

## Cooperatives Versus Corporates in the Spanish Agricultural Sector: Non-Parametric Estimation of Technical Efficiency

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**Abstract** The technical efficiency of small firms is central to the debate about the role of small-scale industries in generating growth and employment in developing economies. Some studies find small firms to be more efficient than large firms in some industrial sectors but not in others, while other studies find them to be less efficient overall. This paper focuses on agricultural enterprises in the northern part of Spain. It compares the distributions of efficiency and identifies most important correlates. It can have important implications for political decisions because this mixed evidence sends conflicting signals to policy makers. It also studies the variation across the two principal forms of business organization focused on ownership, cooperative and corporate firms. Variation in the efficiency may take place between firms that are organised in different ways and result in changes from one form of business organisation to another. This analysis allows us to know what firms are most efficient in the sector considered. Non-parametrical techniques are used in the analysis, concretely Data Envelop-

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ment Analysis (DEA). Highly efficient firms have distinct characteristics that distinguish them from inefficient firms: investments in technology, workforce, automation, organizational practices. . . This analysis allows us to know what firms are most efficient in the sector considered if so why.

**Keywords** Efficiency, DEA, Agricultural Sector, Cooperatives, Corporates.

**JEL Classification** M10, M19, Q13.

## 1. Introduction

Because of the relative decline of agriculture since the 1960s, Spain's rural population decreased and many farms disappeared. Spanish agriculture has remained relatively backward by western European standards: capital investment per hectare is about one-fifth the average for the Organisation for Economic Cooperation and Development (OECD), and the vast majority of farms are small. Since Spain joined the European Economic Community (EEC) in 1986, the Spanish agricultural sector has had to respect Europe-wide policies. As a result, many small-scale operations, especially in grape growing and dairying, had to cease. In recent decades, however, the amount of agriculturally productive land in Spain has increased through irrigation and the conversion of fallow lands.

Viewed in terms of landmass, Spain is one of the largest countries of Western Europe, and it ranks second in terms of its elevation, after Switzerland. A large part of the country is semiarid, with temperatures that range from extremely cold in the winter to scorching in the summer. Rainfall, which is often inadequate, tends to be concentrated in two generally brief periods during the year. Summer droughts occur frequently. Of Spain's 50.5 million hectares of land, 20.6 million, or about 40 percent, are suitable for cultivation; however, the soil is generally of poor quality, and only about 10 percent of the land can be considered excellent. In addition, the roughness of the terrain has been an obstacle to agricultural mechanization and to other technological improvements. Furthermore, years of

neglect have created a serious land erosion problem, most notably in the dry plains of Castilla-La Mancha.

Compared with other West European countries, the proportion of land devoted to agricultural purposes is low. About 5 million hectares are devoted to permanent crops: orchards, olive groves, and vineyards. Another 5 million lay fallow each year because of inadequate rainfall. Permanent meadows and pastureland occupied 13.9 million hectares. Forests and scrub woodland accounted for 11.9 million hectares, and the balance was wasteland or was taken up by populated and industrial areas.

The primary forms of property holding in Spain have been large estates (*latifundios*) and tiny land plots (*minifundios*). The Agrarian Census (INE, 2000) found that 50.9 percent of the country's farmland was held in properties of 200 or more hectares, although farms of this size made up only 1.1 percent of the country's 2.3 million farms. At the other end of the scale, the census showed that 61.8 percent of Spain's farms had fewer than 5 hectares of land. These farms accounted for 5.2 percent of the country's farmland. Furthermore, just under 25-percent of all farms consisted of less than 1 hectare of land, and they accounted for 0.5 percent of all farmland. *Minifundios* were particularly numerous in the north and the northwest. *Latifundios* were mainly concentrated in the south, in Castilla-La Mancha, Extremadura, Valencia and Andalucía.

Crop areas were farmed in two highly diverse manners. Areas relying on non-irrigated cultivation, which made up 85 percent of the entire crop area, depended solely on rainfall as a source of water. They included the humid regions of the north and the northwest, as well as vast arid zones that had not been irrigated. The much more productive regions devoted to irrigated cultivation accounted for about 4 million hectares, it already had doubled since 1950.

Though only about 17 percent of Spain's cultivated land was irrigated, it was estimated to be the source of between 40 and 45 percent of the gross value of crop production and of 50 percent of the value of agricultural exports. More than

half of the irrigated area was planted in corn, fruit trees, and vegetables. Other agricultural products that benefited from irrigation included grapes, cotton, sugar beets, potatoes, legumes, olive trees, strawberries, tomatoes, and fodder grasses. Depending on the nature of the crop, it was possible to harvest two successive crops in the same year on about 10 percent of the country's irrigated land.

Citrus fruits, vegetables, cereal grains, olive oil, and wine (Spain's traditional agricultural products) continued to be important nowadays in the country's agricultural production. Because of the changed diet of an increasingly affluent population, there was a notable increase in the consumption of livestock, poultry, and dairy products. Meat production for domestic consumption became the single most important agricultural activity, accounting for 30 percent of all farm-related production in 1983. Increased attention to livestock was the reason that Spain became a net importer of grains. Ideal growing conditions, combined with proximity to important north European markets, made citrus fruits Spain's leading export. Fresh vegetables and fruits produced through intensive irrigation farming also became important export commodities, as did sunflower seed oil that was produced to compete with the more expensive olive oils in oversupply throughout the Mediterranean countries of the European Union.

Agriculture is an important sector in the Spanish economy. Our objective is to estimate technical efficiency for the main agricultural entities in the northern Spain. For this, the paper uses a non-parametric method, proposed by Charnes *et al.* (1978) to measure technical efficiency of northern Spain mercantile societies (corporates) and cooperatives. According to INE (2000) legal entity is not the most frequent business organization. Cooperatives are the most frequent legal entity in Galicia while mercantile societies are the most frequent in Asturias, Cantabria and Basque Country. However there is wide variation in the legal entity across the levels of efficiency.

