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EFFICIENCY AND PRODUCTIVITY CHANGES OF THE ITALIAN AGRIFOOD COOPERATIVES: A MALMQUIST INDEX ANALYSIS

ANDREA BONFIGLIO

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Efficiency and Productivity Changes of the Italian Agrifood Cooperatives: a Malmquist Index Analysis

Andrea Bonfiglio[1]

Abstract

The objective of this paper is to analyse efficiency and productivity changes of a sample of Italian agrifood cooperatives in the period 2000-2002. Towards this aim, a three-stage analysis is carried out. Firstly, a Data Envelopment Analysis approach is used to estimate technical and pure efficiency scores. Secondly, DEA-based Malmquist indices are calculated to analyse inter-temporal productivity changes. Thirdly, a Tobit regression analysis is carried out to identify the reasons for the differences existing among the cooperatives in terms of technical efficiency. The main results are as follows. The overall efficiency of the agrifood cooperatives is not particularly high: the technical efficiency and the managerial efficiency are, on average, 35% and 63% of the "relative" optimal ones, respectively. In the period analysed, productivity improves by about 2% due to a positive technological change. The technical efficiency worsens because of deterioration of scale efficiency attenuated by an increase in managerial efficiency. Milk and zootechnic cooperatives show the highest average levels of technical and pure efficiency. Their productivity increased in the period considered, owing to improvements in both managerial and scale efficiency. Wine cooperatives present the lowest average levels of technical and pure efficiency. Moreover, their productivity decreased due to a worsening of managerial capabilities. Fruit and vegetables and oil cooperatives represent middle situations. Finally, technical efficiency seems to be affected positively by the scale, technology, structural elasticity and middle-long term balance whilst is negatively affected by financial exposure.

Keywords: agrifood cooperatives, efficiency, Data Envelopment Analysis, Malmquist index, Tobit regression analysis

J.E.L. Classification: C14, C24, O40, Q13

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[1] Department of Economics, Faculty of Economics "G. Fuà", Polytechnic University of the Marche, Piazzale Martelli, 8, 60121 Ancona. Tel.: +39 071 2207116, Fax.: +39 071 2207102, e-mail: bonfiglio@dea.unian.it. I am grateful to an anonymous referee for remarks and suggestions on a previous version of the paper.

Contents

1 Introduction

In Italy, according to data coming from 2001 Census of Industry and Services (ISTAT, 2001), the agrifood cooperatives are 5,322 and concentrate in the food and agricultural sectors[1] (Tab. 1). The rest of the cooperatives are distributed among fishery (15%) and forest sectors (6%). Within the food sector, the most numerous cooperatives are those producing milk and derivatives, beverages (especially wine) and oil. Relative to the overall number of firms, the cooperatives only represent 5% of total, showing a low level of diffusion. The cooperation appears to be more spread in forest, fishery and agriculture, with a percentage of about 9% of total firms operating in the corresponding sectors, while it is less spread in food sector as demonstrates a share of cooperatives which is only 3%. Within food sector, production segments in which the cooperative model is widespread are milk, beverages, fruit and vegetables.

The agrifood cooperation in Italy as well as in all the European Union has been living an important and delicate transition process. The cooperatives have to rediscuss about their role and objectives in front of significant changes involving the economic, social and judicial context in which they operate (van Bekkum and van Dijk, 1998).

Of the various ongoing changes, it is worth mentioning the following ones: (a) less protectionist policy which is more oriented to the market and pursues less quantitative objectives, such as environmental and animal protection, valorisation of high-quality and typical products, integrated rural development;

[1] It needs to remind that data coming from the 2001 Census of Industry and Services underestimate the number of the cooperatives since a part of the agricultural cooperatives (those specialised in farming) were censed by the 2000 agricultural Census (ISTAT, 2000) and do not appear therefore in the 2001 one. Although the two Censuses are not directly comparable, it is anyway possible, by integrating the results, to obtain an indicative estimate of the number of agrifood cooperatives existing in Italy in the period 2000/2001. Whence, there emerge that the overall agrifood cooperatives are around 7,000 units of which about 50% is represented by agricultural cooperatives. In 1996, the Italian agrifood cooperatives represented 28% of all the EU cooperatives (van Bekkum and van Dijk, 1998).

(b) expansion of international trade (also following to EU enlargement) and, in general, growing globalisation and competition, concerning not only commodity markets but also production factors, distribution, R&D and all the entrepreneurial activities subject to worldwide competition; (b) a new model of food consumption, asking for products which have to be more sane, safer, of quality and more linked to territory; (c) increasing diffusion of both informatics technologies, which facilitate the coordination of logistics and marketing, and biotechnologies which provide food with functional characteristics, satisfying, in this way, the more and more complex preferences of industry, distribution and consumers in terms of health, price and reliable quality; (e) internalisation, concentration and integration processes in several segments of the agrifood chain; (f) increasing requirements from farmers (which become more specialised and larger) towards the cooperatives in terms of marketing support and efficiency.

In front of these changes, the cooperatives are called to adapt to the new context. To do that, it is necessary that the cooperatives are sufficiently efficient, whether they intend to remain on the market and compete against agrifood industry even without public aids.

The aim of this paper is to attempt to analyse efficiency and productivity changes of the Italian agrifood cooperatives, focusing on those units which collect agricultural products from their associates to be processed and/or commercialised. Several types of Italian cooperatives, which operate in different sectors of the agrifood chain, are investigated. Towards this aim, a Data Envelopment Analysis (DEA) approach is used. In the literature, there are no many studies facing the question of efficiency about agrifood cooperatives and the existing ones tend to focus on a given activity or sector (see for example Singh *et al.*, 2001; Piesse *et al.*, 2005). Moreover, to the author's knowledge, there are no studies about efficiency expressly targeted to Italian agrifood cooperatives. For these reasons, this paper can be considered a useful contribution to research.

The paper is organised as follows. In the next section, a description of methodology employed is given. The third section is dedicated to illustrate the empirical results of the analysis. Finally, the last section summarises the findings obtained and provides some concluding notes.

Table 1 – The Italian agrifood cooperation, 2001

Sectors	Cooperatives			Employees			
	No.	%	% of total firms	No.	%	% of total employees	Employees / cooperatives (%)
Agriculture	**1,993**	**37.4**	**9.3**	**14,899**	**18.6**	**28.1**	**7.5**
Crops	195	3.7	2.9	2,080	2.6	12.2	10.7
Livestock	18	0.3	2.7	130	0.2	12.1	7.2
Services	1768	33.2	12.7	12,617	15.8	36.2	7.1
Hunting	**12**	**0.2**	**10.6**	**72**	**0.1**	**35.3**	**6.0**
Forest	**312**	**5.9**	**9.9**	**2,359**	**2.9**	**35.7**	**7.6**
Fishery	**811**	**15.2**	**9.7**	**19,659**	**24.6**	**50.1**	**24.2**
Food industry	**2,206**	**41.5**	**3.3**	**43,147**	**53.9**	**9.7**	**19.6**
Meat	153	2.9	4.2	15,959	19.9	27.6	104.3
Fish	23	0.4	5.5	371	0.5	5.6	16.1
Fruits and vegetables	216	4.1	11.2	6,824	8.5	22.5	31.6
Oil	361	6.8	8.2	986	1.2	6.1	2.7
Milk and cheese	832	15.6	21.2	9,163	11.4	16.7	11.0
Corn	32	0.6	1.6	822	1.0	6.7	25.7
Animals feeding	24	0.5	4.0	987	1.2	10.8	41.1
Other products	131	2.5	0.3	2,085	2.6	0.9	15.9
Beverages	434	8.2	14.4	5,950	7.4	15.7	13.7
Total	**5,322**	**100.0**	**5.3**	**80,064**	**100.0**	**14.7**	**15.0**

