they are member–oriented firms) results in biased and irrelevant conclusions.

Nonetheless, economists who worked on the theoretical understanding of cooperatives have pointed out that the differences between cooperatives and IOFs should not be ignored and raised their concerns about the appropriateness of implementing the same approach to both (see e.g. Albaek and Schultz, 1998; Barton *et al.* 1996; Bateman *et al.*, 1979; Cotterill, 1987; Helmberger and Hoos, 1962; Staatz, 1989). In the theoretical literature few authors

present alternative approaches to address the differences between the two types of firms (Choi and Feinerman, 1993; Murray, 1983; Van Dijk and Klep, 2005). However, these approaches are complex and lack the availability of information on prices, equity characteristics or ownership structure.

Dairy cooperatives aim to gain market access for their members and to maximize the returns on behalf of their members, whereas IOFs aim at maximizing returns for their owners investors. These cooperatives determine the milk price to members by deducting the costs of the cooperative firm from total receipts. As a result they are often the regional price leaders. IOFs will normally minimize costs of milk for the firm. Milk payment to members by the cooperatives includes member performance such as taking liability. Therefore, measuring the real price payment to members requires detailed information on the ownership structure of the cooperative and its way of capitalization. Additionally, raw materials (milk from the members) play a different role for cooperatives than for IOFs. Raw materials to the cooperatives are the output of their owners (members) and cooperatives are expected to expand the use of these materials and pay a higher total price for them, contrary to what the IOFs would aim, i.e., to use the quantity of materials which optimize profits since materials are considered other input. The lack of information and the differences on what materials and capitalization are to cooperatives make it difficult to implement some of the theoretical models, especially when performance is to be compared across different organizations and countries. Additionally, empirical studies on differences between European dairy cooperatives and IOFs are lacking when it comes to the differences of their technical and economical performance and distinguishing the cooperatives from the IOFs in terms of financial ratios and other variables.

This thesis contains a review of the literature to highlight the actual gap between what has been theoretically developed and what is actually implemented empirically in measuring the performance of cooperatives. Starting with the gap in the literature and the lack of empirical studies on the European dairy sector, the research conducted in this thesis attempts to investigate empirically whether dairy cooperatives have different patterns in terms of their financial figure from the IOFs in six main milk producing countries in the EU. In addition the research in this thesis uses econometrical and programming tools to evaluate the differences in technical and allocative performance of dairy cooperatives and IOFs and adapts these tools according to the objectives of the cooperatives.

1.2 Objective of the Study

The objectives are to develop performance measurement and to empirically compare the performance of dairy processing cooperatives (as members-oriented firms) and IOFs (as shareholder-value oriented firms). More specifically, this thesis aims:

i) To review the literature on measuring the performance of cooperatives in comparison to IOFs.

ii) To empirically investigate whether cooperatives and IOFs can be distinguished in terms of their financial ratios and other variables as a consequence of the difference in their orientation.

iii) To measure and compare the technical and economical performance of dairy cooperatives and IOFs' using commonly applied approaches.

iv) Finally, to evaluate the technical efficiency of cooperatives by adjusting the commonly used approaches to address their members' orientation.

1.3 Outline of the Thesis

Chapter 2 starts by providing a review of the theoretical and empirical economic literature on measurement and comparison of the cooperatives' performance. This chapter presents a categorization of the theoretical and empirical literature and brings a systematic review of the gap between the theoretical and empirical economic literature on measuring the performance of cooperatives versus IOFs.

Chapter 3 uses logistic regression to investigate which financial characteristics differentiate European dairy cooperatives from IOFs. The empirical classification provides insights into differences in financial ratios and other factors between IOFs and cooperatives in the European sector of dairy processing firms. The distinguishing financial aspects indicate the financial ability and flexibility of these two different types of firms to cope with future challenges faced by the dairy industry.

In Chapter 4, using stochastic frontier analysis, we evaluate the performance of dairy cooperatives and IOFs in terms of their technical efficiencies and production technologies. The methodological approach uses a different frontier for each type of firm, allowing for

measuring technical efficiency of the firm with respect to its own frontier (intra-firm efficiency) and the difference between the two frontiers (catch-up component).

In Chapter 5, using Data Envelopment Analysis, we measure and compare the overall efficiency of dairy processing firms of the two types; additionally, we provide two hyperbolic technical efficiency measurements. The first hyperbolic measurement suggests that dairy processing firms radially expand output and contract all inputs, including materials (mainly raw milk) at the same time with equal proportions. The second hyperbolic measurement incorporates the nature of cooperatives (as members oriented) and suggests that firms radially expand both output and materials and contract other inputs at the same time.

Chapters 3-5 use the same data base on dairy processing firms in six European countries: Belgium, Denmark, Germany, France, Ireland and the Netherlands.

Chapter 6 highlights the main results, presents conclusions and provides a discussion of the theoretical, methodological and empirical issues.

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Performance Measurement of the Agricultural Marketing Cooperatives: The Gap between Theory and Practice

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Abstract

The performance of the agricultural cooperatives depends on their business objective(s) which is(are) defined in different ways in the literature. In this chapter we review the theoretical literature on the performance of agricultural marketing cooperatives according to a class that assumes a single objective and a class that assumes multiple objectives. This classification integrates three views of the cooperatives: 1) vertical integration of firms, 2) independent enterprise and 3) coalition of firms. Empirical studies on the financial performance of the cooperatives are classified into two categories: studies that are based on the economic theory of the firm and studies that emphasize accounting techniques. In this chapter we conclude that empirical studies have failed to address the cooperatives' objectives as represented by the theoretical literature on cooperatives' performance.

Keywords: *Agricultural Marketing Cooperatives, Cooperative Performance Measurements, Financial Ratios and the Performance of the Cooperative.*

2.1 Introduction

In this chapter we review the theoretical and empirical economic literature on the performance of agricultural marketing (AM) cooperatives. Performance measurement is the ongoing process of assessing progress towards achieving predetermined objectives (Bourne *et al.*, 2003). However, in the case of a cooperative, the firm and its objective(s) are not easily defined. Generally, there is a consensus in the economic literature that a cooperative can be defined as a user-owned and user-controlled organization that aims to benefit its members (Sexton and Iskow, 1988). As owners (residual claimants), members are entitled to the net income generated by the firm, but are also the residual risk bearers of the firm's net cash flows. As controllers, members have the residual right to control any assets that are not assigned to other parties or attenuated by law (Chaddad and Cook, 2004). Members generally benefit from their cooperative in proportion to their use (Barton, 1993). According to Helmberger and Hoos, (1962) the prime objective of the cooperative is to provide stability and optimal growth conditions for its members. Since there are a wide variety of cooperatives, we focus on agricultural marketing cooperatives.

Cooperatives differ widely in constitution, aspirations and business organization. With regard to organizational form and objectives, cooperatives may show as much variation as we find between cooperatives and investor-owned firms (LeVay, 1983). Facing the industrialization of farming and agribusiness, (traditional) cooperatives introduce different organizational innovations, e.g. new-generation cooperatives, partnership of limited liability company cooperatives and equity-seeking joint ventures (Cook and Chaddad, 2004). Notwithstanding the vast literature with regard to other types of cooperatives, we limit our analyses to the theoretical behavioral models of AM cooperatives. Nevertheless, it is important to state that some important contributions have been done outside this realm of agricultural marketing cooperatives; see for example Bonin, Jones and Putterman's work on producer cooperatives (1993).

Both the definition of cooperatives and the heterogeneity of their organizational forms are stumbling blocks in analyzing the performance of AM cooperatives. In order to develop manageable models of economic performance, various authors assign either single-objective goals or multiple-objective goals to AM cooperatives. Furthermore, cooperatives are generally viewed in three classes: vertically integrated, independent or coalition. As a result, the literature on AM cooperative economic performance consists of a heterogeneous list of

theoretical and empirical studies. An overview of those studies linking theoretical and empirical approaches to the cooperative's performance is lacking.

The theory focuses on the distinction between the profit-maximizing objective of the IOF and other goals that reflect the dual nature of the cooperative, i.e., member benefits and firm profitability. The assumed objective of the cooperative model often significantly alters the behavioral propositions. The theoretical economic literature on cooperatives has maintained three distinct views on cooperative firms: the cooperative as (a) a vertically integrated firm, (b) an independent business enterprise, and (c) a coalition of firms.

Economists studying cooperative performance have viewed the cooperative as an independent firm with a single objective. The lack of empirical evidence for assuming the other two views appears to be the result of either difficulties in obtaining the relevant data or the applicability of the theoretical models based on these two views. Empirical studies that use accounting tools (i.e., financial ratios) or efficiency measurement techniques (i.e., stochastic frontier analysis) are mainly focused on comparing cooperatives with investor-owned firms (IOFs).

The objective of this chapter is threefold. First, we review the economic literature on models that describe AM cooperative performance. Performance measurement is linked to firms' objective(s) and the economic literature. Second, we review the empirical studies on performance measurement of AM cooperatives. Third, we discuss discrepancies between the conceptual models and the empirical studies on AM cooperatives.

2.2 Theoretical Approaches to Modeling the Cooperative's Economic Objectives

The *raison d'être* of AM cooperatives can be found at the level of members' farms. Farmers began cooperating in order to have a countervailing power, gain access to industrially produced goods and services, realize economies of scale, manage their risk, and improve their own income (Van Dijk, 1997). Cooperatives are successful if they provide service to their members in excess of what they can achieve individually or outside of the cooperative. Although cooperatives also provide non-economic benefits[1] to their members, our focus here is on the economic performance of cooperatives. By establishing cooperatives with defined roles for members, members ensure that transaction-specific investments are less prone to opportunism.

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[1] Such as: participating in a democratic organization, contributing on the local community's development, strengthening the social bonds among members, or any non-economic benefits.

Likewise, cooperatives commonly perform as price leaders and stabilize prices for farm products. Additionally, as they invest in their cooperative business, farmers obtain returns on their investments. Members of AM cooperatives decide on the cooperative's retained earnings, investments, and farmers' output price. However, since price is related to the retained earnings and investments, and because the prices of the farm product represent a cost to the cooperative firm, the cooperative's profit is not, generally speaking, a useful measurement of its performance.

Traditional cooperatives source capital from reservations, up-front investments, debt instruments and member contributions. Traditional cooperatives are characterized by ownership restricted to members, open membership, redeem-ability of non-transformed residual claims, benefits only to patrons and "one-member, one-vote" (Cook and Chaddad, 2004). In order to keep up with the consolidation in the agribusiness and food industries, cooperatives are changing and employing various organizational innovations. These organizational innovations include the new generation cooperative, partnerships, member-investor cooperatives and equity-seeking joint ventures (Chaddad and Cook, 2004).

Economists studying the AM cooperative either assign one objective or multiple objectives to the cooperative. Traditionally, the economic literature on cooperatives has maintained three distinct views of cooperatives. This distinction of three views was presented first by Sosnick (1960) discussed later by Garoyan (1983) and implemented by Staatz (1989) and Cook *et al.,* (2004) as follows:

(a) The cooperative as a vertical integration of otherwise autonomous firms. Its primary objective is to conduct an optimal marketing program for its members.

(b) The cooperative as an independent business enterprise. Its primary objective is to maximize benefits for its owners.

(c) The cooperative as a coalition of firms.

In this chapter we do not ignore this classification from the theoretical literature, but we present the literature and the three views according to the number of assumed objectives for the AM cooperatives, i.e., single- or multiple-objective. Both of the first two views, i.e., vertical integration and independent firm, assume a single-objective cooperative, while the cooperative as a coalition of firms assumes multiple objectives. Table 1.1 provides an overview of the studies and the objectives of the cooperatives as suggested by the different authors.

Table 2.1: Overview of the Studies on the Economic Behavior of the AM Cooperatives

	Authors	Assigned objective(s)
VI*	Emelianoff (1942); Phillips (1953); Robotka (1957); Sexton and Iskow (1988)	To maximize benefits to members (i.e. to maximize both the price paid and the dividends' value)
IF	Lopez and Spreen (1985); Sexton *et al.* (1989); Marcoul and Hueth; Botens and Fulton (2005)	To maximize the profit of the cooperative firm
	Cotterill (1997)	To maximize total members' welfare
	Enke (1945); Carson (1979)	To maximize the (weighted) sum of cooperative's profit and members' profit.
	Van Sickle and Ladd (1983); Albaek and Schultz (1998); Falk(2002);Welch et al.(2007).	To maximize prices paid to members unit of delivery (resulting in higher profit/income for members). Each member only internalizes his/her own profit (loss) independent of other members.
	Feinerman and Falkovitz (1991); Vercammen *et al.*(1996)	To maximize members' profit subject to constraints
	Choi and Fienerman (1993)	To maximize the profit of one group (of members) subject to a constraint on the profit of the other group
	Helmberger en Hoos (1962)	To maximize the dividends to members.
CF	Murray (1983); Worley *et al.* (2000)	To optimize the join benefit of members and managers, while bargaining the financing arrangement of the cooperative.
	Staatz (1983)	To optimize the joined benefit of the coalition while bargaining among heterogeneous members about how to distribute the net benefit.
	Sexton(1986)	To provide benefits at least as great as those attainable elsewhere.
	Shaffer (1987)	To minimize the sum of production and transaction cost.
	Cook (1995)	To collectively optimize the members' benefits.
	Fulton *et al.* (1998)	To achieve economies of size, to minimize cost and to maximize growth opportunities.
	Fullton and Giannakas (2001)	To provide the joined benefits to members.
	Karantininis and Zago (2001)	To achieve better farmers' returns in open membership cooperatives.
	Sykuta and Cook (2001); Boland *et al.* (2007)	To optimize the joined benefit of the members' coalition
	Hendrikse and Bijman, (2002)	To obtain the optimal chain benefit by coordinating the investment on three different tiers of the chain.
	Cook and Chaddad(2004); Chaddad and Cook (2004)	To improve members' returns either by protecting current and future value of farm assets (defensive) or by adding value to farm assets.

* VI: vertical integration; IF: independent firm; CF: coalition of firms

The theoretical approaches presented in Table 2.1 predict different outcomes in terms of the price paid to members, profit of the cooperative and the quantity processed. The price paid to members refers to the payment members receive for their products. The profit of the cooperative is defined as the difference between total revenues and total cost. The quantity processed refers to the total output produced by the cooperative. Table 2.2 provides a comparison between the different theoretical views of the cooperative.

Table: 2.2: Major Differences of the Different Theoretical Views of Cooperatives

View of the cooperative as	Vertical integrated firm	*Single objective* A form of an independent firm				*Multiple objectives* Coalition of firms
		(1)	(2)	(3)	(4)	
Assigned objective(s) to maximize	Members return after paying the highest possible price for their products	Profit	Patronage funds	Sum of cooperative and members profit	Output (member-ship) optimization	The allocation of the optimal profit across the different parties (i.e. different members' categories, managers' board etc)
Decision maker(s)	Members only	Managers only	Managers only	Managers only	Managers only	Not centralized & depends on the negotiation among the different parties. Day to day decisions are the manager's responsibility.
Payment (price) to members' products	Highest (6)	Lowest(1)	High (5)	Medium+(4)	Low(2)	Depends on negotiation & compromise across the different groups (normally medium values)
Quantity processed	Low (2)	Medium+(4)	Lowest(1)	Medium- (3)	Highest(6)	Depends on negotiation process (usually high enough to process all members' production)
Profit of the cooperative	lowest- (1)	Highest (6)	Low (2)	Medium (4)	Medium(3)	Depends on negotiation. Normally upper medium to high
Performance indicator	Gross price and dividends	Profit-ability	Dividends	Profitability & net price payment to members	Turnover (output size)	Profit to each side involved

This chapter only reviews the economic literature on the performance of AM cooperatives, focusing mainly on the literature that suggests implicit or explicit cooperative objective(s).

2.2.1 Literature Assuming a Single-Objective to Cooperatives

The largest part of the existing theoretical work on AM cooperatives assumes a single, well-defined objective. The cooperative as (1) a vertically integrated or (2) an independent firm are

examples in the literature of single-objective. The view of the cooperative as a vertically-integrated firm considers the decision-making process as consisting solely of members, while the view of the cooperative as an independent firm considers the decision-making process to be solely, or primarily, in the hand of the manager(s).

The Cooperative as a Vertically Integrated Entity

In the absence of the conditions of a perfectly competitive market, producers mutually join together in a vertically integrated entity to secure the output flow in the downstream stage of the supply chain and to achieve the optimal return for the farmer-member (Van Dijk and Klep, 2005). This optimal return can be reached by increasing the price paid by the cooperative for farm products, increasing the price paid by the customers for the processed product, reducing the processing cost, reducing framers' income-risk or a combination of all the above (Sexton and Iskow, 1989). Emelianoff (1942) was the first to analyze the cooperative as a form of vertical integration. Robotka (1957) developed this view further and Phillips (1953) formalized it into a model of cooperative output and pricing decisions. Sexton and Iskow (1989) provided a lengthy report on the factors critical to the success of joint vertical integrated cooperative. The vertically integrated cooperative is all about members' objectives. Members are considered to be the absolute decision makers, with no objectives of their own and no preferences. In this approach, the pricing and output rules imply that all member firms produce at a point where their aggregate marginal costs of production are equal to the marginal revenue gained by the cooperative. The performance of such a firm is not only reflected in the prices that members receive for the products they market through the cooperative, but also through patronage refunds (Sexton and Iskow, 1989). Therefore, the vertical integration view focuses on maximizing members return (patronage refund) per unit of input after paying the highest possible price for members' products in comparison to prices paid by other firms in the industry.

Members want an equal or higher price than that paid by any other firm in addition to the optimal value of dividends; all without taking into account other costs or producer surplus. Members of a vertically integrated cooperative focus on the gross price they receive for their products in comparison to those that can be obtained from other firms, while having little interest in the net price, which can be substantially different (Bateman *et al.*, 1979). The vertically integrated cooperative resembles the traditional cooperative in the sense that members' ownership and control are absolute. Let Q_i and ρ_i denote the output quantity and

price, respectively, of cooperative i; q_i and μ_i denote the total quantity supplied by the members and the price paid by the cooperative i to its members; N_i is the number of members and C_i (Q_i) is a cost function incorporating all other costs as a function of the total quantity produced by the cooperative. Assuming a perfectly competitive market, the objective function of the vertically integrated agricultural marketing cooperative is:

$$\underset{Q_i, \mu_i}{Max}\{\pi_i = \rho_i Q_i(q_i) - \mu_i q_i - C_i(Q_i)\}$$
$$s.t. \quad \mu_i \geq \mu_j \quad \forall j, j \neq i \tag{1}$$
$$\pi_i \geq 0$$

On the one hand, the vertically integrated view of cooperatives predicts the highest μ_i paid to members' product and the optimal level of dividend. On the other hand, it predicts zero (or substantially low) profit value of the cooperative and suggests no retained equity-capital. The performance indicators of the vertically integrated cooperative are both prices paid to members and the return on patronage that they receive at the end of the accounting year.

The Cooperative as an Independent Firm

The economists who view the cooperative as an independent firm studied the cooperative in two ways: (i) as an IOF or (ii) as a variant of it. Both views consider the cooperative as a firm managed by entrepreneurs (as the absolute decision makers) who seek to achieve the cooperatives' single objective, discarding members' objectives in the decision-making process.

(i) Viewing the cooperative as an IOF, within the context of the traditional theory of the firm, assumes that the goal of the cooperative is profit maximization (Williamson, 1964). The optimal prices and quantities are determined by setting the cooperative's marginal cost equal to the marginal revenue and therefore the cooperative's profit is the main performance indicator. Studying the cooperative as an IOF assumes profit maximization as its single objective. These studies generally compare the performance of the cooperatives with the performance of the IOFs (Sexton and Iskow, 1993).

Viewing the cooperative as a profit-maximizing firm suggests ignoring members' objectives and considering the price paid for their product as an additional variable cost. The profit-oriented cooperative is expected to pay the lowest possible price for members' products

to achieve the optimal profit level. Assuming a perfectly competitive market, the maximizing function of the profit maximizing AM cooperative is:

$$\underset{Q_i}{Max}\{\pi_i = \rho_i Q_i(q_i) - \mu_i q_i - C_i(Q_i)\} \qquad (2)$$

(ii) Studying the cooperative as a variant of an IOF assumes a single-objective cooperative. Stephan Enke (1945) was the first to analyze the cooperative as a special type of independent firm. Enke concluded that in a monopoly, or monopolistic competitive situation, the welfare of both the members of the cooperative and society as a whole is maximized when the manager of an input cooperative maximizes the sum of the cooperative's profit and the members' profit from lower prices. Carson (1979) presented a "generalized welfare-maximizing firm," which is basically a weighted sum of stakeholders' profits. Helmberger and Hoos (1962) suggested that the cooperative's manager seeks to maximize member benefit by maximizing the average per-unit cooperative profit to the farmer. Bateman et al., (1979); Boyle (2004); Cotterill (1987); and Le Vay (1983) outlined the consequences of choosing different objectives for the cooperative's market behavior and its implication for financial issues. Among the suggested alternative single objectives are: (1) maximize the joint profit of the cooperative's and members' profit, (2) maximize the return to patronage, and (3) maximize the size of the total output (or membership).

(1) Maximizing the joint profit is explained as members seeking to maximize profits on both the inputs and outputs of their cooperatives. The joint profit maximization is represented by the total profits of both the cooperative and member firms. The allocation of the profit is assumed to be distributed equally between member firms and the cooperative firm as the same people both supply the raw input and own the processing plant. This approach (assuming equal weights α) is restricted and indicates that the cooperative gives equal importance to the profit of the cooperatives and members' farm profit. Adding a weight factor (α) allows for generalizing the model to indicate that some cooperatives may place more or less importance on their members' farm profit rather than on the cooperative's profit. The objective of the cooperative in this model is represented by a well-behaved single objective function assuming a centralized production entity which produces the optimal quantity i.e. the quantity which optimizes the joint profit of the cooperative and its members. The joint profit cooperative model is expected to predict a medium level of both: payment to members and profit of the cooperative, but is expected to predict a relatively high level of production

volume (Royer, forthcoming). For the joint profit cooperatives, the performance indicators are both the profit of the cooperative firm and the aggregated profit of the member firms. The formal model of the joint profit firm is:

$$\underset{Q_i, q_{in}}{Max} \left\{ \pi_i = (\alpha)\left[\rho_i Q_i(q_i) - \mu_i q_i - C_i(Q_i)\right] + (1-\alpha)\left[\sum_{n=1}^{N}(\mu_i q_{in} - C_n(q_{in}))\right]\right\}$$

$$s.t. \sum_{n=1}^{N} q_{in} = q_i$$

(3)

in which q_{in} refers to the quantity produced by n members and $C_n(q_{in})$ is the cost function of the nth members to produce q_{in} and $(\alpha) \in (0,1)$ reflects the importance weight, which are assumed to be equal in programme (3).

(2) Maximizing the return to patronage is equivalent to maximizing the dividend to the members. This view focuses solely on the return to patronage and ignores members' interests in the price of their product. This objective of the cooperative is expected to predict a reasonably high level of payments for members' products while producing low levels of cooperative profit and is also expected to process a very limited volume of production (Bateman *et al.*, 1979). For such a cooperative, the performance indicator is the value of dividends, which is measured in accordance with the business members' conduct with their cooperative, i.e., the return to patronage. The formal model in this case is:

$$\underset{Q_i}{Max}\{D_i = (\rho_i Q_i(q_i) - \mu_i q_i - C_i(Q_i))/S_{ni}\}$$

(4)

in which S_{ni} refers to a member's n amount of business conducted with cooperative i.