Our primary purpose in the present study is to differentiate the most efficient companies from the least efficient ones on the basis of a set of economic variables by legal status, ownership and autonomous community.

## **2. Agriculture in the Northern Spain: A Brief Description**

Green Spain is the name given to the strip of land between the Bay of Biscay and the Cantabrian and Basque mountains in northern Spain. Green Spain is considered to be formed by the regions of Galicia, Asturias, Cantabria and the Basque Country. It is called green because it has a wet and moderate oceanic climate, strongly influenced by the Atlantic Ocean winds that get trapped by the mountains. Green Spain contrasts with its dry central plateau.

Because semiarid plateaus and mountains subject to temperature extremes dominate the interior of Spain, the most productive agricultural areas tend to be the coastal regions. Thus the north and the northwest, where there is a relatively mild, humid climate were the principal corn producing and cattle-raising areas. Apples and pears were the main orchard crops in this area, and potatoes were another of its leading products.

Galicia, which consists of Spain's four westernmost provinces directly north of Portugal, had a concentrated farm population living on intensely fragmented plots. Accordingly, per capita farm income was low, compared with that of the northern regions lying to the east, where there were fewer people and higher per capita income levels because of a more diversified economy that included industry, mining, and tourism.

Agricultural operations in northern Spain are most frequently dedicated to a mixed combination of agriculture and livestock farming. According to INE (2000) only 1135 agriculture operations, a 2.7 percent of the total business are exclusively dedicated to agriculture farming.

The main different categories of legal status or condition of the owner in the agriculture industry are the following:

- **Individual:** The owner is considered to be an individual when they are an individual or a group of individual persons (brothers, joint heirs, etc.) that work a joint heir ship or other grouping of lands or livestock together without having legally formed a company or association.
- **Mercantile Company:** is a group of people whose partnership agreement is documented in a public deed and is also registered in the Mercantile Register. These companies are classified as Public Limited Company, Limited, Collective and Company Responsibility.
- **Public Entity:** in this case, ownership corresponds to one of the different public administrations: Central, Autonomous or Local.
- **Production Cooperative:** is an association that works to obtain agricultural products as a joint undertaking, complying with the principles and regulations of the General Law of Cooperatives and their development norms.
- **Agrarian Transformation Company (ATC):** non-profit entity with social and economic purpose for the production, transformation and marketing of agricultural, livestock or forestry products, duly registered in the corresponding register.

Table 1 shows the distribution of agricultural operations. Individual is the most frequent legal status found in the business, consequence of the structural distribution of property holding. This study only takes a sample composed of mercantile companies (corporates) and cooperatives.

### 3. Brief Overview of Methodological Framework

Data Envelopment Analysis (DEA) is an efficiency evaluation model based on mathematical programming theory.

DEA was originally introduced by Charnes, Cooper and Rhodes (1978). It is a methodology that allows management analysis to measure the relative productive

Table 1: Distribution of agricultural operation. *Source: INE (2000).*

|                                    | Asturias     | Cantabria    | Galicia       | Basque C.    | Total         |
|------------------------------------|--------------|--------------|---------------|--------------|---------------|
| <b>Individual</b>                  | 41790        | 16925        | 262068        | 37707        | 358490        |
| <b>Mercantile company</b>          | 118          | 154          | 349           | 212          | 833           |
| <b>Cooperative</b>                 | 14           | 4            | 113           | 24           | 155           |
| <b>Agrarian Transformation Co.</b> | 35           | 153          | 233           | 31           | 452           |
| <b>Public entity</b>               | 256          | 610          | 952           | 643          | 2461          |
| <b>Other legal status</b>          | 611          | 307          | 5280          | 1017         | 7215          |
| <b>Total</b>                       | <b>42824</b> | <b>18153</b> | <b>268995</b> | <b>39634</b> | <b>369606</b> |

efficiency of each member of a set of comparable organizational units based on a theoretical optimal performance for each organization.

DEA offers an alternative to classical statistics in extracting information from sample observations. In contrast to parametric approaches such as regression analysis, which fit the data through a single regression plane, DEA optimizes each individual observation with the objective of calculating a discrete piece-wise frontier determined by the set of Pareto efficient Decision Management Units. For this, the organizational units under analysis are designated as Decision Management Units (DMUs) and these DMUs can be separate firms or institutions, or they can be separate sites or branches of a single firm or agency (Pinilla, 2001; Coelli *et al.*, 1999; Ramanathan, 2003).

The concept of DEA is developed around the basic idea that the efficiency of a DMU is determined by its ability to transform inputs into desired outputs. This concept of efficiency was adopted from engineering which defines the efficiency of a machine/process as Output/Input.

The method was developed as an extension of what is known as Farrell's single-output/input technical efficiency measure, which was introduced earlier in 1957 (Charnes *et al.*, 1994; Banker *et al.*, 1984). Farrell suggested that when assessing the productivity of an organization, at times, it is important to be able to consider more than one output or more than one input simultaneously.

The key advantage of DEA over other methods of performance evaluation is that it allows one to consider a number of outputs and inputs simultaneously, regardless of whether all the variables of interest are measured in common units (Sexton *et al.*, 1986).

DEA generalizes this single output/input technical efficiency measure to multiple outputs/inputs by constructing a relative efficiency measure based on a single "virtual" output and a single "virtual" input. The efficient frontier is then determined by selecting DMUs, which are most efficient in producing the virtual output from the virtual input. Because DMUs on the efficient frontier have an efficiency score equal to 1, inefficient DMUs are measured relative to the efficient DMUs. The efficiency ranking is relative to other DMUs. It is not possible to determine if DMUs judged to be efficient are optimizing the use of inputs to produce outputs.

