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MEASURING THE ECONOMIC EFFICIENCY OF ITALIAN AGRICULTURAL ENTERPRISES

Darina Zaimova

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Fondazione Euricse, Italy

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MEASURING THE ECONOMIC EFFICIENCY OF ITALIAN AGRICULTURAL ENTERPRISES

Darina Zaimova[1]

Abstract

Early microeconomic theory established its framework under the assumption that producers' behaviour is optimal towards input allocation and output level. Since Debreu and Farrell this basic neoclassical approach has been extended, allowing for producers' decisions to diverge from the optimum production choice. The generally accepted reason for production units no to be efficient regards the presence of technical or allocative inefficiency components in their production function. Therefore one of the main objectives of studying production and cost frontiers is to estimate their efficiency towards input utilization and allocation.

This paper aims to measure the technical efficiency of agricultural enterprises in Italy during the period 2003 – 2007 by applying a stochastic frontier analysis to panel data. The developed two-sectored model distinguishes between agricultural production function and non-agricultural production function. The variables included in the first production function are related directly to the final product and are utilized during the production process. The non-agricultural production function includes two categories of variables: the first accounts for the general characteristics of the agricultural enterprises, while the second attempts to describe the opportunities and restrictions of the institutional framework.

Key words: agricultural enterprises, SFA model, stochastic frontier production models, technical efficiency

[1]Darina Zaimova is a post-doctoral research fellow at the European Research Institute on Cooperatives and Social Enterprises, Euricse

1. Introduction

Policy interventions and private initiatives undertaken in the Italian agricultural sector have registered varying degrees of impact at the local level, due to the diversity of regional characteristics. The most important prerequisites for the better accumulation of the institutional and financial resources are the degree of investment opportunities and stimuli for entering into new business initiatives, well-defined contract arrangements among market participants and visibility regarding the achieved results, intensification of production processes and technological innovation. The level of efficiency and competitiveness of agricultural enterprises' economic activity is also defined by these characteristics.

The present paper estimates the technical efficiency of agricultural enterprises registered in 21 Italian regions during a three-year period (2003-2007). Specified organizations such as cooperatives, partnerships, producers' organizations and associations are contained in the constructed data set under the denotation "agricultural enterprises".

The choice to structure a functional model that both accounts for agricultural and non-agricultural factors is grounded on the assumption that production inputs are only part of the overall efficiency equation. The starting point is that there are other resources of efficiency that could be exploited by enterprises, but not modified or changed by them. In general the institutional environment consists of significant requirements and provisions, which every organization is expected to comply with in order to legitimate its activity. An important suggestion by Bromley (1989) states that: *"(…) institutions determine the nature and the magnitude of transaction costs. Therefore, the notion of the firm as a reflection of transaction costs is seen to be subject to some analytical ambiguity"*[2]. Considering that property rights define the costs and benefits and who would receive them, Barzel (1989) specifies that property rights would evolve in a way that provides maximum efficiency. Therefore, an aspect of collective organization in the agricultural sector that goes beyond the definition of the presented legal forms (i.e., cooperatives, companies) is the specific contract mechanisms that guarantee a created organizational reputation associated with the quality and location of particular products[3].

The *first part* of the paper concentrates on the theoretical base and an explanation of efficiency concepts and studies of production and cost functions. The focus is on the possible approaches and methodology for measuring effects and results of institutional policy conducted over contract arrangements in the agricultural sector. The *second part* is represented by the results of an applied stochastic frontier analysis of chosen parameters that describes decision-making units in the case study. The panel data

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[2]Bromley, D.W. (1989) Economic interests and institutions: The conceptual foundations of public policy"; New York: Basil Blackwell, pp.52
[3]Sauvee, L. (2000) "Managing a brand in the tomato sector: authority and enforcement mechanisms in a collective action"; In: XIV International Symposium on Horticulture Economics, vol. 1

model contains information both about the economic status of agricultural enterprises and the provisions of the institutional environment. The *final part* provides some recommendations and general conclusions proceeding from results of the analysis.

