Technical efficiency in agricultural cooperatives: A compared study of Italian and Spanish firms in fresh and vegetables sector

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Introduction

Agricultural cooperatives are an important socio-economic phenomenon in the European Union (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 from the General Confederation of Agricultural Co-operatives in the European Union (COGECA), in the EU(27) exist around 26,000 cooperative companies which employ roughly 700,000 workers, have a turnover of more than 260,000 million Euros and around 7% of these co-ops operate in fresh fruits and vegetables sector.

Spain is the country with the most number of fresh fruits and vegetables cooperatives (945 cooperatives; 53.6% of the total), followed by France (350 cooperatives; 19.9%) and Italy (269 cooperatives; 15.3%).

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 (Guzmán and Arcas, 2008) justify the growing interest in studying their efficiency and performance.

Objective

The objective of this work is:

✓ To check the suitability of Data Envelopment Analysis (DEA) technique to measure the efficiency of co-ops firms;

✓ To evaluate comparatively the performance of Spanish and Italian agricultural cooperatives during the period 2001-2005.

Background

The analysis of the performance of DMUs is rather controversial and the choice of the best criteria to evaluate it is still one of the principal topics of debate in the economic field.

Regarding the criteria to measure the efficiency, the reader can see the existence of a vast and in-depth literature (Bititici et al., 1997; Neely and Waggoner, 1998). Following Parkan (2002) it is possible to classify three main approaches to measure the performance of DMUs:

1) the use of index numbers done by accounting information;

2) the use of frontier methods including parametric or econometric models;

3) the non parametric approach.

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 DEA is a technique first proposed by Charnes et al. (1978) that has gained a lot of attention and it is widely applied to performance analysis of the DMUs.

DEA technique can be usefully used as complement at the index ratio analysis when the goal of the research is to provide information regarding the operating and technical efficiency of the firm (Feroz et al., 2003).

Methodology

In this paper the efficiency of cooperatives is measured using DEA.

The DEA models can take two different orientations:

• *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.

• *output-oriented models* can identify the necessary increase in output to achieve the same effect.

According to Charnes et al. (1978), DEA scores can be computed by the constant returns to scale model (CRS), also called global technical efficiency measure (TECRS), where it is assumed that all units operate at their optimal scale so that a unit can be compared in terms of efficiency to any other unit, and where differences in efficiency have nothing to do with scale.

In many settings this situation may not be realistic and, therefore, according to Banker et al. (1984), a variable returns to scale model (VRS) is recommended. In this case the technical efficiency obtained, called pure technical efficiency (TEVRS), is equal or greater than global technical efficiency (TECRS).

Considering the DEA models under a VRS assumption, the relative efficiency of unit "z" can be calculated by solving the following linear programming problem:

$$Max\ \theta_z \qquad\qquad (1)$$

s.t.:

$$\sum_{f=1}^{n} \lambda_f\, x_{if} + S^i = x_{iz} \qquad i = 1, \dots,m \qquad (2)$$

$$\theta_z\, y_{rz} - \sum_{f=1}^{n} \lambda_f\, y_{rf} + S^o = 0 \qquad r = 1, \dots,s \qquad (3)$$

$$\sum_{f=1}^{n} \lambda_f = 1 \qquad\qquad (4)$$

$$\theta_z \ge 0;\ \lambda_f \ge 0 \qquad f = 1, \dots,n \qquad (5)$$

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 / S^i: slacks of the model of lineal programming.

Materials

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 set of 81 and 106 firms respectively was selected belonging to the fruit and vegetable sector. The final sample used in the analysis was carried out considering the presence of the firms during all the financial years in the period 2001-2005. The approach of analysis adopted is strictly economic and considers the nature of operating income. Smith's (1990) development of DEA to include information from the financial statements. Thus, following Smith's approach, this paper extracts information from the financial statements to measure corporate performance of Italian and Spanish cooperatives, and therefore, for this work we use the accounting variables mentioned in table 1:

Table 1. Set of input and output variables used

Category of variable	Variable	Description
Input	CO	Purchases
Input	SC	Staff costs
Input	DP	Depreciation
Input	OE	Other operating expenses
Output	RV	Revenues

Results

Taking into account the average score of pure technical efficiency (TEVRS) to the entire period, the levels are practically similar for both the sample cooperatives considered (90%). A detailed analysis of TEVRS along the years taken into consideration, shows that with the exception of the year 2001 and 2002, the pure technical efficiency levels of Italian cooperatives are higher than the Spanish cooperatives (Figure 1). According to the meaning of the concept of pure technical efficiency, the gaps 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 contest in which they operate are extremely dynamic. Considering the average score of scale efficiency (SE) during the period, the results underline the high value of the Spanish cooperatives (97%). The largest ability to exploit the scale economy of Spanish firms is a feature for all the financial years, underlining the different structure characteristics of the cooperative analyzed.