Furthermore, DEA calculations are non-parametric. Non-parametric models differ from parametric models in that the model structure is not specified a priori but is instead determined from data. The term non-parametric is not meant to imply that such models completely lack parameters but that the number and nature of the parameters are flexible and not fixed in advance. Non-parametric models are therefore also called distribution free and do not require specification or knowledge of a priori weights for the inputs or outputs.

For many applications, these features make DEA a more flexible tool as compared to other conventional efficiency measures derived from stochastic production frontier or economic value added (EVA), which are based on production function estimation involving many inputs but only one output.

Consider a number of outputs and inputs simultaneously it is problematic because, oftentimes, the different variables of interest are not measured in common units and, thus, are not easily and meaningfully combined into some type of productivity index.



A formula for relative efficiency incorporating multiple inputs and outputs is introduced and the DEA model, which allows relative efficiency measures to be determined is developed. This is followed by a discussion of the information made available by solving the model and some issues of practical concern in applying the technique. The measurement of relative efficiency where there are multiple possibly incommensurate inputs and outputs was addressed by Farrell and developed by Farrell and Fieldhouse, focusing on the construction of a hypothetical efficient unit, as a weighted average of efficient units, to act as a comparator for an inefficient unit.

A common measure for relative efficiency is, efficiency = weighted sum of outputs/weighted sum of inputs, which introducing the usual notation can be written as: -efficiency is usually constrained to the range  $[0,1]$ -,

$$\text{Efficiency of unit } j = \frac{u_1 y_{1j} + u_2 y_{2j} + \dots}{v_1 x_{1j} + v_2 x_{2j} + \dots},$$

where

- $u_1$  = the weight given to output  $i$ ,
- $y_{1j}$  = amount of output 1 from unit  $j$ ,
- $v_1$  = weight given to input 1,
- $x_{1j}$  amount of input 1 to unit  $j$ .

The initial assumption is that this measure of efficiency requires a common set of weights to be applied across all units. This immediately raises the problem of how such an agreed common set of weights can be obtained. There can be any difficulties in obtaining a common set of weights. First, it may simply be difficult to value the inputs or outputs. This measure of efficiency coupled with the assumption that a single common set of weights is required is thus unsatisfactory.

DEA uses linear programming methods to extract information about the production process of each decision DMU. This information extraction is accomplished by calculating a maximum performance measure for each firm, and

comparing this measure to similarly calculated measures for all other firms. Each firm's performance measure traces out a best-practice frontier, and all DMUs lie either on or below the frontier (Charnes *et al.* 1994). A best-practice frontier maps out the maximum level of output (minimum level of input) that could be produced (used) for any given level of input (output). Figure 1 shows a graphical representation of an output-oriented DEA model with a single input for 10 firms. The best-practice frontier is traced through the points representing the maximum level of output for a given input; any points below the frontier are deemed inefficient.

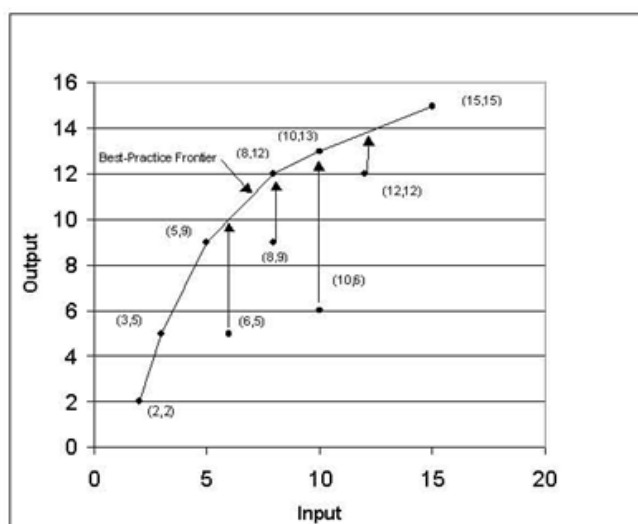


Figure 1: Output-oriented DEA model.

For example, the DMU at point (8,12) produces 12 units of output with 8 units of input, while the DMU at point (8,9) produces 9 units of output with 8 units of input. The second DMU is deemed to be inefficient compared to the first because only 9 units of output (versus 12) are produced for the same level of input. Inefficiency for any DMU is determined by comparison to either another DMU or to a convex combination of other DMUs on the frontier which utilize

the same level of input and produce the same or higher level of output. The analysis is accomplished by requiring solutions that can increase some outputs (decrease some inputs) without worsening the other inputs or outputs (Charnes *et al.* 1994).

The one-input, one-output case can be expanded to cases involving multiple inputs and multiple outputs. Charnes *et al.* (1978) proposed a method in which the multiple-input, multiple-output model was reduced to a ratio with a single “virtual” input and single “virtual” output by estimating a set of weights depicting each DMU in the most favourable position relative to other DMUs. In equation form, the model is as follows:

$$\begin{aligned} \text{Max } h_0(u, v) &= \frac{\sum_r u_r y_{ro}}{\sum_i v_i x_{io}} \\ \text{s.t.: } \frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} &\leq 1, \quad \text{for } j = 0, 1, \dots, n \\ \frac{u_r}{\sum_i v_i x_{io}} &\geq \varepsilon, \quad \text{for } r = 1, \dots, s \\ \frac{v_i}{\sum_i v_i x_{io}} &\geq \varepsilon, \quad \text{for } i = 1, \dots, m \end{aligned}$$

where:

$y_{rj}$  = quantity of output  $r$  produced by firm  $j$

$x_{ij}$  = quantity of input  $i$  produced by firm  $j$

$u_r$  = weight for output  $r$

$v_i$  = weight for input  $i$

$\varepsilon$  = small positive quantity

The estimated ratio provides a measure of technical efficiency for each DMU. However, there are an infinite number of solutions because if  $(u^*, v^*)$  is optimal, then  $(\beta u^*, \beta v^*)$  is also optimal for  $\beta > 0$  (Charnes *et al.* 1994). This problem is corrected by converting the ratio form into an equivalent linear programming

problem as follows:

$$\begin{aligned}
 \text{Max } w_0 &= \sum_r u_r y_{ro} \\
 \text{s.t.: } \sum_i v_i x_{io} &= 1 \\
 \sum_r u_r y_{rj} - \sum_i v_i x_{ij} &\leq 0 \\
 u_r &\geq \varepsilon \\
 v_i &\geq \varepsilon
 \end{aligned}$$

Färe *et al.* (1994) developed a variation of the preceding linear programming approach to model efficiency, productivity, and capacity<sup>1</sup>. The models they use measure the efficiency of individual producers by constructing a “best-practice frontier” through a piecewise linear envelopment of the data generated by all producers in the group. Estimates generated by those models are therefore “relative” measures based on the best producers within the group.