Source: author's elaboration from ISTAT (2001)

2 Methodology

In this research, a three-stage analysis is carried out. Firstly, a Data Envelopment Analysis approach is used to estimate technical and pure efficiency scores of the Italian agrifood cooperatives. Secondly, DEA-based Malmquist indices are calculated to analyse inter-temporal productivity changes. Thirdly, a Tobit regression analysis is carried out to identify the reasons for the differences existing among the cooperatives in terms of technical efficiency. In the next two sub-sections, given the abundant literature about this subject, only a brief description of DEA approach and the Malmquist productivity index will be given. The third sub-section describes the sample of data used, the input-output variables employed in the DEA model and the internal and environmental variables investigated in the regression analysis.

2.1 Data envelopment analysis

Data envelopment analysis (DEA) is a linear-programming methodology that, starting from data on inputs and outputs of a sample of decision-making units (DMU), allows constructing a piece-wise linear surface over the data points. This frontier surface is constructed by the solution of a sequence of linear programming problems, one for each DMU. The distance between the observed data point and the frontier measures the relative technical efficiency of each DMU.

The main advantages of this technique are that it considers multiple inputs and outputs and does not require parametric assumptions of traditional multivariate methods. However there are some recognised limitations that should be taken into account when DEA models are applied[2].

Within the DEA approach, several models have been developed since the pioneer work of Charnes *et al.* (1978). First of all, DEA can be either input-orientated or output-oriented. In the first case, the DEA method defines the frontier by searching for the maximum possible reduction in input usage, with output held constant. While, in the second case, the DEA method seeks the maximum proportional increase in output production, with input levels held fixed. The two measures give the same technical efficiency scores when constant returns to scale (CRS) technology is applied, but are different when variable returns to scale (VRS) are assumed. In this research, an output-orientation was applied since it is realistic to assume that cooperatives tend to maximise output given a set of inputs rather than minimising the use of inputs to reach the same level of output.

[2] The efficiency scores could be very sensitive to changes in the data end depend heavily on the number and type of inputs and outputs analysed. DEA is a good method to estimate the “relative” efficiency of a DMU (i.e. relative to the other DMUs) but it converges very slowly to “absolute" efficiency. In other words, it gives information about performances of a given DMU compared to the most efficient units but not compared to a "theoretical optimum". Finally, since a standard formulation of DEA requires a separate linear program for each DMU, large problems can be computationally intensive.

A brief methodological explanation follows. The efficiency score of the DMU p in the presence of multiple input and output factors is defined as the ratio between the weighted sum of outputs and the weighted sum of inputs, i.e.:

$$\delta = \frac{\sum_{k=1}^{z} v_k y_{kp}}{\sum_{j=1}^{m} u_j x_{jp}} \tag{1}$$

where z is the number of outputs; m is the number of inputs; v_k is the weight given to output k; u_j is the weight given to input j; y_{kp} is the amount of output k produced by DMU p; x_{jp} is the amount of input j used by DMU p.

While in input-oriented models the objective is to maximise the efficiency score, by reducing proportionally the amount of inputs used to obtain given levels of output, in output-oriented models the aim is to minimise the reciprocal of the efficiency score, $1/\delta$, (i.e. the ratio between the weighted sum of inputs and the weighted sum of outputs), by increasing proportionally the amount of outputs given the level of inputs.

Assuming that there are n DMUs, each using m inputs to produce z outputs, under the hypothesis of constant returns to scale, the reciprocal of relative efficiency score of a hypothetical DMU p is derived by solving the following model (denoted CCR being introduced by Charnes, Cooper and Rhodes, 1978):

$$\begin{aligned} &\min \frac{\sum_{j=1}^{m} u_j x_{ji}}{\sum_{k=1}^{z} v_k y_{ki}} \\ &s.t \quad \frac{\sum_{j=1}^{m} u_j x_{ji}}{\sum_{k=1}^{z} v_k y_{ki}} \geq 1 \qquad i = 1, \ldots, n \\ &\qquad v_k, u_j \geq 0 \qquad \forall k, j \end{aligned} \tag{2}$$

The fractional model (2) can be converted to a linear program by setting the denominator equal to a constant (generally the unity). The resulting model will be:

$$
\begin{aligned}
&\min \sum_{j=1}^{m} u_j x_{jp} \\
&s.t \quad \sum_{k=1}^{z} v_k y_{kp} = 1 \\
&\qquad \sum_{j=1}^{m} u_j x_{ji} - \sum_{k=1}^{z} v_k y_{ki} \geq 0 \quad i = 1,\ldots,n \\
&\qquad v_k, u_j \geq 0 \qquad \forall k, j
\end{aligned}
\tag{3}
$$

The model (3) should be run n times in order to measure the reciprocal of relative efficiency scores of all the DMUs. Every DMU choices input and output weights which minimise the reciprocal of its efficiency score. Note that the reciprocal of the efficiency score is constrained in order that it cannot be less than one. Generally, a DMU is efficient when the reciprocal of its score is 1 whereas it is inefficient when the reciprocal of its score is bigger than 1.

The model (3) is also known as the multiplier form, as it searches for the weights on the input and output variables which form the model's decision variables. However, the following dual form (derived from the "primal" using the standard primal-dual relationship of linear programming) is usually calculated:

$$
\begin{aligned}
&\max \theta \\
&s.t \quad \sum_{i=1}^{n} \lambda_i x_{ji} - x_{jp} \leq 0 \quad j = 1,\ldots,m \\
&\qquad \sum_{i=1}^{n} \lambda_i y_{ki} - \theta y_{kp} \geq 0 \quad k = 1,\ldots,z \\
&\qquad \lambda_i \geq 0 \qquad i = 1,\ldots,n
\end{aligned}
\tag{4}
$$

Where λ is sometimes known as the dual variable or dual multiplier. The variable θ is the factor by which DMU p's output should be increased to achieve efficiency. A value of one indicates that DMU p is efficient relative to the set of DMUs considered, while a value bigger than one expresses inefficiency. The ratio $1/\theta$ coincides with the efficiency score δ which varies between zero to one. The formulation of this model can be also interpreted as the attempt to search for a composite efficient DMU (obtained as linear combination of units in the set) which utilises no more inputs than the DMU p to obtain at least the same output levels. Every composite DMU identifies, by means of the vector $\boldsymbol{\lambda}$, the so-called peer group for the inefficient unit. The peer group is formed of those efficient units that define the facet of the frontier against which the inefficient unit is projected.

