Original article

Technical efficiency in the fresh fruit and vegetable sector: a comparison study of Italian and Spanish firms

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Abstract — Introduction. Agricultural cooperatives play an important socio-economic role in European (EU) countries, especially in the fresh fruit and vegetable sector. For this reason, in an economic perspective, the measurement of their efficiency has become an area of investigation which attracts great interest. Given that Spain and Italy are the biggest producers of fresh fruits and vegetables, the aim of this paper was to recognize the evolution of their technical efficiency. **Materials and methods**. Performance analysis in the economic field is rather controversial. Following Parkan (2002), it is possible to classify three main approaches to measure performance: index numbers; frontier methods and the non-parametric approaches. In this paper, efficiency was evaluated by applying the Data Envelopment Analysis (DEA) technique considering two separate frontiers. Through the AIDA database for Italian agricultural cooperatives and the SABI database for Spanish cooperatives, two different sets of 81 and 106 firms, respectively belonging to the fruit and vegetable sector, were selected over a five-year period (2001–2005). **Results**. The analysis of the DEA results underlines the higher ability of Italian cooperatives to calibrate and optimize the inputs, and to maximize the results (technical efficiency), as well as the ability of Spanish cooperatives to exploit scale economies. **Conclusions**. Over the period taken into consideration, the average value of global technical efficiency decreased for Spanish as well as Italian cooperatives. In the case of Spanish cooperatives, this situation is due to the loss of ability to calibrate and optimize the inputs, even if the considered firms reveal ability to develop scale economies. In the case of Italian cooperatives, the results reveal the substantial firm technical efficiency, even if scale inefficiency undermines the global efficiency.

Spain / Italy / fruits / vegetables / cooperatives / economic analysis / efficiency

Efficacité technique du secteur des fruits et légumes frais : une étude comparée des sociétés italiennes et espagnoles.

Résumé — Introduction. Les coopératives agricoles jouent un rôle socio-économique important dans les pays européens (UE) et, en particulier, dans le secteur des fruits et légumes frais. Pour cette raison, d'un point de vue économique, la mesure de son efficacité est devenue un champ d'investigation qui suscite un grand intérêt. L'Espagne et l'Italie étant les plus grands producteurs de fruits et légumes frais de l'UE, mous avons cherché à étudier l'évolution de leur efficacité technique. **Matériel et méthodes**. L'évaluation des performances dans le domaine économique est plutôt controversée. Selon Parkan (2002), il est possible d'envisager trois approches principales pour mesurer ces performances : utilisation de nombres-indices ; méthodes des frontières, et méthodes non paramétriques. Dans cet article, l'efficacité du secteur a été évaluée à l'aide d'une analyse d'enveloppement des données (AED) en considérant deux frontières séparées. À partir de la base de données AIDA pour les coopératives agricoles italiennes et de la base de données SABI pour les coopératives espagnoles, deux ensembles différents de 81 et 106 sociétés, appartenant respectivement au secteur des fruits et des légumes, ont été choisis sur une période de cinq ans (2001–2005). **Résultats**. L'analyse des résultats de l'AED a mis en évidence une capacité plus élevée des coopératives italiennes à calibrer et à optimiser les intrants et à maximiser les résultats (efficacité technique) aussi bien qu'une capacité des coopératives espagnoles à utiliser des économies d'échelle. **Conclusions**. Au cours de la période prise en compte, la valeur moyenne de l'efficacité technique globale a diminué pour les coopératives espagnoles comme pour les coopératives italiennes. Dans le cas des coopératives espagnoles, cette situation est due à une perte de la capacité à calibrer et optimiser les intrants, même si les sociétés considérées ont la capacité de développer des économies d'échelle. Dans le cas des coopératives italiennes, les résultats indiquent une efficacité technique substantielle des entreprises, même si l'inefficacité d'échelle mine l'efficacité globale.

Espagne / Italie / fruits / légume / coopérative / analyse économique / efficience

1. Introduction

Agricultural cooperatives are currently an important socio-economic phenomenon in European (EU) countries in terms of the number of companies, but also in terms of the employment they generate and the volume of business they create. According to the data of the General Confederation of Agricultural Cooperatives in the European Union[1], around 26 000 cooperative companies exist in the EU, which employ roughly 700 000 workers and have a turnover of more than 260 000 M€. This turnover figure indicates that cooperatives account for more than 50% of the production, transformation and commercialization of agricultural products. Within this broader European setting, Spain and Italy stand out. The former has some 4 175 cooperatives, which have a turnover of more than 14 000 M€, and the latter has 4 011 cooperatives with a turnover of more than 27 000 M€.