The following sections describe several linear programming models to estimate input and output technical efficiency and capacity output based on the approach used by Färe *et al.* (1994).

Output technical efficiency is a measure of the potential output of a DMU given that inputs are held constant. Färe *et al.* (1994) modeled the output technical efficiency measure for any DMU using linear programming:

$$\begin{aligned}
 \text{Max } &\theta \\
 &\theta, z \\
 \text{s.t.: } &\theta u_{jm} \leq \sum_{j=1}^J z_j u_{jm}, \quad m = 1, 2, \dots, M \\
 &\sum_{j=1}^J z_j x_{jn} \leq x_{jn}, \quad n = 1, 2, \dots, N, \\
 &z_j \geq 0, \quad j = 1, 2, \dots, J
 \end{aligned}$$

where:

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<sup>1</sup> See Färe *et al.* (1989).

$\theta$  = output technical efficiency measure

$u_{jm}$  = quantity of output  $m$  produced by DMU  $j$

$x_{jn}$  = quantity of input  $n$  produced by DMU  $j$

$z_j$  = intensity variable for DMU  $j$

A value of  $\theta = 1.0$  signifies that the DMU is efficient; a value of  $> 1.0$  indicates that the DMU is inefficient. For example, a score of 1.25 means that it should be possible to increase all outputs from a DMU by 25 percent with the same level of inputs.

An input-oriented technical efficiency model examines the vector of inputs used in the production of any output bundle, and measures whether a firm is using the minimum inputs necessary to produce a given bundle of outputs. Efficiency is measured by the maximum reduction in inputs which will still allow a given output bundle to be produced.

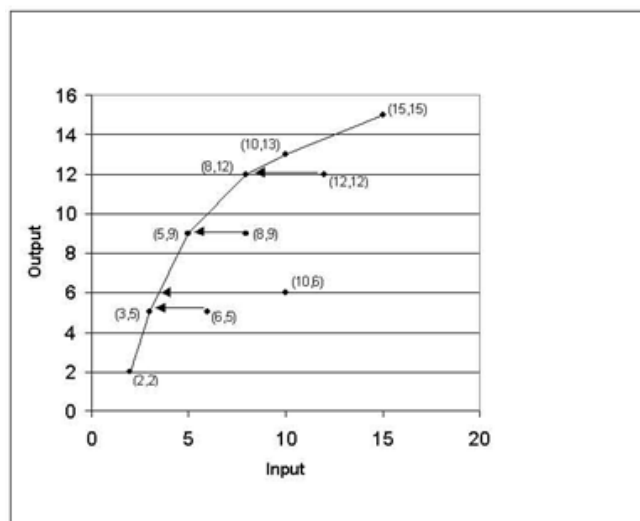


Figure 2: Input-oriented DEA model.

Figure 2 depicts the results of an input-oriented model using a single-input, single-output example. Firms to the right of the frontier are deemed to be inef-

efficient because they could produce the same level of output for less input. For example, the point (6,5) means 6 units of input are used to produce 5 units of output. Another firm is using 3 units of input to produce 5 units of output. The first firm is technically inefficient compared to the second firm because much more input is used to produce the same level of output.

Färe *et al.* (1994) proposed the following input-oriented DEA model to measure technical efficiency:

$$\begin{aligned} & \text{Min } \lambda \\ & \lambda, z \\ \text{s.t.: } & u_{jm} \leq \sum_{j=1}^J z_j u_{jm}, \quad m = 1, 2, \dots, M, \quad (\text{Eq. 1}) \\ & \sum_{j=1}^J z_j x_{jn} \leq \lambda x_{jn}, \quad n = 1, 2, \dots, N, \quad (\text{Eq. 2}) \\ & z_j \geq 0, \quad j = 1, 2, \dots, J, \end{aligned}$$

where:

$$\begin{aligned} \lambda &= \text{efficiency measure to be calculated for each DMU } j \\ u_{jm} &= \text{quantity of output } m \text{ produced by DMU } j \\ x_{jn} &= \text{quantity of input } n \text{ used by DMU } j \\ z_j &= \text{intensity variable for DMU } j \end{aligned}$$

Since the variable  $\lambda$  is calculated for each DMU, the preceding formulation is estimated once for each DMU in the data set. Equations 1 and 2 define a set of constraints for each output and input. If there are two outputs, Equation 1 will define a set of constraints, one for each output. A value of  $\lambda=1.0$  means that a firm is considered efficient, while a value  $\lambda < 1.0$  means a firm is inefficient. Thus, a value of  $\lambda=0.70$  means that a firm could reduce its inputs by 30%, and produce the same level of output.

Since its introduction by Charnes *et al.* (1978), there have been many applications of DEA. A detailed bibliography related to DEA (1978-1992) can be

found in Charnes *et al.* (1994, chp. 22). Since the early work of Charnes, Cooper and Rhodes (CCR), there have been a number of extensions to the DEA model.