Note that at the optima, the primal and dual formulations provide the same objective value and the dual prices of each constraint of the primal give the values of the decision variables of the dual, and viceversa.

The measure of efficiency obtained from the solution of the model (4) can be decomposed in two components: "pure" technical efficiency and scale efficiency. This can be made by using the variable returns to scale (VRS) version of the model (4), denoted as BCC since it was introduced by Banker, Charnes and Cooper (1984).

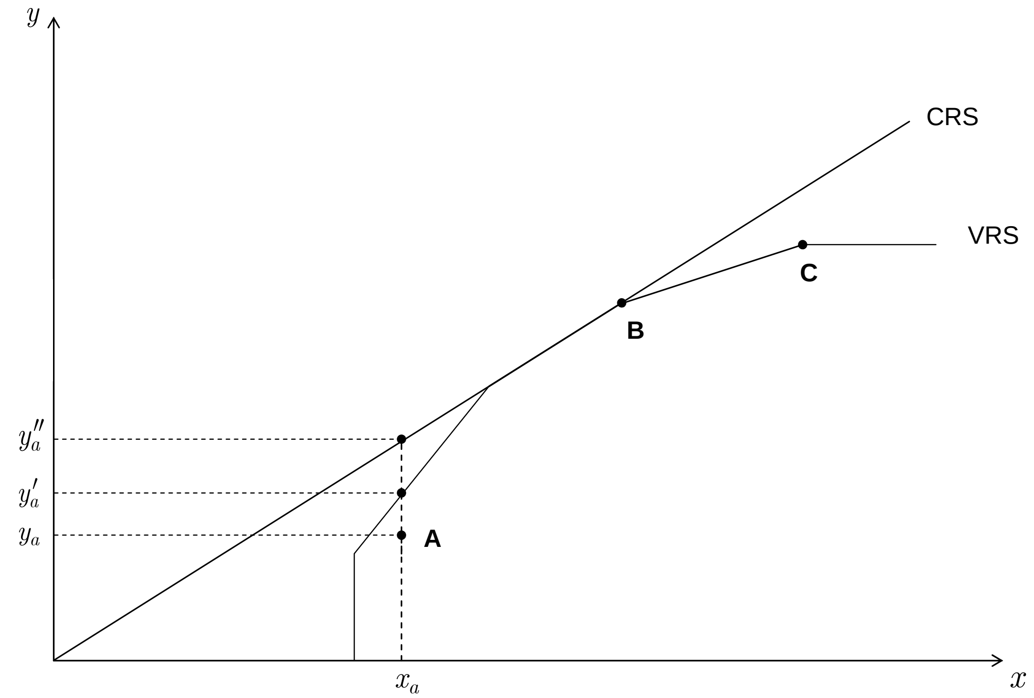
The BCC model is the model (4) along with the following additional convexity constraint:

$$\sum_{i=1}^{n} \lambda_i = 1 \tag{5}$$

Which allows capturing returns to scale characteristics. The model estimates the reciprocal of the pure technical efficiency. The pure technical efficiency also defined managerial efficiency, is the overall technical efficiency (estimated by CCR model) net of the scale efficiency, which expresses the capability of the DMU to exploit production possibilities fully. The scale efficiency does not depend on managerial abilities but it is affected by external factors such as credit constraints, market demand and so on. It can be obtained by calculating the ratio between overall technical efficiency and pure technical efficiency. Values of pure technical efficiency and scale efficiency below unity indicate inefficient units whereas unitary values indicate efficient units.

The idea can be illustrated by a graphical example (Fig. 1). Let consider a simple case with only one input to produce only one output. The CRS line represents the production frontier under the hypothesis of constant returns to scale, whereas the VRS curve represents the frontier assuming variable returns to scale. Point A corresponds to an inefficient production unit which uses a quantity of input x_a to produce output y_a. This production unit is not efficient since it operates under its production possibilities. Looking at the VRS frontier, the unit would be efficient if it was able to produce output y_a' (pure efficiency). Instead, under the CRS hypothesis, the unit would be efficient if it produced output y_a'' (overall efficiency). The ratio y_a / y_a'' quantifies the level of overall efficiency whereas the ratio y_a / y_a' is the level of pure efficiency. The extent of scale efficiency is y_a' / y_a'' which can be also obtained dividing the level of overall efficiency by the level of pure efficiency. Different from the production unit A, the point B identifies a production unit which is fully efficient whereas the point C is an example of a production unit which is "purely" efficient but is inefficient from the scale standpoint.

Fig. 1 – Graphical decomposition of technical efficiency into pure and scale efficiency



2.2 The Malmquist productivity index

The Malmquist index is defined using distance functions. Distance functions allow describing a multi-input, multi-output production technology without the need to specify a behavioural objective (such as cost minimisation or profit maximisation). It is possible to define both input distance functions and output distance functions. An input distance function measures the minimal proportional contraction of the input vector, given an output vector. An output distance function measures the maximal proportional expansion of the output vector, given an input vector. Here we only consider an output distance function.

A production technology may be defined using the output set, $P(\mathbf{x})$, which represents the set of all output vectors, $\mathbf{y}$, which can be produced using the input vector, $\mathbf{x}$. For sake of convenience, assuming only one input and one output, it can be written as:

$$P(x) = \{y : x \text{ can produce } y\} \tag{6}$$

The output distance function is defined on the output set, $P(x)$, as:

$$\mathrm{d_o}(x,y) = \min\left\{\delta : \left(y/\delta\right) \in P(x)\right\} \tag{7}$$

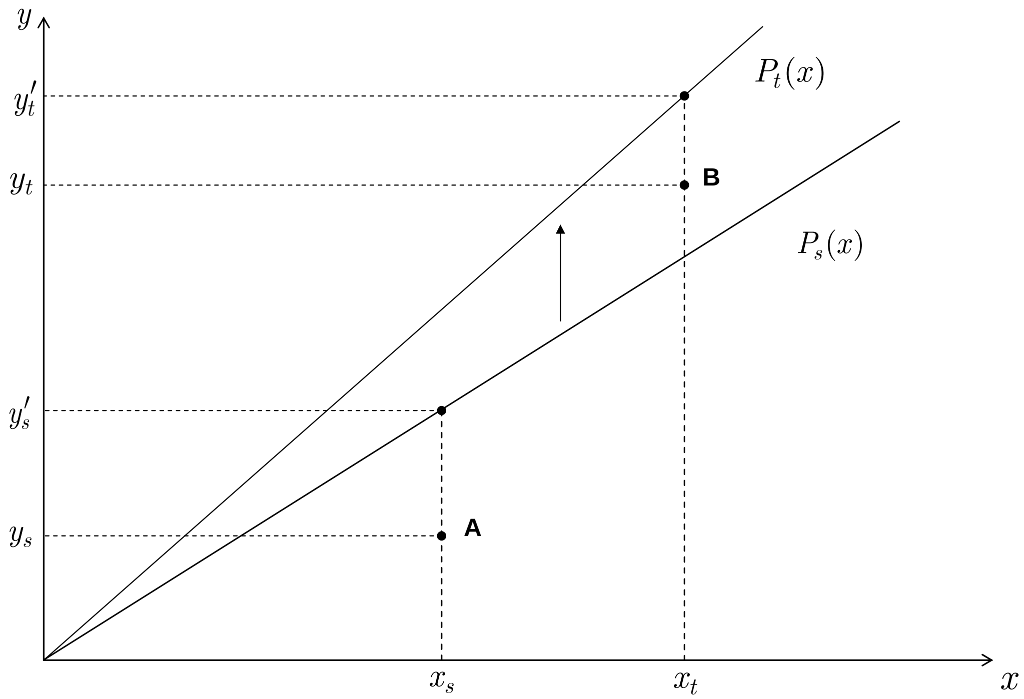
The distance function $\mathrm{d_o}(x,y)$ will take a value which is less than or equal to one if the output, y, is an element of the feasible production set, $P(x)$. In particular, the distance function will take a value of unity if y is located on the outer boundary of the feasible production, while it will assume a bigger value than one if y is located outside the feasible production set.