The fresh fruit and vegetable sector is the largest agricultural sector in terms of output value in the EU-27, with an average share of 8.3% of the worldwide production during the period 2003–2005[2]. In the same period, this sector represented 16.9% of the total agricultural production of the EU-27. The importance of the sector is particularly relevant in the Mediterranean Member States, especially in Spain, where 31% of its total agricultural production is fresh fruits and vegetables, Greece (28%), Italy (26%), Malta (25%) and Portugal (23%). The major producing countries in the EU-27 are Spain, whose production accounts for 29% of the EU fresh fruit and vegetable production, Italy (24%) and France (12%), all together adding up to 65% of the EU production for this sector.

The EU fresh fruit and vegetable sector is heterogeneous in terms of kind of products, methods of production, type and size of farms and marketing channels[3]. Moreover, the sector is characterized by high levels of concentration among retailers and discount chains as well as the increasing competition from third-world country imports. A way to solve the structural problems of the sector is to strengthen the role of producer organizations (POs), which in most cases are cooperatives[2].

In the EU-27, around 7% of the 26 000 agricultural cooperatives operate in this sector and they represent 6% of the total turnover and employment[1]. Spain is the country with the highest number of fresh fruit and vegetable cooperatives (945 cooperatives; 53.6% of the total), followed by France (350 cooperatives; 19.9%) and Italy (269 cooperatives; 15.3%). There are significant differences in terms of economic size of cooperatives in EU countries and the smallest ones are located in Spain (4 M€), Italy (3 M€) and Malta (0.5 M€). Fresh fruit and vegetable cooperatives precisely reach a higher market share in the countries where they have a larger size. In this way, in Belgium and Holland, 80% and 60%, respectively, of the fresh fruits and vegetables are commercialized by cooperatives, while in Spain these percentages vary up to 15% for fresh fruits and 40% for vegetables[1].

The importance of agricultural cooperatives in economic terms, the significance they have gained in rural development and the role they play in the attainment of the objectives of the Common Agricultural Policy [1, 2] justify the growing interest in studying their performance [3–7].

Following the seminal work of Smith [8], applying the Data Envelopment Analysis technique (DEA) to the financial data of the Spanish and Italian agricultural cooperatives which were considered, the objective of our work was to check the suitability of DEA to measure the level and causes of efficiency in Spanish and Italian agricultural cooperatives during the period 2001–2005. The

[1] According to Cocega, Agricultural cooperatives in Europe (2005), Issues and trends. Available online at http://www.copa-cogeca.be, accessed on December 1, 2006.

[2] According to European Commission. Fruit and vegetable reform, in http://ec.europa.eu, accessed on August 6, 2007.

[3] Information about cooperatives that process fresh fruits and vegetables was considered because, in the databases used, this is the minimum level of merchandise detail.

paper will be organized as follows: after a description of the background about the use of the DEA technique to verify the level of efficiency and the performance of the decision-making unit, the methodological aspect of the DEA technique and the information used for this work will be described. Some concluding remarks will follow the results of the analysis.

2. Materials and methods

2.1. Methodology

The analysis of the decision-making unit's (DMU) performance is rather controversial and the choice of the best criteria to evaluate is still one of the principal topics of debate in the economic field. Regarding the criteria for measuring efficiency, there exists a vast and in-depth literature [9 10]. The term efficiency, in particular, is generally used to describe the level of performance that can be reached by an economic unit in accordance with its production possibilities. Farrell [11] demonstrated that the evaluation of efficiency has two components: technical efficiency is based on achieving the maximum level of output from the consumption of determined inputs, while price efficiency assumes knowledge of the price of the different employed inputs, in order to reach the optimum output at the lowest possible cost. Global efficiency is obtained from the values of technical and price efficiency.