Some of the benefits of DEA are:

- no need to explicitly specify a mathematical form for the production function
- proven to be useful in uncovering relationships that remain hidden for other methodologies
- capable of handling multiple inputs and outputs
- capable of being used with any input-output measurement
- the sources of inefficiency can be analysed and quantified for every evaluated unit

It should be emphasized that a linear program of this form must be solved for each of the DMU.

Data Envelopment Analysis (DEA) has been recognized as a valuable analytical research instrument and a practical decision support tool<sup>2</sup>. DEA has been credited for not requiring a complete specification for the functional form of the production frontier nor the distribution of inefficient deviations from the frontier. Rather, DEA requires general production and distribution assumptions only. However, if those assumptions are too weak, inefficiency levels may be systematically underestimated in small samples. In addition, erroneous assumptions may cause inconsistency with a bias over the frontier. Therefore, the ability to alter, test and select production assumptions is essential in conducting DEA-based research.

Numerous applications of this technique can be found in the literature. A comprehensive collection of theoretical and empirical work can be found in Emrouznejad (2001).

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<sup>2</sup> See Lovell & Schmidt (1988) and Seiford & Thrall (1990).

#### 4. Analytical Framework

Many studies have focused on the analysis of efficiency in the primary sector. Global and business efficiency in processing of milk products have been thoroughly studied by Arzubi & Berbel (2001), Singh *et al.* (2000) and Ferrier and Porter (1991) in Argentina, India and USA, respectively. A similar research was done by González *et al.* (1996) and Pardo *et al.* (2001) in Spain. Efficiency of raw cotton cooperatives was studied by Caputo & Lynch (1993) in California. Japanese agricultural cooperative sector was studied by Sueyoshi *et al.* (1998). Athanassopoulos & Ballantine (1995) analyzed the efficiency of the agricultural processing industry in United Kingdom, industry also studied by Aldaz & Millan (2000) with a temporal evolution perspective in Spanish regions.

Many studies have been devoted to the agricultural industry in the Southern and Eastern parts of Spain. Temporal evolution was used by Damas & Romero (1997) for olive oil mill cooperatives in Jaén, while Vidal *et al.* (2000) and Segura & Vidal (2001) studied efficiency on citrus fruit cooperatives in Valencia with a static analysis. Despite not being an application of the DEA analysis, works of Calatrava & Cañero (2001a, 2001b) applied to the study of technical efficiency in the glasshouse growers of Almería by econometrical techniques. Aldaz & Millán (1996) work, focused on measurement and comparison of agricultural productivity between Spanish autonomous communities, is remarkable. And also works by Chavas & Aliber (1993), Colom *et al.* (1996), Damas *et al.* (1997), Fernández & Herruzo (1996), Martínez *et al.* (2002), Pardo *et al.* (2001), Prieto (1987), Prieto *et al.* (1990), Sabaté (2002) and Vidal *et al.* (2000), among others.

Nevertheless, no works have been focused on the estimation of efficiency in the agricultural industry in Northern Spain. That is why this paper covers the agricultural firms established in northern Spain, called Green Spain, autonomous communities of Principality of Asturias, Cantabria, Galicia (provinces: La Coruña, Orense, Lugo and Pontevedra) and Basque Country (provinces: Alava, Guipuzcoa and Vizcaya).



Our primary purpose in the present study was to differentiate the most efficient companies from the least efficient ones on the basis of a set of economic variables by legal status<sup>3</sup>, ownership and autonomous community.

Sample selection starts from a database that is made up of the annual accounts of the agricultural companies located in Asturias, Cantabria, Galicia and Basque Country (based on Agrarian Census and the database SABI –Sistema de Análisis de Balances Ibéricos-). So the sample was limited to business required to deposit their financial statements in the Registro Mercantil (Business Register). This keeps out any individual operation and any other legal status not compelled to deposit financial statements. Analysed accounts correspond to the year 2004.

A set of filters is applied to the database to guarantee the quality of financial information and also to guarantee that the selected sample really shows the economic activity of mercantile companies and cooperatives in the agricultural sector. Companies are eliminated if they did not carry out any activity, omit data about fixed assets or operating income or they do not provide any information about their employees. We also test the sectorial classification declared by every company against its business purposes in financial statements.

After the filtering process, sampling was limited to 118 companies whose legal status is mercantile company (corporates) or cooperative. Mercantile companies are divided on legal liability so we have in the sample public limited companies and limited liability companies (Sociedad Anónima and Sociedad de Responsabilidad Limitada according to Spanish mercantile legislation, R.D. 1564/1989, Official Spanish Gazette BOE 310-1564; for cooperatives legislation, see Ley 27/1999, Official Spanish Gazette BOE 170-15681) that in the paper will be denoted by their Spanish acronyms, S.A. for public limited companies and S.L. for limited liability companies. Cooperatives are autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspi-

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<sup>3</sup> See Bab & Boynton (1981), Chaddad & Cook (2004) and Salazart & Galve (2008).

rations through a jointly owned and democratically controlled enterprise, as defined by International Cooperative Alliance. It may also be defined as a business owned by the people who use its services. A mainstream cooperative comprises a legal entity owned and democratically controlled by its members, with no passive shareholders, unless they hold non-voting shares. It thus combines the equal control characteristic of many partnerships with the legal personality conferred on corporations.

Many works have been devoted to the measure of efficiency in agricultural cooperatives; of these we mention Akridge & Hertel (1991), Cook (1995), Cook & Iliopoulos (2000), Guzmán *et al.* (2006), Lerman & Parliament (1991), Montegut *et al.* (2002), Porter & Scully (1987), Segura & Oltra (1995), Sexton & Iskow (1993). However, this work goes beyond and focuses on the comparative between companies with different legal and organizational forms.

The output and input orientation (see section 3) have been applied to the study of the efficiency on the agricultural sector. Nevertheless, in this paper we have performed an input orientation model because we consider input model to be more relevant to the working scheme of cooperatives whose members work for a fixed production while minimizing cost.