This concept can be shown graphically using a simplified case of one input and one output with CRS technology (Fig. 2). Points A and B represent the input-output combinations of a production unit in periods *s* and *t*, respectively. In both cases, the production unit is acting below the production possibility frontier. For example, in period *s*, using input x_s, the unit produces an output quantity of y_s but it should produce equal to y'_s if it operated with full technical efficiency. The technical efficiency is measured by $\delta_s = y_s / y'_s$.

Productivity change between the two data points can be measured by the part of output variation which is not due to input variation. This can be made calculating the ratio between output variation and variation along the production frontier in the base period $\left(y_t/y_s\right)/\left(y'_t/y'_s\right)$.

The ratio can be also rewritten as $\left(y_t/y'_t\right)/\left(y_s/y'_s\right)$ where the numerator indicates the distance function for output in period *t* with reference to the technology of period *s* whereas the denominator expresses the distance function for output in period *s* with reference to the technology of period *s* (representing technical efficiency in period *s*).

Fig. 2 – Graphical decomposition of the Malmquist Productivity Index



This is the Malmquist Productivity Index defined by Caves *et al.* (1982) with reference to the base period, i.e.:

$$\mathrm{m}_{\mathrm{o}}^{\mathrm{s}}\left(x_s, y_s, x_t, y_t\right) = \frac{d_o^s\left(x_t, y_t\right)}{d_o^s\left(x_s, y_s\right)} \tag{8}$$

However, it is possible to choose the technology in period t as the reference in defining a productivity index, that is:

$$\mathrm{m}_{\mathrm{o}}^{\mathrm{t}}\left(x_s, y_s, x_t, y_t\right) = \frac{d_o^t\left(x_t, y_t\right)}{d_o^t\left(x_s, y_s\right)} \tag{9}$$

To avoid the arbitrariness in choosing the benchmark, we follow Färe *et al.* (1994) specifying the Malmquist (output-oriented) index as the geometric mean of the two indexes abovementioned, i.e.:

$$\mathrm{m_o}\left(x_s,y_s,x_t,y_t\right)=\left[\frac{d_o^s\left(x_t,y_t\right)}{d_o^s\left(x_s,y_s\right)}\times\frac{d_o^t\left(x_t,y_t\right)}{d_o^t\left(x_s,y_s\right)}\right]^{1/2} \tag{10}$$

A value of $\mathrm{m_o}$ greater than one will indicate positive productivity growth from period s to period t whereas a value less than one will indicate a decline. An equivalent way of writing this productivity index is:

$$\mathrm{m_o}\left(x_s,y_s,x_t,y_t\right)=\frac{d_o^t\left(x_t,y_t\right)}{d_o^s\left(x_s,y_s\right)}\left[\frac{d_o^s\left(x_t,y_t\right)}{d_o^t\left(x_t,y_t\right)}\times\frac{d_o^s\left(x_s,y_s\right)}{d_o^t\left(x_s,y_s\right)}\right]^{1/2} \tag{11}$$

Where the ratio outside the square brackets measures the change in technical efficiency between periods s and t, whereas the geometric mean of the two ratios inside the square brackets captures the shift in technology between the two periods, evaluated at x_t and at x_s.

Following Färe *et al.* (1994) the required distance measures for the Malmquist (output-oriented) productivity index can be derived using DEA-like linear programs. For the *p-th* DMU, we have to calculate four distance functions to measure the productivity change between the two periods. This requires solving four linear programming problems[3]. Assuming CRS technology, the required LPs for a generic DMU p are:

$$\begin{aligned}
&\left[d_o^t\left(x_t^p,y_t^p\right)\right]^{-1}=\max\ \theta^p\\
&s.t.\quad \sum_{i=1}^{n}\lambda_t^{i,p}y_t^{k,i}-\theta^p y_t^{k,p}\geq 0\qquad k=1,\ldots,z\\
&\qquad\ x_t^{j,p}-\sum_{i=1}^{n}\lambda_t^{i,p}x_t^{j,i}\geq 0\qquad j=1,\ldots,m\\
&\qquad\ \lambda_t^{i,p}\geq 0\qquad i=1,\ldots,n
\end{aligned} \tag{12}$$

[3] The linear programming problems were codified and solved by an algorithm developed by the GAMS software.

$$
\begin{aligned}
&\left[d_o^s\left(x_s^p, y_s^p\right)\right]^{-1} = \max\ \theta^p \\
&s.t. \quad \sum_{i=1}^{n} \lambda_s^{i,p} y_s^{k,i} - \theta^p y_s^{k,p} \geq 0 \quad k = 1,\ldots,z \\
&\qquad x_s^{j,p} - \sum_{i=1}^{n} \lambda_s^{i,p} x_s^{j,i} \geq 0 \quad j = 1,\ldots,m \\
&\qquad \lambda_s^{i,p} \geq 0 \qquad i = 1,\ldots,n
\end{aligned}
\tag{13}
$$

$$
\begin{aligned}
&\left[d_o^t\left(x_s^p, y_s^p\right)\right]^{-1} = \max\ \theta^p \\
&s.t. \quad \sum_{i=1}^{n} \lambda_t^{i,p} y_t^{k,i} - \theta^p y_s^{k,p} \geq 0 \quad k = 1,\ldots,z \\
&\qquad x_s^{j,p} - \sum_{i=1}^{n} \lambda_t^{i,p} x_t^{j,i} \geq 0 \quad j = 1,\ldots,m \\
&\qquad \lambda_t^{i,p} \geq 0 \qquad i = 1,\ldots,n
\end{aligned}
\tag{14}
$$

$$
\begin{aligned}
&\left[d_o^s\left(x_t^p, y_t^p\right)\right]^{-1} = \max\ \theta^p \\
&s.t. \quad \sum_{i=1}^{n} \lambda_s^{i,p} y_s^{k,i} - \theta^p y_t^{k,p} \geq 0 \quad k = 1,\ldots,z \\
&\qquad x_t^{j,p} - \sum_{i=1}^{n} \lambda_s^{i,p} x_s^{j,i} \geq 0 \quad j = 1,\ldots,m \\
&\qquad \lambda_s^{i,p} \geq 0 \qquad i = 1,\ldots,n
\end{aligned}
\tag{15}
$$

The change in the technical efficiency can be further decomposed into two components: the change in pure efficiency and the change in scale efficiency. Toward this aim, it needs to calculate two further linear programming problems for deriving distance functions related to pure efficiency.