(3) Maximizing output (turnover) as an objective focuses on processing as much product as members optimally produce and having the capacity to anticipate the potential increase in the supply of raw material. This objective is subject to the constraint that sufficient return is made in order to pay out the total costs. In this approach, as done in Albaek and Schulz (1998), a cooperative is committed to let every n member choose their profit maximizing quantity (q_{in}^*) given a purchase price (μ_i), making sure the cooperative's viability condition holds. Note here that the production quantity is decentralized; unlike in programme (3), in the sense that each member is free to choose the quantity he wants to produce. The success of the cooperative is determined in terms of its volume, which is measured by the

total turnover. The total output is determined by the quantity produced by members. The payment to members as well as the profit of the cooperative is expected to be low. This model predicts the optimal capacity of the cooperative in processing members' (both current and potential future members) inputs. The formal model of the size-maximizing cooperative is:

$$
\begin{aligned}
&\underset{Q_i}{Max}\{Q_i(q_i^*)\} \\
&s.t. \rho_i Q_i(q_i^*) - \mu_i q_i^* - C_i(Q_i) \geq 0 \\
&q_i^* = \sum_{n=1}^{N} q_{in}^* \\
&q_{in} : \max[\mu_i q_{in} - C_n(q_{in})]
\end{aligned}
\qquad (5)
$$

2.2.2 Literature Assuming Cooperatives to have Multiple Objectives

Viewing the cooperative as a coalition of firms is basically assigning multiple objectives to the cooperative. The coalition can be formed between firms such as, but not limited to heterogeneous member groups, managers, non-member customers and non-member shareholders, in which each firm has its own objective. These firms participate in the organization as long as a compromise set of decisions is reached. The objective of the different groups can be conflicting, in which a compromise decision will be reached as a result of bargaining processes. Therefore, the decision making unit is assumed to consist of many parties within the cooperative.

The economical behavior of the cooperative as a coalition assumes that each participant maximizes its own profits subject to the existence of the cooperative. The business relationship among the various stakeholders of the cooperative can be organized either via a set of explicit and implicit contracts or a settlement of bargaining processes using game theoretical approaches. These approaches combine characteristics of markets and internal (integrated) coordination in ways that are different from either the view of the cooperative as a form of vertical integration or the view of the cooperative as an independent firm (Sexton, 1984; Shaffer, 1987; Van Dijk and Klep, 2005). These multiple-objective views regard the cooperative as an entity that is legally separated from its member firms with its own administrative and decision-making units, although final control lies with the members via the board of directors.

Early authors with this view (e.g., Kaarlehto, 1955; Ohm, 1956; Pichette, 1972; Trifon, 1961) have focused on situations where conflicts could arise between the farmer

members and the other participants in the cooperative. Recently authors have integrated approaches such as agency theory (Eilers and Hanf, 1999), property rights (Cook and Chaddad, 2004), contracting (Sykuta and Cook, 2001), transaction costs (Hendrikse and Bijman, 2002) and game theories (Karantininis and Zago, 2001) in their efforts to explain the economic characteristics of cooperatives. These approaches, although useful in explaining the behavior of the cooperative as a coalition, are not empirically useful in evaluating the performance of cooperatives.

Constructing a formal model for such a cooperative is not only problematic, but also requires strong assumptions to define the different sides (and their objectives) and their relations to each other. Among these different groups are: new and active members, old (inactive) members and non-member shareholders. The proportion of the total profit allocated to each side is settled through bargaining and negotiation processes that reflect each party's weight and influence. Therefore, the payment to members, the quantity processed and the profit of the cooperatives depend on the bargaining power of each party involved. The formal model predicts that each side maximizes its own proportion of the cooperative's optimal profit.

The formal model can be expressed in two stages. In the first stage, the cooperative maximizes its own profit (as an independent firm) given prices and quantities decided at a previous annual meeting. In the second stage, each party maximizes its own proportion of this profit:

Stage 1

$$\underset{Q_i}{Max}\{\pi_{ti} = \rho_{ti}Q_{ti}(q_{ti}) - \mu_{t-1i}q_{ti} - C_{ti}(Q_{ti})\} \tag{6}$$

in which π_{ti} is the profit at year *t*, which depends on the output price of year *t*, quantities decided on year *t-1* to be produced at year *t*, and members' prices at year *t* decided on year (*t-1*).

Stage 2

Each party maximizes its share in total profit α_m, which is a function of z_m that reflects the bargaining power of party *m*.

$$Max_{z_{m_i}}\{\alpha_m = f(z_m)\}$$

$$s.t. \sum_{n=1}^{N} \alpha_m = 1 \tag{7}$$

The combined programme (6 & 7) differs from both programme (2) and programme (3). Programme (6) has a single profit objective similar to the one in (2) but it is combined with programme (7) which generalizes the profit allocation rule of programme (3). Programme (7) incorporates the interest (could be unequal) of several stakeholders within the cooperative (i.e. cooperative's profit, objectives of active members, non active members and non-members shareholders), while programme (3) is restricted to two stakeholders with equal profit weights. The performance indicators are reflected in the profit per party in the coalition. To illustrate a typical situation of a cooperative as a coalition of firms, we consider a simple example with only two involved groups: active members and inactive members. The active members need (beside the optimal return to patronage) a high price for their product. The inactive members however, care only about maximizing the return to membership. Formally, the interests of these two different groups can be represented as follows:

S_{1i} is the number of active members and S_{2i} is the number of in-active members. The objective of the inactive members is simply to maximize the dividend per total number of members (active and inactive ones). The maximizing function for the M ($S_{1i} + S_{2i}$) members would be:

$$Max_{Q_i}\{D_i = (\rho_i Q_i(q_i) - \mu_i q_i - C_i(Q_i))/(S_{1i} + S_{2i})\} \tag{8}$$

However, for the active members, in addition to maximizing the return to patronage, the objective includes receiving the highest price (in comparison with other firms) for their farm's production. Active members are assumed to prefer a higher payment for their production rather than a return to patronage. The objective function for the S_{1i} members would be:

$$Max_{Q_i,q_i,\mu_i}\{R(active) = (\gamma)[(\rho_i Q_i(q_i) - \mu_i q_i - C_i(Q_i))] + (1-\gamma)\left[\sum_{n=1}^{N} \mu_i q_{in} - C_n(q_{in})\right]\}$$

$$s.t. \sum_{n=1}^{N} q_{in} = q_i \tag{9}$$

In which (γ) represents the importance's weight of each part, which depends on the bargaining power of the active members *vis-à-vis* the cooperative.

This implies paying a high price μ_i for the S_{1i} member products. In this cooperative, the value of μ_i, which is paid to the S_{1i} active members, is the core issue in the bargaining process.

2.3 Empirical Studies of the Cooperative's Performance

Empirical studies are mainly focused on implementing the behavior model of cooperatives as a profit-maximizing firm. So far in this field (AM cooperative), empirical applications of the other existing models (described above) do not exist. The lack of empirical application can be explained as a result of difficulty in obtaining the relevant data (if they exist at all), lack of interest on the part of applied economists or lack of theoretical approaches that are well developed for empirical application.

The existing empirical studies on the performance measurement of the AM cooperatives, viewing them as profit-maximizing firms, can be classified into two categories. The first category consists of studies that measure financial and other types of economic ratios. The second category consists of studies that measure (economic) efficiency (Sexton and Iskow). The empirical studies that use financial ratios which do not rely on any formal behavioral model and may be considered ad-hoc studies dominating the literature concerning the financial performance of AM cooperatives.

In Table 2.3 we present the empirical studies on the performance of the cooperatives in various industries and countries, all of which apply different tools. The overview in table 3 shows that the greatest number of empirical studies focuses on U.S. cooperatives. Furthermore, it can be seen that the performance of the dairy sector has been intensively studied and financial ratios were used more frequently than economic efficiency measurements. Techniques measuring economic efficiency were never applied to European data. Only four studies implemented other types of ratios other than the classical financial ratios as typically used in accountancy literature.

Table 2.3: List of Empirical Studies on the Performance of Cooperatives

Source Year	Data period	Sector	Country	Performance measurement
Porter & Scully (1987)	1973-1983	Dairy	USA	Production function.
Sexton *et al.* (1989)	1980-1987	Cotton	USA	Allocative efficiency
Akridge & Hertel (1992)	1980-1990	Grain & supply	USA	Cost efficiency
Featherstone & Rahman (1996)	1979-1988	Several agricultural sectors	USA	Productive efficiency
Sueyoshi *et al.* (1998)	1988	Several agricultural sectors	Japan	Production index comparative cost index & reduction ratio
Ariyaratne, *et al.* (2000)	1988-1992	Grain & supply	USA	X-efficiency & Scale-efficiency
Doucouliagos & Hone (2000)	1969-1996	Dairy	Australia	Technical efficiency
Singh *et al.* (2001)	1996	Dairy	India	Economic efficiency
Mosheim (2002)	1982-1993	Coffee	Costa Rica	Cost efficiency
Boyle (2004)	1961-1987	Dairy	Ireland	Economic efficiency
Hailu *et al.* (2005)	1984-2001	Fruits & vegetable	Canada	Technical efficiency
Ling & Liebrand (1998)	1986-1996	Dairy	USA	Extra value index & Return on equity
Parcell *et al.* (1998)	1996	Dry edible bean	USA	SWOT & Sensitivity analysis
Ebneth & Theuvsen (2005)	2001-2004	Dairy	Germany	Foreign sales index & Network spread index
Ling (2006)	1992-1996; 2000-04	Dairy	USA	Extra value index with different values of interest rate
Schrader *et al.* (1985)	1979-1983	Dairy, grain & farm supply	USA	ROE, Leverage ratios & Asset turnover.
Chen *et al.* (1985)	1983	Dairy	USA	ROE, Leverage ratios
Venieris (1989)	1985	Win	Greece	ROE, Leverage & Liquidity ratios
Parliament *et al.*(1990)	1971-1987	Dairy	USA	ROE, SR & Liquidity ratios
Lerman & Parliament (1990)	1976-1987	Fruits, vegetables & Dairy	USA	ROE, SR & Liquidity ratios
Barton *et al.* (1993)	1991	Agricultural sectors	USA	ROE, Asset turnover, & Leverage ratios
Hind (1994)	1992	Several agricultural sectors	UK	Profitability, Current ratio, & Solvency ratio
Harris & Fulton(1996)	1989-1993	Several agricultural sectors	Canada	Liquidity, profitability, productivity Growth
Gentzoglanis (1997)	1986-1991	Dairy	Canada	Profitability, Liquidity, Solvency& Leverage ratios
Trechter *et al.* (1997)	1993-1994	Several agricultural sectors	USA	Profitability, Equity redemption, patronage refund
Hardesty & Salgia (2004)	1991-2002	Several agricultural sectors	USA	Profitability, Liquidity, Solvency & Leverage ratios
Barton (2004)	2002-2003	Several agricultural sectors	USA	Profitability, solvency, & equity structure ratios
Notta & Vlachvei 2007	1990-2001	Dairy	Greece	Profitability, Market share, Asset & Capital structure
Brester & Boland(2004)	1996-2000	Sugar	USA	Profitability & capital financing.
McKee (2007)	2002-2006	Input supply & grain	USA	Profitability, liquidity, & efficiency ratios

2.3.1 Empirical Studies Based on Financial and Other Economic Ratios

There is no clear link between the financial ratios and economic theory. Financial ratios are often used, more or less intuitively, without sufficient consideration of their theoretical meaning and statistical properties. However, the financial ratios are necessary to handle the dynamic reality of the firm's status and activities (Shubik, 1996). Financial ratios give a quick indication of the firm's position in several dimensions (i.e., profitability, liquidity, solvency, efficiency, etc). They fail, however, to provide a unified and representative evaluation of the overall performance of the cooperative (Salmi and Martikainen, 1994).

The financial ratios represent the relative value of a certain aspect of the firm to the value of another aspect of the same firm. For example, the distribution of the value of the firm's profit over the value of its total equity gives the value of the return on equity. Equity may refer to a different aspect for the cooperative than it represents for the profit-maximizing firm (Zwanenberg *et al.*, 1993). Therefore, a meaningful interpretation of the financial ratios requires understanding of what the values of each aspect of the ratio refers to for each cooperative.

Researchers who have analyzed cooperative performance using the financial ratios differ in the ratios they consider when they analyze cooperative performance cooperative (Gentzoglanis, 1997). Financial ratios typically used in empirical studies of cooperative performance can be summarized in two main categories. The first category consists of ratios that show the ability and the efficiency of equity capital to generate returns, i.e., profitability and efficiency. In the second category are ratios that show the nature of financing this equity capital and the ability of the firm to pay its debts, i.e., capital financing (Gentzoglanis, 1997; Lerman and Parliament, 1990; Soboh, 2004)

The Expected Value of Cooperative Financial Ratios

The interpretation and the expectation of the financial ratio value depend on the authors' objective and on the definition of each value (Gentzoglanis, 1997). However, some authors provide theoretical foundations for differences in the value of the cooperative's ratios as compared to the investor-owned firms. These theoretical foundations are reasonably valid when viewing the cooperative as a vertically integrated firm in comparison to a profit-maximizing independent firm.

The first category concentrates on profitability and efficiency of equity, assets and working capital to generate returns and sell products. Profitability ratios refer to the return to

equity capital, assets and working capital. The return on equity is the most often used ratio indicating the profitability of the firm. Gentzoglanis (1997) argued that the cooperatives seek to provide members with the best possible price in addition to other services. Therefore, according to this view, cooperatives are expected to have a lower rate of return on equity than IOFs in the same industry. Efficiency ratios refer to the efficiency of equity capital, assets and working capital in terms of the production or sales size. Asset turnover, an example of an efficiency ratio, indicates the efficiency of the firm's assets in terms of the total turnover. Lerman and Parliament (1990) argued that cooperatives are expected to have lower efficiency rates than IOFs in the same industry, because of the cooperative's tendency to over-invest in fixed assets for the same sales.

The second category, which contains leverage, solvency and liquidity ratios, concentrates on ratios that show the nature of financing equity capital and the ability of the firm to pay its debts. Leverage ratios refer to the amount of debt used to finance the firm's capital and operations both in short- and long-term. Cooperatives have limited property rights and are considered 'equity bound' and therefore rely more on debt financing in order to finance growth than IOFs. Traditional cooperatives (i.e., viewed as a vertically integrated firm) by definition, can only raise equity capital from members. In addition, for reasons related to moral hazard concerns, cooperative managers perceive that their cooperative is more likely to merge with another cooperative in case of financial stress rather than face bankruptcy (Gentzoglanis, 1997). Therefore, cooperatives are expected to have a higher leverage ratio than IOFs.

Solvency ratios refer to the ability of a firm to meet its long-term fixed expenses and debts and to accomplish long-term expansion and growth. An example of a solvency ratio is the ratio of equity to long-term liabilities (such as debt obligations to other parties for more than one year). Lerman and Parliament (1990) argued that given that cooperatives have the tendency to use more debt than IOFs, the expectation is that cooperative's solvency is lower than the solvency of IOFs (assuming a traditional and vertically integrated firm). A low solvency level implies that the cooperatives would have a higher likelihood of default on debt service payments and higher prospects of bankruptcy than IOFs.

Liquidity ratios refer to the ability of the firm to meet its short-term liabilities and to quickly convert an asset into cash. An example of a liquidity ratio is the current ratio, defined as current assets over current liabilities. For the same reasons as the solvency ratios, Lerman and Parliament (1990) argued that traditional and vertically integrated cooperatives are expected to have lower liquidity ratios than IOFs.

Comparing Cooperatives with IOFs

Schrader *et al.* (1985) examined the relative performance of the cooperatives versus IOFs using a cross-section of various agricultural sectors from 1979 to 1983. They found that cooperatives had a lower return on equity than IOFs, a lower leverage than their IOFs counterparts and no difference in the assets turnover.

Chen *et al.* (1985) examined the relative performance of U.S. cooperatives to IOFs in the dairy industry using data from 1983. Their results confirm the theoretically expected performance of cooperatives relative to IOFs, i.e., they found that the profitability of cooperatives is lower relative to IOFs. Cooperatives also have a higher leverage than IOFs in the dairy industry.

Venieris (1989) compared the performance of Greek wine cooperatives with the performance of IOFs. His results confirm the theoretically expected differences in profitability, leverage and liquidity, i.e., cooperatives showed lower profitability, higher leverage and higher liquidity than IOFs. However, according to Venieris, these results are due to the fact that cooperatives in Greece borrow capital at low interest rates from government agencies, while IOFs borrow at the market interest rate.

Lerman and Parliament (1990) studied the financial performance of the cooperatives and the IOFs of two sectors in the U.S.: the fruit and vegetables processing sector and the dairy sector over the years 1976-1987. Their results show that on average, the cooperatives and IOFs generated similar returns on equity and similar leverage results. In the dairy sector, cooperatives outperformed the IOFs on the rate of return on equity. In the fruit and vegetables sector, on the contrary, the cooperatives showed a lower rate of return on equity.

Gentzoglanis (1997) examined the relative performance of Canadian dairy cooperatives to IOFs using data from six major dairy cooperatives and six IOFs from 1986 through 1991. His results contradict the theoretically expected relationship, i.e., the cooperatives have a higher profitability, higher liquidity, and lower leverage than the IOFs.

Hardesty and Salgia (2004) compared the financial performance of cooperatives to IOFs using ratios for profitability, liquidity, leverage and asset efficiency in four U.S. sectors: – dairy, farm supplies, fruits and vegetables and grain. Cooperatives in all four sectors were less leveraged, but results indicated higher rates of asset efficiency for cooperatives only in the dairy sector. The results regarding the relative profitability and liquidity of cooperatives were not conclusive.

Notta and Vlachvei (2007) tested whether significant profitability differences exist between cooperatives and IOFs in the Greek dairy sector. They used a net profit to total assets ratio for profitability, market share and several asset efficiency ratios over the period 1990 to 2001. Their findings suggest that IOFs are more profitable than the cooperatives, which they explained as due to the IOFs' effective capital structure and high market shares.

Inter-Cooperative Comparisons

Lerman and Parliament (1989) examined the effect of size and sector on capital structure, efficiency, liquidity and profitability. They used data from a sample of 43 U.S. dairy supply, food marketing and processing and cotton and grain marketing cooperatives over the period 1970–1987. Their results show that cooperatives with higher total assets have a higher asset turnover, but lower profitability and liquidity than cooperatives with lower total assets. As for the industry, dairy cooperatives were found to outperform cooperatives in the other two industries, but the authors suggest that this is due to government intervention in milk prices.

Other Ratios and Indicators

A number of studies applied other ratios that are not commonly used in the accountancy literature to represent the cooperative's performance.

Ebneth and Theuvsen (2005) analyzed the performance of agricultural cooperatives in several industries in terms of their ability to enter the international markets. They used two index numbers that reflect the performance of the cooperative, i.e., the foreign sales index and the network spread index. The foreign sales index is defined as the ratio of foreign sales to total sales. The network spread index is defined as a ratio of the number of countries in which a company owns subsidiaries to the maximum number of countries in which a company could have subsidiaries. Their results showed that cooperatives in small countries with a comparative small domestic market, such as the Netherlands and Denmark, have higher values for both ratios than cooperatives from large countries, such as Germany and France. Ebneth and Theuvsen explained that companies in small countries are forced to internationalize to become cost-efficient.

Ling and Liebrand (1998) introduced an index that reflects the operational efficiency of the cooperative that they termed as "Extra Value Index", defined as the difference between

the net operating margin and the interest on equity[2]. They used this index in addition to the rate of return on equity to investigate the performance of dairy cooperatives and compare it with the performance of dairy IOFs. Their study was based on the 25 largest dairy cooperatives and 15 largest IOFs in the U.S. dairy sector between 1986 and 1996. Their results indicate that dairy cooperatives did just as well create value for its members as the IOF created for its shareholders, while dairy cooperatives realized lower rates of return on equity than did the IOFs. In another study Ling implemented the Extra Value Index, developed by himself and Liebrand in 1998, with different values of the interest rate to evaluate the ability of the 21 largest U.S. dairy cooperatives across two time periods: 1992 through 1996 and 2000 through 2004.

2.3.2 Empirical Studies Based on Economical Efficiency Techniques

Authors of the empirical studies in this category view the cooperative as an independent profit-maximizing firm. They utilize different tools such as Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). These studies basically use quantitative tools to explain the value of one output using the value of many different inputs.

Comparing Cooperatives to IOFs

Cooperatives, as perceived by Alchian and Demsetez (1972), Furubotn (1976) and Jensen and Meckling (1979) are inferior organizations due to monitoring, horizon, common property, non-transferability and control problems. Porter and Scully (1987), Ferrier and Porter (1991), and Oustapassidis *et al.* (1998) claimed that the cooperative is less technically efficient mainly due to the higher cost to control their many principles. Moreover, they argue that cooperatives are less able to allocate efficiently due to the horizon problem (i.e., the lack of the property right that allows the member to sell his ownership share upon leaving the cooperative). This can cause the cooperative to underutilize capital. Cooperatives can also be scale inefficient due to the rapidly increasing cost to control large numbers of members,

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[2] Extra value= net operation margin (before tax) – interest on equity, where:
Net operation margin(before tax) = operating margin + interest income - interest expenses + other income – other expenses, and
interest on equity = (member or stockholder equity – investment in other firms) * interest rate (Ling and Liebrand, 1998)

which prevents them from achieving a scale efficient operation (Mosheim, 2002). On the contrary, some other researchers view the cooperatives as advantageous due to their goal alignment with members giving the cooperative an informational advantage in case altruism is present (Bontems and Fulton, 2005). Also, due to lower agency rents, cooperatives have an operational advantage in the lower return economical conditions (Hueth and Marcoul, 2007). In the following paragraphs we present the major findings of the different empirical literature.

Porter and Scully (1987) utilized a Stochastic Production Frontier approach to evaluate the relative performance of cooperatives versus IOFs using 1972 data for a sample of U.S. milk processing plants. They conclude that dairy cooperatives were on average only 75.5% as efficient as their IOF counterparts and that the cooperatives could raise output by 32.4% without requiring extra inputs. According to Porter and Scully, this inefficiency is attributed to problems related with the cooperative's property rights, specifically the horizon problem, the free rider problem and the portfolio problem as summarized in later work by Cook (1995).

Akridge and Hertel (1992) estimated cost differences between grain and farm supply cooperatives and IOFs using a generalized Translog multi-product cost function. They concluded that IOFs were more cost efficient than the cooperatives in this industry. Sexton *et al.* (1989) tested the allocation efficiency of cotton ginning cooperatives and the hypothesis that cooperatives are not using their total capital efficiently. Their results reject the argument that cooperatives tend to underutilize capital.

Singh *et al.* (2001) applied DEA and SFA to compare the performance of the dairy cooperatives to the private sector in India. They used data collected over four years from 13 dairy cooperatives and 10 IOFs in two different Indian states. They concluded that cooperatives are more cost efficient than IOFs.

Doucouliagos and Hone (2000) used DEA and SFA to assess the technical efficiency of Australian dairy processing firms using data over the period 1969-1996. Their results show a modest technical progress and indicate some convergence in productivity levels across regions. They conclude that the Australian dairy sector is operating at a high level of technical efficiency.