2. Discussion of efficiency concepts and functional forms

Efficiency and productivity are the core concepts of economics. The general interest in measurement has opened the prospect of micro-level approaches in studies that develop new perspectives on how to define efficiency and productivity and how to calculate benchmark technology. There are two different concepts related to the measurement of efficiency: production and cost efficiency. One of the most debated findings is the particular inefficiency's sources, which are usually addressed to the deficiency in applying technology and the suboptimal allocation of resources. The definition of technical efficiency provided by Koopmans (1951) formulates that: *"A producer is technically efficient if, and only if, it is possible to produce more of any output without producing less of some other output or using more of some input"*. However, determining whether or not a producer is efficient is not only a matter of providing technical information and descriptions of production possibilities. The contribution of Farrell (1957) is significant in regards to decomposition of technical efficiency, price (or allocative) efficiency and overall efficiency at the micro level. He introduces the input-oriented measure of allocative efficiency as the ratio of cost efficiency to technical efficiency. Later, Kuenzle (2005) formulates in detail the economic dimension of estimating cost minimization opportunities. This assumption allows for analyzing whether a producer uses production inputs according to their relative prices. Therefore efficiency is defined not only by the utilization of inputs in the most economical way, but also according to their relative price ratios. Consequently a producer appears to be allocatively efficient if he uses his production inputs considering their optimal price distribution. More precisely the technical rate of substitution has to be equal to the economic rate of substitution at the optimum level (Varian, 1999). The third concept related to efficiency estimation draws attention to scale efficiency, which ascertains whether the producer operates at an economically reasonable size. The output level, associated with the minimum average costs of production is the economically correct size of the production unit. It is necessary to mention two dimensions related to scale efficiency. First, the elasticity of scale measures the percentage change in output when all inputs are changed by a small amount. The second dimension is the elasticity of size that accounts for the per-cent of cost when the output is marginally altered.

Indisputably Farrell's (1957) article on efficiency measurement led to the development of several approaches to efficiency analysis. The literature on efficiency measurement can be broadly categorized in two main streams: frontier (parametric and non-parametric approaches) and non-frontier approaches. The frontier approach, represented by Stochastic and Bayesian approaches, requires structuring a functional form (production, cost, profit functions or regression equations). The non-parametric estimates are conducted by data envelopment analysis, which is characterized as a linear-programming methodology. Both analyses provide for a wide spectrum of opportunities to measure and quantify the influence of exogenous factors over technical efficiency.

The term *"frontier"* appears to be the key element in the performed analyses. According to Koopmans and Lovell (2000), production technology is described as a set of feasible input – output vectors. The production frontier itself represents the boundary of these feasible production technologies and is characterized by *"(…) the upper boundary of production possibilities, and the input – output combination of each producers is located on or beneath the production frontier"*[4].

Following Mahadevan (2002) the frontier is constructed as a "set of obtainable positions". The provided definition specifies that: *"(…) a production frontier traces the set of maximum outputs obtainable from a given set of inputs and technology, and a cost frontier traces the minimum achievable cost given input prices and output. The production frontier is an unobservable function that is said to represent the 'best practice' function as it is a function bounding or enveloping the sample data."*

Both frontier approaches provide for significant studies and results in the agricultural sector and market behaviour of participants. Battese and Coelli (1992) have applied stochastic frontier analysis to study the technical efficiency of paddy farmers in India. They have estimated a production frontier for the following models: farm effects have time-varying structure; farm effects have half-normal distribution; time-invariance is considered and farm effects again have half-normal distribution; and decision-making units are assumed to be fully technically efficient. Later, in 1995 the authors applied a maximum likelihood method for simultaneous estimation of the parameters of the stochastic frontier and of the model for technical inefficiency effects. The proposed inefficiency model accounts for both technical change and time-varying inefficiency effects.

The data envelopment analysis has also provided significant results in studying frontier efficiency. Barros and Santos (2007) have estimated the technical efficiency of the Portuguese wine sector cooperatives with the general goal to determine whether they are more or less efficient than private enterprises. According to the results provided cooperatives have achieved better efficiency performance than private companies due to their unique assets, locations, scale economies and specific organizational structures. This conclusion is supported by the work of Maietta and Sena (2008) and their frontier estimations that prove that cooperatives appear to be more efficient than conventional companies. Cooperative organizations have improved their technical efficiency and thereby increase their competitive positions. Managerial capabilities and technological improvements have also been acknowledged as significant factors for the more efficient performance of cooperatives that perform in

[4]Kumbhakar, S.C., C.A.Knox Lovell (2000) Stochastic frontier analysis, Cambridge University Press, pp.28

the agricultural sector (Bonfiglio, 2007).