Although the scope of this paper is not to carry out an exhaustive analysis of the literature about this topic, following Parkan [12], it is possible to classify three main approaches to measure the performance of DMUs: the use of index numbers done by accounting information; the works based on the use of frontier methods including parametric or econometric models; and the non-parametric approach such as DEA techniques.

Different performance indicators based on accounting information can be found in the literature. Amongst these the most commonly used are sales, market share, profits and profitability, and they have been used individually or in combination [13]. The use of index numbers to evaluate the efficiency and the performance of the business unit is criticized in the literature [14] and the main critics refer to the inability of this method to capture the real in-depth essence of performance of the analyzed DMUs, their level of efficiency and the determinants that affect the efficiency. This problem is even greater in the case of companies that adopt a cooperative form because, in contrast with capitalist companies that are operated for the benefit of investors, cooperatives are operated for the benefit of producer-members [15].

The second approach to analyze the performance of DMUs is based on the knowledge of cost function and production function, and the relations between them, through the use of stochastic frontier analysis. These approaches require a huge quantity of data and restrictive assumptions concerning the model specification. For these reasons, the utilization of this approach is not so simple.

The third group is a non-parametric approach, generally used when ex-ante knowledge of the causality relation between cost and production function is not available. In this group, the Data Envelopment Analysis (DEA) is a technique that was first proposed by Charnes *et al.* [16] that has gained a lot of attention, and it is widely applied to performance analysis of the DMUs. DEA's strength is its practicability and applicability, that are confirmed by the vast research effort in which this technique was applied in various decision contexts. DEA is a mathematical programing technique which calculates the relative efficiency of objects with the presence of multiple inputs and multiple outputs. Through an identification of an "efficient frontier", determined by the most efficient DMUs according to the productive technology applied and based on the notion of Pareto optimally, the aim of DEA is not to define the best level of efficiency but to identify which DMUs are efficient and, therefore, belong to the frontier, and which are not. In general this technique can be used to measure the relative efficiency and

Table I.
Linear programing problem VRS model (output-orientation).

Equation	Limits	Equation number
Max θ_z	–	(1)
Subject to:		
$\sum_{f=1}^{n} \lambda_f x_{if} + S^i = x_{iz}$	$i = 1, ..., m$	(2)
$\theta_z y_{rz} - \sum_{f=1}^{n} \lambda_f y_{rf} + S^o = 0$	$r = 1, ..., s$	(3)
$\sum_{f=1}^{n} \lambda_f = 1$	–	(4)
$\theta_z \geq 0$; $\lambda_f \geq 0$	$f = 1, ..., n$	(5)

where:

θ_z: index or score of efficiency for the DMU z evaluated.

x_{if}: quantity of the i-th input consumed by the DMU f.

y_{rf}: quantity of the r-th output produced by the DMU f.

x_{iz}: quantity of the input consumed by the DMU z evaluated.

y_{rz}: quantity of the output produced by the DMU z evaluated.

λ_f: weighting of the DMU f in the virtual reference unit.

S^o and S^i : slacks of the model that allow the elimination of the original inequalities presented, thus contributing from a productive point of view to registering the variation in inputs/outputs for a determined inefficient DMU independently from the radial variation in factors/products required by the factor of intensity (θ_z).

inefficiency of each DMU observed, and to support the action of the manager to maximize the performance of the firm. For these reasons, the DEA technique can be usefully used as a complement of index ratio analysis when the goal of the research is to provide information regarding the operating and technical efficiency of the firm [17].

In our paper, the efficiency of cooperatives is measured using DEA[4]. Through this technique, it is possible to calculate a discrete piece-wise frontier based on a set of information of DMUs. Firms are considered efficient if they lie on the frontier thus established. The DEA models can take a different orientation with regard to managerial guidelines needed for the analysis. Basically, two different orientations can be found: input-oriented models refer to the reductions that it would be necessary to make in the inputs of the assessed DMU so that it can be become qualified as efficient. Likewise, output-oriented models can identify the necessary increase in output to achieve the same effect. According to Charnes *et al.* [16], DEA scores can be computed by the constant returns to scale model (CRS), also called a global technical efficiency measure (TE_{CRS}), where it is assumed that all units operate on their optimal scale so that a unit can be compared in terms of efficiency with any other unit, and where differences in efficiency have nothing to do with scale. However, in many settings this situation may not be realistic and, therefore, according to Banker *et al.* [18], a variable returns to scale model (VRS) is recommended[5]. In this case, the technical efficiency obtained by the VRS model, called pure technical efficiency (TE_{VRS}), is equal to or higher than global technical efficiency (TE_{CRS}).