These are:

$$
\begin{aligned}
&\left[d_o^t\left(x_t^p, y_t^p\right)_{pure}\right]^{-1} = \max \theta^p \\
&s.t. \quad \sum_{i=1}^{n} \lambda_t^{i,p} y_t^{k,i} - \theta^p y_t^{k,p} \geq 0 \quad k = 1,\ldots,z \\
&\qquad x_t^{j,p} - \sum_{i=1}^{n} \lambda_t^{i,p} x_t^{j,i} \geq 0 \quad j = 1,\ldots,m \\
&\qquad \sum_{i=1}^{n} \lambda_t^{i,p} = 1 \\
&\qquad \lambda_t^{i,p} \geq 0 \qquad i = 1,\ldots,n
\end{aligned}
\tag{16}
$$

$$
\begin{aligned}
&\left[d_o^s\left(x_s^p, y_s^p\right)_{pure}\right]^{-1} = \max \theta^p \\
&s.t. \quad \sum_{i=1}^{n} \lambda_s^{i,p} y_s^{k,i} - \theta^p y_s^{k,p} \geq 0 \quad k = 1,\ldots,z \\
&\qquad x_s^{j,p} - \sum_{i=1}^{n} \lambda_s^{i,p} x_s^{j,i} \geq 0 \quad j = 1,\ldots,m \\
&\qquad \sum_{i=1}^{n} \lambda_s^{i,p} = 1 \\
&\qquad \lambda_s^{i,p} \geq 0 \qquad i = 1,\ldots,n
\end{aligned}
\tag{17}
$$

The change in the pure efficiency is therefore $\dfrac{d_o^t\left(x_t, y_t\right)_{pure}}{d_o^s\left(x_s, y_s\right)_{pure}}$ whereas the change in the scale efficiency can be derived as $\dfrac{d_o^t\left(x_t, y_t\right)}{d_o^s\left(x_s, y_s\right)} \cdot \dfrac{d_o^s\left(x_t, y_t\right)_{pure}}{d_o^t\left(x_s, y_s\right)_{pure}}$.

2.3 Description of the data

2.3.1 The sample used

The data used come from a database elaborated by C.R.M. (Centre for economic research and firm monitoring) and containing certificated balance sheets of 1.243 Italian agrifood cooperatives associated to the "Legacoop Agroalimentare" association. Balance sheets are available from 1999 to 2002. Since for the year 1999, information is not available for most cooperatives, we limited our analysis to the period 2000-2002. Of the cooperatives represented in the sample, after eliminating the spurious ones and those with unbalanced balance sheets, there was selected and analysed a constant sample of 276 units operating in the main agrifood sectors and collecting agricultural products from their associates to be processed and/or commercialised. The selected units represent about 22% of the complete sample and 4% of the Italian agrifood cooperatives.

Since it is advisable to concentrate on a homogenous group of farm, having comparable production techniques when calculating efficiency scores, the sample was further subdivided into 5 sub-samples according to the relevant sector: milk and derivatives, fruit and vegetables, wine, oil and zootechnics. Information about the sector in which cooperatives operate comes from the database used. The problem is that the sector classification aggregates both agricultural and food cooperatives which might have very different technology to each other.[4] This reduces the degree of homogeneity within the sectors and may affect the results significantly.

[4] For example, the zootechnic sector includes both livestock cooperatives and meat cooperatives, which notoriously use different technology.

2.3.2 Input and output variables

The choice of the variables in DEA is an empirical issue given the absence of a generally valid model to be followed. That which emerges from the literature is that including many variables is not advisable since as the number of variables used increases, more and more units become efficient, as well as neglecting some important variables brings about underestimation of efficiency.

In this research, we decided to use one output and three inputs. The output included is the value of total production, whereas the inputs considered are labour costs as a proxy of labour factor[5], depreciation plus interests as a proxy of capital factor and the value of intermediate consumption as a variable input factor.

Data are expressed in monetary terms. In order to eliminate inflation effects we deflated data, by the Consumer Price Index, translating them to 2000 base. In Tab. 2, some descriptive statistics about input and output variables are shown.

2.3.3 Internal and environmental variables

In order to identify the reasons for the differences existing among the cooperatives in terms of efficiency scores, a regression analysis is carried out. The estimated efficiency scores obtained applying DEA are taken as a dependent variable and regressed against some environmental and internal variables using a Tobit model which was chosen for its capability of handling the restricted range of Farrell's (1957) efficiency scores.

[5] Instead of labour costs, it would have been better to use the number of employees. However, this information is often missing in the database. Therefore we were forced to use labour costs as a proxy of labour factor.

Table 2 – Descriptive statistics of output and input variables of the Italian agrifood cooperatives' sample data for Data Envelopment Analysis (values in thousand Euro; 2000 prices)

Variables per sector	Mean	Median	Standard deviation	Min	Max
Milk and derivatives (83)					
Output					
Production	7,597	2,133	22,402	57.4	177,020
Inputs					
Capital	124	38	332	1.6	2,641
Labour costs	387	189	785	1.7	6,973
Intermediate consumption	6,677	1,693	20,946	2.8	175,104
Fruit and vegetables (51)					
Output					
Production	8,517	2,373	19,337	51.1	116,443
Inputs					
Capital	114	23	310	1.1	2,085
Labour costs	894	141	2,921	8.1	18,148
Intermediate consumption	6,540	1,739	13,492	17.0	85,447
Wine (55)					
Output					
Production	10,885	3,718	22,984	252.0	157,387
Inputs					
Capital	294	106	706	1.1	5,057
Labour costs	830	225	1,916	10.3	12,234
Intermediate consumption	8,176	2,717	16,458	36.1	115,590
Oil (33)					
Output					
Production	1,348	352	3,496	20.0	23,250
Inputs					
Capital	48	18	78	1.2	412
Labour costs	98	54	120	6.0	727
Intermediate consumption	1,059	180	3,149	1.6	21,563
Zootechnics (54)					
Output					
Production	11,673	990	39,470	29.0	257,009
Inputs					
Capital	146	32	404	1.0	2,535
Labour costs	898	168	2,884	5.6	22,070
Intermediate consumption	9,401	536	32,694	1.2	218,769
All cooperatives (276)					
Output					
Production	8,473	1,742	25,318	20.0	257,009
Inputs					
Capital	151	38	434	1.0	5,057
Labour costs	635	165	2,052	1.7	22,070
Intermediate consumption	6,812	1,298	20,869	1.2	218,769

Note: number of observations among parentheses

Source: author's elaboration from CRM data

The variables chosen are: the scale of the cooperatives, technology, the financial exposure, the degree of adaptability to changes, the long-term financial balance and the territorial component. It is evident that these variables do not represent an exhaustive list of all the possible factors, which can influence efficiency, but they have to be only considered as a starting point in this direction.