The agricultural sector, its participants and their typical features provide a fruitful research field for studying the relationships among efficient performance, market competition and policy-making. An interesting perspective is given by several studies that attempt to quantify institutional influence over economic efficiency. Stochastic frontier analysis has been applied in order to measure how divergence in the quality of institutions, including: control of corruption, strength of the law and quality of the regulatory framework - explains cross-country differences in aggregate efficiency (Meon, Weill, 2006). The relationship between foreign direct investment and the rate of growth of Gross Domestic Product is also developed through quantitative and comprehensive results obtained from the same analysis (Wijeweera, Villano, Dollery, 2004). According to the results, the flow of foreign direct investment exerts a positive impact on economic growth only in the presence of a highly skilled labour force; accordingly open trade policy gains efficiency, but at the same time corruption practices have a negative impact.
The above mentioned analysis' application and suggested results are only part of the existing research experience (See Appendix A). Although it is not possible to describe them all, it is important to consider the opportunities that frontier methodology provides in studying the various aspects that influence efficiency.

The earliest models in parametric frontier estimation (Ordinary least squares) refer to the estimation of deterministic frontiers or specification of a one-sided error term in order to represent the inefficiency component. The second class of frontier models, represented by stochastic frontier models, adds an additional error term which accounts for a measurement model and is assumed to be symmetric. The analysis dates back to Aigner, Lovel and Schmidt (1977) and Meeusen and van den Broeck (1977), who independently proposed a stochastic frontier production function with a two-part "composed" error term. In 1987 Kumbhakar developed a profit maximizing approach where both output and inputs are choice (endogenous) variables. He used this profit maximizing framework to confirm that a producer is unable to attain the profit frontier due to the presence of either a technical or allocative inefficiency or both.

There are two sub-levels of stochastic frontier models: cross sectional models and panel data models. The cross sectional sub-model is estimated by the maximum likelihood estimation and its appropriate application is when there is only one observation per decision-making unit. The panel data sub-model consists of decision-making units observed at different periods. Such data contains more information about the parameters chosen to characterize the decision-making units. Furthermore as already mentioned the model proposed by Battese and Coelli (1995) allows for estimation of the effects of technical change in the stochastic frontier and of time-varying technical inefficiencies, but at the same time this model could not capture the different temporal patterns of changes in technical efficiency[5].

The main difference between stochastic frontier analysis and Ordinary Least Squares ensues from the additional error term. In the case of cost frontier the OLS model could be expressed by:

$$\mathbf{Ln\ Y_{it} = f(x_{it}\ \beta) + v_i} \qquad \mathbf{(1)}$$

where **Ln** $\mathbf{Y_i}$ is the logarithm of production of the i-th unit, **f (...)** is the production function and $\mathbf{v_i}$ is the error term. The input quantities of the i-th unit are represented by $\mathbf{x_i}$ and the parameters that are to be estimated are denoted by β.

The stochastic frontier model introduces the non-negative random variable associated with technical inefficiency $\mathbf{u_i}$ that is the *white noise* in the data. The stochastic frontier production function is expressed by the following form:

$$\mathbf{Ln\ Y_{it} = f(x_{it}\ \beta) + v_i - u_i} \qquad \mathbf{(2)}$$

The stochastic composite error term is estimated by $\varepsilon_i = \mathbf{v_i - u_i}$. The error component $\mathbf{u_i}$ is assumed to be distributed independently from $\mathbf{v_i}$, and to satisfy $u_i \leq 0$ or N (μ, σ_u^2). Battese and Cora (1977) replace σ_v^2 and σ_u^2 with $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / \sigma_v^2 + \sigma_u^2$.

The best known production function is introduced by Cobb and Douglas. An alternative of the Cobb-Douglas production function is the introduced transcendental logarithmic (translog) production by Christensen, Jorgenson and Lau (1973):

$$\mathbf{Ln\ Y_{it} = \beta_0 + \beta_T \ln t + ½\ \beta_T \ln t^2 + \sum_{j=1}^{n} \beta_j \ln x_{jit} + ½ \sum_{j=1}^{n}\sum_{k=1}^{l} \beta_{jk} \ln x_{jit}\, x_{kit} + \sum_{j=1}^{n} \beta_{jt} \ln x_{jit}\, t + e_{it}} \qquad \mathbf{(3)}$$

where $\mathbf{Y_{it}}$ represents the output level, $\mathbf{x_{jit}}$ is the $\mathbf{j^{th}}$ input used by the $\mathbf{i^{th}}$ cooperative, **t** is the time index that serves as a proxy for the technical change, and β stands for the parameters that are to be estimated.