Boyle (2004) investigated the economic efficiency of Irish dairy cooperatives over the period 1961-1987. He argued that cooperatives are not efficient for two reasons: (a) cooperatives suffer from technical inefficiency because of principal-agent problems and allocation inefficiency due to horizon problems; (b) cooperatives prices for raw milk are inefficient. Boyle's results suggest that cooperatives price their inputs just as IOFs.

For other empirical literature dealing with the efficiency of cooperatives in relation to other organizational types, see for example Ferrantino *et al.* (1995), Dong and Putterman (1997) and Zhang *et al.* (2001)

Inter-Cooperative Comparisons

Ariyarantne *et al.* (2000) studied three efficiency measurements (technical efficiency, allocation efficiency and sales efficiency) for 89 U.S. grain marketing and farm supply cooperatives over the period 1988-1992. They conclude that cooperatives could improve efficiency by increasing their scale, but the potential gains were relatively small. Large cooperatives are generally more efficient than smaller ones and cooperatives with a diversified output mix are more technically efficient and more efficient overall compared to specialized cooperatives.

Sueyoshi *et al.* (1998) used Data Envelopment Analysis for a bilateral performance comparison of Japanese agricultural cooperatives on the basis of cross-sectional data in 1998. They used three index numbers (comparative production index, comparative cost index, and comparative cost reduction ratio) as the DEA measures for the bilateral performance comparisons. They conclude that the size of the cooperative does not affect efficiency.

Hailu *et al.* (2005) examined the productive efficiency of 54 Canadian fruit and vegetable cooperatives over the period 1984-2001. They conclude that the production costs for these cooperatives could have been reduced by 28% if they had only operated at their production frontiers. They also note that financial leverage had a negative effect on cost efficiency and possibly caused a negative financial pressure on the performance of the cooperatives.

2.4 Discussion

In reviewing the theoretical literature we explore the plethora of optimizing behavior that may emerge according to different theoretical views. Generally speaking, the empirical approaches view the cooperative as an independent firm that does not explicitly address members' objectives. Addressing members' objectives in performance measurement can be achieved by using multiple-objectives methodologies, e.g., multi-criteria analysis. This methodology was used in evaluating the performance of a single dairy cooperative (Soboh, 2006). Members' objectives were related to price payment, the cooperative's long-term perspective of growth

and profitability with the lowest price (equity-funding) possible (Zwanenberg *et al.*, 1993) A high equity growth rate is an indicator of either an increase in the member's contribution (in cases where members are the only shareholders) or an increase in equity from non-members who aim to maximize the return on their investment (in cases where non-members can invest in the cooperative). Soboh (2004) implemented a growth-rate indicator to reflect the long-term performance of a few large European agricultural cooperatives.

On the other hand, empirical evidence of cooperative performance using the frameworks of vertical integration and coalition of firms is impossible due to lack of data. Authors who view the cooperative as a form of vertical integration suggest that maximizing the benefits of the members is the cooperative's objective. Among these authors are Sexton and Iskow (1988), who suggested that evaluating the vertical integration model requires long-term information related to members' economical well-being and cooperative growth perspectives. Empirical application requires data that represents the economical well being of members before and after forming (or joining) the cooperative and the economical well being of the farmers who are not part of the cooperative. In addition, empirical applications require data that represent the growth perspectives of the cooperative in comparison to the IOF growth perspectives and the benefits for dairy farmers vertically integrated in a cooperative.

2.5 Conclusions

The review of the theoretical and empirical economic literature on the performance of AM cooperatives provides insight into the match between the conceptual frameworks and the empirical applications. AM cooperatives differ widely both in constitution and in their aspirations and vary considerably from investor-owned firms. AM cooperatives have developed from purely traditional to different organizational forms such as new generation cooperatives and partnerships between investor-owned and cooperative firms. The variation, the development and the lack of a clear definition of the cooperative firm promote three different views of the cooperative that are analyzed by assuming either single or multiple cooperative objective(s). In the literature we observe that authors usually start from a single-objective cooperative view and also assume that members are homogenous in their characteristics, objectives and cost structures. Within the literature that assumes a single objective, two views of cooperatives exist: one as a vertically integrated firm and another as an independent firm (or a variant of it). On the other hand, the literature that suggests multiple

cooperative objectives assumes heterogeneous stakeholders (such as new members, inactive members, investors, suppliers, and management board) with different characteristics, objectives and cost structure. Viewing the cooperative as a coalition of firms assumes multiple objectives for the cooperatives.

Presently, there are few matches between the theoretical analyses and empirical evidence on cooperative objectives and performance. Although theoretical contributions on the performance of cooperatives recognize the differences between the economic behavior of cooperatives and IOFs, empirical studies mostly focus on evaluating cooperative performance as if the cooperative were an IOF, albeit with different types of shareholders. Evaluating the performance of cooperatives as vertically integrated firms or as coalitions has virtually been ignored as a subject for empirical analysis. This seems to be due to either the inaccessibility of data, the inability to take into account the interests of all the various types of members and stakeholders of the cooperative or the difficulty in testing the various hypotheses in practice. In particular, the difficulty of aggregating the objectives of the heterogeneous stakeholders of the cooperative can hardly be overstated. However, it is fair to say from our review of the empirical studies that empirical economists have focused more on regarding the cooperative as an independent firm, while ignoring (intentionally or not) the other views of the economical behavior of the cooperatives.

Financial ratios have been used in many empirical studies to compare the performance of the cooperative with the performance of the IOF in the same industry. These studies, however, fail to address the difference in financing the cooperative's capital and the financial viewpoint of the owners of the cooperative, i.e., the members.

Few studies have used mathematical and statistical tools in evaluating the (micro) economic efficiency. These techniques, although based on economic theory, view the cooperative as an independent firm with a single objective, i.e., to maximize its profit. These studies fail to address the nature of the cooperative as an organization with a specific characteristic, that of being a firm that is user-owned, user-controlled and user-benefited.

Considering the performance of the cooperative in isolation would be meaningless, since cooperatives represent a firm with a dependent nature. Thus the appraisal of performance has to take into account the objectives of the cooperatives' owner-patrons, as well as the marketing and processing of the cooperative's product in the supply chain. Cooperatives are firms with a dual purpose or two-layer entrepreneurship that have to cope with both the competitive market environment and have to fulfill the objectives of the member firms. Empirical studies of cooperative performance have failed so far to address the

specific structure and conduct of the cooperative from that point of view: as an organization that needs to fulfill the objectives of its members. Members' return and continuity should be viewed as at the core of the objectives of the cooperative. Therefore, a meaningful empirical evaluation of the cooperative's performance should address the dual objective nature of the organization.

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Distinguishing Dairy Cooperatives from Investor-Owned Firms in Europe using Financial Indicators

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Abstract

The European dairy industry is facing a number of challenges related to policy changes and global trends that add pressure on their economic performance. This study uses logistic regression to analyze differences in financial and performance indicators between European dairy cooperatives and investor-owned firms. The investigated indicators are profitability, debt, operational efficiency, equity growth, size and country dummies. The empirical application uses data from 170 European dairy firms. Cooperatives are on average less profitable, operate more efficiently and have a stronger financial position than investor-owned firms. Using the above mentioned financial and performance indicators, cooperatives appear to be well equipped to cope with the challenges ahead.

Key words: *Dairy Cooperatives, Financial Performance, Logistic Regression.*

3.1 Introduction

The European dairy sector is facing challenges related to policy changes, demand and price volatility in global markets, introduction of new regulations, changes of consumers' preferences and increasing demand for animal feed by bio-fuel sector. First, the European Union aims to transform the dairy sector towards a competitive and market-oriented sector (Boel, 2007), starting with the CAP reforms and the gradual lifting of the quota system until its anticipated ending in 2015. The CAP reforms (or "health check" as Boel calls them) resulted in a lower budgetary support for the production of bulk dairy products (milk powder and butter). The EU-commission claims that the reform, which started in 2003, has introduced strong incentives towards market orientation, which makes the classical market management tools (export refunds and interventions) less relevant and less defendable in WTO discussions (Boel, 2008). The gradual lifting of the quota system requires the EU policy makers to search for transitional measures to ensure that the abolition of the quota system ends in a soft landing. Ending the quota system provides opportunities to dairy farmers who are able to produce more than their quota, while adding more difficulties on farmers in the less favored areas and who are not able to produce above their quota (Boel, 2007). Second, the global dairy market is increasingly volatile. In 2007 the demand for dairy products is being stretched by reduction in milk output from major exporters such as Australia and South America, along with increasing demand from major European markets such as Germany and Italy and emerging markets such as China, India and Russia (Kleibeuker, 2007). Third, the dairy sector faces the introduction of new regulations related to nutritional claims and environmental requirements. Dairy producers will need to ensure that they are meeting these new legal requirements (Picazo-Tadeoa and Reig-Martíneza, 2007, Merrett, 2007). Fourth, consumers' preferences are changing towards more value-added dairy products with high nutritious

claims and a longer shelf life (Devlieghere *et al.*, 2004). Fifth, the dairy sector faces an increasing demand for bio-fuel that largely uses the same plants which dairy farmers need for feeding their cattle (Hill *et al.*, 2006). In 2005, the EU produced 80% of the total bio-diesel production in the world, which is promoted by direct and indirect subsidies. Brussels aims to have 5.75 percent of the motor fuel consumed in the EU to come from biofuels by 2010 and 10 percent by 2020 (Runge and Senauer, 2007). As a result feed costs have increased and are projected to continue to increase.

Dairy farmers in Europe are left to operate in a more competitive market with more volatile returns and increasing costs. More volatile returns are partly due to the growth of global demand and partly due to the latest EU policy changes, such as the reduction of export refunds and interventions. EU milk prices have been particularly volatile in the past two years, i.e., in the period between February 2007 and February 2008 prices increased by more than 33 percent (LTO, 2008). Concerns are now raised about the sustainability of the growth in milk prices and the impact of the price volatility on the development of the dairy industry (Merrett, 2008). Increasing costs are due to the recent health and environmental requirements, responding to the consumers changing preferences and the growing prices of animal feed. In this more competitive and volatile environment, European dairy farmers need partners in the dairy processing industry that have a sound performance, serve their objectives efficiently and help the farmers in easing their financial stress. Farmers generally have their raw milk processed by dairy processing firms with ownership structure of either a cooperative or an investor-owned firm , where the latter is dominated by stock-listed and family owned firms.

The challenges facing the European dairy sector also have financial implications for the dairy processing industry. This industry operates increasingly in transparent markets in which information about the performance and goodwill spreads globally and quickly (Lin, 2006). These factors, although strengthening the competitive market conditions, raise

concerns about the rationality behind the existence of the cooperative as a distinguished type of firm (Cross and Buccola, 2004). Additionally, these challenges have different implications for cooperatives rather than for IOFs. For instance, as a consequence of quota removal, milk production will no longer be frozen within certain national/regional boundaries. This has very different implications for cooperatives rather than for IOFs, as the first will try to remain locally rooted, while the second will be more prepared to source wherever the milk is cheapest, provided the distance from consumer markets is not prohibitive (Van Bekkum, 2001). Van Bekkum (2001) also highlighted that the implications of these challenges are different depending on the strategy of the firm, such as focusing on bulk or on high value added production.

To successfully deal with the challenges described above requires an active search for new investments in product development and acquisition in new markets. Coping with these challenges requires an efficient performance and a strong capital position to finance the new investments.

An empirical analysis of the performance and financial characteristics of dairy cooperatives versus IOFs will provide insight into the sustainability of the cooperative dairy firms in the more competitive market environment.

The average difference of the financial performance between the dairy cooperatives and IOFs has been widely studied in literature (see e.g. See Schrader, 1985; Chen *et al. 1985;* Lerman and Parliament, 1989 &1990; Parliament *et al.,* 1990*;* Gentzoglanis, 1997). These studies generally assumed cooperatives and IOFs to have identical, objective functions, which led to erroneous or at least incomplete conclusions (Van Dijk and Klep, 2005). However, a comparison of mean values generally yields inaccurate insights into distinguishable characteristics between cooperatives and IOFs; a multivariate analysis can address this.

Furthermore it is noted that none of these studies provided a comparison for the European dairy industry.

The objective of this chapter is to provide an empirical classification based on a multivariate analysis and to study the distinguishing financial aspects of European dairy processing cooperatives from IOFs. The classification aims to differentiate the two types of firms in terms of their financial ratios and other factors reflecting the difference in the orientation of cooperatives (as members' profit oriented firms) and IOFs (as share holder value oriented firms). The empirical classification provides insight into differences in financial ratios and other factors between IOFs and cooperatives in the European sector of the dairy processing firms. The distinguishing financial aspects indicate the financial ability and flexibility of these two different types of firms to cope with the future challenges faced by the dairy industry.

3.2 Theoretical Background

Cooperatives differ in their essence, objectives and their sources of capital from IOFs. They are essentially formed by their members to have a countervailing power, to gain access to industrially produced goods and services, to gain access to markets for their products, to use the efficiency of economies of scale, to manage their risk and to improve their own income (Van Dijk, 1997). Therefore, cooperatives, which are owned, controlled and aimed to benefit their members, have different objectives than IOFs which are typically characterized as shareholder-value oriented firms, i.e. as profit maximizers. Cooperatives aim to provide services to their members and distribute the surplus according to patronage; IOFs aim to maximize the return to investment and distribute the surplus according to the investment (Helmberger and Hoos, 1962; Lerman and Parliament, 1990). With a few exceptions,

cooperatives in the EU are not traded publicly in stock markets. The principal sources of finance for the cooperative's capital are mainly the members (farmers) retained equity (Van Dijk and Klep, 2005). IOFs differ fundamentally in their sources of capital; IOFs are publicly traded and have non-farmer shareholders (Chaddad and Cook, 2004). The differences in objectives and sources of capital between the two types of firms implies that the performance of the cooperatives *vis-à-vis* IOFs differs in terms of profitability, capital financing and operational efficiency (Hendrikse and Bijman, 2002).

With respect to profitability, cooperatives are not considered to be maximizers of return on capital investments (Lerman and Parliament, 1990; Van Dijk, 1997). The owners of cooperatives, contrary to the owners of IOFs, are not mainly interested in the return on their investment but in other services and benefits provided by the cooperatives, such as a high milk price and a secure market outlet (Staatz, 1989). Consequently, cooperatives are expected to have a lower profitability and higher material cost (including raw milk) than IOFs (Lerman and Parliament, 1990).

With respect to capital financing, cooperatives are usually viewed as equity-bound firms, suggesting that members' equity, in principle, is the only source of capital financing. Therefore, cooperatives may need to rely more on debt financing than IOFs in order to finance their activities and sustain comparable growth rate (Lerman and Parliament, 1990). An additional factor is the attitude towards risk. Gentzoglanis (1997) argued that the cooperative's principle of risk sharing and mutual responsibility may provide an incentive to decision-makers of cooperatives to accept higher levels of risk rather than what the managers of IOFs would accept. Copeland and Weston (1988) argued that cooperatives have a higher level of debt because of the risk of bankruptcy. Therefore, cooperatives are expected to have a higher debt than IOFs and to have lower safety margins against the risk of defaulting on debt service and current liabilities.

With respect to operational efficiency, as measured by utilization of assets to generate revenue, Lerman and Parliament (1990) argued that cooperatives have the tendency to over-invest to form a greater asset base than the asset base of IOFs. This is because cooperatives may treat own cooperative's equity as costless funds, without acknowledging their opportunity cost. Undervaluing the cost of equity may lead to over-investments, resulting in a lower utilization of assets by cooperatives rather than IOFs. These aspects suggest that cooperatives have higher yearly equity growth than IOFs. However, the over-investment needs not only be in fixed assets; it can also affect current assets, resulting in a higher level of inventories (Lerman and Parliament, 1990).

The major source of equity funding for cooperatives is retained patronage. The cooperative's retained patronage is either allocated or unallocated. The allocated type of patronage is assigned to the individual member and is to be redeemed to this member sometimes in the future. The unallocated type is not assigned to a specific member-account and therefore is only paid back to members when the cooperative dissolves (Cropp *et al.*, 1998). Cooperatives have slow and different redemption systems of the allocated equity (Kenkel, 2005).

European dairy cooperatives are generally not publicly traded, nor are they open for non-members' investment. The nature of the allocated and unallocated equity, in addition to the slow redemption process, leads to the conclusion that cooperatives have a higher growth in their general reserves and other non-issued equity base (Zwanenberg *et al.*, 1993). However, the size of the general reserves and other non-issued equity base depends on the firm's size. Evans (1987) found that the firm's size of equity growth decreases at a diminishing rate with the firm's size represented in the firm's total assets. The fact that the firm is publicly traded makes no difference for the relation between its equity growth and its size (Evans, 1987).

The cooperatives' financial characteristics may substantially differ across countries. Zwanenberg *et al.* (1993) argued that the cooperatives in the Netherlands and Belgium determine profitability in a similar way, but different from the way it is determined by cooperatives in France, Germany and Ireland. The total milk payment in the Netherlands and Belgium depends on the performance of the cooperative, while in France, Germany and Ireland the total milk payment is independent of the cooperatives performance (Zwanenberg *et al.*, 1993). Moreover, in Ireland cooperatives are public limited companies in which some proportion of the cooperative's shares is publicly traded (Harte, 1997). These two arguments suggest that the differences in financial and other ratios between cooperatives and IOFs may be country-specific.

Dairy processing firms substantially differ in terms of their size. These size differences may affect the extent to which the variables described above distinguish cooperatives from IOFs. More specifically, dairy processing cooperatives are expected to have a larger size than IOFs. This is because IOFs choose the size that optimize the return to investment, whereas the size of dairy cooperatives is determined by the quantity of milk delivered by its members.

3.3 Empirical Model

The empirical model aims to study if the dairy firm's financial characteristics can determine whether this firm is an IOF or cooperative. The firm's financial characteristics, which are highlighted by the literature, are related to profitability, capital financing, operational efficiency, equity growth and firm size.

3.3.1 Indicators

Profitability is represented by two indicators: the ratio of profit before taxes to total asset *(PTA)* and the ratio of material cost to total assets *(MC)*. Profit after taxes of the firm reflects the firm's objective to maximize profit. Several indicators of profitability are available in the data set; i.e. profit before taxes, profit after interests and taxes, and cash flow. Profit before taxes (*PTA*) was selected, because this variable had the smallest number of missing values in the available data set used for estimation. The costs of materials reflect the firm's payment for the milk delivered by the farmers (or members in case of cooperatives). The *MC* was the only indicator to include the milk payment; however, *MC* includes also the costs of other materials used in processing the dairy product.

Capital financing is represented by three indicators: total debt to total assets (*DTA*), long term debt to equity (*DR*) and current assets to current debt (*CR*). Total debt to total assets reflects the dependence of the firm on debt financing; long-term debt to equity reflects the ability of the firm to meet its long-term obligations, while current assets to current debt reflects the ability of the firm to meet its current obligations.

Operational efficiency is represented by two indicators: turnover to fixed assets (*FT*) and turnover to inventories (*IT*). Turnover to fixed assets reflects the efficiency of the firm's fixed assets in producing its total turnover, while turnover to inventories reflects the proportional size of the inventories to the total assets.

The yearly growth of non issued equity (*EG*) reflects the rate of change of the size of the non issued equity such as general reserves between two successive years.

Firm size is reflected by the value of total assets *(TA)*.

3.3.2 Methodology

Logistic Regression

This study uses logistic regression as a descriptive tool to investigate whether cooperatives are empirically different from IOFs in their financial ratios and a number of other factors. Using the logistic regression allows us to investigate the hypothesis that the cooperatives' financial characteristics are statistically different from the ones of the IOFs. Logistic regression is a similar method as discriminant analysis (Press and Wilson, 1978), but maintains less restrictive assumptions than discriminant analysis (Efron, 1975). Unlike discriminant analysis, logistic regression does not require the independent variables to be normally distributed and to have equal variance within each group. Logistic regression was used in many studies in different fields as a descriptive tool to empirically discriminate or investigate differences between two categories as represented by the dependant variable (see e.g. Pearce and Ferrier (2000); Morgan *et al.* (2003); Timmerman *et al.*(2005); Khan *et al.* (2006)).

The dichotomous dependent variable in our study represents the type of dairy processing firm, i.e., IOF or cooperative. Logistic regression applies maximum likelihood after transforming the dependent into a <u>logit</u> variable (i.e., the natural logarithm of the odds of the observation being a cooperative or an IOF) to estimate the changes in the log odds of the dependent variable. The relationship describing the impact of the independent variables on the log of the odds of being a cooperative is assumed to be linear (Tabachnick and Fidell, 2007).

Model Specification

The logit-transformation of the likelihood of being cooperative (θ) has a linear relationship with several independent variables. This relationship is specified as:

$$(1) \qquad \log\left[\frac{\theta_i}{1-\theta_i}\right] = \alpha + \beta_1 PTA_i + \beta_2 MC_i + \beta_3 DTA_i + \beta_4 DR_i + \beta_5 CR_i + \beta_6 FT_i +$$

$$\beta_7 IT_i + \beta_8 EG_i + \beta_9 TA_i + \gamma_1 Land_i + \upsilon_i$$

Land is a dummy variable indicating the country of the processing firm. All α, β, and γ are parameters to be estimated.

The interpretation of the coefficients is not straightforward. While β is convenient for testing the significance of predictors, the exponential value of the βs is easier to interpret. The exponential value of the (β) represents the ratio-change in the odds of being a coop for a one-unit change in the predictor, i.e., the odds-ratio. Note that an odds ratio above 1 reflects a positive odds that the dependent = 1, i.e., that the observation represents a cooperative. An odds value close to unity suggests the independent variable does not distinguish cooperatives from IOFs.

Bootstrapping

Bootstrapping is a general approach to obtaining statistical inference on a sampling distribution for a parameter by re-sampling from the data at hand. The term 'bootstrapping', due to Efron (1979), is an allusion to the expression 'pulling oneself up by one's bootstraps' – in this case, the sample data as a population from which repeated samples are drawn (Fox, 2002). There are many advantages of using the bootstrapping technique. It allows us to take into account more of the data variability while using the logistic regression, i.e., bootstrapping allows the variability of the indicators in the selected sample to mimic their variability in the total population (Efron and Tibshirani, 1993). This is useful to correct for any possible sample bias and strengthen the validity of the estimators. In this study we drew 100 repeated samples and estimated the bootstrapped results based on 90 percent of the total observations. About 90 percent of the total observations were drawn randomly from the sample of IOFs and

cooperatives separately using a Bernoulli random selection procedure with probability parameter of 0.9. The 10 percent of the total sample, which was not used in the estimation, was used to validate the estimation results.

3.4 Data

The data used in this study are accounting data of dairy processing firms from the Netherlands, Germany, Belgium, France and Ireland. The data were obtained from AMADEUS, which is a comprehensive, pan-European database containing financial information on over 10 million public and private companies in 38 European countries. It combines data from over 30 specialist regional information providers, i.e., chambers of commerce. To address the accounting differences across the different countries, AMADEUS provides standardized definitions of the different financial ratios. In this study, we used unbalanced panel data over the period 1996-2004 of 170 dairy processing firms (of which 27% are cooperatives). Of the 1226 observations, 136 observations are with missing variables, leaving us with 1090 complete observations. Several indicators were selected to represent profitability (*PTA* and *MC*), capital financing (*DTA, DR,* and *CR*), operational efficiency (*FT* and *IT*) and equity growth (*EG*). Other variables in the model are dummy variables to represent the country of origin and total assets (TA) to represent the impact of firm size. Table 3.1 provides descriptive statistics of the variables used in the logistic regression model.