With reference to the **scale of the cooperatives**, there is little agreement how to measure the economic size. Lund and Price (1998) underline that there is no generally accepted measure in economics literature. Different measures have been used in various contexts (total assets, value added, output, sales, inputs, incomes). In this research, we decided to use total output as a proxy of the size. As for the relationship between size and efficiency, it is logical to expect that a large cooperative should be more efficient since it can accede more easily to finance and investments opportunities besides benefiting from economies of scale. However, as the size increases and the managerial operations become more complex, information asymmetries among the various contractual groups raise as well as opportunistic behaviour by managers is bound to increase, producing a negative impact on the level of efficiency. Studies which focus explicitly on the relationship between firm size and technical efficiency (see for example Gumbau-Albert and Maudos, 2002 and Alvarez and Crespi, 2003) found that the technical efficiency improves as the firm size increases.

The **financial exposure** has been measured as a percentage of total liabilities on total assets. In the cooperatives, debts generally represent the main source of financing, since the application of the democratic principle, about which one member is entitled to exert only one right, does not incentive to invest owners' equity. This originates the phenomenon of undercapitalisation. In any case, a certain dose of indebtness is beneficial whether it contributes to generate income, through investments (positive financial leverage). While excessive debts can produce too high financial costs which reduce the margin remaining after covering costs and remunerating the associates or, even, generate losses (negative financial leverage). This diminishes the possibilities of both self-financing and obtaining further debts, thus impeding to effect investments and technological improvements. In the literature, a few studies have attempted to test the relationship existing between financial exposure and efficiency. For example, Nasr *et al.* (1998) tried to estimate the efficiency of Illinois grain farms for the period 1988-1994 by a non-parametric approach. Then, they explained the variations in efficiency scores through a Tobit model. They did not find a significant relationship between the incidence of debt and efficiency scores. Davidova and Latruffe (2004) estimated DEA efficiency scores concerning a sample of 1999 livestock and crop Czech farms. Likewise, their results, coming from the application of a Tobit model, did not confirm the existence of a relationship between financial exposure and efficiency. On the contrary, Shankar *et al.* (2001), using the stochastic frontier approach in an application to a panel of dairy farms in England and Wales over the period 1984-1997, found that high levels of debt ratios are associated to low levels of efficiency.

Technology has been expressed in terms of ratio between capital factor and labour cost. It is expected that the most "technological" cooperatives (i.e. having higher capital intensity) also exhibit higher efficiency. Several studies have tested this relationship and, generally, conclusions are for a positive correlation (see for example, Mathijs and Vranken, 2000). However, Latruffe *et al.* (2004) found that more capital-intensive farms are less efficient and this was justified with the obsolete equipment used.

The **degree of adaptability to changes** has been approximated by the degree of elasticity of assets measured by a ratio between current assets and total assets. It is acknowledged that a high degree of elasticity, and thus a lower weight of long-term assets, indicates a better capability of a given structure to adapt to contextual changes, which, sometimes, lead to modifications of technical structure with consequent costs of conversion. Therefore, it is predicted that structural elasticity is positively related to efficiency.

The **long-term financial balance** has been measured by the ratio between long-term resources (equity plus long-term liabilities) and long-term operating assets (long-term investments). If the ratio is bigger than one, the long-term operating assets have been correctly financed by long-term debts. This is because the operating assets generate income only in a middle-long period, which will serve to return like-duration resources. Otherwise, if the ratio is less than one, a part of the resources has to be repaid in the short term, causing a liquidity problem. It is likely that an efficient cooperative also shows a balanced distribution between long-term resources and investments.

The **territorial component** has been analysed on two levels: macro and micro-economic levels. The former refers to the macro-area in which the cooperative operates and has been expressed as a dummy taking the unity value for the Centre-Northern cooperatives and zero for those localised in the Southern Italy. The latter is related to the level of economic development of the region in which the cooperative carries out its activity and has been approximated by the regional per capita GDP (at 2000 prices). The objective is to evaluate how the macro-regional component affects technical efficiency and, within a given macro-area, how characteristics and differences in terms of development among regions influence efficiency levels. It is expected that profound and historical, economic and socio-political disparities existing between the Centre-Northern Italy and the Southern Italy also reflect in higher efficiency of the cooperatives localised in the Centre-North.[6] Likewise, a higher economic development level should be associated to higher efficiency levels due to the presence, in the richest areas, of major and better infrastructure, more efficient administrative and judicial system, dynamic entrepreneurial climate, lower criminality, more developed public and private services and so forth. However, it is also true that in the less favoured areas, the cooperative often represents the only feasible entrepreneurial alternative to start an activity (thanks to funding and facilities allowed to this typology of firm rather than others) also for those efficient units that, in other circumstances, would have opted for other organisational forms. Conversely, in the richest areas, more organisational possibilities exist and the hypothesis can be that the most efficient firms tend to adopt other organisational forms rather

[6] However, an ISMEA's (2005) study has demonstrated that technical efficiency of Southern individual farms is higher than that of the Centre-Northern individual farms.

than the cooperative model. This would explain an eventual inverse relationship between regional economic development and cooperative efficiency.

Finally, the **sector** has been expressed by 4 dummies according to the sector in which the cooperative operates: milk and derivatives, fruit and vegetables, oil and zootechnics. The wine sector was used as a reference group.

Some descriptive statistics regarding the variables discussed so far are shown in Tab. 3.[7]

Table 3 – Descriptive statistics of internal and environmental variables of the Italian agrifood cooperatives' sample data for Tobit regression (N=276, 2000-2002)

Variables	Mean	Median	Standard deviation	Min	Max
Total output (Log)	14.461	14.370	1.581	9.903	19.365
Liabilities as % of total assets	0.727	0.779	0.207	0.103	1.071
Ratio capital / labour	0.381	0.239	0.548	0.004	8.631
Current assets as % of total assets	0.627	0.662	0.226	0.050	0.989
Ratio long-term resources / long-term assets	2.719	1.110	6.892	-1.786	130.545
GDP per capita (Log)	9.793	9.891	0.257	9.295	10.050

Source: author's elaboration from CRM data

[7] Looking at the minimum-maximum range and the ratio between standard deviation and mean, it emerges that the variable related to technology and, especially, the one related to long-term financial balance show marked data variability. This is due to the presence of some extreme outliers, identified by the technique of box plots with fences. In order to evaluate the impact of the outliers on the results, the regression analysis has been also conducted on a narrowed sample of cooperatives excluding the extreme outliers. Since results were found to be similar and considering the low number of observations available, it was decided to maintain the entire sample.

3 Empirical results

Results of the application of Data Envelopment Analysis are reported in Tab. 4. Under the CRS assumption, considering the whole sample of cooperatives, it turns out that the average technical efficiency is not particularly high, being only 35% of the "relative" optimal value. Most cooperatives are thus very far from the production frontier. This is also confirmed by the low percentage of cooperatives positioned on the frontier (little more than 2%).

Moreover, the average technical efficiency decreased in the period 2000-2002, passing from 0.397 in 2000 to 0.324 in 2002 This highlights a worsening of performances of cooperatives: with the same amount of inputs, the cooperatives tend to produce lower output.