The translog form is a flexible functional form and there are no a priori restrictions on the constructing technology. The theoretical properties are incorporated by restrictions:

$$\mathbf{\sum_{i=1}^{N} \beta_i = 1,\ \sum_{i=1}^{N} \beta_{ij} = 0,\ \text{and}\ \sum_{i=1}^{N} \delta_{ij} = 0} \qquad \mathbf{(4)}$$

The null hypothesis is tested by the following formula:

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[5]Battese, G.E., T.J. Coelli (1995) A Model of Technical Inefficiency Effects in a Stochastic Production Function for Panel Data, Empirical Economics 20: 325-332

$$LR=-2\,Ln[L(H_0) - L(H_1)] \qquad (5)$$

where LR or λ stands for the likelihood ratio (Likelihood Ratio test), Ln (H_0) represents the initial value of the null hypothesis (H_0) and the value of log likelihood function (H_1) is denoted by Ln (H_1).

The formulated production function defines the maximum possible output for a given set of production inputs. Inefficiency components exist if the level of production or output is less than the level observed in a fully technically efficient firm (Battese and Tassema 1993). Hence the frontier defined by the production function is a benchmark to estimate the output efficiency of an enterprise.

3. Results from stochastic frontier analysis in studying the economic efficiency of the Italian agricultural sector

Development in the Italian agricultural sector could be described accurately as "(...) localization through intensified interaction and cooperation" (Brunori, Cerutti, Medeot, Rossi, Valini, 2002). The leading agricultural sub-sectors are organized in well-structured network of enterprises that are particularly concentrated on production and market supply. Strong regional identity is preserved in fruit, wine and cheese production. Local production systems emerge in these sectors, which are based on small-scale production. This is an opportunity to maintain small-scale and semi-subsistence farming and to integrate through a large set of cooperative arrangements. It could be observed that this fact as rather beneficial because the concentration of production and distribution processes ensures continuity and imposes high quality standards for the final product. Nevertheless this "modernization" of the agricultural sector causes its restructuring in a manner less favourable for market participants in certain regions. The imbalanced relationship between small producers and their customers, processors or retailers, as well as the high level of fragmentation and low level of cooperation additionally complicate the retail system.

Policy mechanisms and interventions also could be described as complicated and varying because of the heterogeneity of Italian regions. In the first place they fall into different European funding categories. Secondly, not all regions possess the same special forms and conditions of autonomy pursuant to the special statutes adopted by Italian constitutional law[6]. Observations so far envisage that large-scale industry is more favoured since it receives a considerable percentage of European funds. At the same time administration costs are pushed up because of minute payments to small scale farmers. A solution was imposed by fixing limits on the payments that farmers could receive under the Single Payment Scheme. Policy implementation relies on more market conformity and fewer direct payments, but what is the consequent effect on

[6]Constitution of the Italian Republic, Art.116, "Friuili-Venezia Giulia, Sardinia, Sicily, Trentino-Alto Adige/Südtirol and Valle d'Aosta/ Valle d'Aoste have special forms and conditions of autonomy pursuant to the special statutes adopted by constitutional law.

employment, income and consumers in the sector? The marginal cost of producing goods which use land will exceed the social cost of production. Consequently market prices will influence the service sector, regardless of the products' true values. Besides this, a decrease in total employment in the agricultural sector probably cannot be avoided as it follows the extent to which production responds to price fluctuation.

In light of the advantages and obstacles presented, an interesting phenomenon is the relatively stable share of cooperatives in the sector (Table 1).

Table 1 - Number of registered agricultural cooperatives

	2006		2007		2008	
Region	**Number**	**%**	**Number**	**%**	**Number**	**%**
Piedmont	288	5,57	286	5,47	296	5,63
Valle d'Aosta/Vallée d'Aoste	45	0,87	44	0,84	43	0,82
Liguria	61	1,18	64	1,22	65	1,24
Lombardy	320	6,19	320	6,12	310	5,89
Trentino Alto Adige	227	4,39	220	4,21	210	3,99
Veneto	401	7,76	398	7,61	401	7,63
Friuli-Venezia Giulia	158	3,06	161	3,08	159	3,02
Emilia-Romagna	671	12,98	653	12,48	638	12,13
Tuscany	171	3,31	174	3,33	170	3,23
Umbria	111	2,15	112	2,14	113	2,15
Marches	125	2,42	128	2,45	124	2,36
Lazio	324	6,27	329	6,29	334	6,35
Abruzzo	143	2,77	145	2,77	146	2,78
Molise	52	1	48	0,92	49	0,93
Campania	420	8,12	439	8,39	447	8,5
Puglia	561	10,85	575	10,99	589	11,2
Basilicata	96	1,86	100	1,91	103	1,96
Calabria	324	6,27	337	6,44	341	6,48
Sicily	518	10	543	10,38	565	10,74
Sardinia	154	2,98	155	2,96	156	2,97
Total	**5170**	**100**	**5231**	**100**	**5259**	**100**