Table 3.1: Descriptive Statistics of the Dairy Processing Firms 1996-2004

Variable (Denotation)	Definition	Theoretical Expectation	Mean (Std. Dev.)			Difference Sign. level
			All	*IOF*	*Coop*	
Profitability						
Profit (PTA)	profit before interest and taxes/total assets	IOF > COOP	0.049 (0.15)	0.053 (0.09)	0.040 (0.24)	0.13
Material cost (MC)	material cost/total asset	IOF < COOP	0.220 (0.62)	0.180 (0.39)	0.323 (0.98)	0.00
Capital financing						
Total Debt (DTA)	total debt /total asset	IOF < COOP*	0.689 (0.18)	0.705 (0.19)	0.652 (0.17)	0.00
Debt ratio (DR)	long term debt/total equity	IOF < COOP	1.04 (4.0)	0.99 (3.33)	1.16 (5.24)	0.54
Current ratio (CR)	current assets/current liabilities	IOF > COOP	1.50 (0.95)	1.32 (0.9)	1.94 (1.06)	0.00
Operational efficiency						
Fixed Asset Turnover (FT)	turnover/fixed assets	IOF > COOP*	87.6 (1151)	14.7 (66.46)	263.6 (2121.3)	0.00
Stock turnover (IT)	turnover/ inventories	IOF > COOP*	41.3 (21.3)	37.2 (22.19)	43.1 (18.21)	0.00
Equity growth						
Growth Ratio (GR)	[NI-Equity (y+1) – NI-Equity (y)]/NI-Equity y)[1]	IOF < COOP*	1.12 (2.92)	1.27 (2.10)	0.75 (4.28)	0.475
Size factor						
Total assets (TA) (100000x)			0.992 (151)	0.578 (11.22)	1.94 (274.7)	0.00

* Results contradicted the theoretical expectation.

3.5 Results and Discussion

3.5.1 Model Estimation

Maximum likelihood estimation was used to estimate how likely the odds of the observed values of the dependent (being an IOF or a cooperative) may be predicted from the observed values of the independents. Table 3.2 provides the results of the bootstrapped estimation while Table 3.3 provides the percentage of the correctly classified firms. Hosmer-Lemeshow goodness-of-fit statistic (Pseudo R^2) yields an average p-value of 0.1877, which is higher than

the benchmark for the model as being model fit, Pseudo R^2 > 0.05. This indicates that the model fits the data used in the estimation (90% of the total observations).

Profitability

For the profitability indicators, the odds-ratio of profit before interest and taxes to total assets (*PTA*) was less than one (0,00) and significant at the critical 5% level, while the odds-ratio of material cost to total assets (*MC*) was greater than one (1,368) and significant.

The odds-ratio of the *PTA* coefficient suggests that, *ceteris paribus,* an increase of the *PTA* value by 1 unit increases the estimated odds that the firm is a cooperative by 0.000, this suggest that a dairy processing firm with the high profit ratio is properly not a cooperative.

The odds-ratio of the *MC* coefficient reflects that*, ceteris paribus,* an increase of the *MC* value by 1 unit increases the estimated odds that the firm is a cooperative by 1.368. This suggests that a dairy processing firm with high material costs is more likely to be a cooperative. The results for profitability and material costs are consistent with their theoretical expectations.

Capital Structure

For the capital financing indicators, the odds-ratio of the total debt to total assets (*DTA*) was less than one (0.025) and significant, while both the long-term debt to total equity (*DR*) and the current ratio (*CR*) were greater than one, i.e, (1,029) and (1,005), and insignificant. The odds-ratio of the *DTA* coefficient suggests that, *ceteris paribus*, an increase of the *DTA* value by 1 unit increases the estimated odds that the firm is a cooperative by 0.025. This suggests that a dairy processing firm with high total debt ratio is probably not a cooperative. The result for *DTA* is not in line with the *a priori* theoretical expectation.

Operational Efficiency

Among the operational efficiency indicators, the odds-ratio of the turnover to fixed assets (*FT*) was greater than one (1,012) and significant, while the odds-ratio of turnover to inventories (*IT*) was less than one (0,988) and significant.

The odds-ratio of *FT* suggests that, *ceteris paribus*, an increase of the *FT* value by 1 unit increases the estimated odds that the firm is a cooperative by 1.012, i.e., a dairy processing firm with high turnover to fixed asset is more likely to be a cooperative. The odds-ratio of the IT suggests that, *ceteris paribus*, an increase of the *IT* value by 1 unit increases the estimated odds that the firm is a cooperative by 0.988, i.e. a dairy processing firm with high turnover to inventories is probably not a cooperative. The result for FT is inconsistent with its theoretical expectation whereas the result for *IT* is in line with its a *priori* theoretical expectation.

Growth Ratio

The growth rate of the non-issued equity (*EG)* was less than one (0.988) but insignificant. The odds-ratio of *EG* reflects that, given that the value of every other indicator is fixed, an increase of the *EG* value by one unit increases the estimated odds that the firm is a cooperative by 0.988. This suggests that a dairy processing firm with a high growth ratio is more likely not a cooperative. This result is inconsistent with the theoretical expectation.

Country

The four dummies of German, Belgium, France and Ireland are all greater than one, i.e., (1.17), (2.07), (2.83), (3.42) respectively, but are insignificant at the critical 5% level. These insignificant results indicate that the differences between countries (in terms of taxes and accounting rules or any other influential factor) are not significantly influential in classifying the firms into cooperative or IOF.

Size

The odds-ratio of firm size, as represented by total assets (*TA*) was greater than one and significant. The odds-ratio of the *TA* suggests that, *ceteris paribus*, an increase of the *TA* by 1 unit increases the estimated odds that the firm is a cooperative by 1.294, i.e. cooperatives *ceteris paribus* have a larger size than IOFs. This result confirms the *a* priori theoretical expectation that cooperatives attain a larger size than IOFs. This result follows from the fact that cooperatives are less flexible in determining the optimal firm size than IOFs, i.e., cooperatives have to process the volume of milk delivered by their members.

This study also investigated the hypothesis that firm size affects the extent to which the financial variables distinguish cooperatives from IOFs. In order to do so, the data was separated into two subsets, a subset of firms smaller and a subset of firms larger than average sizes. The model in (1) was estimated for each subset and a likelihood ratio test was performed to test whether the parameters are significantly different between the model of all the samples and the two separated data groups (i.e., small and large firms). The hypothesis was rejected at the 5% critical level implying that firm size does affect the relationship between financial variables and firm type. This finding leads us to continue with the results of our model as presented in Table 3.2.

Table 3.2: The Average of the Estimations of the Logistic Model

Variable (Denotation)	Odds-ratio [exp(α; β)] [Effectiveness]{ if ≈ 1→ no effect }	p-Value [Significance]
Constant (α)	145	0.000
Profitability		
Profit ratio (PTA)	0.000	0.000
Material cost ratio(MC)	1.368	0.053
Capital financing		
Total debt ratio (DTA)	0.025	0.000
Long term debt ratio (DR)	1.029	0.629
Current ratio (CR)	1.005	0.947
Growth		
Growth Ratio	0.988	0.332
Operational efficiency		
Turnover to fixed assets (FT)	1.012	0.000
Turnover to inventories (IT)	0.988	0.003
Size factor		
Total Assets (TA)/100000	1.294	0.000
Country		
Germany	1.166	0.752
Belgium	2.067	0.649
France	2.833	0.137
Ireland	3.417	0.137

Pseudo R^2 (Hosmer and Lemeshow test) = 0.1877.

3.5.2 Validating the Results

The previous results (presented in Table 3.2) show the results of classifying the dairy processing firms using financial and performance characteristics. In this section we investigate the ability of the logistic model to correctly classify the firms used in the

bootstrapped estimation (90% of the total observation) and to validate with the firms which were not used in the estimation (the remaining observations).

Table 3.3: Classification and Validation Results

Observed	Predicted						
	Selected cases			Unselected cases[1]			Total
	IOF	Cooperative	Percentage correct	IOF	Cooperative	Percentage correct	Percentage correct
IOF	718	40	94.7	84	9	90.3	94.3
Cooperative	180	87	32.6	16	11	40.7	33.41
Overall percentage	-		78.5			79.2	78.6

Percentage of Correctly Classified Firms

Table 3.3 provides the percentages of correctly classified IOFs and cooperative firms using the bootstrapped logistic model. The results show that, on average 78.5 percent of the selected sample (90% of the total observations) was correctly classified, while 79.2 percent of the unselected sample (10% of the total observations) was correctly classified. The model performs better when classifying IOFs rather than cooperatives. In total, the model classifies 94.3 percent of the IOFs correctly, while 33.41 percent of the cooperatives were correctly classified.

The difference in the predictive performance of the model may be due to the fact that cooperatives are more heterogeneous than IOFs. The financial structure and characteristics of cooperatives across different European countries are largely determined by the characteristics and cultural background of local communities, whereas IOFs operating across countries are publicly traded and have a clearly defined objective to maximize profit. For instance, the cooperatives in Ireland have 50 percent of their capital base publicly traded, while the cooperatives in none of the other countries in our sample have any of their capital-base publicly traded (Harte, 1997). Also, the milk price system used by Dutch and Belgian cooperatives differs from the one used by French and German cooperatives. The cooperatives

in the first group of countries pay a proportion of the price to their milk suppliers relative to the firm's performance, while the cooperatives in the second group of countries pay a predetermined and fixed price, which is not related to the firms' performance (Zwanenberg *et al.*, 1993). Another issue is the cultural characteristics of cooperatives in the different countries which will reflect on their policy to invest, produce and sell in the international arena (Ebneth and Theuvsen, 2005). Ebneth and Theuvsen found that German and French cooperatives in particular are less internationally oriented than Dutch and Belgian cooperatives.

Description of the Classified Firms

Describing the statistics of the cooperatives and IOFs, which were both correctly and wrongly classified, allows us to identify the variables that differentiate correctly from wrongly classified firms. Table 3.4 below describes the correctly and wrongly classified firms and indicates the results of statistical testing (F-test) of whether the firms are significantly different at the 1% and 5% critical levels. The difference between the correctly and wrongly classified cooperatives is significant (at 5%) for five indicators out of nine (i.e., *PTA*, *MC*, *DR, FT* and *TA*) and for four indicators (*PTA, DTA, FT* and *TA*) in case of IOFs. Material cost and debt ratio are significantly different between the correctly and wrongly classified cooperatives and not for IOFs. The total debt is significantly different between the correctly and wrongly classified IOFs and not for cooperatives

Table 3.4: The Characteristics of the Firms Correctly and Wrongly Classified

Variable (Denotation	Mean (Std Dev.)			
	Correctly classified		*Wrongly classified*	
	IOF	*Coop*	*IOF[1]*	*Coop[2]*
Profitability				
Profit (PTA)	0.053 (0.077)	-0.0238 (0.074)	-0.053 (0.171)*	0.017 (0.041)*
Material cost (MC)	0.176 (0.404)	0.372 (1.371)	0.085 (0.169)	0.117 (0.327)**
Capital financing				
Total Debt (DTA)	0.703 (0.202)	0.613 (0.222)	0.642 (0.292)**	0.653 (0.155)
Long- term debt ratio (DR)	0.785 (3.301)	1.595 (5.949)	0.579 (1.553)	0.437 (0.865)*
Current ratio (CR)	1.318 (1.314)	1.481 (0.598)	1.470 (0.790)	1.516 (0.1.38)
Operational efficiency				
Fixed Asset Turnover (FT)	12.75 (22.73)	110.6(285.7)	45.09 (118.3)*	15.77 (19.71)*
Inventories turnover (IT)	46.23 (23.62)	40.46(14.60)	41.69 (17.78)	43.18 (14.90)
Equity growth				
Equity Growth (EG)	1.365 (14.48)	1.511 (7.887)	0.431 (1.688)	0.527 (2.538)
Size factor				
Total assts/ x100000	0.475 (0.955)	2.75 (4.990)	1.164 (0.955)*	0.434 (0.521)*

[1] [2]: *The significant level of the difference between the correctly classified IOFs (cooperatives) with the wrongly classified IOFs (cooperatives) * at 1%; ** at 5%.*

The wrongly classified cooperatives make more profit and have lower material cost, long-term debt ratios, fixed assets to turnover and firm size than the correctly classified cooperatives. The wrongly classified IOFs make less profit, have a higher value of total debt, a higher value of fixed assets turnover and larger firm size than the correctly classified IOFs. The implication here is that the cooperatives which are more profitable tend to be smaller in size and have low *MC*, *DR* and *FT*, whereas the lower profitable IOFs tend to be larger in size and have low *DTA* and high *FT*.

3.6 Conclusion and Implications

The objective of this study is to analyze the financial and performance characteristics that distinguish European dairy processing cooperatives from IOFs.

The results show that European dairy processing cooperatives are different from IOFs and that cooperatives are more heterogeneous. Cooperatives are significantly distinguished from IOFs in terms of profitability, material cost, total debt, turnover to fixed assets and turnover to inventories. On the other hand long-term debt, current and growth ratios were insignificant in distinguishing dairy cooperatives from IOFs. The European dairy cooperatives that were analysed in this study tend to have a lower profit, a higher material cost, a lower ratio of total debt to total assets, a higher ratio of turnover to fixed assets, a lower ratio of turnover to inventories and a larger size than IOFs. The results of the total debt and turnover to fixed assets contradict *a priori* theoretical expectations. None of the country dummy variables were significant, which indicates that any differences in the accounting and tax system or other country-specific factors do not distinguish dairy cooperatives from IOFs. Cooperatives showed more heterogeneous results in terms of the mean value of the indicators for cooperatives, i.e. higher variance of the variables used in the empirical analysis than the IOFs. Moreover, only 33.4 percent of the cooperatives were classified correctly in comparison to 94.3 percent of the IOFs. The larger heterogeneity among cooperatives complicates their correct classification based on the estimation results. Cooperatives across countries have different traditions, financial characteristic and managerial attitude, while IOFs seem to have more homogenous financial characteristics.

These differences between the two types of dairy processing firms have implications for their flexibility to cope with the challenges ahead and to accommodate the effects of the policy changes in the EU. Since both dairy processing cooperatives and IOFs sell dairy

products and operate under the same competitive market conditions, the results of profitability imply that IOFs produce more profitable products, have lower costs or higher operational efficiency.

The issue of higher costs was studied by investigating the influence of the material cost which includes the payment to the raw milk. Cooperatives, on average have higher material costs than IOFs and since milk payment comprises the largest part of the material cost (in the database), higher material cost might result from the fact that cooperatives pay a higher price for raw milk and may therefore be preferred by dairy farmers.

The issue of operational efficiency was studied by investigating the influence of turnover to fixed assets and turnover to inventories. Cooperatives tend to have a higher ratio of turnover to fixed assts and a lower ratio of turnover to inventories. These results suggest that cooperatives have a better operational efficiency than IOFs. In terms of operational efficiency (*FT* and *IT*), dairy farmers would prefer a cooperative rather than an IOF.

Cooperatives tend to have a lower ratio of total debt to total assets size than IOFs. This indicates that the financial position of the cooperatives allows them to acquire more debt capital, if needed, i.e. cooperatives have a greater financial flexibility than IOFs. This suggests that dairy cooperatives have a strong financial position and are well equipped for making investments in innovations and new acquisitions.

The implications of our results are that cooperatives are, on average less profitable, pay a higher milk price to farmers, operate more efficiently, and have a stronger financial position than IOFs. Therefore, cooperatives seem well-equipped to deal with the challenges ahead. Given their financial flexibility and their ability to pay a higher milk price, they may provide a more important role than IOFs in providing a soft landing for the expected abolishment of the quota system and the foreseen reduction of dairy subsidies. However, it should be noted that future research could shed more light on the importance of cooperatives

and IOFs under the future conditions. Additional insights would particularly be needed on issues such as the internal pricing system, the internal organization and differences in access to financial capital. Also, future research would greatly benefit from more information on the dairy processing firms on their degree of specialization and globalization.

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Chapter 4

Production Technologies of Cooperatives and IOFs in the Dairy Industry

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Abstract

This chapter compares the technical efficiency and the production technology of dairy processing cooperatives and investor-owned firms in Belgium, Denmark, the Netherlands, Germany, Ireland and France. Two parametric production frontiers are estimated for cooperatives and investor-owned firms separately, which are used to evaluate the intra- and inter-type technical efficiency of each firm. The models are estimated using accountancy data from the AMADEUS data base over the years 1995-2005. Results show that dairy cooperatives have more productive technology, but are overall slightly less efficient than investor-owned firms. Differences in production technology and technical efficiency of the cooperatives across countries reflect differences in local market conditions and characteristics of the companies. Both cooperatives and investor-owned firms are characterized by decreasing returns to scale. However, the scale of operation is much larger for cooperatives.

Keywords: *Dairy Cooperatives, Technological differences, technological gap*

4.1 Introduction

Evaluating the production efficiency of cooperatives and comparing it with investor-owned firms is meaningless if fundamental differences between IOF's and cooperatives are ignored. Cooperatives differ in their assumed objectives and organizational structure from IOFs and these differences are not independent of their production technology. They are justified by the dual relationship between the cooperatives and their members in comparison to the more simple relationship between the shareholders and their firm. As for cooperatives, members are the owners, controllers[3] and the main (if not the only) user of the cooperative (Sexton & Iskow, 1988) who seek other objectives rather than maximizing the rate of return to equity. Whereas, within the IOF shareholders are not the users of the firm and are basically interested in maximizing profit.

The dual objectives of the cooperatives are defined in different ways in the theoretical and the empirical literature. Among the members' long-term interests in marketing cooperative is (i) having a guaranteed access to market outlets for their outputs and (ii) a strong competitive position so that members receive competitive payments for their outputs. Marketing cooperatives are expected to be the first who put price increases for the supplier of the farm product on the agenda. Various objectives of the cooperative are suggested in the literature, such as: service at cost, maximizing the aggregate members' profit, maximizing the joint profit of the cooperative firms and the aggregate members' profit (Soboh *et al.*, 2009).

The organizational structure of cooperatives differs from IOFs due to the fact that their objectives and those of its members are more closely aligned[4] than the objectives of the principals (shareholders) and their agents (firms) in the IOF (Bontems & Fulton, 2005). This alignment of objectives, which incorporate the user-owner and user-controller characteristic of the cooperatives, shapes the organizational structure of the cooperative in the long-run (Bontems and Fulton, 2005).

The differences in both objectives and organizational structure imply that not only the business model of cooperatives (from entrepreneurial perspective) differs from the one of the IOFs in terms of the trade-offs between revenue sources, cost drivers, volume of investments and success factor - as suggested by Hamermesh *et al.* (2002)- but also in terms of decision making processes. Cooperatives, which are mainly financed by members, are more risk averse

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[3] Members, as owners (residual claimants), are entitled to the net income generated by the firm and also the residual risk bearers of the firm's net cash flows. While members, as controllers (have the residual right to control), have the rights to any assets that are not assigned to other parties nor attenuated by law (Chaddad and Cook, 2004).
[4] However, there are examples in the literature which shows that this alignment is not perfect. For instance, with a heterogeneous membership, non members owners, distributional issues (see Carson (1979) and Sexton (1986)).

and are less likely to launch new ventures, which suggest less diversification for cooperatives rather than for IOFs. Therefore, the market orientation of cooperatives differs from the one of IOFs, which tends to target the higher risk and higher value added segments of the market. The cooperatives' drivers of cost reduction focus on improving members' income, which implies that cooperatives are more concerned with reducing operational costs other than costs related to members' products. Cooperatives' investments in new product portfolios are restricted by the members' reluctance to engage into risky new revenue streams. The ability of cooperatives to process the potential capacity growth of its members is a major determining factor for investment. The cooperatives success factors are the competencies of cooperative to be sustainably fulfilling the members' objectives. To a large extent these success factors are similar to those characterizing IOFs, yet it should be kept in mind that the IOFs goals are more closely linked to profitability. The cooperatives first concern is to process all of its members' products and to process and valorise this optimally. IOFs on the other hand determine their markets on the basis of profit maximising. The size of their operation is dependent on their market strategy and they are not obliged to process a predetermined quantity.

Different objectives and organizational structure and the implications of these, will also affect the cooperatives production technology and technical efficiency *vis-à-vis* the cooperative. Bontems and Fulton (2005) used agency theory to argue that the strong alignment of objectives (members with their cooperative) within the cooperatives gives some advantages to cooperatives' production efficiency over the IOFs'. Contrary to argument of Bontems and Fulton (2005); Oustapassidis *et al.* (1998) argued that cooperatives due to their organizational characteristics which endorse over-supply of members' inputs are disadvantaged, and therefore less scale efficient. Moreover, Porte and Scully (1987), Ferrier and Porter (1991), and Gentzoglanis (1997), also argued that cooperatives are less scale-efficient due to higher costs of control when there are many principals having an incentive to free-ride on others' efforts. The recognition that cooperatives and IOF's have different technologies suggests that the common practice of modelling the cooperative as having an identical production structure is theoretically ungrounded (Bontems and Fulton, 2005).

The present study uses a parametric frontier approach to efficiency measurement to evaluate and compare the technical efficiency of dairy cooperatives with that of IOFs. The chapter aims to estimate a firm type-specific (cooperatives and IOFs) production frontier to statistically test on differences. Firm type-specific production frontiers and firm-specific efficiency parameters allow obtaining intra- and inter- type technical efficiency

measurements. Intra-type technical efficiency involves computing the efficiency of a particular firm's (of particular type, either cooperatives or IOFs) relative to the frontier of this firm's particular type. This efficiency measurement reveals this firm's performance relative to its type's technology. Inter-firm technical efficiency involves computing the efficiency of that same firm relative to the frontier of the firm type that represents the best practice. Inter-type (IE) efficiency is decomposed into intra-type efficiency (IA) and inter-type catch-up (CU) components, where the CU component reflects the potential for improving performance by adopting the other firm type's technology. A CU of a firm of certain type (for instance cooperative) lower than one indicates that the technology of the other type is better than the technology of the firm's own type. The catch-up component may include differences in technology across the two types of firms occur from differences in the incentives (and therefore the pace) to adapt and invest in new technologies and/or input quality differences (Oude Lansink *et al.*, 2001). The empirical application focuses on data from cooperatives and IOFs in the dairy processing industry in Belgium, the Netherlands, Ireland, Denmark, Germany and France.

4.2 Econometrics Methodology

The present study uses a parametric frontier approach to efficiency measurement to evaluate and compare the technical efficiency of dairy cooperatives with that of IOFs. The parametric approach to efficiency measurement has been implemented widely in several industries. See, for instance, Schmidt(1986), Lovell and Schmidt(1988), and Bauer(1990) each for an overview of modelling and estimating the parametric frontier functions in relation to the efficiency measurement and Battese (1992) for a survey of application of the parametric (or stochastic) frontier analysis to technical efficiency measurement in the agricultural sector. Application of the parametric frontier approach to comparing efficiency of cooperatives and IOFs has been previously undertaken by Sexton *et al.* (1989), Doucouliagos and Hone (2000), Singh *et al.* (2001), Mosheim (2002)[5]. In these studies, measuring and comparing the technical efficiency of both types of firm (cooperative and IOF) is conducted assuming IOF's and cooperatives employ the same production technology.

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[5] See Soboh *et al.*, (2009) for an extended list of literature used similar techniques while comparing the performance of cooperatives to IOFs.