Considering the DEA models under a VRS assumption, the relative efficiency of unit "*z*" can be calculated by solving a linear programing problem (*table I*). This problem (equations 1 to 5) must be resolved for each of the DMUs contained in the sample analyzed. The θ value that one obtains for each unit is the index of efficiency of that unit, whereas the values of the λ vector for each unit form a "virtual unit" that is on the frontier, built from one or some of the units that lie on the frontier (called reference units). If it is not possible to create such a virtual unit, then the unit being evaluated is considered to be "efficient" ($\theta = 1$). Nevertheless, for the proposed technique to have discriminatory power, it is necessary for the number of elements sampled, "*n*", to be considerably greater than the total number of inputs/outputs included in the model, suggesting that the number of DMUs should be at least three times the number of variables utilized [19].

[4] Readers interested in the DEA technique can consult: Emrouznejad A., DEA bibliography, available online at www.DEAzone.com, accessed on November 4, 2008.

[5] This approach adds a convexity constraint to the CRS formulation to ensure that any unit is compared with another one that is similar in size.

Based on the CRS score (θ_{CRS}) and VRS score (θ_{VRS}), and keeping in mind that the DMU is fully efficient when it is locally and globally efficient, it is reasonable to calculate the scale efficiency (SE) by the ratio of these two scores and taking into account that the SE score is not greater than one [20]. Considering this relation, the "global" technical efficiency" (TE_{CRS}) can be split into the "pure technical efficiency" (TE_{VRS}) and scale efficiency (SE) as: $SE = [TE_{CRS} / TE_{VRS}]$ (equation 6) and $TE_{CRS} = [TE_{VRS} \times SE]$ (equation 7), where: TE_{CRS} is the global technical efficiency (TE) and TE_{VRS} is the pure technical efficiency (PTE); SE = 1: scale efficiency, SE < 1: scale inefficiency.

Equation 7 is able to depict the possible sources of inefficiency. The technical efficiency is affected by inefficient[6] operation (PTE), by the critical condition displayed by the scale inefficiency (SE < 1) or, in the third instance, by both. In particular, pure technical inefficiency results from using more inputs than necessary (input waste), while scale inefficiency occurs if the DMU does not operate at constant returns to scale.

The mathematical calculation of the model was carried out considering the dual methodology proposed in the CRS and VRS models, and an output orientation was taken as the only option, as this seems to be the natural way of thinking about operating income, which is composed of revenues, and, therefore, maximizing the operating income is sought by each productive unit.

2.2. Materials

The analysis approach adopted is strictly economic and considers the nature of operating income. In this case, it is possible to evaluate the application of resources (costs) in order to obtain the products (revenue) that are the principal activity of the DMUs. With regard to the measurement of efficiency of cooperatives, the criteria applied to the design of DEA models have been different [21–25]. Following Smith's approach [8], financial statement information was used to measure performance of Italian and Spanish cooperatives. In particular, purchases (CO), staff costs (SC), depreciations (DP) and other operating expenses (OE) are used as input variables for the DEA model, with revenues (RV) as output variables (*table II*).

Through the database AIDA – Bureau van Dijk for the Italian agricultural cooperatives and the database SABI – *Sistema de Análisis de Balances Ibéricos* for the Spanish cooperatives, two different sets of 81 and 106 firms, respectively belonging to the fruits and vegetable sector, were selected. The final samples used in the analysis were assessed considering the presence of the firms during all the financial years from 2001 to 2005. In order to evaluate the level and causes of efficiency in Italian and Spanish cooperatives two separate frontiers were calculated.

3. Results

Based on the technologies of each country, the analysis of DEA results[7] underlines the different level of global efficiency of Spanish and Italian cooperatives during the period considered (*table III*). The average global efficiency of Spanish DMUs is 88%, 5% more than the level of Italian cooperatives.