Source: Italian National Institute of Statistics, Istat.it

Cooperatives' success has become a function not only of local initiative and social responsibility, but also of managements' capacity to adapt to dynamic business conditions and adjust to institutional environments. In fact this dynamic has been provoked not only by cooperatives' economic strategies and incentives but also by the diverted priorities of institutional policy and support.

Cooperative organizations operate in every sector of the economy: agriculture, banking, industry and services. The Gross Value Added (GVA) of Italian agricultural cooperatives for 2007 represents 5 per cent of the economy's total GVA. As a comparison the GVA in the industrial sector is 3,0 per cent and in the services sector 6,8 per cent.

The organizational process in the agricultural sector is further developed in the form of producer organizations, second degree cooperatives, consortia and associations. The organizational rate in the fruit and vegetable sector is 100 per cent in Trentino Alto Adige and 65 per cent in Emilia Romagna, while in Sicily the organizational rate is about 7 per cent and in Puglia per cent. The turnover of the dairy sector represents 15 per cent of total turnover in the food industry. Its structure is defined by a group of big enterprises, and by a great number of small firms. The production of fresh milk and innovated products is very concentrated within a number of mergers and is significantly vertically integrated strategic groups. The same process of concentration in wine production has created an important framework and conditions for innovation and knowledge sharing, institutional support and small-scale producers' support.

The main objective in applying stochastic frontier analysis in the present case study is to measure the efficiency levels of cooperatives, partnerships and producer organizations in the agricultural sector in the context of the influence of institutional factors on their productive choices. The formulation of the production function requires the definition of two types of variables: the output of agricultural enterprises and the inputs, utilized in the production process[7].

Instead of the physical quantities of output, the gross margin and the gross value added are used as measurement tools. This decision is based on the fact that the higher physical output of the more intensive enterprises is not comparable to the lower output of smaller enterprises. Additionally, the gross margin variable includes subsidies as payment received for the fixed production factors. Therefore the area under permanent crops is also included as an input variable[8]. Three types of permanent crops are eligible to receive subsidy payments partially or completely based on area: olive trees, vineyards and more recently nuts. Decision-making units are also compared on the basis of the relationship between annual working unit and employed annual working unit. In the analysis, annual working unit corresponds to the total labour input, including family labour.

The parameters of the constructed translog production function in the present case study are represented in Table 2:

[7]Information about the quantitative characteristics of the output and production inputs is derived from Eurostat, Istat and the Farm accountancy data network of the European Commission for the period from 2003 to 2007.
[8]Since 1992, the role of remote sensing and geomatics in the management and control of the Common Agricultural Policy has become significantly important in terms of implementation of the Land Parcel Identification System (LPIS) for identification of all parcels, for which area-based subsidies are claimed.

Table 2 - Parameters in translog production function

Output (Y)		Input (X)	
Standard gross margin	The total production in mil euro minus variable costs	**B_1** - Utilized agricultural area (UAA)	In hectares per each region (cereals, vegetables in open field, industrial crop, vegetables in greenhouses)
		B_2 - Permanent crops (PC)	In hectares, in relation to the received subsidies and the impact they exert upon efficiency and productivity (fresh fruits, vineyards and wine, olive plantations)
Gross added value	Output at market prices minus intermediate consumption at purchaser prices	**B_3** - Intermediate consumption (IC)	Measured by cumulative costs of raw material consumption and service procurement
		B_4 - Annual working unit (AWU)	Corresponds to the work performed by one person who is occupied on agricultural enterprises for each region on a full-time basis
		B_5 - Employed annual working unit (EAWU)	Employed on a regular basis, including group holders

In the present analysis, one of the main attempts is to estimate institutional influence and its particular importance for the efficiency of agricultural enterprises. Variables in the inefficiency model are grouped in two categories that attempt to explain the level of inefficiency: the first one is regarding the general information about agricultural enterprises; the second category refers to characteristics of the opportunities and restrictions of the institutional framework (Table 3).

The training level variable denotes the ratio of the professional and trained managers and employees to the total number of employees[9]. The specialized mixed farming variable indicates output orientation and product diversification in the enterprises.