The stochastic frontier production model was presented independently by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977). The stochastic frontier analysis (SFA) has been theoretically and empirically implemented on firms of different industries and sectors (see Coelli, 1995). Measuring production efficiency allows one to test competing hypotheses regarding sources of efficiency or differences in productivity (Farrell, 1957; Lovell and Schmidt, 1988). Moreover, such measurement allows for quantifying the potential increases in output that might be associated with an increase in efficiency (Farrell, 1957).

In this chapter, two Translog production frontiers (i.e. for cooperatives and IOFs separately) are estimated using data on three inputs and one output of dairy processing firms in the EU. The stochastic frontier model, assuming an exponential distribution of the non-negative random term u_i is expressed as:

$$Y_i = f(x_i, \beta)e^{(v_i - u_i)}, \; i=1,...,N \qquad (1)$$

where Y_i is the output of the i-th dairy firm; x_i is a $k \times 1$ vector of the input quantities of the i-th type of firm; β is a parameter vector. Moreover, v_i represents the random disturbance term that is assumed to be *i.i.d.* $N(0, \sigma_v^2)$. This random term (v_i) is incorporated into the model and is independent of u_i. The non-negative random term (u_i) represents technical inefficiency in production and is assumed to be *i.i.d.* and exponential distribution. The relationship between u_i and the output oriented technical efficiency (*TE*) is: $TE_i = \exp(-u_i)$.

Estimating the two type–specific production frontiers (cooperatives and IOFs) allows for measuring technical efficiency of the firm relative to the frontier for: (1) its own type and (2) the best practice frontier. Using this approach we can measure the inter-type catch up component. Measuring technical efficiency indicates that the best practice frontier can either be the same type of the firm or the other type. Measuring the technical efficiency of the firms relative to the other type's frontier (if it was the best practice frontier) indicates a potential improvement in the technical efficiency of any firm of a particular type when adapting the other type's technology. Using terminologies used by Oude Lansink *et al.* (2000, 2001), the first measurement is called intra- type efficiency (i.e. efficiency of the firm relative to its own type frontier), while the second is called inter-type efficiency (i.e. efficiency of the firm relative to the best practice frontier). To illustrate these concepts, take the case of an IOF (Figure 4.1):

The actual output produced by the IOF firm is Y_I, Y'_I refers to the maximum obtainable output from the frontier of the firm's type:

$$Y'_I = f_I(X_I) \qquad (2)$$

While Y''_I refers to the maximum obtainable output from the best practice frontier:

$$Y''_I = \max_{I,C}[f_I(X_I), f_c(X_I)] \qquad (3)$$

Figure 4.1 An Illustration of an IOF Produces (Y_I) Below Both Frontiers.
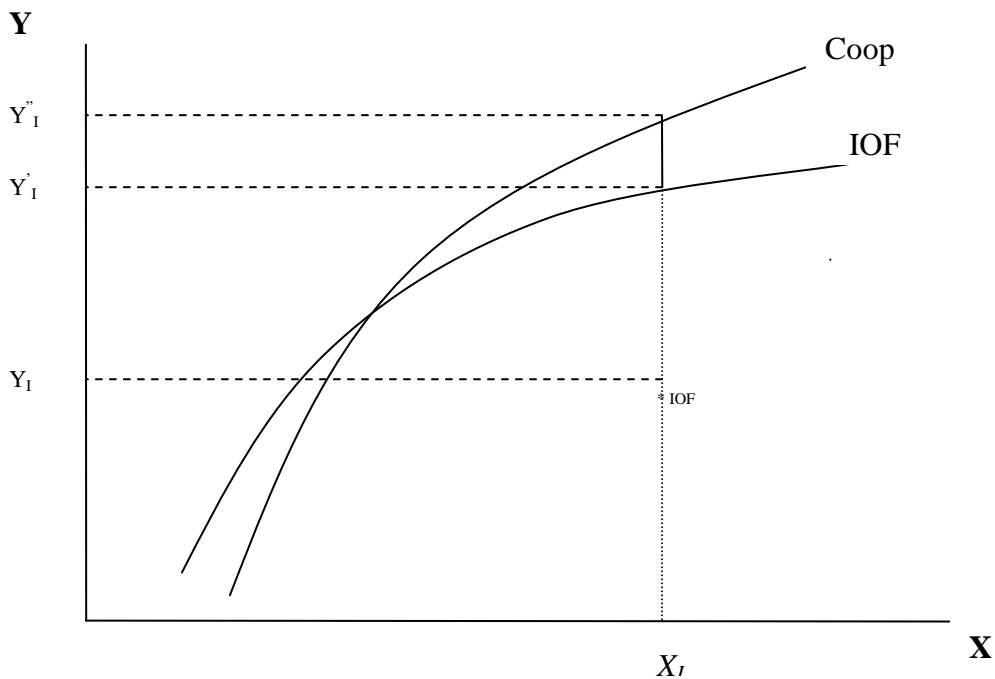
Y: output ; X: input

The intra-type efficiency (IA) is defined as:

$$IA = \frac{Y_I}{Y'_I}; \qquad 0 < IA \leq 1 \qquad (4)$$

The inter-type efficiency (IE) is defined as:

$$IE = \frac{Y_I}{Y''_I}; \qquad 0 < IE \leq 1 \qquad (5)$$

The catch-up (CU) component is the ratio of output obtained at the own type frontier and the output obtained at the best practice frontier:

$$CU = \frac{Y'_I}{Y''_I}; \qquad 0 < CU \leq 1 \qquad (6)$$

The relation between these measurements is :

$$IE = CU \times IA \Rightarrow IE = \frac{Y'_I}{Y''_I} \times \frac{Y_I}{Y'_I} \Rightarrow IE = \frac{Y_I}{Y''_I}$$
(7)

The critical point is when CU of any type (i.e. coop or IOF) is equal to 1. Firms, of certain type, with CU = 1 perform better with their own type technology than the other type's. While firms, of certain type, with CU<1 perform worse with their own type technology rather than the other type's technology and therefore have a potential for technological improvement.

Figure 4.2 illustrates the four possible situations: a cooperative above the IOF's frontier (Coop1), an IOF above the cooperative's frontier (IOF2), a cooperative below both frontiers (Coop2), and an IOF below both frontiers (IOF1).

Figure 4.2: Cooperatives and IOFs Represented by Two Frontiers.

------: *Cooperative; _____ : IOF ; Y: output ; X: input*
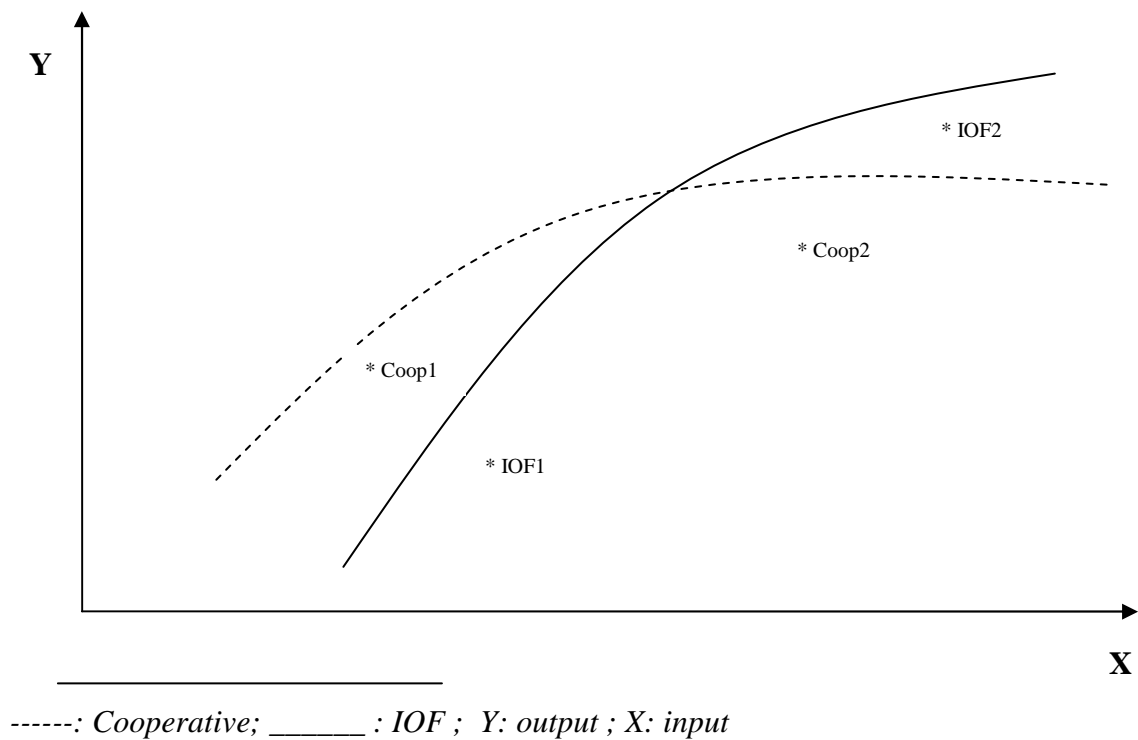
4.3 Data and Empirical Model

4.3.1 Data

Panel data on dairy processing firms from six European countries (Belgium, Denmark, France, Germany, Ireland and the Netherlands) were used in this study. These countries are considered to be the European states that produce the bulk of the EU cow's milk. The panel data cover the period 1995-2005 is obtained from AMADEUS. AMADEUS is a European financial data base prepared by Bureau van Dijk and contains more than 5 million private, cooperative and public companies. The data-base is collected from reports produced by the chamber of commerce of the different European countries. AMADEUS unified the figures of the financial statements of the different countries. Our sample consists of 1221 observations among which 861 are IOFs and 360 are cooperatives.

The model distinguishes one output (total turnover), three inputs (material cost, employment cost, and fixed assets) and a time trend variable (T). The outputs and inputs are expressed in Euros of 1996 (base year) by deflating the monetary values with their price indexes (provided by Eurostat).

The dairy plants in these countries are typically producing more than one product. However, the available data report total revenues and do not distinguish between revenues from different outputs. Output is measured as total operating revenue from selling all products produced by the processing company, deflated by the country-specific price index of consumer prices for milk, cheese and egg.

Fixed asset is measured as the value of physical land, buildings, machinery, and the non-physical fixed assets: such as the goodwill, patents, brands, and market shares. The value was deflated using the average value of the prices index of the agricultural gross fixed capital formation and the price index of the agricultural machinery and equipment per country.

The data base provides us with an input titled as "material cost". This input variable refers to the cost of purchasing the input materials before the processing operation starts. This input mainly consists of raw milk purchased by the dairy plant. We used the deflated EC-index of producer prices of the cows' milk per country as the deflator for the material cost. Labor cost is deflated using the nominal value of the labor cost index in total industries (excluding public administration).

Table 4.1 provides the mean, minimum and maximum values of turnover, fixed assets, raw material, and labor. It shows that cooperatives have, on average, a higher value of the output and three inputs than IOFs.

Table 4.1: Descriptive Statistics (Million Euros)

	Cooperatives (n=360)			Investor-owned firms (IOFs) (n=861)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Output	429.26	2.91	5513.82	96.45	2.58	1605.03
Fixed assets	108.30	0.03	2243.13	19.59	0.01	406.47
Raw Material	202.57	0.04	4604.08	7.25	0.03	222.31
Labor	24.85	0.01	742.61	1.12	0.01	24.09

4.3.2 Empirical Model

The type-specific frontier for each type of firms in the sample is assumed to follow a Translog specification:

$$\ln(Y_{it}) = \beta_0 + \sum_{i=1}^{3} \beta_i \ln(x_{it}) + 0.5\left(\sum_{i=1}^{3}\sum_{j=1}^{3} \beta_{ij} \ln(x_{it})\ln(x_{jt}) \right) + \gamma_1(T) + 0.5(\gamma_2 T^2) + 0.5\left(\sum_{i=1}^{3} \gamma_i T \ln(x_{it}) \right) + (v_{it} - u_{it})$$

Where x_{it} are input quantities at time t, with i = 1 (fixed assets), 2 (raw materials), and 3 (Labour). A time trend T is included in the empirical model to account for exogenous technological change in the estimation. The coefficients of the 3 inputs *(β_i, i =1,2,3)*, the quadratic part of the model (β_{ij}, *i and j =1,2,3)*, the time trend (γ_1), its quadratic term (γ_2), and the cross term of the time trend with the inputs (γ_i, *i =1,2,3)* are to be estimated.

4.4 Results

The log-likelihood-test which tests the null hypothesis of no difference in production technology between IOFs and cooperatives yields a value of 68[6]. This implies that the null hypothesis is rejected at 5%. In what follows, we will discuss the parameter estimates and the estimates of technical efficiency assuming two separate production frontiers for IOFs and cooperatives.

Table 4.2 provides the estimation results of the two production frontiers. The number of significant (at 5%) coefficients of the cooperatives' production frontier is six, whereas nine coefficients were significant at critical 5% level for the IOFs' production frontier. Only three parameters (single terms of material cost, labor, and the quadratic term of fixed assets) are significant for both frontiers. The parameter estimates of six terms have opposite signs for the two frontiers (such as: the time trend).

Table 4.2: Results of Estimation of the Type Specific Frontiers (p-values in brackets)

Variable	Cooperatives	Investor-Owned Firms (IOFs)
Constant	12.138 (0.000)	4.979 (0.000)
Ln(x1)	-0.560 (0.000)	-0.105 (0.403)
Ln(x2)	-0.536 (0.018)	-0.344 (0.049)
Ln(x3)	0.573 (0.004)	0.810 (0.000)
T	-0.007 (0.959)	0.382 (0.000)
Ln(x1) Ln(x2)	0.011 (0.550)	0.020 (0.164)
Ln(x1) Ln(x3)	-0.020 (0.162)	-0.036 (0.030)
Ln(x1) T	0.004 (0.621)	-0.024 (0.000)
Ln(x2) Ln(x3)	-0.052 (0.000)	0.004 (0.747)
Ln(x2) T	-0.001 (0.915)	0.015 (0.054)
Ln(x3) T	-0.009 (0.435)	-0.024 (0.001)
½ [Ln(x1) Ln(x1)]	0.124 (0.000)	0.124 (0.000)
½ [Ln(x2) Ln(x2)]	0.086 (0.000)	-0.002 (0.924)
½ [Ln(x3) Ln(x3)]	0.032 (0.248)	-0.028 (0.186)
½ T^2	-0.001 (0.970)	-0.010 (0.052)

x1= fixed assets; x2 = raw material; x3 = labour and T = time trend

Table 4.3 provides annual mean, maximum and minimum value of the three different efficiency measurements across countries and at for the entire sample, (intra-firm (IA), Catch-

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[6] The result of the log-Likelihood ratio test yields a value of (66) in testing the hypothesis of difference in the production technology of the IOFs with the cooperatives with comparable turnover size (i.e. excluding the cooperatives that are larger than the IOFs). This implies that the size of the turnover does not alter the difference between the production technology of IOFs and cooperatives.

Up (CU) and Inter-firm efficiency (IE)). Additionally, these measurements were presented by country to investigate any differences across countries.

Table 4.3: Efficiency Scores and Catch-Up Components

| | Cooperatives | | | Investor-owned firms (IOFs) | | | Difference |
	IA_C	IE_C	CU_C	IA_I	IE_I	CU_I	CU_C-CU_I
Belgium	0.81	0.81	1	0.78	0.65	0.8166	0.1834
Denmark	0.62	0.62	1	0.75	0.65	0.8593	0.1407
France	0.74	0.74	1	0.80	0.70	0.8580	0.1420
Germany	0.82	0.82	1	0.78	0.67	0.8547	0.1453
Ireland	0.83	0.83	1	0.81	0.58	0.6872	0.3128
Netherlands	0.78	0.78	1	0.72	0.62	0.8094	0.1906
Total (Mean)	0.76	0.76	1	0.79	0.68	0.8142	0.1858

The results in table 3 show that the average intra-firm efficiency score for cooperatives (IA_C) is lower than intra-firm efficiency score for IOFs (IA_I). This indicates that cooperatives are, on average, less efficient relative to their own technology than IOFs. The results across countries show that cooperatives in Denmark and France have a better intra-firm efficiency than IOFs. Therefore, cooperatives in these countries better succeed in exploiting their technology to its full potential than IOFs. It is important to indicate, that the efficiency measurements reflect, not only the efficiency of the physical transformation of inputs into outputs but also implicitly the success of marketing strategies so as to generate more value added and output quality differences between companies of the same type (cooperative or IOF).

Additionally, the results in Table 4.3 show that, on average, the catch-up component of cooperatives (CU_C) equals one whereas the catch-up component of IOFs (CU_I) is on average approximately equal to 0.8. The difference between the two catch-up components (CU_C and CU_I) is on average equal to 0.1858. This result indicates the superiority of the cooperatives' technology over the IOFs technology. The difference is attributable to a better technology of the physical transformation of inputs into outputs and to quality differences and differences in the success of marketing strategies between IOFs and cooperatives. However, the difference between the catch-up components (CU_C and CU_I) differs across countries. For

example, Denmark, has the lowest value of the difference in catch up components between IOFs and cooperatives (0.1407). This suggests that the superiority of the cooperatives' technology over that of the IOFs is less apparent in Denmark. Ireland has the highest value of the difference in catch-up component (0.3128), suggesting that the cooperatives' technology is the most superior to the IOFs' technology in this country.

The difference in catch-up component between IOFs and cooperatives across countries is explained by cross-country differences in the (i) characteristics of cooperatives/IOFs and (ii) market conditions for cooperatives/IOFs. An exception is the results in Denmark, which requires analyzing the characteristics of Danish firms, dairy market and the degree of production specialty of the Danish IOFs.

(i) The characteristics of the cooperatives differ across countries in terms of their financial structure (partially traded in the public market or not), market orientation and membership (targeting international markets or not). The differences in the financial structure of cooperatives refer to the level of control and ownership of members of the cooperative. For instance, cooperatives in Ireland can trade about half of their equity in the stock market, which implies more diversity in the sources of capital (Edward *et al.*, 2007). This, relative diversified source of capital for the Irish cooperatives[7], in addition to the characteristics of the Irish dairy sector, may explain the large difference in the catch up components of cooperatives and IOFs for Ireland. The differences in the market orientation of the cooperatives across countries refer to whether the cooperative is targeting international markets or not. Cooperatives in Denmark (which exports around 2/3 of the total milk production), the Netherlands, and Belgium are found to target international markets more than French and German cooperatives (Ebneth & Theuvsen, 2005). The Irish cooperatives are mainly exporting their production to the UK, which is encouraged by the geographical location and the strong UK pound relative to the Euro.

(ii) The local market conditions for cooperatives refer mainly to the cooperatives' market share which reflects the degree of competitiveness in the local market and the opportunity to exercise market power. As an example, one large cooperative in Denmark produces more than 90% of Danish milk production, whereas there are more than 10 other small cooperatives which handle around 6% of Danish milk production. This leaves the Danish IOFs to process less than 3% of the total Danish milk production (Danish dairy

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[7] Termed as public limited companies (PLC). The PLC is not obliged to take in more milk of members or new membership (Harte, 1997).

board[8]). The large proportion of the processed milk by cooperative (around 97% - the largest in Europe) reflects that the majority of the Danish farmers are cooperative oriented and that Danish IOFs must be highly specialized with loyal customers. The characteristics of the Danish market suggest that the countervailing power of cooperatives is working and that the dairy market is mainly exploited by cooperatives, which leaves no (or little) margin for any further cooperative exploitation. The situation of the dairy processing industry in Ireland, however, is largely fragmented and dominated by three relatively not so large cooperatives[9]. The Irish cooperatives have weak incentives to consolidate and they achieve efficiency by co-processing arrangement and milk-sharing arrangements rather than by expanding revenue areas. The Irish dairy sector is not fully exploited and has potential to improve cooperatives' share of the dairy processing sector (Edward *et al.*, 2007). In the Netherlands, there are two large cooperatives (presently merged into a single one), processing about 85% of the total milk production in the Netherlands, whereas three small cooperatives account for another 6% of total Dutch milk production (Productschap Zuivel). The German and French cooperatives account for less than 60% and 40% of the local dairy market, respectively (Productschap Zuivel)[10].

To further analyze the results, we compare the number and the characteristics of the firms with catch up component equal to one to those with catch up component lower than one in Table 4.4.

Only one cooperative (of the 360 cooperatives) has a catch up value less than one, whereas, only seven IOFs (of the 861 IOFs) have a catch-up value equal to one. These seven IOFs have, on average, a higher turnover, fixed assets and raw materials but lower use of labor than the other IOFs. Also, these seven IOFs have, on average a higher efficiency score (0.87) than the other IOFs (0.79). Whereas, the single cooperative (with $CU_C <1$) does not appear to have different characteristics (in terms of value of output and inputs) than the average characteristics of the other cooperatives (with $CU_C =1$). The intra-firm efficiency score of cooperatives (IA_C) of the only cooperative with $CU_C <1$ is equal to 0.86 and is higher than the average value of the intra-cooperatives efficiency score (0.76), of the other cooperatives (with $CU_C=1$).

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[8] These figures are estimated based on data available on (www.mejeri.dk).
[9] When compared to the large cooperatives in Denmark and the Netherlands.
[10] The cooperatives' market share per country is ordered from largest: DK, NL, Ire, B, D, Fr. (based on estimation based on data from (www.prodzuivel.nl)

Table 4.4: The Characteristics of the Firms with Different Values of the Catch-Up

Item (average)	Cooperatives		Investors Owned Firms	
Million Euros	$CU_C = 1$	$CU_C < 1$	$CU_I = 1$	$CU_I < 1$
Number of firms	359	1	7	854
Turnover	430.38	450.73	155.57	95.96
Fixed assets	108.43	100.09	9.75	19.67
Raw Material	203.13	187.79	29.97	7.07
Labor	24.92	30.36	0.93	1.12
Intra-Firm Efficiency	0.76	0.86	0.87	0.79

Almost 100 per cent of the cooperatives have a catch-up value of one, whereas around 99 per cent of the IOFs have a catch-up value less than one. These results show that the technology of relatively small IOFs (in terms of turnover) is dominated by the technology of the cooperatives. The IOFs with a catch-up term smaller than one have a relatively high value of both fixed assets and labor compared to the seven IOFs with a catch-up term equal to one. This relatively high value of fixed assets and labor of the small IOF may be due to their high costs in producing a limited quantity of specialized output from a relatively small quantity of raw materials. From these results, it may be suggested that small IOFs, in order to improve their technical efficiency and to prevent losses due to inadequate organization adapt strategies which either reduce the use of both fixed assets and labor or increase the level of output.

The differences in Intra-firm Efficiency (IA) confirm that IOFs have different internal incentives and are focused on other market segments than IOFs. The cooperatives first intention is to collect and processes the members' entire production while IOFs draw their incentives from collecting and processing the milk quantity that maximizes shareholder value. As a result, IOFs' are inclined to target different market segments than the cooperatives. The high value-added segment of the market requires high quality in production, packaging and marketing, while quantities will be much lower than in coops, which explains the relatively high value of fixed assets to total output of the small and less efficient IOFs. Second, targeting the value added segment of the market requires highly skilled and specialized labor and management, which explains the relatively high value of labor to total output of the small and the lower inter-firm (overall) efficiency of IOFs. The management team in the cooperative, however, is required to meet members' demands by processing their entire production while paying them (for providing the raw material) a long term competitive price.