Focusing attention on the trend of global efficiency coefficients (*figure 1*), it is possible to distinguish two different situations. In Spanish cooperatives efficiency decreases gradually from 2001 (91%) to 2005 (86%), while in Italian cooperatives, it increases rapidly from 2001 (83%) to 2003 (88%). Only after 2003 does Italian cooperatives' global efficiency drop to 77% in 2005. Although in both countries the general efficiency of analyzed cooperatives decreases, an in-depth analysis underlines two different sources of inefficiency and two different situations (*table III*, *figure 1*).

Taking into account the average score of pure technical efficiency (TE_{VRS}) for the

[6] The relationship between efficiency (E) and inefficiency (IE) is E = [1 / (1 + IE)].

[7] DEA models were estimated using the program PIM-DEASoft-V1 [26].

Table II.
Descriptive statistics for the variables used for studying technical efficiency in the fresh fruit and vegetable sector of Italian and Spanish cooperatives (× 10^3 €).

Variable	Italy				Spain			
	Mean	Standard deviation	Maximum	Minimum	Mean	Standard deviation	Maximum	Minimum
Revenues 2001	7.074	7.838	46.200	267	11.195	17.459	90.240	19
Revenues 2002	8.389	9.800	61.420	348	12.237	19.088	96.081	7
Revenues 2003	9.345	10.704	69.321	532	12.782	19.386	96.620	13
Revenues 2004	9.477	11.334	72.976	302	12.906	19.667	101.555	7
Revenues 2005	8.630	9.729	68.219	460	13.051	20.491	117.541	4
Cost materials consumed 2001	5.303	6.689	42.014	167	8.849	14.270	72.316	4
Cost materials consumed 2002	6.698	8.565	57.171	246	9.732	15.763	77.451	3
Cost materials consumed 2003	7.259	9.133	63.953	391	10.176	16.175	82.709	5
Cost materials consumed 2004	7.422	9.812	67.711	266	10.082	16.012	84.419	5
Cost materials consumed 2005	6.672	8.277	62.172	390	10.290	17.233	104.419	4
Staff costs 2001	658	640	2.783	8	1.221	1.913	11.155	3
Staff costs 2002	674	652	2.595	20	1.384	2.126	12.934	4
Staff costs 2003	778	752	2.722	25	1.488	2.383	14.856	6
Staff costs 2004	779	755	2.715	20	1.559	2.455	13.588	4
Staff costs 2005	792	770	2.695	19	1.580	2.487	14.679	6
Depreciation 2001	324	419	1.674	1	201	356	2.209	1
Depreciation 2002	365	489	2.149	1	230	399	2.802	1
Depreciation 2003	399	522	2.076	2	263	462	3.054	1
Depreciation 2004	394	525	2.676	1	304	593	4.772	2
Depreciation 2005	4.119	503	1.930	1	365	754	6.079	2
Other operating expenses 2001	154	187	861	2	3.176	6.895	59.061	19
Other operating expenses 2002	143	170	677	1	3.320	6.021	45.133	27
Other operating expenses 2003	162	192	886	3	3.545	6.784	54.172	22
Other operating expenses 2004	305	475	2.065	3	3.729	7.218	59.463	18
Other operating expenses 2005	385	693	3.529	3	3.599	5.829	35.222	30

entire period, the levels are very similar for both the samples of cooperatives considered (90%). A detailed analysis of TE_{VRS} over the years shows that the pure technical efficiency levels of Italian cooperatives are equal to or higher than 91% during the considered period, while the pure technical efficiency of Spanish cooperatives declines from 94% to 89% (figure 2).

According to the meaning of the concept of pure technical efficiency, the differences between the two realities underline the higher ability of Italian cooperatives to calibrate and optimize the inputs to maximize the results, especially when the economic context in which they operate is extremely dynamic. Considering the average score of scale efficiency (SE), the results underline

Table III.
Descriptive statistics of the estimated efficiency scores in Italian and Spanish cooperatives, obtained from the DEA.

Panel A: Italian cooperatives (*n* = 81).