Figure 1. DEA Scores: pure technical efficiency (VRS Model)
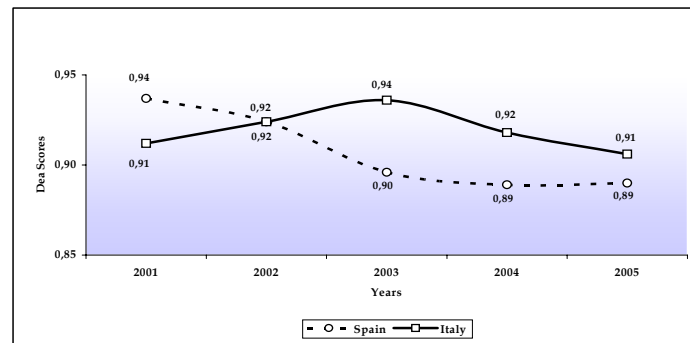
Conclusions

DEA model applied to financial data of cooperatives operating in processing and preserving of fruit and vegetables, shows that in the period 2001-2005 the average value of global technical efficiency decreases for Spanish as well as Italian cooperatives. This approach of analysis is able to underline two different sources of inefficiency. For Spanish cooperatives the global inefficiency is due to the loss of ability to calibrate and optimize the inputs, especially when increase in the competitiveness into the economic "arena" and when the market are 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 the Italian cooperatives the results reveal a substantial technical efficiency even if the analysis underlines a progressive reduction after the year 2003. For this reason the sources of inefficiency for the Italian cooperatives were found to be derived from scale inefficiency rather than pure technical inefficiency. This result means that the DMUs considered are able and effective to calibrate their inputs in respect to the output obtained but not completely able to operate at constant return to scale. In particular this inefficiency of scale is represented by the imbalance between the size of the cooperatives and the reached production levels.

Bibliography

BANKER RD. CHARNES A. and COOPER WW. (1984). Some models for estimating technical and scale inefficiencies in Data Envelopment Analysis, *Management Science*, 30, 1078-1092.

BITITICI U. CARRIE A.S. and McDEVITT L. (1997). Integrated performance measurement systems: a development guide, *International Journal of Operations & Production Management*, 17, 5, 522-34.

DAMAS E. and ROMERO C. (1997). Análisis no paramétrico de la eficiencia relativa de las almazaras cooperativas en la provincia de Jaén durante el período 1975-1993, *Revista de Economía Agraria*, 180, 279-304.

CHARNES A. COOPER WW. and RHODES E. (1978). Measuring the efficiency of decision making units, *European Journal of Operational Research*, 2, 429-444.

COGEGA (2005). Agricultural cooperatives in Europe. Issues and trends. Available online at http://www.copa-cogeca.be. Downloaded December 1, 2006.

EUROPEAN COMMISSION (2007). Fruit and vegetables reform. In www.europa.eu.int. Downloaded August, 6.

FEROZ E.H. KIM S. and RAAB R.L. (2003). Financial statement analysis: A data envelopment analysis approach, *Journal of the Operational Research Society*, 54, 48-58.

FERRIER GD. and PORTER PK. (1991). The productive efficiency of US milk processing co-operatives, *Journal of Agricultural Economics*, 42, 2, 161-174.

GUZMÁN I. and ARCAS N. (2008). The usefulness of accounting information in the measurement of technical efficiency in agricultural cooperatives. *Annals of Public and Cooperative Economics*, 79, 1, 107-131.

PARKAN C. (2002). Measuring the operational performance of a public transit company, *International Journal of Operations & Production Management*, 22, 6, 693-720.

SMITH P. (1990). Data Envelopment Analysis applied to financial statements, *International Journal of Management Science*, 131-138.