Studying the differences of the output elasticities between the firms with CU equal to unity and those with CU less than unity provides additional information on the impact of increases in input on the quantity of output. Table 4.5 provides the average value of the output elasticities of cooperatives and IOFs and the p-value, testing whether the elasticity is statistically significantly different from zero. The output elasticities of the firms (of both types) with catch-up equal to one are different from the firms with catch-up less than unity.

Table 4.5: Output and Scale Elasticities (p-Values in Brackets)

Output elasticity of (p-value)[11]	Cooperatives		Investor-owned firms (IOFs)	
	$CU_C = 1$ N=359	$CU_C < 1$ n=1	$CU_I = 1$ n=7	$CU_I < 1$ n=854
Fixed assets	0.569 (0.000)	0.135	0.629	0.593(0.00)
Raw Material	-0.102 (0.001)	-0.114	0.056	0.034 (0.133)
Labor	0.071 (0.013)	0.100	-0.017	0.022(0.359)
Time	-0.037 (0.005)	-0.0459	-0.021	-0.012 (0.194)
Elasticity of scale	0.623 (0.020)	0.121	0.668	0.646 (0.028)

The results, presented in table 5, show that the output elasticity of fixed assets (which includes brand value) has the highest value (if compared with output elasticity in terms of the other inputs and time trend). Therefore, this input (fixed assets) is important for both IOFs and cooperatives. However, fixed assets is more important to IOFs (with $CU_I = 1$ and $CU_I < 1$) than cooperatives (with $CU_C = 1$ and $CU_C < 1$). The output elasticity of fixed assets is significantly different from zero for cooperatives with $CU_C = 1$ and the IOFs with $CU_I < 1$.

The output elasticity of raw materials is negative for cooperatives and is significantly different from zero at the critical 5% level for the cooperatives with catch-up component equal to one, while it is insignificant and positive for IOFs. This difference indicates that an increase in the quantity of raw materials (which is mainly raw milk) decreases output of cooperatives while it increases output of IOFs. The difference is explained by the cooperative's obligation to process the entire production of its members, adding to that the incentive given by the common agricultural policy (CAP) allowing dairy processing

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[11] We evaluated the p-value of the elasticities by directly interpreting the first order effects as elasticities, because the input variables were normalized by their geometric means prior to estimating the same frontier model. The hypothesis testing with respect to the elasticity of scale is simple since by definition it is a linear combination of parameters that have been estimated (by using Oaxaca's decomposition).

companies to produce low value added commodities for inventories (e.g. butter, milk powder). However, in order to explain the negative output elasticity of materials for cooperatives, more information on quality differences of materials and the composition of output is needed. This result may suggest that (i) the quality of raw milk provided to cooperatives is worse than the quality provided to IOFs (leading to a lower supply response), (ii) that the production technology of cooperatives is over-used due to their obligation to process all members milk, or (iii) the value of the raw materials is more costly to cooperatives than to IOFs.

The output elasticity of labor is positive and is higher for cooperatives than for IOFs. It has a negative value for IOFs with catch-up component equal to unity. Moreover, the output elasticity of labor is significantly different from zero only for cooperatives with catch-up component equal to unity. The high value of the output elasticity of cooperatives indicates that labor is more important to cooperatives than to IOFs in producing output. The importance of labor to cooperatives (when compared to IOFs) may suggest cooperatives aim to reduce all other operational cost (in order to pay the highest price for raw materials), which implies to have few but highly qualified labor. Additionally, the value of the output elasticity in terms of labor is negative for the seven IOFs with catch-up component that equals unity, this implies that as labor increases the output decreases for these IOFs.

Also, technical change of cooperatives and IOFs is negative, which indicates that, the technology of dairy processing firms on average gets worse over time, although not with equal speed for cooperatives and IOFs. The cooperatives' technology gets worse over time more quickly than the IOFs technology. Also, IOFs with a catch-up component less than unity($CU_I<1$) have the lowest technical regress, implying that these IOFs (although not highly efficient and using inferior technology) are relatively better off.

Finally, results in Table 4.5 show that firms of both types have production technologies that are characterized by decreasing returns to scale. The cooperatives' technology is facing a more pronounced degree of decreasing returns to scale than IOFs'. Furthermore, results show that IOFs with catch-up component equal to unity ($CU_I=1$) have the lowest degree of decreasing returns to scale. This finding implies that an increase in the size of operation has a more positive effect on IOFs rather than cooperatives, and may be a direct consequence of the larger size of cooperatives and their obligation to process all members' milk.

4.5 Conclusions

This study contributes to the literature in using two different frontiers to compare and measure the technical efficiency and production technology of dairy processing cooperatives and IOFs in six European countries. The methodological approach uses a different frontier for each type of firm, allowing for measuring technical efficiency of the firm with respect to both: its own type frontier (intra-type efficiency) and the frontier of the other type (inter-type efficiency), and the difference between the two frontiers (catch-up component). The cooperatives, on average have a lower intra-type efficiency than IOFs. However, the cooperatives, on average have a higher catch-up component and a higher inter-type efficiency than IOFs. The superiority of the cooperatives in their inter-type efficiency measurement reflects, in addition to the physical productivity, the marketing efficiency as a result of normalizing the outputs and inputs, of cooperatives and IOFs, with the same price indices.

The catch-up term differs across countries. This is explained by differences in cooperatives characteristics and market condition which imply differences in the internal incentives. In Ireland the superiority of the cooperatives' technology compared to IOFs is the highest which is explained by the fact that Irish cooperatives legal entity is that of a public limited company, by the fragmented nature of the Irish processing sector and by the proximity to the British market. Seven IOFs are the exceptional ones with catch up component equal to unity. They have a larger turnover and quantity of raw materials, and smaller fixed assets and labor than the other IOFs. Moreover, these seven IOFs are not only the most efficient if compared to their own technology, they also have the highest output elasticities in terms of fixed assets and raw material and the least decreasing returning to scale production technology. Other IOFs would benefit from reviewing the characteristics of these seven IOFs and improving their own technical efficiency with respect to the technology of the IOFs and the technology of the cooperatives. The cooperatives' superiority has a strong impact on the future dairy market structure, i.e. cooperatives may increase their market share in the near future at the cost of IOFs. In Denmark, cooperatives already account for 97 percent of the total milk production.

Future research would benefit from data on the composition of outputs in the dairy processing firms analyzed in this study. Having this information would allow for a better representation of heterogeneity attributable to output composition. At present, the currently available data do not allow for investigating this. Also, future research should focus on

analyzing the socio-economic and environmental factors that explain differences in inefficiency between dairy processing companies.

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Chapter 5

Efficiency of Cooperative and Investor-Owned Firms: Measuring and Comparing

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Abstract

Relevant performance measurements should consider the firm's objectives. Cooperatives objectives differ from investors owned firms. This requires different tools to measure their performance. Typically, the performance of cooperatives and investor-owned firms is compared using the same approach. We compare the performance of dairy cooperative and investor-owned firm in major European dairy producing countries implementing a traditional input oriented approach viewing both types of firms as cost minimisers, and an alternative approach using two hyperbolic models to consider the objectives of cooperatives. Cooperatives' performance differs across the two approaches from being out performed by investor-owned firms using the traditional approach to outperforming them when using an approach that is in line with the cooperatives' objective.

Keywords: *Input-oriented technical efficiency, overall efficiency hyperbolic efficiency, cooperative model, IOF model.*

5.1 Introduction

Dairy cooperatives in Europe have played an important role in the dairy processing sector. In major dairy producing-countries, such as Denmark, the Netherlands and Ireland, cooperatives process more than 85% of the total milk production (Van Bekkum, 1997). However, the performance of the cooperative and their ability to function efficiently in competitive and global markets in comparison to the investor-owned firms have been long debated in literature (see: Soboh *et al.*, 2009). The debate has been intensified due to major trends in the past few decades such as globalization, changes in related policies, international trade liberalization and treaties, and changes in consumers' preferences (Soboh *et al.*, 2009). Recently, due to the expected abolishment of the quota system in 2015 and the current financial crisis, the debates are intensified on the competitive strength of the cooperatives and IOFs, and cooperatives are argued to have more suitable and sustainable organizational structure than IOFs (Van Campen, 2009).

Cooperatives are not easily defined (Hind, 1999) and do not have a standard ownership structure like IOFs (Chaddad and Cook, 2004). However, there is a general consensus in the literature that cooperatives are generally seen as user-controlled, user-owned and user-benefit oriented firms (Soboh *et al.*, 2009). In the case of dairy cooperatives, this emphasis on members' control, ownership and benefit to members is reflected in the milk payment to members which includes, in addition to milk price, a proportion of the dividends (Zwanenberg *et al.*, 1993). The members' role and objective in their cooperatives is a major reason for debating the argument and empirical findings that cooperatives are technically and economically inefficient when compared to the IOFs. Those who advocate cooperatives model reject this argument and demand a different approach to evaluate the performance of the cooperatives empirically. For instance, Van Dijk and Klep (2005) argued that cooperatives have double objectives; one of which is to benefit members while the other is to healthily function in the competitive market. Additionally, the members' control on the cooperatives investment decisions, makes the cooperatives less willing to be involved in risky ventures and therefore more immune to cope with policy changes (Soboh *et al.*, in progress) or economical crises (Van Campen, 2009). It is argued, on one hand, that the cooperatives are more beneficial to farmers and the rural development than profit maximizing IOFs (Chavez, 2003). On the other hand, Hind (1999) argued that the control and ownership of members of the cooperative cause cooperatives to be less oriented to value added production, less efficient in input use (especially members' product) and more focused on

exploiting economies of scale. Hence, cooperatives are argued to be less technical, scale and cost efficient.

Theoretically, both arguments of those who advocate the cooperative form of firms and those who criticize it, are defendable but hardly disputed. However, empirically- as far as we know- there is no concrete evidence of any of the arguments neither for such comparison in general nor for the European dairy cooperatives in comparison to their IOFs counterpart in particular(see: Soboh *et al.*, 2009).

In this study, using Data Envelopment Analysis (DEA), we first analyze technical, scale and allocative efficiency of dairy processing firms using the traditional efficiency techniques. Second we use a hyperbolic approach to dairy cooperatives and IOFs with a special emphasis on the role of raw materials (mainly milk deliveries by the farmers) in two models. The first model, measures the hyperbolic technical efficiency of the firms, assuming they expand output and contract materials and other inputs simultaneously. The second model, measures the hyperbolic technical efficiency of the firms assuming they expand both output and materials and contract the other inputs. These two hyperbolic measurements provide us with alternative approaches to evaluate the technical efficiency taking into account the cooperative's general objective to serve the interests of its members as the major (if not the only) suppliers of materials. Subsequently, we use bootstrapping technique to allow for statistical inference.

This chapter uses Data Envelopment Analysis (DEA), outlined in Färe *et al.* (1994). This method was used by many authors to evaluate and to compare the performance of cooperatives to IOFs, such as Doucouliagos and Hone (2000); Singh, *et al.* (2001) and Boyle (2004). However, this study contributes to the literature by addressing the nature of the cooperative which aims to serve its members, which is done in two ways. First, this study provides the first empirical comparison of the technical, scale and allocative efficiency of European dairy cooperatives and IOFs. The results of large IOFs and cooperatives are presented in more detail. Second, this chapter presents an alternative approach to measuring technical and scale efficiency of cooperatives that explicitly, i.e. an approach that is in line with the different objectives of cooperatives versus IOFs.

The remainder of the chapter is presented as follows. The next section presents the DEA models. This is followed by a discussion of the data of the dairy processing firms. In section four we present the results of the DEA models. The conclusion is provided in the fifth section.

5.2 DEA Models for Modeling Efficiency of Firms

The performance of dairy cooperatives in comparison to IOFs has been studied by others using DEA. Doucouliagos and Hone (2000) used DEA to assess the technical efficiency of Australian dairy processing firms using data over the period 1969-1996. Their results show a modest technical progress and indicate some convergence in productivity levels across regions. They conclude that the Australian dairy sector is operating at a high level of technical efficiency. Singh, *et al.*(2001) applied DEA to compare the performance of the dairy cooperatives to the private sector in India. They concluded that cooperatives are more cost efficient than IOFs. Boyle (2004) investigated the economic efficiency of Irish dairy cooperatives over the period 1961-1987. He argued that cooperatives are not efficient for two reasons: (a) cooperatives suffer from technical inefficiency because of principal-agent problems and allocation inefficiency due to horizon problems; (b) cooperatives prices for raw milk are inefficient. Each of the above studies used the same approach on cooperatives and IOFs to measure and compare their performance.

In this study we use two different approaches to evaluate the performance of the cooperatives. The first is the traditional, measuring the overall efficiency of the firms and decomposing its input oriented technical, scale and allocative efficiency. The traditional approach views the firms as cost minimisers and ignores the different nature of cooperatives and IOFs. The second is the alternative approach, measuring technical efficiency of the firms, assuming that firms expand output(s) and materials and simultaneously contract other inputs with equal proportions.

5.2.1 Traditional Efficiency Approach and Models

In this approach we measure the input-oriented technical, scale and allocative efficiency. The models view the cooperatives and the IOFs as cost minimizing firms, in which all inputs (including the materials) are being contracted.

The input-oriented technical efficiency, in which inputs and materials are contracted while keeping output at fixed level, is expected to be higher for IOFs than for the cooperatives. For the IOFs, as owners are solely interested in profit, materials (mainly raw milk) are considered to be a regular input, while materials for the cooperatives are more complex and are not viewed as simply an input since the suppliers of raw milk are themselves the owners. The owners of the cooperatives, the suppliers of raw milk, aim to maximize their

return by obtaining a high payment for raw materials while at the same time- like other firms- want cost minimization for all other inputs and production factors. Therefore, the cooperatives are expected to have a lower value of the input-oriented technical efficiency.

The scale efficiency of the cooperatives is expected to be lower than that of the IOFs. The cooperatives are not totally free in choosing their scale of operations, by default they are obliged to process and market all members' production. IOFs on the other hand choose the optimal scale to process the quantity of material that maximizes their profit.

The average allocative efficiency of the cooperatives is expected to be lower than of the IOFs. cooperatives are not assumed to be profit maximizers or cost minimizers; instead, they aim to minimize a different objective function which aims to pay a higher milk price than the IOFs, in addition to minimizing all other costs. And since IOFs are profit maximizers, hence cost minimisers as well, they are expected to have a higher value of the allocative efficiency (equal to one), while cooperatives, as they are not cost minimisers for their raw material, are expected to have lower allocative efficiency than IOFs.

Before representing the linear programming needed to measure the traditional models, to measure the input-oriented technical efficiency and scale and allocative efficiencies, it is necessary to introduce some notations. Consider a firm that uses a vector of inputs (x) and a vector of raw material (m) to produce a vector of output (y).

The DEA input-oriented model to measure the technical efficiency of firms i, $i=1,...,N$, which produces one output using three inputs including the raw material is calculated form the following non-linear program:

$$\min_{\phi,\lambda} \phi_{vrs},$$
$$-y_i + Y\lambda \geq 0,$$
$$\phi m_i - M\lambda \geq 0,$$
$$\phi x_i - X\lambda \geq 0,$$
$$N1'\lambda = 1,$$
$$\lambda \geq 0,$$

$$(1)$$

Where ϕ_{vrs} is the overall technical efficiency score ($\phi \in [0,1]$) for the i th firm, Y is the *(1×N)* vector of observed output, M is the *(1×N)* of observed use of raw material, X is the matrix of

observed inputs and λ is a *(Nx1)* vector of intensity variables (firm weights). The constraint $N1'\lambda = 1$ (with $N1$ being an *Nx1* vector of ones) implies the sum of the lambdas equals one and allows for a variable return to scale (*VRS*) technology. Here, the overall technical efficiency measures the minimum proportional contraction in observed inputs (*x*) and raw material (*m*) subject to the constraints imposed by the observed inputs and the technology. This is illustrated in Figure 5.1 line (1).

To measure the scale efficiency for the two models above, we modify both models to exclude the constraint $N1'\lambda = 1$ [12]. This will produce ϕ_{crs} - input oriented technical efficiency assuming constant return to scale- which will be used to measure scale efficiency (SE), which equals $\dfrac{\phi_{crs}}{\phi_{vcrs}}$.

The cost efficiency is computed by solving the LP model (2):

$$\min_{\lambda, \dot{x}_i, \dot{m}_i} \quad w_x \dot{x}_i + w_m \dot{m}_i$$

$$s.t:$$
$$-y_i + Y\lambda \geq 0$$
$$\dot{x}_i - X\lambda \geq 0$$
$$\dot{m}_i - M\lambda \geq 0$$
$$N1'\lambda = 1$$
$$\lambda \geq 0$$

where $\dot{m}_i$ and $\dot{x}_i$ denote material cost and other inputs quantities, respectively, of the *i*th firm that minimize the cost given the input prices (w_x) and raw material prices (w_m). The overall efficiency is defined as the ratio of actual to minimum cost: OE (i) $= \dfrac{\dot{C}_i}{C_i}$, where C_i is the actual cost defined as ($w_x x_i + w_m m_i$) and $\dot{C}_i$ is the minimum cost which is obtained by solving model (2).

The overall efficiency OE_i of the dairy processing firm is calculated as following:

$$OE_i = TE_i \times SE_i \times AE_i \tag{3}$$

In which TE_i is input oriented technical efficiency assuming variable return to scale, SE_i is the scale efficiency and AE_i is the allocative efficiency of the firm (i).

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[12] We don't write down the models of the constant return to scale here to avoid repetition.

5.2.2 Alternative Efficiency Approach and Hyperbolic Models to Incorporate the Nature of the Cooperatives

In this alternative approach we consider two hyperbolic models. In the first model, we measure the hyperbolic technical efficiency considering the firm radially expands output and radially contracts inputs and materials simultaneously with equal proportions; this is presented in model 4 which is illustrated in Figure 5.1 with line (4). In the second model, we measure the hyperbolic technical efficiency considering an aspect of the cooperatives which aims, not only to expand the total turnover, but also materials, while contracting all other input simultaneously with equal proportions (see model 5). In the first model (model 4), we view each firm (of both types) as an IOF, while in the second model (model 5), we view each firm (of both types) as a cooperative. In the rest of this chapter, we will use the term "IOF model" when referring to model 4 and "cooperative model" when referring to model 5

Our expectation is that, on average, the cooperatives will score lower with the first hyperbolic technical efficiency model rather than with the second one. This is due to the nature of the cooperatives which is assumed to maximize the revenue of the milk delivered by its members (raw milk which makes up the major part of materials).

$$
\max_{\vartheta,\lambda} \left\{ \psi : (\psi y^i) \in P(\lambda^{-1}x^i; \lambda^{-1}m^i) \right\}
$$
$$
s.t :
$$
$$
-\psi y^i + Y\lambda \geq 0
$$
$$
\psi^{-1}m^i - M\lambda \geq 0
$$
$$
\psi^{-1}x^i - X\lambda \geq 0 \qquad\qquad (4)
$$
$$
N1'\lambda = 1
$$
$$
\lambda \geq 0
$$

The technical efficiency in which inputs (x) are contracted and both output (y) and raw material (m) are simultaneously expanded is measured in the cooperative model (5) and illustrated in Figure 5.1 with line (5). Technical efficiency is expected to be higher for cooperatives rather than for IOFs.

$$\max_{\vartheta,\lambda}\left\{\vartheta:(\vartheta y^{i};\vartheta m^{i})\in P(\lambda^{-1}x^{i})\right\}$$

$$s.t:$$

$$-\vartheta y^{i}+Y\lambda\geq 0$$

$$-\vartheta m^{i}+M\lambda\geq 0$$

$$\vartheta^{-1}x^{i}-X\lambda\geq 0 \qquad\qquad (5)$$

$$N1'\lambda=1$$

$$\lambda\geq 0$$

Figure 5.1 illustrates the three models (the traditional and the two alternative ones), that are applied to both types of firms. For simplification, we use two dimensions: output (*y*) and materials (*m*). Firm (*a*) can be either a cooperative or an IOF. Line (1) in Figure 5.1 illustrates the traditional situation where material is contracted while output is held fixed. Lines (4) and (5) illustrate the two hyperbolic models, where line (4) in Figure 5.1 presents the situation where materials is contracted while output is expanded, and line (5) in Figure 5.1 presents the situation where material and output are expanded. Given the assumed objective of cooperatives to pay a high price for inputs delivered by their members (materials), the cooperatives are expected to be located further to the right corner, while IOFs are expected to be located left upper corner in Figure 5.1.

Figure 5.1: The Direction of the Different Models.
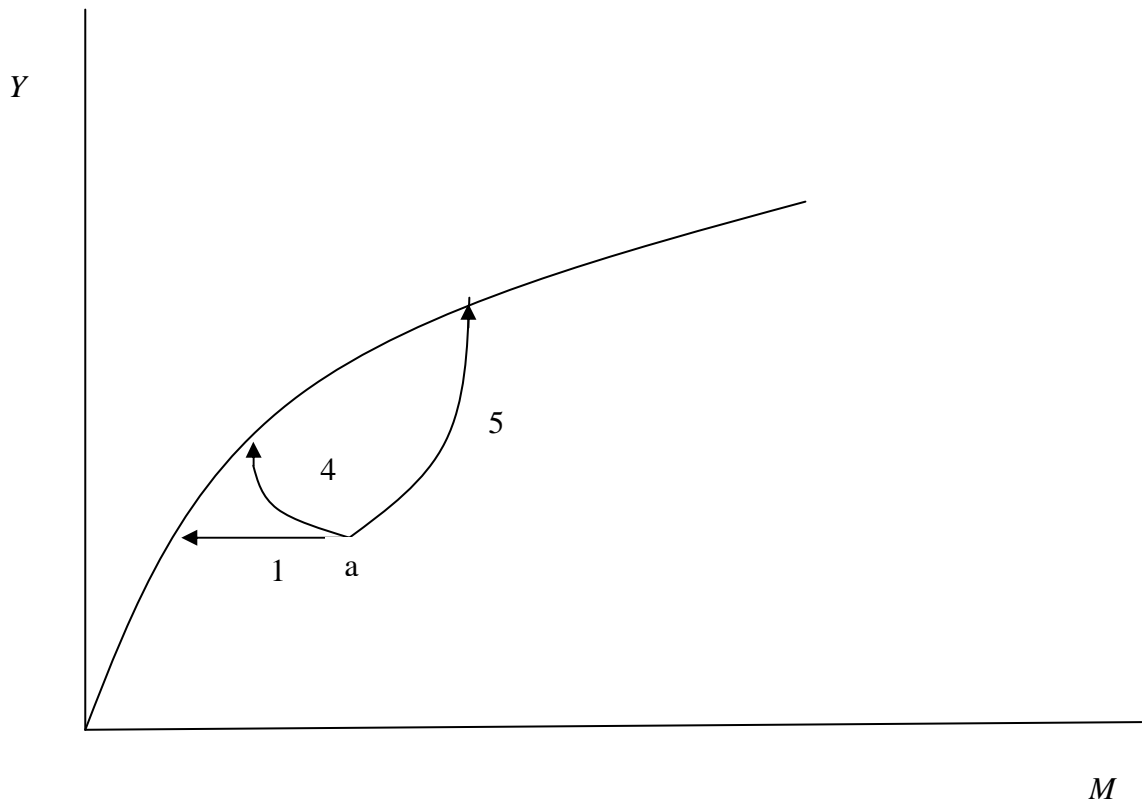
Y: total turnover, M: material cost

5.2.3 Bootstrapping Method

The bootstrap method is an established statistical resampling method used to perform inference in complex problems. If the data generating process (DGP) characterises the true data generation well and is mimicked in the resampling simulation, then the bootstrap method is well-performed in validating statistical inference. The bootstrap is mainly to approximate the sampling distribution of the estimator (in this study: input-oriented, hyperbolic and scale efficiencies). To approximate this sampling distribution we use the empirical distribution of the resampled estimate, which is obtained from the Monte Carlo resampling distribution of the estimation procedure (in this case the DEA). Repeated re-samples. which are obtained from an estimate of the DGP, are used in the estimation procedure to produce repeated estimates (Lothgren and Tambour, 1999).