Under the VRS assumption, the average pure efficiency, which expresses the only managerial capability of combining inputs to obtain outputs, is predictably higher than technical efficiency and amounts to 63% of the optimal one. The percentage of cooperatives on the frontier is contained (about 9%), though it is higher than that observed under the CRS assumption. In the period 2000-2002, the managerial efficiency increases passing from 0.541 to 0.674 whereas the percentage of cooperatives on the frontier remains stable.

However, the results could be affected by the extreme heterogeneity which characterises the whole sample of the cooperatives. For this reason and in order to obtain more details, the same analysis has been conducted on 5 sub-samples, each one corresponding to a given sub-sector.

Assuming constant returns-to-scale, results indicate that the milk cooperatives have on average the highest technical efficiency score (85% of the optimal value), followed by the zootechnic cooperatives, oil cooperatives, fruit and vegetables cooperatives and, finally, wine cooperatives whose efficiency score amounts to 44% of the optimal value.

Table 4 – Efficiency of the Italian agrifood cooperatives, 2000-2002

Sector	Constant returns-to-scale (technical efficiency)				Variable returns-to-scale (pure efficiency)			
	Average	Median	Standard Deviation	% units on the frontier	Average	Median	Standard Deviation	% units on the frontier
Milk and derivatives (83)								
2000	0.851	0.864	0.109	7.2	0.884	0.882	0.094	13.3
2001	0.828	0.812	0.072	9.6	0.880	0.859	0.070	12.0
2002	0.867	0.862	0.071	9.6	0.894	0.890	0.071	15.7
Average	0.849			8.8	0.886			13.7
Fruit and vegetables (51)								
2000	0.606	0.567	0.253	15.7	0.734	0.714	0.244	31.4
2001	0.834	0.835	0.144	21.6	0.901	0.928	0.110	33.3
2002	0.861	0.873	0.125	17.6	0.911	0.925	0.101	33.3
Average	0.767			18.3	0.848			32.7
Wine (55)								
2000	0.513	0.479	0.223	7.3	0.875	0.909	0.134	21.8
2001	0.394	0.360	0.199	5.5	0.807	0.818	0.154	20.0
2002	0.409	0.370	0.210	5.5	0.802	0.816	0.171	20.0
Average	0.439			6.1	0.828			20.6
Oil (33)								
2000	0.792	0.798	0.183	21.2	0.895	0.916	0.125	39.4
2001	0.800	0.826	0.171	18.2	0.863	0.934	0.183	39.4
2002	0.819	0.857	0.169	27.3	0.888	0.988	0.155	48.5
Average	0.804			22.2	0.882			42.4
Zootechnics (54)								
2000	0.785	0.788	0.171	25.9	0.875	0.883	0.131	38.9
2001	0.828	0.831	0.138	18.5	0.899	0.937	0.127	35.2
2002	0.837	0.824	0.127	20.4	0.904	0.936	0.112	38.9
Average	0.817			21.6	0.893			37.7
All cooperatives (276)								
2000	0.397	0.338	0.201	2.2	0.541	0.490	0.231	9.1
2001	0.323	0.272	0.186	2.5	0.684	0.717	0.217	9.1
2002	0.324	0.264	0.191	1.8	0.674	0.693	0.213	9.1
Average	0.348			2.2	0.633			9.1

Note: number of observations among parentheses

Source: author's elaboration from CRM data

The latter are also those exhibiting the lowest share of units positioned on the frontier (6.1%), whereas the oil cooperatives are those with the highest percentage (22.2%). In the period analysed, the average levels of technical efficiency improve for all the cooperatives with the exception of the wine cooperatives, whose technical efficiency decreases. The share of the best cooperatives increases for milk, fruit and vegetables and oil cooperatives whereas wine and zootechnic cooperatives see their percentage of units located on the frontier decrease.

Under the hypothesis of variable returns-to-scale, for all the types of cooperatives, both the average levels of pure efficiency and the percentage of the best cooperatives are higher than in terms of technical efficiency. The zootechnic and milk cooperatives are those with the highest pure efficiency (amounting to 89%), followed by oil, fruit and vegetables and wine cooperatives. In any case, the differences in terms of pure efficiency average scores among the cooperatives are by far less marked than in terms of technical efficiency. The oil cooperatives are those showing the highest percentage of cooperatives located on the frontier (42%), against the milk cooperatives, which exhibit the lowest share (14%). In the period analysed, managerial efficiency increases with reference to all the sectors except for the wine one about which the average value of pure efficiency decreases. The percentage of cooperatives positioned on the frontier remains stable only with regard to the zootechnic sector. In fact, it increases in all the other sectors excluding the wine sector in which it decreases.

To provide a more detailed picture of the changes in productivity occurred in the period analysed, Malmquist indices are estimated. Tab. 5 shows the Malmquist productivity indices and the decomposition into indices of technical efficiency change and technological change over the sample period. Moreover, the index of technical change is further decomposed into indices of pure efficiency change and indices of scale efficiency change.

Table 5 – Malmquist productivity index of the Italian agrifood cooperatives, 2000-2002

Sector	Technical efficiency change			Technology change	Productivity change
	Total	Pure efficiency	Scale efficiency		
Milk and derivatives (83)					
2000-01	1.004	1.013	0.988	1.049	1.037
2001-02	1.050	1.018	1.033	0.939	0.985
Geometric mean	1.027	1.015	1.010	0.992	1.011
Fruit and vegetables (51)					
2000-01	1.678	1.527	1.176	0.648	0.980
2001-02	1.042	1.015	1.026	0.979	1.018
Geometric mean	1.322	1.245	1.098	0.797	0.999
Wine (55)					
2000-01	0.770	0.938	0.839	1.247	0.960
2001-02	1.057	1.002	1.061	0.929	0.978
Geometric mean	0.902	0.970	0.944	1.077	0.969
Oil (33)					
2000-01	1.043	0.959	1.096	0.920	0.945
2001-02	1.055	1.070	0.993	1.036	1.088
Geometric mean	1.049	1.013	1.043	0.976	1.014
Zootechnics (54)					
2000-01	1.079	1.033	1.041	0.924	0.990
2001-02	1.026	1.020	1.006	1.027	1.047
Geometric mean	1.052	1.027	1.024	0.974	1.018
All cooperatives (276)					
2000-01	0.833	1.406	0.659	1.229	1.018
2001-02	1.035	1.010	1.036	0.989	1.016
Geometric mean	0.928	1.192	0.827	1.103	1.017

Note: number of observations among parentheses

Source: author's elaboration from CRM data

Different from the efficiency estimates, which are based on the frontier of a given year, the Malmquist indices and its components measure changes across two years. Values more than unity indicate improvements whereas values less than unity show deterioration. Considering the whole sample, it emerges that, on average, in the period 2000-02, the cooperatives experience an increase in productivity by 1.7%. This increase is attributable to a considerable technological change (+10%), which is compensated by the negative change in terms of technical efficiency (-7%). This latter is a result of deterioration undergone by scale efficiency attenuated by an increase in managerial efficiency (+19%).

Analysing the single sectors, it turns out that the productivity of milk, oil and zootechnic cooperatives improves. The biggest improvement involves the zootechnic sector, whose productivity increases by 1.8%, followed by oil sector (+1.4%) and milk sector (+1.1%). In these sectors, the positive variation is due to an increase in technical efficiency. This increase is related to improvement in both managerial and scale efficiency, attenuated by a worsening in technology.