The variables in the second group attempt to describe institutional characteristics closely related to the economic performance of the agricultural enterprises. Information about property rights protection, enforcement of contract arrangements and incentives for starting a new business is derived from the Economic Freedom of the World (EFW index)[10]. The index measures the consistency of institutions and policies within the concept of ownership and business activity. The main incentive to include these particular variables stems from the supposition that enterprises regardless of their legal forms, face the same market pressures, compete through the

[9]The training levels of farm holders are indicated by: IRENA 06, the level of agricultural training of managers of agricultural holdings; IRENA 06a, the training in agri environmental issues; IRENA 01, the area under agri-environment support; IRENA 02, regional levels of good farming practice; IRENA 13, cropping/livestock patterns; IRENA 14, farm management practices; IRENA 15, intensification/ Eextensification; IRENA 16, diversification/specialization

[10]Economic Freedom of the World: 2010 Annual Report, p.1

adoption of similar strategies, and aim at higher levels of efficient business performance.

Considering the impact of cooperatives' economic activity on overall regional development, an additional variable for 2007 is included: the number of agricultural cooperatives[11]. Cooperatives have the incentive to be an equivalent competitor in the market along with other investment oriented companies as long as this position would secure their financial stability and maintain the loyalty of their members.

Table 3 - Parameters in the inefficiency model

Group 1: General information about agricultural enterprises	**C_1** - Training level	refers to the ratio of trained managers and employees to all employees in agricultural enterprises
	C_2 - Specialized mixed farming	corresponds to the output orientation of the agricultural enterprises specialized in a particular activity (crop production) that provides a standard gross margin of at least 2/3 of the total standard gross margin of the enterprises
Group 2: Characteristics of the institutional framework	**C_3** - Protection of property rights	rank provided by the component "Protection of property rights" in Area 2 "Legal structure and security of property rights" measured by Economic Freedom of the World index
	C_4 - Legal enforcement of contracts	rank provided by the component "Legal enforcement of contracts" in Area 2 "Legal structure and security of property rights" measured by Economic Freedom of the World index
	C_5 - Starting a business	rank provided by the component "Starting a business" in Area 5 "Regulation of credit, labour and business" measured by Economic Freedom of the World index
	C_6 – Cooperatives	Number of the registered agricultural cooperatives

The null hypotheses in the present analysis states that there is no technical inefficiency in the model or:

$$\mathbf{H_0: h_i\ (\theta) = 0 \text{ against } H_1: h_i\ (\theta) \neq 0} \qquad (6)$$

The vector of estimated parameters is represented by θ. In order to determine the lower and upper bounds the Kodde and Palm's Wald test for jointly testing nonlinear equality and inequality constraints either under H_0 or H_1 is used (Kodde, Palm, 1986). The null hypothesis H_0 is rejected when the estimated value of LR-tests exceeds the upper bound value, and H_0 is accepted when the LR-tests value is smaller than the lower bound value. The parameter $\gamma = \sigma_u^2 / \sigma_v^2 + \sigma_u^2$ is the variance ratio, which explains the total variation in the output from the frontier level attributed to technical

[11]The information about the number of cooperative is taken from the cooperative register of the Economic Development Ministry

efficiency. When γ=0 then there is no technical inefficiency observed in the data set and all decision-making units belong to the optimal production frontier.

According to the ***first hypothesis*** there are no inefficiency components in the constructed Cobb-Douglas function.

$$\mathbf{Ln\ (Y)} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} \text{Ln}(B_1) + \boldsymbol{\beta_2} \text{Ln}(B_2) + \boldsymbol{\beta_3} \text{Ln}(B_3) + \boldsymbol{\beta_4} \text{Ln}(B_4) + \boldsymbol{\beta_5} \text{Ln}(B_5) \quad \mathbf{(7)}$$