In this study, we use the bootstrapping method suggested by Simar and Wilson (2007) to avoid sample biases of the technical and hyperbolic efficiency measurements, and we use the bootstrapping approach in Lothgren and Tambour (1999) to correct for data biases when

measuring scale efficiencies. We use *Hall-percentile* intervals based on differences to construct 95% confidence interval for input-oriented and hyperbolic technical efficiency and scale efficiency.

5.3 Data

Data on dairy processing firms in six European countries (Belgium, Denmark, France, Germany, Ireland and the Netherlands) covering the year 2004 come from AMADEUS[13]. The data set used for estimation consists of 133 firms among which 90 are IOFs and 43 are cooperatives.

The model distinguishes one output (total turnover) and three inputs (fixed assets, material cost and employment cost). The outputs and inputs are expressed in Euros of 1996 (base year) by deflating the monetary values with their Tornqvist price indexes (Coelli *et al.*, 2005).

The dairy plants in these countries are typically producing more than one product. However, the only relevant output available in the data set is the total turnover. This output represents the total operating revenue from selling all products produced by the processing company. Turnover (output) is deflated using the countries harmonized index of consumer prices for milk, cheese and egg.

Fixed asset is measured as the value of physical asset such as land, buildings and machinery, and the non-physical fixed assets such as the goodwill, patents, brands and market shares. The value was deflated using the average value of the prices index of the agricultural gross fixed capital formation and the price index of the agricultural machinery and equipment per country.

The AMADEUS data base includes material cost, reflecting the cost of purchasing the input materials before the processing operation starts. This input mainly consists of raw milk purchased by the dairy plant. We used the deflated EC-index of producer prices of the cows' milk per country as the deflator for the material cost. Labor cost is deflated using the nominal value of the labor cost index in total industries (excluding public administration).

The price indexes vary over the years and the different countries but not over the firms or over their type, implying differences in the composition of inputs and output or quality

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[13] AMADEUS is a European financial data base prepared by Bureau van Dijk and contains more than 5 million private, cooperative and public companies. The data-base is collected from reports produced by the chamber of commerce of the different European countries. AMADEUS unified the figures of the financial statements of the different countries.

differences are reflected in the quantity (Cox and Wohlgenant, 1986). Additionally, the quantities also reflect differences in prices of the production factors between the two types of firms; a higher the milk payment implies a higher quantity of materials.

Table 5.1 provides the means and standard deviations of turnover, fixed assets, raw material, labor and prices. It shows that cooperatives have, on average, a higher average value of the output and the three inputs than IOFs.

Table 5.1: Description of the Data

Variable	Dimension	Mean (n)		Standard deviation	
Type		IOFs (90)	Cooperatives(43)	IOFs	cooperatives
Quantities					
Output (turnover)	10^6 Euros	14.37	49.04	47.21	110.39
Fixed assets	10^6 Euros	2.40	9.67	5.80	27.36
Materials	10^6 Euros	9.64	34.64	4.97	94.92
Labor	10^6 Euros	0.28	1.05	0.66	1,52
Prices					
Output (turnover)	1996=100	91.83			
Fixed assets	1996=100	87.54		--	
Materials	1996=100	128.59		--	
Labor	1996=100	113.14		--	

5.4 Results

The results of the DEA models and the bootstrapping measures all were obtained using the package FEAR (Wilson, 2008). Section 4.1 presents the results of the traditional approach and Section 4.2 presents the alterative approach of the two hyperbolic models.

5.4.1 Results of the Traditional Approach

Results in Table 5.2 show that IOFs, on average, are more technically, scale and allocative efficient than cooperatives, hence, more overall efficient. The cooperatives are technically less efficient when compared to IOFs, cooperatives are slightly less scale efficient than IOFs, and cooperatives are less allocatively efficient than IOFs. Using the traditional approach, in which firms are considered to minimize cost (and contract the quantity of materials), cooperatives are out-performed by IOFs in their technical, scale and allocative efficiencies. Treating the material as an input, which has to be minimized, provides us with an expected lower performance of the cooperatives. On average, the input oriented technical efficiency of

the IOFs is more than 50 percent higher than the one of the cooperatives. The results of the technical efficiency also reflect differences in for example prices paid for raw materials between cooperatives and the IOFs, where cooperatives is expected to pay higher total price. On average, the scale efficiency of the IOFs, using the traditional approach, is 10 percent higher than the one of the cooperatives. This difference in scale efficiency suggests that cooperatives are operating on a less optimal size than IOFs. This finding may be due to the fact that cooperatives are more restricted in choosing their optimal size due to their obligation to process all what members provide to the cooperatives. On average, the allocative efficiency of the IOFs is 20 percent higher than the one of the cooperatives. This difference of the allocative efficiency suggests that the cooperatives are less successful in minimizing costs than IOFs (as assumed to be more of profit oriented firms). The latter finding suggests that cooperatives may have another objective rather than minimizing costs, cooperatives may be more interested in paying a high milk price to their farmers.

These results do confirm the hypothetical expectations of the cooperatives performance when compared to the IOFs. The difference of the technical and scale efficiencies between the cooperatives and IOFs are statistically significant as their confidence intervals do not overlap. Therefore, the overall performance of the cooperatives using the traditional model is lower than the IOFs over all efficiency.

Table 5.2: Overall Efficiency and its Decomposition for Cooperatives and IOFs (95% Confidence Interval in Parentheses)

	Technical efficiency	Scale efficiency	Allocative efficiency	Overall efficiency
Coops	0.428 (0.29-0.54)	0.769 (0.71-0.77)	0.416	0.137
IOFs	0.642 (0.52-0.71)	0.849 (0.79-0.85)	0.582	0.317

5.4.2 Results of the Alternative Approaches

Table 5.3 presents the results of the two hyperbolic efficiency models (i.e. the IOF model and the cooperative model). The IOF model expands outputs and contracts materials along with other inputs, whereas the cooperative model expands outputs and materials and contracts the use of other inputs.

Results of the IOF model in Table 5.3 show that cooperatives score, on average, 1.659 which says that cooperatives can increase their output with 65.9 percent and contract their

inputs (including materials) by $((1-\frac{1}{1.659})*100 =)$ 39.7 percent in order to end up at the frontier IOFs and cooperatives have in common. The IOFs, on the other hand, scored on average 1.430 in the IOF model (model 4), which says that the IOFs can expand their output with 43 percent and contract their inputs with 30.1 percent in order to end up at the frontier IOFs and cooperatives have in common.

cooperatives score slightly higher in the cooperative model (model 5) than the IOF model with 1.638, which says that cooperatives can on average expand output and materials by 63,8 percent and decrease the use of inputs (excluding materials) by $((1-\frac{1}{1.638})*100 =)$ 39.0 percent efficient in contracting their input (excluding materials). The IOFs score worse in the cooperative model rather than in the IOF model with 1,647, which implies a potential for expansion of outputs and materials by 64,7 percent their and a 39.3 percent contraction of inputs (excluding materials). When moving from the IOF to the cooperative model, the scale efficiency has also improved for the cooperatives (from 1.21 to 1.10) while it has worsened marginally for the IOFs (from 1.09 to 1.10).

The results of the bootstrapping show that all differences in technical and scale between cooperatives and the IOFs are not significant at the critical 5% level in the IOF and cooperative models. In the IOF model, the hyperbolic technical and scale efficiencies of the cooperative (1.659) and (1,21) lie within the confidence interval of the hyperbolic technical and scale efficiencies of the IOFs [1,14-1,74] and [0,89- 1,97], respectively. The situation is similar for the hyperbolic technical and scale efficiencies of the IOFs (1,430) and (1,091) which are also located within the cooperatives confidence interval for both measurements [1,21-1,92] and [0,88-1,47], respectively. The bootstrapping results of the cooperative model (model 5) are similar to the results of the IOF model in terms of location within the confidence intervals. The hyperbolic technical and scale efficiencies of cooperatives (1.638) and (1,10) lie within the confidence interval of the hyperbolic technical and scale efficiencies of the IOFs [1,03-1,97] and [0,73- 1,43], respectively. The situation is similar for the hyperbolic technical and scale efficiencies of the IOFs (1,647) and (1,10) which are also located within the cooperatives confidence interval for both measurements [1,09-2,61] and [0,73-1,43], respectively.

Table 5.3: Hyperbolic Technical and Scale Efficiencies of Cooperatives and IOFs (95% Confidence Interval in Parentheses)

	IOF Model in (4): Contract Materials		Cooperative Model in (5): Expand Materials	
	Technical Efficiency	Scale Efficiency	Technical Efficiency	Scale Efficiency
Cooperatives	1.659 (1,21-1,92)	1,21 (0.88-1,47)	1.638 (1.09-2,61)	1,10 (0,73-1,43)
IOFs	1.430 (1,14-1,74)	1,091 (0,89-1,43)	1.647 (1,03-1,97)	1,10 (0.89-1,48)

Although the difference of the measures between the two is not significant at the critical 5% level, it shows that the performance of the cooperatives improved by 8 percent while the IOFs performance is worsened by 17 percent when moving from a model that contracts materials to a model that expands materials. This change of the performances between the two models, suggest that cooperatives are more oriented to increasing material costs (e.g. through a higher price), whereas IOFs are more focused on decreasing material costs. Additionally, the difference of the scale efficiency between the cooperatives and the IOFs reduced to zero in the second model, which implies that cooperatives are more scale efficient when materials and output are expanded rather than when the cooperatives expand only the output while contracting materials and other inputs.

5.4.3 Performance of the Largest Cooperatives and IOFs

In Appendix 5A, we present the results of the ten largest cooperatives and IOFs in terms of turnover. Arla and Friesland are the only two cooperatives which are technically efficient using the traditional and both alternative approaches. Campina and Glanbia are only technically efficient using the traditional model, while Nordmilch is technically efficient in both hyperbolic models (IOF and cooperative models).

Results in Appendix 5A show that the scale efficiency of the largest cooperatives is rather poor in both the traditional model and the IOF model, and improved significantly using the cooperative model. Nordmilch and Arla are the only two cooperatives that are scale efficient in the cooperative model. However, Friesland and Campina are the least scale efficient using the traditional model and the IOF model. The average improvement of the scale efficiency from the IOF to the cooperative model is 19 percent for the ten largest cooperatives and only three percent for the ten largest IOFs.

The allocative efficiency of the cooperatives is generally very low, which suggests that the objective of large cooperatives differs from the objective of large IOFs. Among the ten largest IOFs, there are five IOFs technically efficient using the traditional model. The number

of technically efficient IOFs drops dramatically (to two IOFs) when measured using the cooperative model; this drop in the number of efficient IOFs in the cooperative model is in line with the finding in section 3.2 which showed that IOFs perform worse in the cooperative model rather than in the traditional and IOF models. More details can be viewed from the Appendix.

5.5 Conclusions

The raison d'etre of cooperatives differs from the one of IOFs. Therefore in order to evaluate the efficiency of the cooperatives, a different approach should be considered namely an approach that takes into account the different objectives of the owners of the cooperative. Comparing the performance of cooperatives to the one of the IOFs using the same model imposes the same behavioral characteristic on either type of firm. cooperatives, as user-owned, user-controlled and user beneficiary firms, are more restricted to members' interest in processing their own production and receiving the highest overall payment for their product which serves as the material to the cooperative. Therefore, materials have a different role for cooperatives rather than for IOFs. The role of material in cooperatives influences the choice of the input bundle by the cooperative firm to produce output, restricts the choice of the optimal size and implies a deviation from cost minimizing behavior.

Our empirical findings show that, on average, the cooperatives under-perform the IOFs in their input-oriented technical, scale, allocative efficiencies. However, the performance of the cooperatives in comparison to the IOFs improved when considering the model that expands the use of materials and output. Additionally, the differences in the scale efficiencies between cooperatives and IOFs disappear. The improvement of technical efficiency and the disappearance of the difference in scale efficiency suggest that materials have different roles in cooperatives and IOFs due to different objectives of the two firm types.

To provide a relevant comparison of the performance of the cooperatives with the IOFs' analysts should incorporate the interest of the owners of the firm. The overall conclusion is that cooperatives and IOFs need different tools to evaluate their performances, comparing the performance of the cooperatives to IOFs is not suitable if the same approach is used assuming same objectives to both.

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Appendix 5A: The Results of the 10 Largest cooperatives and IOFs

Name	Traditional Models 1-3			IOF Model		Cooperative Model	
	TE	SE	AE	TE	SE	TE	SE
Coop							
Arla Foods A.M.B.A.	1.00	0.68	0.12	1.00	1.21	1.00	1.00
Koninklijke Friesland Foods N.V.[14]	1.00	0.39	0.14	1.00	1.60	1.00	1.06
Zuivel Coöperatie Campina U.A..	1.00	0.40	0.18	1.07	1.60	1.06	1.11
Nordmilch E.G.	0.87	0.51	0.12	1.00	1.41	1.00	1.00
Glanbia P.L.C.	1.00	0.61	0.55	1.55	1.33	1.59	1.18
Candia (CEDILAC)	0.44	0.45	0.75	1.48	1.53	2.04	1.20
Belgomilk	0.31	0.65	0.64	1.73	1.30	1.87	1.16
3A SA	0.58	0.55	0.62	1.27	1.39	1.49	1.17
Sodiaal International	0.44	0.70	0.48	1.49	1.22	1.50	1.12
Drentsoverijsselse Coöperatie Kaas BA.	0.24	0.68	0.51	1.91	1.29	1.88	1.13
IOF							
Cogesal Miko	1.00	0.64	0.54	1.00	1.25	1.00	1.24
Danone SA	0.39	0.27	0.74	1.00	1.93	1.59	1.33
SAS Entremont Alliance	1.00	0.46	0.49	1.00	1.47	1.25	1.41
Nestle Produits Laitiers Frais	1.00	0.69	0.61	1.00	1.21	1.00	1.31
S.A. Corman	0.84	0.51	0.30	1.08	1.42	1.99	1.31
Goldsteigkasereien Bayernwald GMBH	0.74	0.69	0.24	1.13	1.23	1.21	1.36
SA Ingredia	1.00	0.55	0.60	1.00	1.36	1.75	1.22
Glaces Thiriet	0.66	0.73	0.54	1.21	1.20	1.20	1.26
SAS Laiterie Du Val D'Ancenis	0.71	0.64	0.63	1.14	1.30	1.47	1.22
Molkerei-Laiterie Walhorn	1.00	0.81	0.77	1.00	1.11	1.02	1.17

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[14] It is owned 100 percent by the cooperative Friesland.

Chapter 6

General Discussion and Conclusions

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6.1 Introduction

The central topic of this study is to measure performance and to conduct a comparative analysis of the cooperatives and IOFs in the dairy industries of major European countries. This objective was approached by first highlighting the gap between the empirical and theoretical literature on cooperatives performance; second by providing empirical evidence of differences in the financial characteristics between cooperatives and IOFs; thirdly by comparing technologies and technical efficiencies of the cooperatives in comparison to the IOFs; and finally by proposing a performance measurement which takes into account the nature of the cooperative as a distinguished type of firm. Cooperative firms are distinguished in the relation to their member-owners who are not only the main users of their services or products, but they also control the firms' management and therefore are the main beneficiaries. Cooperatives are diverse in their ownership structure and financing mechanisms and do not have a standard form to be generalized to represent all different cooperatives (Chaddad and Cook, 2004). However diverse, cooperatives are still distinguished from the investor-owned firm in the role of members- users- within the cooperatives as owners, controllers and benefiters and therefore risk takers (Staatz, 1989). Therefore, in order to provide a relevant comparison of the performance cooperatives and IOFs, members' objectives should be taken into account.

Section two discusses the theoretical issues with regards to the differences with the investor-owned firms. The third section discusses the data and methodological issues, which is followed by the discussion of the empirical results and future research. Finally, the main conclusions of the study are presented.

6.2 Theoretical Issues

To compare the performance of dairy cooperatives with IOFs, it is crucial to understand the theoretical models of the cooperative and the IOF.

Cooperatives differ from IOFs both in their structure and orientation. Additionally, the cooperative firm is not easily defined nor does any standard form of cooperative firm exist. Cooperatives are very much heterogeneous in terms of origin, purpose and ownership structure, which makes it hard to provide a performance measurement that applies to all cooperatives. Defined differences will result in differences in the general objective of the cooperatives to be taken into account in performance measurement. However, there is general consensus that cooperatives are member-oriented in the sense that members control the cooperative and are responsible for the capitalization of the cooperative firm. Cooperative business is all about members 'who own, control and have the benefit from the cooperative as they are the main users. Cooperatives are to be seen as double layered enterprises (Van Dijk and Klep, 2005).

Economists and financial analysts who studied the performance of cooperatives assigned different objectives (see chapter 2 for details). Studies assuming a single objective of the cooperative view the cooperative either as a form of vertical integration, an independent form comparable to the IOFs or as a variant form of firms from the IOFs. Studies that assume multiple objectives view the cooperative as coalition of otherwise independent firms. The fact that cooperatives have a different objective than maximising return to shareholders should lead to the conclusion that cooperatives are non-profit organizations. Cooperatives are member oriented and seek profit and market growth in a comparable way to the profit seeking firms. Yet they do not strive for profit maximization as do IOFs. Cooperatives have a dual purpose: to maximize price in the long run for their members and to be successful as a firm. The fact that there are different suggested objective(s) for cooperatives, implies that there is debate on

whether the differences in the institution between the cooperative and the IOFs results in different patterns of the financial characteristics and therefore require different approaches and tools when measuring performance. Chapter 3 provides empirical evidence of the influence of the institutional differences on financial ratios; chapter 4 investigates whether cooperatives and IOFs have different production technologies and chapter 5 provides an alternative approach to measuring the performance of cooperatives in order to address the nature of cooperatives. I am aware that ideally we should include the views of the firm as a form of vertical integration or as a coalition of independent firms and also to explicitly consider multiple objectives. Unfortunately this is not realistic and a choice had to be made - also the quality of the available data and methodological issues limited our ability to consider these other views.

6.3 Data and Methodological Issues

In this section, I discuss the data and methodological issues, since in my view the available data at my disposal was very much determining the direction of the methodological approaches used in this study. This discussion tackles each issue encountered in this thesis by describing their consequences, presenting my way in addressing them and discussing potential improvements in terms of methodological approaches in case better data is available.

6.3.1 Data Issues

In this study, I used the AMADEUS database, which was the only source of data at my disposal, to measure and compare the financial performance of cooperatives and IOFs in Belgium, Denmark, France, Germany, Ireland and the Netherlands. The data issues of this study are: the standardization of the variables across observations and the details provided per

observation. This section discusses the standardization of AMADEUS, which is a European data base that combines accounting and financial information from the chambers of commerce of 30 European countries.

Standardizing the information from different European countries was crucial and provided us with the ability to draw conclusions about the performance of the different firms across countries. As any data standardization criteria, AMADEUS achieved uniformity and integration of the information and it allowed for managing the complexity of the different information and accounting systems (Jacucci *et al.*, 2003) across the six mentioned EU countries. Our choice of these six countries was mainly based on the importance of milk production in these countries but also on the availability of the data. Data from several countries, in particular eastern and southern European countries, have many missing values. AMADEUS imposed its standard measurements on heterogeneous measurements that are based on different accounting systems (mainly Anglophone and Francophone) across countries. Accounting data depend on specific national budgeting rules and practices, which cannot be harmonized internationally without providing inconsistent information. Imposing the standardized AMADEUS measures result in errors in measurement like what item to be included under terms such equity, profit, debt, etc. Also, imposing standardized measurements produces biased results, i.e. differences in results between countries may reflect differences in accounting systems. However, as we mainly aim to compare the performance of cooperatives with IOFs, knowing that within each country both types of firms are faced with the same accounting regulations, the issue of errors in the standardizing way of AMADEUS was not a major concern. Moreover, in order to deal with the lack of across-country uniformity, I included dummy variables to tackle any country specific conditions (Chapter 3).

AMADEUS defines the firm's type by taking the definition as it is stated by each country (or chamber of commerce). This leaves the researcher in confusion when not familiar with the

essence of the definitions of the cooperative firms across countries. The categorization of firms differs across countries, as AMADEUS does not solely distinguish two ownership categories (for instance cooperatives from IOFs), but several legal categories. A good example are the Limited liability company in the Netherlands: the BV and the NV. Both are usually an IOF in the Netherlands, while family businesses and stock listed companies are not distinguished. In this study, I made my own categorizations by combining the information of AMADEUS with the information I obtained by either checking all the existing websites of the firms or by contacting the firms directly. This combination of information establishes more confidence in the definition of the type of firm that was used in this study.

Next, I discuss the details provided per observation in AMADEUS. More details in terms of turnover, shareholders-funds, materials and labor would have enabled me to conduct further analysis (Chapters 3, 4 and 5) and to explain the efficiency results (Chapters 4- 5). More details on the turnover compositions, in terms of dairy and non dairy related activities, would have enabled me to analyze in terms of studying the performance according to the composition of turnover. The total turnover of the dairy sector is generated by different types of products (both dairy and non-dairy) with different values and market conditions. Firms producing a single product will produce at a larger scale and may reap the benefits of economies of scale. On the other hand, firms that diversify in several products may have cost savings (economies of scope) in case some inputs are used for multiple production processes. Thus, the performance of the firm (conducted in Chapters 4 and 5) should vary according to the compositions of turnover. Also, AMADEUS imports the classification of the sector of firms from its original source. For instance, firms can be defined as dairy firms although a large proportion (in few cases the largest proportion) of its turnover is from non-dairy production, for example from chocolates, sweets, and fruits drinks. By contacting firms and obtaining information from all the existing firms' websites about the major activities, in

combination with information from AMADEUS, we improved the AMADEUS sector classification[15] by removing few firms which have major non-dairy activities, such as Nestle in the Netherlands.