DEA requires to define the inputs and outputs to be used in the analysis. Different criteria have been applied for the selection of variables in the design of DEA models (Martínez & Martínez Carrasco, 2002; Damas & Romero, 1997; Jaenicke & Lengnick, 1999; Chavas & Aliber, 1993; Ferrier & Porter, 1991). We have followed the seminal work of Smith (1990) which developed a financial analysis by means of DEA for multidimensional ratio scaling.

To reach our goal, we conducted a Delphi<sup>4</sup> study. Through this study, we asked a panel of sectorial experts their opinion about the best measures of efficiency

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<sup>4</sup> The Delphi method is a systematic and iterative process by which the opinions of a group of experts are obtained, anonymously reconsidered and modified with the purpose of reaching a consensus view among those experts, if it is possible.

(inputs and outputs) contained in the account books of the companies. Then, we proceeded to observe whether there was correlation between the answers using the Kendall<sup>5</sup> correlation coefficient. Kendall coefficient validated the variable selection with a value of 0.85.

Selected variables were: operating revenue, net fixed assets, staff cost, raw material and consumables cost and another operating expenses. They were classified as inputs-outputs according to Table 2.

Table 2: Variables used in the analysis.

|                |                              |
|----------------|------------------------------|
| OUTPUTS:       | Operating revenue            |
| INPUTS:        | Net fixed assets             |
| W Kendall=0.85 | Staff costs                  |
|                | Raw material and consumables |
|                | Operating expenses           |

## 5. Isotonicity Test

For the validation of the developed DEA model, we examined the assumptions of the “isotonicity” relationships between the input and output factors, i.e., an increase in any input should not result in a decrease in any output (Charnes *et al.*, 1985; Bowlin, 1987). Following Golany and Roll (1989), regression analysis on the selected input and output factors is a useful procedure to examine the isotonicity relationships between the input and output factors. If the correlation of the selected input and output factors is positive, these factors are isotonicity related and can be included in the model. The factor that has a weak isotonicity relation to the other factors should be re-examined. Alternatively, a strong

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<sup>5</sup> This statistic allows us to know the correlation coefficient between the various alternatives proposed by the experts.

correlation may indicate that the information contained in one factor is already represented redundantly by other factors. In addition, according to Golany and Roll (1989), the number of DMUs should be at least twice of the total number of input and output factors considered when applying the DEA model. In this study the number of DMUs is 118. Therefore, in this study, the proposed DEA model has high construct validity.

According to the results of intercorrelation analysis, we easily see that the correlation coefficients between outputs and inputs are all positive and the isotonicity test is passed. The results are shown in Table 3.

Table 3: Correlation results.

|                |                        | <b>Input 1</b> | <b>Input 2</b> | <b>Input 3</b> | <b>Input 4</b> | <b>Output</b> |
|----------------|------------------------|----------------|----------------|----------------|----------------|---------------|
| <b>Input 1</b> | <i>Pearson</i>         | 1              | 0,015          | 0,225 **       | 0,375 **       | 0,161 *       |
|                | <i>Sig. (1-tailed)</i> | ,              | 0,436          | 0,007          | 0,000          | 0,040         |
| <b>Input 2</b> | <i>Pearson</i>         | 0,015          | 1              | 0,235 **       | 0,508 **       | 0,796 **      |
|                | <i>Sig. (1-tailed)</i> | 0,436          | ,              | 0,005          | 0,000          | 0,000         |
| <b>Input 3</b> | <i>Pearson</i>         | 0,225 **       | 0,235 **       | 1              | 0,712 **       | 0,729 **      |
|                | <i>Sig. (1-tailed)</i> | 0,007          | 0,005          | ,              | 0,000          | 0,000         |
| <b>Input 4</b> | <i>Pearson</i>         | 0,375 **       | 0,508 **       | 0,712 **       | 1              | 0,834 **      |
|                | <i>Sig. (1-tailed)</i> | 0,000          | 0,000          | 0,000          | ,              | 0,000         |
| <b>Output</b>  | <i>Pearson</i>         | 0,161 *        | 0,796 **       | 0,729 **       | 0,834 **       | 1             |
|                | <i>Sig. (1-tailed)</i> | 0,040          | 0,000          | 0,000          | 0,000          | ,             |

\*\* Correlation is significant at the 0.01 level (1-tailed).

\* Correlation is significant at the 0.05 level (1-tailed).

**Input 1:** Net fixed assets. **Input 2:** Raw material and consumables. **Input 3:** Staff costs.

**Input 4:** Operating expenses. **Output:** Operating revenue.

## 6. Empirical Results and Discussion

Table 4 illustrates the results obtained in the input efficiency analysis. DMUs, legal entity and efficiency levels are shown.

According to these results, 37 percent of observations are 100 percent efficient. These DMUs define the efficient frontier of production. 7 percent are in the high level, more than a 90 percent of efficiency. 40 percent are on the intermediate

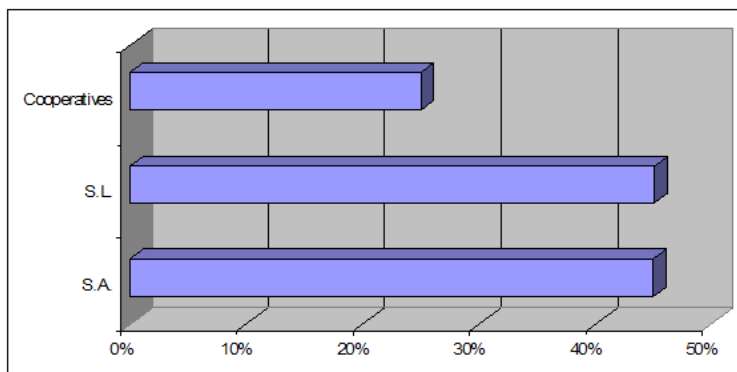
Table 4: Efficiency Results.