The ***second hypothesis*** also states that the value of β_i parameters is zero and the formulated translog function is:

$$\mathbf{Ln(Y)} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} \text{Ln}(B_1) + \boldsymbol{\beta_2} \text{Ln}(B_2) + \boldsymbol{\beta_3} \text{Ln}(B_3) + \boldsymbol{\beta_4} \text{Ln}(B_4) + \boldsymbol{\beta_5} \text{Ln}(B_5) + \boldsymbol{\beta_6} \text{Ln}(B_6) + \tfrac{1}{2}[\boldsymbol{\beta_7} \text{Ln}(B_7)^2 + \boldsymbol{\beta_8} \text{Ln}(B_8)^2 + \boldsymbol{\beta_9} \text{Ln}(B_9)^2 + \boldsymbol{\beta_{10}} \text{Ln}(B_{10})^2 + \boldsymbol{\beta_{11}} \text{Ln}(B_{11})^2] + \boldsymbol{\beta_{12}} \text{Ln}(B_{12}) + \boldsymbol{\beta_{13}} \text{Ln}(B_{13}) + \boldsymbol{\beta_{14}} \text{Ln}(B_{14}) + \boldsymbol{\beta_{15}} \text{Ln}(B_{15}) + \boldsymbol{\beta_{16}} \text{Ln}(B_{16}) + \boldsymbol{\beta_{17}} \text{Ln}(B_{17}) + \boldsymbol{\beta_{18}} \text{Ln}(B_{18}) + \boldsymbol{\beta_{19}} \text{Ln}(B_{19}) + \boldsymbol{\beta_{20}} \text{Ln}(B_{20}) + \boldsymbol{\beta_{21}} \text{Ln}(B_{21}) \quad \mathbf{(8)}$$

The ***third hypothesis*** states that the values of $\boldsymbol{\delta_i}$ parameters in the inefficiency model are zero:

$$\mathbf{U_{it}} = \boldsymbol{\delta_0} + \boldsymbol{\delta_1} \text{Ln}(C_1) + \boldsymbol{\delta_2} \text{Ln}(C_2) + \boldsymbol{\delta_3} \text{Ln}(C_3) + \boldsymbol{\delta_4} \text{Ln}(C_4) + \boldsymbol{\delta_5} \text{Ln}(C_5) + \boldsymbol{\delta_6} \text{Ln}(C_6) \quad \mathbf{(9)}$$

The values of the loglikelihood calculations for Cobb-Douglas, translog production functions and inefficiency model are presented in table 4.

Table 4 - LR-test results

Test	**Null Hypothesis**	**Loglikelihood function**	**Value λ**[*]	**Critical Value**[**]	**Decision**
			2003		
1	$H_0 : \beta_i = 0$	-16,0378	70,0171	25,689	Reject H_0
2	$H_0 : \beta_{ij} = 0$	-6,1317	3,1885	2,706	Reject H_0
3	$H_0 : \gamma = \delta_i = 0$	28,1062	20,0499	17,670	Reject H_0
			2005		
1	$H_0 : \beta_i = 0$	-11,9286	92,059	25,689	Reject H_0
2	$H_0 : \beta_{ij} = 0$	18,8789	8,1042	2,706	Reject H_0
3	$H_0 : \gamma = \delta_i = 0$	23,6858	17,7180	17,670	Reject H_0
			2007		
1	$H_0 : \beta_i = 0$	-6,7947	75,821	25,689	Reject H_0
2	$H_0 : \beta_{ij} = 0$	25,0111	19,2112	2,706	Reject H_0
3	$H_0 : \gamma = \delta_i = 0$	17,0140	32,169	17,670	Reject H_0

***λ** – is the value of the likelihood ratio test of the null hypothesis associated with each of the three models against the alternative general model. This test has 16 degree of freedom
**.005 significance level

The information in Table 4 signifies the likelihood ratio test of the three null hypotheses against the general model, which assumes that there are no inefficiency components in the structured production functions. The first null hypothesis states that the Cobb-Douglas production function is preferable to the translog production function. According to the results of the LR-test, the null hypothesis is strongly rejected at the 5 per cent level. The second null hypothesis states that each decision-making unit in the analysis operates on the technical efficiency frontier. The LR-test results also reject the hypothesis, which suggests that there is a technical inefficiency component in the structured production function. Following this, the focus is towards the joint effect of the selected variables and the possibility for optimization in terms of cost reduction. According to the third null hypothesis, the inefficiency effect is not a function of the two groups of explanatory variables. The results also reject this hypothesis, which confirms the supposition that these variables have a considerable effect on the technical efficiency of the decision-making units.