Years	Pure technical efficiency (VRS model)				Global technical efficiency (CRS model)				SE (Scale efficiency)			
	Average efficiency (θ_{VRS})	Standard deviation	Maximum	Minimum	Average efficiency (θ_{CRS})	Standard deviation	Maximum	Minimum	Average efficiency	Standard deviation	Maximum	Minimum
2001	0.912	0.093	1.000	0.643	0.830	0.115	1.000	0.601	0.910	0.086	1.000	0.619
2002	0.924	0.075	1.000	0.622	0.865	0.083	1.000	0.606	0.937	0.055	1.000	0.761
2003	0.936	0.067	1.000	0.698	0.876	0.083	1.000	0.675	0.936	0.055	1.000	0.805
2004	0.918	0.094	1.000	0.430	0.807	0.129	1.000	0.405	0.880	0.111	1.000	0.684
2005	0.906	0.118	1.000	0.423	0.767	0.145	1.000	0.373	0.850	0.130	1.000	0.625
Average	0.919	0.089	–	–	0.829	0.111	–	–	0.903	0.088	–	–

Panel B: Spanish cooperatives (*n* = 106).

Years	Pure technical efficiency (VRS model)				Global technical efficiency (CRS model)				Scale efficiency (SE)			
	Average efficiency (θ_{VRS})	Standard deviation	Maximum	Minimum	Average efficiency (θ_{CRS})	Standard deviation	Maximum	Minimum	Average efficiency	Standard deviation	Maximum	Minimum
2001	0.937	0.080	1.000	0.383	0.913	0.092	1.000	0.378	0.974	0.058	1.000	0.515
2002	0.924	0.083	1.000	0.700	0.899	0.109	1.000	0.214	0.973	0.079	1.000	0.214
2003	0.896	0.110	1.000	0.499	0.873	0.118	1.000	0.411	0.975	0.066	1.000	0.411
2004	0.889	0.110	1.000	0.532	0.863	0.127	1.000	0.180	0.972	0.087	1.000	0.180
2005	0.890	0.128	1.000	0.279	0.856	0.146	1.000	0.155	0.964	0.096	1.000	0.155
Average	0.907	0.102	–	–	0.881	0.119	–	–	0.972	0.077	–	–

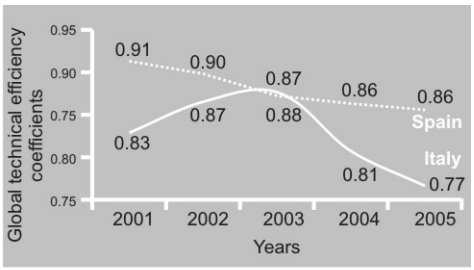

Figure 1.
DEA scores: global technical efficiency (CRS model) measured in the fresh fruit and vegetable sector, when comparing Italian and Spanish firms.

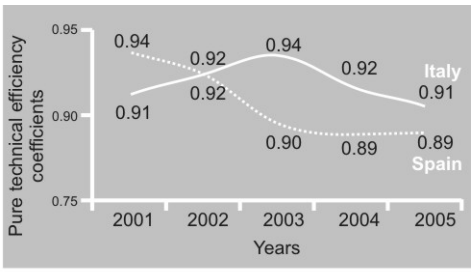

Figure 2.
DEA scores: pure technical efficiency (VRS model) measured in the fresh fruit and vegetable sector, when comparing Italian and Spanish firms.

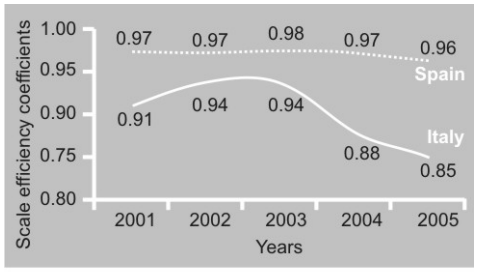

Figure 3.
DEA scores: scale efficiency (SE) measured in the fresh fruit and vegetable sector, when comparing Italian and Spanish firms.

the high value of the Spanish cooperatives (97%)[8]. The greatest ability to exploit scale economies of Spanish firms is a feature of all the financial years (*figure 3*), underlining the different structural characteristics of the cooperatives analyzed.

4. Conclusions

The DEA model applied to financial data of cooperatives operating in processing and preserving of fruit and vegetables shows that, over the period 2001–2005, the average value of global technical efficiency decreased for Spanish as well as for Italian cooperatives. This analysis approach underlines two different sources of inefficiency. In the case of Spanish cooperatives the global inefficiency is due to the loss of ability to calibrate and optimize the inputs, especially when there is an increase in the competitiveness in the economic "arena" and when the market is characterized by a high level of uncertainty. In this case, the low level of pure technical efficiency is covered by the ability of Spanish cooperatives to develop scale economies, preserving their global efficiency.