|       |      |       |       |      |       |        |      |       |
|-------|------|-------|-------|------|-------|--------|------|-------|
| DMU1  | S.A. | 1,000 | DMU41 | S.L. | 1,000 | DMU81  | S.L. | 0,792 |
| DMU2  | S.L. | 1,000 | DMU42 | S.L. | 1,000 | DMU82  | C.   | 0,598 |
| DMU3  | S.L. | 1,000 | DMU43 | C.   | 0,608 | DMU83  | S.L. | 0,660 |
| DMU4  | S.A. | 0,920 | DMU44 | S.L. | 0,657 | DMU84  | C.   | 0,677 |
| DMU5  | S.A. | 0,429 | DMU45 | S.L. | 0,790 | DMU85  | S.L. | 0,607 |
| DMU6  | S.L. | 1,000 | DMU46 | S.A. | 0,124 | DMU86  | S.L. | 0,783 |
| DMU7  | S.L. | 1,000 | DMU47 | S.L. | 0,801 | DMU87  | S.L. | 0,106 |
| DMU8  | S.A. | 0,869 | DMU48 | S.L. | 0,297 | DMU88  | S.L. | 1,000 |
| DMU9  | S.L. | 0,779 | DMU49 | S.L. | 1,000 | DMU89  | S.A. | 1,000 |
| DMU10 | S.L. | 1,000 | DMU50 | S.L. | 0,671 | DMU90  | S.L. | 1,000 |
| DMU11 | S.A. | 0,177 | DMU51 | S.L. | 0,727 | DMU91  | S.A. | 1,000 |
| DMU12 | C.   | 0,877 | DMU52 | S.L. | 0,791 | DMU92  | C.   | 0,481 |
| DMU13 | S.L. | 0,016 | DMU53 | S.L. | 0,782 | DMU93  | S.L. | 0,857 |
| DMU14 | S.L. | 0,963 | DMU54 | S.L. | 0,863 | DMU94  | S.L. | 1,000 |
| DMU15 | S.A. | 0,628 | DMU55 | S.L. | 1,000 | DMU95  | S.L. | 0,892 |
| DMU16 | S.L. | 1,000 | DMU56 | S.L. | 0,731 | DMU96  | S.A. | 1,000 |
| DMU17 | S.L. | 0,891 | DMU57 | S.L. | 1,000 | DMU97  | S.L. | 0,709 |
| DMU18 | S.A. | 0,335 | DMU58 | S.L. | 0,762 | DMU98  | S.L. | 1,000 |
| DMU19 | S.L. | 0,604 | DMU59 | S.L. | 1,000 | DMU99  | S.L. | 0,982 |
| DMU20 | S.A. | 1,000 | DMU60 | S.L. | 0,943 | DMU100 | S.L. | 1,000 |
| DMU21 | S.L. | 1,000 | DMU61 | S.L. | 0,360 | DMU101 | S.A. | 1,000 |
| DMU22 | S.L. | 0,852 | DMU62 | S.A. | 0,124 | DMU102 | S.L. | 0,524 |
| DMU23 | S.L. | 0,752 | DMU63 | S.L. | 0,419 | DMU103 | C.   | 0,687 |
| DMU24 | C.   | 0,792 | DMU64 | S.L. | 0,937 | DMU104 | S.A. | 1,000 |
| DMU25 | S.L. | 1,000 | DMU65 | S.L. | 1,000 | DMU105 | S.L. | 0,741 |
| DMU26 | S.L. | 1,000 | DMU66 | S.L. | 1,000 | DMU106 | S.A. | 1,000 |
| DMU27 | S.A. | 0,713 | DMU67 | C.   | 0,733 | DMU107 | C.   | 1,000 |
| DMU28 | S.L. | 0,651 | DMU68 | S.L. | 1,000 | DMU108 | C.   | 1,000 |
| DMU29 | S.L. | 0,790 | DMU69 | S.L. | 1,000 | DMU109 | S.L. | 1,000 |
| DMU30 | S.A. | 0,445 | DMU70 | S.A. | 0,258 | DMU110 | S.L. | 0,406 |
| DMU31 | C.   | 0,624 | DMU71 | C.   | 0,345 | DMU111 | S.L. | 1,000 |
| DMU32 | S.L. | 0,782 | DMU72 | S.L. | 1,000 | DMU112 | S.L. | 1,000 |
| DMU33 | S.L. | 0,736 | DMU73 | S.L. | 1,000 | DMU113 | S.A. | 1,000 |
| DMU34 | S.L. | 1,000 | DMU74 | S.L. | 0,985 | DMU114 | C.   | 1,000 |
| DMU35 | S.L. | 0,750 | DMU75 | S.L. | 0,770 | DMU115 | C.   | 0,961 |
| DMU36 | S.L. | 1,000 | DMU76 | S.L. | 0,681 | DMU116 | S.L. | 0,890 |
| DMU37 | S.L. | 0,809 | DMU77 | C.   | 0,718 | DMU117 | S.L. | 1,000 |
| DMU38 | S.L. | 0,815 | DMU78 | S.L. | 0,679 | DMU118 | S.L. | 0,937 |
| DMU39 | S.L. | 0,826 | DMU79 | S.L. | 0,987 |        |      |       |
| DMU40 | S.L. | 0,706 | DMU80 | C.   | 0,648 |        |      |       |

level, between 60 and 80 percent of efficiency. 14 percent of the companies are in low levels, below 50% of efficiency.

According to legal entity there is about 45 percent of S.A. and another 45 percent of S.L. in the highest levels of efficiency, while only about a 25 percent of cooperatives.