The wine sector is instead the one in which the productivity decreases. The diminution is by 3% and is due to a negative change in technical efficiency (-10%), partly compensated by a positive technological change (+8%). With regard to fruit and vegetables cooperatives, productivity remains stable. This apparent stability is however due to compensative changes in technology (which worsens) and technical efficiency (which increases significantly).

In order to test the influence of various internal and environmental variables on the differences among the cooperatives in terms of technical efficiency, a Tobit model for censored data was adopted. The variables are regressed against the technical efficiency estimates calculated under CRS assumption. The sample includes all the 267 cooperatives in a pooled data set over the years 2000 to 2002. The results of the calculations are provided in Tab. 6.

The results show that all the variables considered are significant in explaining technical efficiency.

As expected, the size of the cooperatives is positively correlated to technical efficiency. The bigger cooperatives are also the most efficient ones since they have likely easier access to finance and investments opportunities, benefit from economies of scale and obtain more advantageous market conditions.

The incidence of debt to assets affects negatively technical efficiency. Cooperatives which recur excessively to debt to finance their own investments (strongly undercapitalised cooperatives), having to repay onerous debt interests, depress the margin which could be bound to self-financing and end to face serious difficulties in obtaining further resources. This enormously limits the possibility of making new investments and technological improvements.

The technology intensity produces a positive effect on technical efficiency. This implies that the most technological cooperatives are also those exhibiting higher levels of technical efficiency.

Table 6 – The determinants of agrifood cooperatives' efficiency (results of Tobit regression in efficiency scores under CRS assumption, N=276, 2000-02)

Variable	Coefficient	Standard deviation	T statistics	
Intercept	2.499	0.485	5.150	***
Total output (Log)	0.022	0.004	5.090	***
Liabilities as % of total assets	-0.152	0.031	-4.885	***
Ratio capital / labour	0.034	0.016	2.132	**
Current assets as % of total assets	0.216	0.033	6.516	***
Ratio Long-term resources / long-term assets	0.004	0.001	4.913	***
Centre-North (dummy)	0.091	0.026	3.458	***
GDP per capita (Log)	-0.258	0.052	-4.933	***
Milk and derivatives sector (dummy)	0.461	0.023	20.255	***
Fruit and vegetables sector (dummy)	0.352	0.017	21.329	***
Oil sector (dummy)	0.458	0.023	19.518	***
Zootechnic sector (dummy)	0.447	0.020	22.643	***
Sigma	0.155			
Log likelihood function	369.994			

*** Significant at 1%, ** Significant at 5%

Source: author's elaboration from CRM data

The elasticity of assets is positively and significantly correlated to technical efficiency, as the high and positive value of the coefficient shows. This would induce us to argue the cooperatives with more liquid assets are able to adapt more rapidly and with lower costs of conversions to changes (i.e. technological costs) occurring in the context in which they act. This is reflected in higher technical efficiency. Liquidity is also related to short-term financial balance. This means that the most liquid cooperatives and thus the most efficient ones are likely also those able to face short-term financial deadlines.

Technical efficiency is also affected positively by the long-term financial balance or rather by the capability of the cooperative to finance long-term investments by long-term resources (debt and equity). Thus, cooperatives, which are also balanced in the middle-long term, exhibit higher technical efficiency.

With reference to the territorial component, as expected, the cooperatives operating in the Centre-Northern Italy are more efficient than those localised in the Southern Italy. Therefore, factors related to macro-regional development demonstrate to play an important role in determining technical efficiency of the cooperatives. Moreover, the relationship between regional per capita GDP and technical efficiency suggests that, within a given macro-area (Centre-North or South), the most efficient cooperatives localise in the less developed areas probably because here the cooperative model is often the most feasible organisational solution, whereas, in the richest areas, the most efficient firms may choose different organisational forms.

4 Concluding remarks

This paper has analysed efficiency and productivity changes of a sample of 267 Italian agrifood cooperatives associated to "LegaCoop Agroalimentare" association in the period 2000-2002. Towards this aim, a DEA approach has been adopted to estimate technical and pure efficiency scores. To analyse inter-temporal productivity changes, DEA-based Mamlquist indices have been calculated. The Malmquist productivity index has been decomposed into technical efficiency and technological efficiency change indices. The technical efficiency change index has been further decomposed into pure and scale efficiency change indices.

From the empirical analysis, there would emerge several positive signals for the future of the cooperatives in general. Although, the cooperatives overall do not show a particularly high level of efficiency, productivity rose in the period analysed, thanks to increases in managerial efficiency and technological improvements. This might indicate that the cooperatives have been moving to face increasing competitiveness and continuous changes in consumption model, by refining managerial capabilities and by investing in technology.

However, the situation is not the same for all the cooperatives but it varies according to the sector in which they operate. The two extreme situations are represented by the wine cooperatives, on one hand, and the milk and zootechnic cooperatives, on the other hand. The wine cooperatives present the lowest average levels of technical and pure efficiency. Moreover, their productivity decreased due to a worsening of managerial capabilities. Although the cooperation in the wine sector is mostly acknowledged to be more solid and consolidated compared to other sectors, this result may highlight some difficulties of the sector in competing on the market effectively, which might undermine the future of a significant part of the wine cooperatives.

On the contrary, milk and zootechnic cooperatives are those giving more positive signals. They show the highest average levels of technical and pure efficiency and their productivity increased in the period considered, owing to improvements in both managerial and scale efficiency. Fruit and vegetables and oil cooperatives represent middle situations.

With reference to the factors affecting technical efficiency, from the analysis, it turns out that the most efficient cooperatives localise in the Centre-Northern Italy. They have bigger size and are more capitalised (less indebted). Moreover, they invest in technology, are able to adapt to exogenous changes more rapidly and, finally, present a balanced situation from a financial standpoint.

However, all these considerations should be taken with caution, for four main reasons. Firstly, being the period considered quite limited and considering that DEA-based indices can fluctuate considerably over time, the results could be affected by non-structural factors. Secondly, the sample could not be representative, impeding to obtain a more complete and correct picture of the Italian agrifood cooperatives. These drawbacks strictly depend on the limits of the database used and, in general, of the information system about the Italian agrifood cooperation which is characterised by low accessibility, heterogeneity, fragmentation and discontinuity. In this connection, future efforts should be addressed to improve information system, taking account of the peculiarities of the cooperatives in order to carry out more accurate and complete analyses. Thirdly, performance of cooperatives should not be measured only among the cooperatives but also relatively to all the agrifood firms in order to frame the cooperatives in a more general competitive context. A last but more important reflection is that performances of cooperatives should be evaluated also with reference to the capability of the cooperative to differ from other organisational forms, by providing the associates "something more" which justifies the choice of this kind of organisation rather than others (the so-called “distinctive utility”). In this regard, a possible way of evaluating the “value added” provided by the cooperative model to the associates could be that to compare performances of farms associated to cooperatives to those of farms which are not linked to any associative form. The measurement of the distinctive utility will be an objective for future research.

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