Having more quantitative details on the shareholders' groups and the type of their funds, materials compositions, and labor would have allowed me to conduct provide a more in-depth analysis of the firm classification (Chapter 3) a second stage regression to explain the efficiency results. Details on the shareholders group such as membership, age and origin of the shareholders, if available, would provide a better understanding of technical efficiency (Chapters 4 and 5) and the characteristics of the classified firms (Chapter 3). Additionally, having quantitative information on the shareholders and the type of their funds (allocative or non allocative) would have allowed for a comparison of the performance of the cooperatives from the perspective of shareholders with potentially conflicting interests (for instance members who own large farms versus members who own small farms, old versus young members, or members versus non-members shareholders). It is important to mention here that cooperatives rarely have shareholders in the same manner IOFs have. AMADEUS refers to the capital ownership of both types as shareholders fund. Apart from Ireland, cooperatives in the countries included in this study are mainly not stock listed (Van Bekkum, 1997), which suggests that non-member shareholders are not significant contributors in financing dairy cooperatives. Only in Ireland the capital of the cooperatives is proportionally stock listed. However, the characteristics of the shareholders fund is not the same for all cooperatives in other countries. For instance, (former) Friesland issued two types of shares for members, (former) Campina issues members' certificate, and ARLA has unallocated members shares. All the above differences were reported by AMADEUS as shareholders fund. However, information on the type of shareholders' funds, i.e. allocative or non-allocative would for sure

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[15] Only less than 1 percent of the total number of firms that are classified as dairy firm by AMADEUS raised the concern of large proportion (more than 50 percent) of non-dairy turnover composition and they were removed at early stage for the sack of consistency.

take this study a step ahead. In the same way, having more quantitative details on the composition of materials and labor is helpful in explaining the results in Chapters 3, 4 and 5. Although, raw milk is the major component of materials in the dairy processing industry which may justify my choice to address the raw milk by materials, it should be acknowledged that dairy production involves other materials particularly for producing high value added dairy products. Details on the type and quality of labor is also relevant in the measurement and comparison of performance. The contribution of skilled labor to performance most likely differs from the contribution of the unskilled one; the same goes for part-time versus full-time labor. Having information on the separate labor categories would have allowed a deeper analysis of the causes of differences in performance.

6.3.2 Methodological Issues

In this study, I had to make choices in terms of methods in implementing the objective of this study. These choices were based on the objective of the study and on the availability of data. In the following, I analyze my choices and provide an overview of the possible alternatives and modifications, baring in mind the objective of this study and the quality of the data.

The first methodological issue was about applying statistical approaches and econometrics in the study rather than using different financial ratios. This issue was related to two matters: a) how to describe the pattern of the cooperatives' financial characteristics as distinguished from IOFs (Chapter 3); b) and how to precisely measure and compare the performance of cooperatives and IOFs in several countries (Chapters 4 and 5). Although financial ratio analysis provides insights in the first matter, these insights are partial. Econometric techniques (e.g. logistic regression) allows for addressing the multivariate nature of the problem of analyzing differences in financial characteristics between IOFs and

cooperatives. Logistic regression is the optimal technique when the issue is to predict the type of firm based on different financial aspects (Van der Lans, 2009). There are some concerns, though, whether this is the ideal technique for giving a description of financial ratios that differentiate the cooperative from the IOF. In comparison with discriminant analysis, logistic regression is more robust and efficient in terms of data requirement as was explained in Chapter 2. Applying the technique to each country separately produces results reflecting more clearly the contribution of each aspect to separating IOFs from cooperatives per country. However, this approach produces weak and meaningless results because of the limited number of observations for some countries (e.g. the Netherlands) Instead, it produces low pseudo-R values which reflects failure in achieving stable and meaningful results (Dufty, 2007). This thesis used country dummies to control for country differences.

In Chapters 4 and 5 we use parametric (Stochastic Frontier Analysis - SFA) and non-parametric (Data Envelopment Analysis - DEA) efficiency techniques, respectively. In the case of DEA no restrictive assumptions about the functional form and distribution of efficiency have to be made. However, DEA confounds stochastic events and errors in the data with inefficiency. A main advantage of the SFA technique is the possibility it offers for a richer specification. It also allows for (among other things) a formal statistical testing of hypotheses and the construction of confidence intervals for the parameters. Whereas a statistical stochastic approach may seem most attractive, it also implies that the frontier has generated all data (see Schmidt, 1985) The choice of these techniques depends on tradeoffs related to the purpose of the study, type of data and technology characteristics. Differences exist between these techniques in terms of the magnitude of the efficiency scores and the level of scale efficiency. However, generally the efficiency ranking of units does not vary much (Hjalmarsson *et al.*,1996). In Chapter 4, we used separate stochastic frontiers for each firm type. The main purpose is to provide a comparison of the production technologies of these

two types, additionally to provide a measurement of the technical efficiency of each type with respect to its own frontier (intra type). The production frontiers significantly differ between the two types and it was also found that the cooperatives technology is superior to that of IOFs. Introducing a hyperbolic measurement (termed as cooperative model), which allows for expanding the materials (i.e. mainly raw milk provided by members in case of the cooperatives), shows that the relative performance of cooperatives to IOFs has improved compared to the traditional technical measurements and the model that contracts milk and other inputs (termed as IOF model). In Chapters 4 and 5 we use cross sectional type of data and conducted a static approach. An alternative would be to use the panel nature of the data and implementing dynamic efficiency approaches. Using panel data in our techniques has many advantages in terms of better inference of the model parameters, greater capacity to capture the complexity of firms behavior (Hsiao, 2003) and comparing trends over time (Yee and Niemeier, 1996). However, we missed the necessary data to use the panel data nature efficiently (see data section). Dynamic approaches (both parametric (such as in: Battese and Coelli, 1992 and Desli, Ray and Kumbhakar 2003[16]) and non-parametric (such as in: Nemoto and Goto, 1999)) require good quality panel data. Dynamic efficiency approaches are able to accommodate the long-term behavior of firms and the adjustment of their efficiency score across years. This ability of the dynamic approaches is accompanied by high complexity in modeling and the requirement of making strong assumptions related to future prices of inputs and outputs. The complexity in modeling, strong assumptions about future prices and the difficulty in obtaining high quality panel data make applying dynamic approaches less preferable in this study.

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[16] Although in several occasions the approaches of these two literatures are referred to as dynamical approaches they are time variant efficiency approaches.

6.4 Empirical Issues and Results

Two empirical issues are to be discussed here; the first is related to the gap between the empirical and theoretical literature which was highlighted in Chapter 2 and the second is related to the integration of the chapters. In Chapter 2, we found that the highest number of the empirical applications viewed the cooperatives as an independent firm and compare its performance from the perspective of shareholders. This finding indicates that for many empirical economists it is ambiguous whether differences in orientation between cooperatives and IOFs result in differences in financial performance or whether different approaches to measure and compare performances should be implemented. The results of this study provided empirical evidence of differences in financial ratios (Chapter 3) and alternative performance measurements (Chapters 4 and 5). This study contributed to narrowing the gap between the empirical and theoretical literatures by approaching the performance of cooperatives separately from IOFs to compare differences of technologies (Chapter 4) and by providing alternative measurements of technical performance to address the differences in objectives between cooperatives and IOFs (Chapter 5).

The second empirical issue is related to the integration of the chapters. Chapter 3 presents empirical evidence of differences in financial characteristics between cooperatives, which are members' oriented, and IOFs, which are investors' oriented. This empirical evidence is relevant for academics, all stakeholders of the dairy sector and policy makers. The cooperatives were found to be less profitable than IOFs, which can be a consequence of either less profitable products, having a higher cost or having higher operational efficiency. Material costs are higher for cooperatives than IOFs. The operational efficiency, however, is found to be higher for cooperatives since cooperatives have a higher ratio of turnover to fixed assets. These insights can be used for recognizing financial strengths and weaknesses of members'

oriented firms in fulfilling members' objectives and in facing policy changes and financial distress in comparison to investors' oriented firms. Chapter 4 investigates whether differences in technologies between cooperatives and IOFs exist. Furthermore, this chapter measures the technical efficiencies relative to the two technologies. The results showed that cooperatives have a more productive technology and when compared to their own technologies, they are slightly less efficient. Differences in production technology and technical efficiencies exist across the different countries reflecting characteristics of the local markets and characteristics of the firms. Although the operational scale of cooperatives is much larger than that of IOFs, both type of firms are characterized by decreasing returns to scale. The results of this chapter provided the insight that cooperatives differ in their production technologies. All these differences promote the need to introduce different approaches in measuring and comparing the efficiency of cooperatives to IOFs.

Acknowledging the fact that for cooperative materials are not just a factor of production, but more specifically the products of members (who are also owners), Chapter 5 introduces an alternative approach to comparing the technical efficiency. The results showed that if materials were treated as input to be contracted, the technical efficiency of cooperatives would be underestimated. The results of chapter 5 support the findings in chapter 3 that the cost of materials are higher for cooperatives than for IOFs.

The results of Chapter 4 showed higher average technical efficiencies of both types of firms than the results of Chapter 5. This is explained by the empirical evidence that non-parametric methods usually produce smaller values of technical efficiency than parametric ones (Hjalmarsson *et al.*,1996).

6.5 Main Conclusions

In the following, I provide the main conclusion of this study. These are related to the main results of each chapter and to the implications of the study as whole.

i)　　　There is a gap between what theoretically has been developed and what empirically has been implemented in terms of measuring and comparing the performance of agricultural cooperatives and IOF's. Among the reasons for this gap is the difficulty in finding and getting access to relevant data (Chapter 2).

ii)　　　In the existing literature, the members' objectives are ignored when the performance of cooperatives is measured or compared with the performance of IOFs (Chapter 2).

iii)　　　Cooperatives differ significantly from IOFs in terms of the pattern of key financial ratios. It may be assumed that this is due to the orientation of cooperatives towards members (Chapter 3).

iv)　　　Dairy cooperatives are more homogenous in terms of their financial ratios than dairy IOFs in the six EU countries analyzed (Chapter 3).

v)　　　Drawing conclusions about the technical performance of cooperatives *vis-à-vis* IOFs can be misleading if both types are compared to the same production frontier (Chapter 4).

vi)　　　The production technology of cooperatives is mostly superior to the production technology of IOFs (Chapter 4).

vii)   The technical efficiency of IOFs is decreasing if assessed using the cooperative model rather than the IOF model (Chapter 5).

viii)   The cost of materials is minimized by IOFs which is not necessarily the case for cooperatives. (Chapter 5).

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Summary

Cooperatives are member-user oriented firms and have different objectives than IOFs. However, when comparing and measuring their performance, the empirical literature usually treats cooperatives as if they were investor-owned firms. Performance measurement for cooperatives, where their orientation towards their members is incorporated, is missing. Additionally, for the European dairy sector, empirical evidence that the different orientation of the cooperatives results in different financial characteristics is lacking.

This thesis aims to measure and compare the performance of cooperatives to IOFs as two types of firms with two different orientations. This study provides an extensive literature review of the theoretical and empirical literature. Additionally, this study uses econometric techniques to provide empirical evidence of the financial characteristics of cooperatives that distinguish them from IOFs in the dairy sector and to measure and compare the performance of cooperatives in terms of technical and economical efficiencies in a way that addresses the objectives of cooperatives. The empirical applications of this study focus on dairy processing firms in Belgium, Denmark, France, Germany, Ireland and the Netherlands.

An extensive list of studies exists on measurement and comparison of the performance of cooperatives and IOFs. Chapter 2 proposes classifications of the theoretical and the empirical literature and highlights the gap between the two streams of literature. The classification of the theoretical literature integrates three views on cooperatives: a vertical integration of firms, independent enterprise and coalition of firms. Chapter 2 presents several formal models of the economical behavior of cooperatives; some assume single and others multiple objectives. The empirical literature is classified into two categories, studies based on economic theory and studies that use accounting techniques. Both of these categories failed to address the characteristic of the cooperatives as member oriented. Instead they predominantly viewed the cooperatives as if they were investor-owned firms.

Chapter 3 provides empirical evidence of the differences in financial characteristics of cooperatives and IOFs in the dairy industry of several European countries. It is assumed that the difference in orientation between cooperatives (as members oriented) and IOFs (as investor-owned) results in different financial characteristics. This chapter uses logistic regression to describe the differences in several indicators such as profitability, debt, operational efficiency, equity growth, size and country dummies (accounting for across country differences). These differences of the cooperatives' orientation produce differences in patterns of financial ratios as cooperatives are found to be less profitable, have higher material

costs, operate more efficiently, and have a stronger financial position in terms of total debt than IOFs. Differences across countries, however were not significant in distinguishing cooperatives from IOF. The indicators have a larger variance for cooperatives than IOFs, suggesting that cooperatives are more heterogeneous than IOFs in their financial indicators. As a conclusion, cooperatives differ in several financial ratios, especially in terms of their financial position. They are expected to be better equipped to face future challenges of the dairy sector.

As cooperatives differ from IOFs in their orientation, technical efficiency is analyzed in Chapter 4 using different production frontiers. The approach that is adopted allows for measuring technical efficiency of the firm with respect to its own type specific frontier (called intra-type efficiency) and for measuring the catch-up component which reflects the difference between the frontiers of cooperatives and IOFs. As results show, the difference between the production frontiers of cooperatives and IOFs is statistically significant. This implies that using a pooled frontier for measuring technical efficiency is misleading as cooperatives have a more productive technology, which also reflects a higher marketing efficiency than IOFs in the dairy processing industry. On the other hand, cooperatives are slightly less efficient than IOFs relative to their own frontier. Although the scale of operation is much higher for cooperatives than for IOFs, both types of firms are characterized by their decreasing returns to scale.

Chapter 5 measures and compares the overall efficiency of cooperatives and IOFs in the dairy processing industry. The overall efficiency is decomposed into allocative, technical and scale efficiencies assuming cost minimization behavior for all firms. Furthermore, two alternative hyperbolic efficiency measures were implemented. The first hyperbolic measurement (the IOF model) assumes that firms expand output and contract all inputs, while the second (the cooperative model) addresses the different objectives of cooperatives by assuming that firms expand output and materials and contract all other inputs. The results show that the technical efficiency of IOFs decreases when applying the cooperative model rather than the IOF model, whereas the technical efficiency of cooperatives remains the same. This chapter provides evidence that a relevant performance comparison between cooperatives and IOFs has to incorporate the relation of the owners to their firm.

The difference in orientation of the cooperatives results in differences in financial characteristics between cooperatives and IOFs. Measuring the performance of cooperatives (as members oriented firms) as if they were IOFs is misleading. Accounting for the members objectives is crucial in measuring the performance of cooperatives.

Samenvatting

In coöperatieve ondernemingen staan transacties met de leden centraal. Coöperaties hebben daarom andere doelstellingen dan aandeelhouder-georiënteerde ondernemingen (investor-owned firms of IOFs). Echter, de bestaande literatuur die de prestaties van coöperaties vergelijkt met die van IOFs behandelt coöperaties als zijnde IOFs. Tot nog toe ontbreekt het aan methoden van prestatiemeting van coöperaties die rekening houdt met het gegeven dat coöperaties de doelen van de leden nastreven. Tevens is er in de huidige literatuur over Europese zuivelverwerkende bedrijven geen empirische ondersteuning voor het mogelijke effect van de lidoriëntatie van coöperaties op de financiële ratios.

Het doel van deze thesis is het meten en vergelijken van de prestaties van coöperaties met die van IOFs, rekening houdend met de verschillen in oriëntatie tussen deze bedrijfstypen. Deze studie maakt allereerst een uitgebreid overzicht van de relevante theoretische en empirische literatuur. Tevens maakt deze studie gebruik van econometrische technieken om inzicht te verschaffen in verschillen in financiële variabelen tussen coöperaties en IOFs in de zuivelsector in de EU, en om de prestaties van coöperaties te meten en vergelijken met IOFs, op een wijze die rekening houdt met de verschillende doelen van coöperaties en IOFs. De empirische toepassingen van deze studie zijn gericht op zuivelverwerkende bedrijven in België, Denemarken, Duitsland, Frankrijk, Ierland en Nederland.

De literatuur omvat een groot aantal studies die de prestaties van coöperaties vergelijken met die van IOFs. Hoofdstuk 2 stelt enkele classificaties voor van theoretische en empirische studies en maakt duidelijk welke discrepanties er bestaan tussen deze twee stromingen. De theoretische literatuur hanteert drie verschillende visies op de coöperatie: een verticale integratie van bedrijven, een onafhankelijke onderneming en een coalitie van bedrijven. Hoofdstuk 2 behandelt verschillende modellen van het economisch gedrag van coöperaties; modellen die enkelvoudige en meervoudige doelstellingen veronderstellen. In de empirische literatuur worden twee categorieën onderscheiden: studies gebaseerd op micro-economische theorie en studies gebaseerd op accounting technieken. Geen van beide categorieën houdt rekening met de doelstellingen van de coöperatie, als een leden-georiënteerd bedrijf; in plaats daarvan wordt de coöperatie doorgaans beschouwd als een IOF. Hoofdstuk 3 onderzoekt met empirische technieken of er verschillen zijn in financiële variabelen tussen coöperaties en IOFs in de zuivelverwerkende industrie in verschillende Europese bedrijven. Er wordt verondersteld dat de oriëntatie van coöperaties leidt tot

verschillen in financiële variabelen. Dit hoofdstuk gebruikt logistische regressie om verschillen te zoeken tussen coöperaties en IOFs tussen landen en in indicatoren als winst, schuldposities, operationele efficiëntie, groei van eigen vermogen en bedrijfsgrootte. Zoals verwacht worden enkele verschillen gevonden. Coöperaties zijn minder winstgevend, hebben hogere materiaalkosten, opereren efficiënter en hebben minder schulden dan IOFs. Verschillen tussen landen, gecorrigeerd voor financiële ratios zijn niet significant. De variantie in de gebruikte indicatoren is groter voor coöperaties dan voor IOFs, wat suggereert dat coöperaties heterogener zijn dan IOFs in termen van hun financiële indicatoren. Concluderend: coöperaties verschillen van IOFs in enkele financiële ratios en vooral in hun financiële positie. Coöperaties zijn beter toegerust op de komende uitdagingen voor de zuivelsector.

Hoofdstuk 4 analyseert de technische efficiëntie van coöperaties en IOFs. Aangezien coöperaties een andere oriëntatie hebben dan IOFs, wordt verondersteld dat IOFs een andere productiefrontier hebben dan coöperaties. Met de gekozen benadering kan de technische efficiëntie worden bepaald t.o.v. de eigen frontier (intra-bedrijf efficiëntie). Ook kan het verschil tussen de frontiers van IOFs en coöperaties worden bepaald: de catch-up component. De resultaten laten zien dat het verschil tussen de frontiers van coöperaties en IOFs statistisch significant is. Dit impliceert dat het veronderstellen van een gezamenlijke frontier tot misleidende inzichten leidt: de productie technologie (inclusief vermarkting van producten) van coöperaties is productiever dan die van IOFs. Coöperaties zijn echter wel minder efficiënt ten opzicht van hun eigen frontier dan IOFs en maken dus minder goed gebruik van hun productiepotentieel. Beide bedrijfstypen worden gekarakteriseerd door afnemende schaalopbrengsten, alhoewel coöperaties een veel grotere omvang hebben dan IOFs.

Hoofdstuk 5 meet en vergelijkt de totale efficiëntie van coöperaties met die van IOFs in de zuivelverwerkende industrie. De totale efficiëntie bestaat uit allocatieve, technische en schaalefficiëntie en veronderstelt kostenminimaliserend gedrag voor de bedrijven. Daarnaast worden twee alternatieve hyperbolische efficiëntie-maatstaven ontwikkeld. De eerste hyperbolische maatstaf (het IOF model) veronderstelt dat bedrijven de output willen vergroten en de kosten van alle inputs willen verminderen. Het tweede model (het coöperatie model) komt tegemoet aan het doel van coöperaties door te veronderstellen dat zij output en de kosten van materialen (vooral melk) willen vergroten en tegelijkertijd de kosten van de overige inputs willen verminderen. De resultaten laten zien dat de technische efficiëntie van IOFs afneemt wanneer het coöperatie model wordt toegepast; de technische efficiëntie van coöperaties blijft daarentegen gelijk. Dit hoofdstuk laat zien dat het belangrijk is om de

doelstelling van het bedrijf zoals die voortvloeit uit de relatie met de eigenaar of transactiepartner, mee te nemen in de meting van de bedrijfsprestatie.

Het verschil in oriëntatie tussen coöperaties en IOFs leidt tot verschillen in financiële ratios. Het is van cruciaal belang om rekening te houden met de doelstellingen van de leden van de coöperaties bij het meten van haar prestaties. Het meten van de prestaties van een coöperatie alsof het een IOF betreft leidt tot misleidende inzichten.

List of publications

Peer-reviewed Scientific articles

Soboh, R.A.M.E.; Oude Lansink, A.G.J.M.; Giesen, G.W.J.; Dijk, G. van (2009). Performance Measurement of the Agricultural Marketing Cooperatives: The Gap between Theory and Practice. *Review of Agricultural Economics 31 (3). - p. 446 - 469.*

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Rafat A.M.E. Soboh was born on April, 26th , 1979 in Jerusalem, Palestine. He accomplished his high school in the scientific specialization in 1996. He did his bachelor at Science faculty of Birziet University, Ramallah, Palestine. He received his B.Sc. degree in Mathematics Applied to Economics in 2000. He worked at the Palestinian Bureau of Statistics in Ramallah and then he worked at the Applied Research Institute of Jerusalem in Bethlehem. He obtained a higher diploma from the Mediterranean Agronomic Institute of Chania (MAICh), Chania, Greece in 2002. In 2003 he conducted his master thesis titled as *"financial performance of some large cooperatives in Europe"* at Nyenrode university in Breukelen, the Netherlands. He obtained his M.Sc. degree in economics from MAICh in 2003. He Started his second M.Sc. degree in Econometrics at Amsterdam university (UvA) in 2003. He obtained a second M.Sc. diploma in 2006 by finalizing the thesis titled as *"the return to schooling of the Dutch education system"*. From June 2005 till June 2009 he was working on his PhD entitled as *"Econometrics Analysis of the performance of the cooperatives and IOFs in the European Dairy Industry"*. He followed his PhD education program at the Mansholt Graduate School of Wageningen University. He defends his PhD dissertation on December 14th, 2009 and he is working as researcher at LEI since September, 2009.

Completed Training and Supervision Plan of Rafat A.M.E. Soboh from Mansholt graduate School of Social Science

Description	Institute/Department	Year	Credits[*]
Courses:			
Techniques for Writing and Presenting a Scientific Paper	Mansholt Graduate School of Social Sciences (MG3S)	2007	1.2
Scientific Writing	Wageningen Graduate Schools (WGS)	2008	1.5
PhD Council at Mansholt Graduate School of Social Sciences (MG3S) – Academic Committee	MG3S	2006-2007	2
Course on Philosophy and Ethics of Food Science &Technology	VLAG	2008	1.5
Mansholt Introduction Course	MG3S	2005	1
Multidisciplinary Seminar: Mansholt PhD Day and Chains and Networks Conference doctoral symposium	Wageningen, the Netherlands	2006	1
Presentation at conferences and workshops			2
XI European Workshop on Efficiency and Productivity Analysis (EWEPA)	Pisa, Italy	2009	
XII the EAAE Congress, 2008-08-26/ 2008-08-29	*Gent, Belgium*	2008	
Fifth North American Productivity Workshop (NAPWV)	*New York, USA*	2008	
VII AIEA2 Congress on the role of cooperatives in the European Agri-food system	*Bologna, Italy*	2008	
Quantitative Research Methodology	MG3S	2005	4
Efficiency and Productivity Analysis Summer School Parametric and Non-Parametric Approaches	MG3S	2006	5.5
Multiple Criteria Analysis for Agricultural Decisions	MG3S	2005	4
Theory and Practice of Efficiency and Productivity Measurement: Dynamic Approaches	MG3S	2008	1.5
Agri-Food Industrial Organization	MG3S	2008	2
Two Advanced Econometrics courses: (I and II)	Amsterdam University (UvA)	2004	10
Micro- Econometrics	Amsterdam University (UvA)	2004	5
General Equilibrium Theory	Amsterdam University (UvA)	2004	5
PhD Discussion at Business Economics group	Business Economics, Wageningen university	2005-2009	4
Total			51.2

*One ECTS on average is equivalent to 28 hours of course work

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