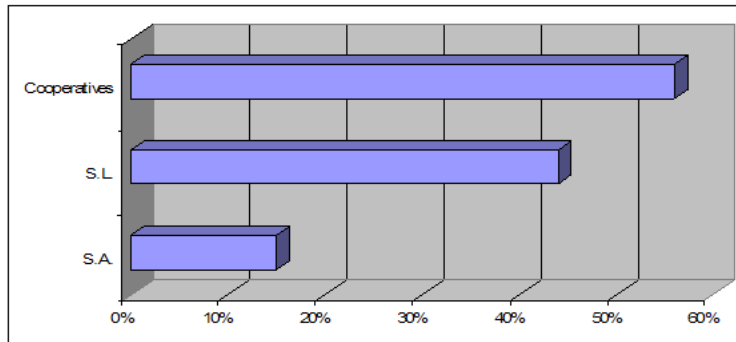
Cooperatives are mostly grouped on the intermediate level of efficiency, about a 56 percent, with a 44 percent of S.L. and a 15 percent of S.A. In the lowest level of efficiency we can find a majority of mercantile societies, 35 percent of S.A. and 10 percent of S.L., while only 18 percent of cooperatives. Graphs 1, 2 and 3 show these results for each level of efficiency.



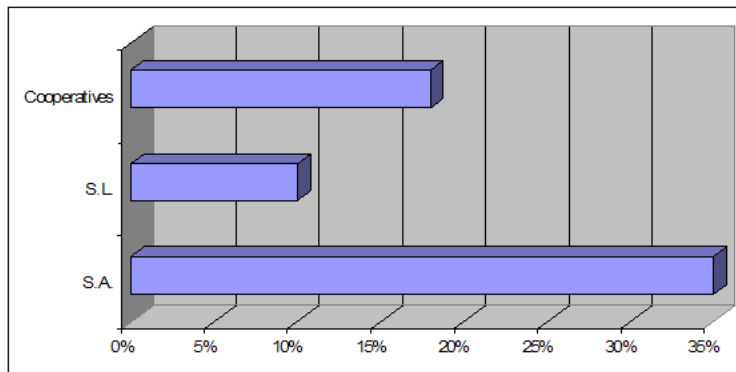
Graph 1: High levels efficiency.

Most efficient S.A. and S.L. can be found at Basque Country and while S.L. also at Cantabria. We must remember almost cooperatives in Green Spain are located at Galicia, so there we can find the most and the less efficient.

Empirical study shows the most efficient legal entities are mercantile societies and cooperatives are at intermediate level. At lowest degree of efficiency we find a majority of mercantile societies. This contradictory result could be congruous with the analysis of individual DMUs that show us some mercantile societies with a low level of activity. This low level of activity combined with a fixed input (fixed



Graph 2: Medium levels efficiency.



Graph 3: Low levels efficiency.

assets, permanent workers. . . ) results in a low efficiency. Otherwise, cooperatives are enterprises that put people at the centre of their business and not capital, decisions taken by cooperatives balance the need for profitability with the needs of their members and the wider interests of the community. Cooperatives create and maintain employment-providing income so maybe there is no interest in holding a low level of activity.

Summarizing, the form of legal entity do not seem to be very decisive for the efficiency of the organization. In this way, we observe that the average efficiency is 0.73 for the cooperatives and 0.80 for the corporates. With these results, we hypothesize that there is no significant difference for the efficiency of the organization according to legal entity. In comparing the efficiency degree means of

corporates and cooperatives we are testing the hypothesis that the two samples came from the same population. Testing for difference of two means we found that there is no significant difference between them (see Table 5). So we conclude that legal entity is not related in any way to efficiency degree.

Table 5: Test of two means of unpaired samples with unequal variance.

|                                     | <b>Corporates</b> | <b>Cooperatives</b> |
|-------------------------------------|-------------------|---------------------|
| <b>Mean</b>                         | 0.806             | 0.734               |
| <b>Variance</b>                     | 0.060             | 0.037               |
| <b>Observations</b>                 | 102               | 16                  |
| <b>Hypothesized Mean Difference</b> | 0                 |                     |
| <b>Observed Mean Difference</b>     | 0.072             |                     |
| <b>df</b>                           | 23.369            |                     |
| <b>t Stat</b>                       | 1.331             |                     |
| <b>P (T&lt;=t) one-tail</b>         | 0.098             |                     |
| <b>T Critical one-tail</b>          | 1.713             |                     |
| <b>P (T&lt;=t) two-tail</b>         | 0.196             |                     |
| <b>T Critical two-tail</b>          | 2,068             |                     |

Results are consistent with another works in this field and have consequences at the managerial and legislative levels. The result should not be interpreted that the definition of property rights does not affect the efficiency in which resources are allocated in organizations. Cooperatives could have problems that create inefficiencies within the cooperative form, but its legal entity as cooperative also could put them on edge over the rest of legal entities. If benefits are properly utilized, cooperative form can obtain the same or even higher levels of efficiency (Salazar & Galve, 2008).

Economic literature that analyzes the differences in efficiency between cooperatives and corporates, attributes to the rights of property of the cooperatives as the source of the inefficiencies that it could generate. Specifically, literature identifies five problems known as horizon, control, influence, common property and investment portfolio problems.



According to these arguments, derived from property rights theory, cooperatives should always be less efficient than capitalist firms. But reality leads us to question this statement and consider the advantages of cooperatives against capitalist forms. The arguments that support these advantages are based on the theory of transaction costs, greater flexibility in the cooperative firm and in their tax protection (Salazar & Galve, 2008). Higher tax protection is pointed by Porter & Scully (1987) as the main cause of advantages through reduction of tax rates and favouritism in subsidies.

To conclude, certain characteristics that may increase the inefficiency of the cooperative firm can place it in a better position to efficiency in a contradictory way. This may explain the little influence of the form of government over efficiency and the inconsistency of the results of the analysis. It is also very important to remark that the results of our work are biased by its regional and sectoral characteristics. This bias prevents consideration of the companies analyzed as representative of the rest of Spanish companies, we must be cautious about extrapolating results.

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