In Italian cooperatives, the results reveal a substantial technical efficiency, although the analysis underlines a progressive reduction after 2003. For this reason, the sources of inefficiency for Italian cooperatives derive from scale inefficiency rather than from pure technical inefficiency. This result means that the considered DMUs are effective for calibrating their inputs in respect to the output obtained, but not completely able to operate at constant returns to scale. In particular, this inefficiency of scale is represented by the imbalance between the size of the cooperatives and the production levels reached. Cooperatives' incapacity to make the most of technical and structural potentiality empowers their general efficiency (technical as well as economic). This circumstance underlines the influence of structural costs with regard to firms' performance, too. On this matter, the cooperatives are frequently characterized by a "pachydermic" structure that characterizes the real activity.

In general, it is possible to highlight the suitability and applicability of the DEA technique to measure and analyze the

[8] A Student's test reveals significance differences in scale efficiency (SE) for the whole period (p-value = 0.000 for all year). As for the global technical efficiency (TE_{CRS}) and pure technical efficiency (TE_{VRS}) scores, differences were also found for all years evaluated (CRS model, p-value < 0.20; VRS model, p-value < 0.054), except in 2003 for the CRS model (p-value= 0.816) and 2002 and 2005 for the VRS model (2002, p-value = 0.991; 2005, p-value = 0.368). When the pooled sample was assessed, again significant differences were found at the 1% level for scale efficiency and global technical efficiency (TE_{CRS}), and at the 10% level for the pure technical efficiency (TE_{VRS}).

determinant of technical efficiency through financial data. It would be very interesting for the future to test the technical efficiency of cooperative firms using a multi-output and multi-input model through financial and non-financial data to verify the level of technical efficiency and the determinant of efficiency. Furthermore, it would be very profitable to test the performance of the cooperatives by adopting simultaneously a parametric and a non-parametric model.

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Eficiencia técnica del sector de las frutas y hortalizas frescas: un estudio comparado de las sociedades italianas y españolas.

Resumen — Introducción. Las cooperativas agrícolas juegan un importante papel socioeconómico en los países europeos (UE) y, en particular, en el sector de las frutas y hortalizas frescas. Por ello, desde un punto de vista económico, la medida del rendimiento de dichas empresas se viene convirtiendo en un campo de investigación que suscita gran interés. España e Italia son los países productores más importantes de productos hortofrutícolas de la Unión Europea, por lo que el principal objetivo del presente estudio es conocer la evolución de sus niveles de eficiencia técnica. **Material y métodos**. En el campo económico, la medida de desempeño es un tema bastante controvertido. Según Parkan (2002), se pueden contemplar tres enfoques diferentes para medir el rendimiento: número índices, métodos de frontera y métodos no paramétricos. En este artículo, la eficiencia del sector ha sido evaluada aplicando la técnica del Análisis Envolvente de Datos (AED) considerando dos fronteras separadas. A partir de la base de datos AIDA para las cooperativas agrarias italianas y de la base de datos SABI para las cooperativas españolas, se seleccionaron dos muestras del sector hortofrutícola de 81 y 106 sociedades, respectivamente, para un periodo de cinco años (2001 a 2005). **Resultados**. El análisis de los resultados DEA evidencia una mayor capacidad de las cooperativas italianas para optimizar sus inputs y maximizar sus resultados (eficiencia técnica), así como la capacidad de las cooperativas españolas para explotar las economías de escala. **Conclusión**. En relación al periodo temporal evaluado, el valor medio de la eficiencia técnica global disminuye para las cooperativas españolas así como para las italianas. En el caso de las cooperativas españolas, esta situación es debida a la falta de optimización de sus inputs, incluso cuando las sociedades consideradas revelan cierta capacidad para desarrollas economías de escala. En el caso de las cooperativas italianas, los resultados indican la existencia de un firme nivel de eficiencia técnica, si bien se detecta la presencia de importantes ineficiencias de escala.

España / Italia / frutas / hortalizas / cooperativas / análisis económico / eficiencia