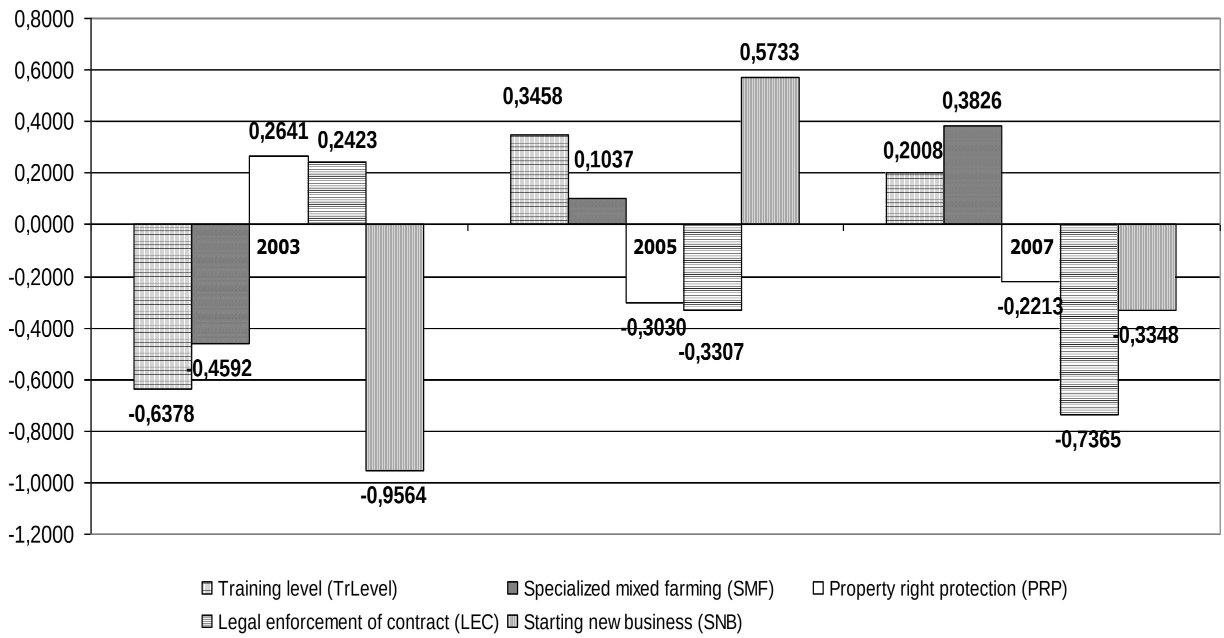
The results obtained for the variance parameter **γ(gamma)** indicate the proportion of the one-sided error component in the total variance of the composed error term (see Appendix B). The average variation in the estimated output from the frontier level of the output, which is attributed to technical inefficiency is estimated at 0,6509. According to the estimated variances, output variability is mainly due to technical inefficiency rather than to statistical noise. For the period 2003-2007, 13 coefficients out of 21 total coefficients in the translog function are statistically significant at the 5 per cent level. This leads to the conclusion for interaction and non-linearity among the included variables. The estimated parameters in the inefficiency model are modes of inefficiency. When the parameter has a negative value, the variable it describes has a positive effect over the obtained efficiency scores; and the opposite is true - in the case of a positive sign, the concrete variable exerts a negative effect over total efficiency.

The parameter β_1 that corresponds to the utilized agricultural area (UAA) appears to be significant at the 5 per cent level for the last two years. This confirms that the larger size of the enterprises entails better labour and capital endowments; they obtain higher efficiency levels and achieve better economic performance. The following is supported by the positive effect of the interaction between utilized land and the variables: permanent crops (β_{12}), intermediate consumption (β_{13}), annual working unit (β_{14}) and employed annual working unit (β_{15}). The coefficients obtained for the period suggest the existence of scale economies. Since in the analysis, agricultural enterprises vary in terms of land size it is reasonable to consider what is the relationship between utilized area and permanent crops. From the results it could be assumed that a specialization in permanent crops is preferable in small-sized enterprises, especially if there are insufficient investment funds and capital.

The variable annual working unit (AWU) refers to the total labour input in the enterprise. Furthermore, the variable employed annual working unit (EAWU) is included in the analysis, which represents employees on a regular basis. The first reason for that choice is that it is difficult to obtain information about the family labour component or the *"implicit costs"*. These costs include non-distributed income from own labour in the farm, entrepreneurs income, income from own land and from own capital included in production. The second reason is that even evaluated implicit costs do not account for market demand conditions. Finally, when family labour is to be considered it is better to be described as a distinct input variable and not to be included in the hired labour variable. The results from translog function calculation show that utilization of the two variables (AWU, EAWU) in production process has reached satisfactory levels for 2005 and 2007. The most efficient enterprises use labour more rationally due to the more intensive use of other production resources, such as machinery or any technology equipment.

Based on the differences in the obtained parameters' coefficients, it is appropriate to focus on the extent to which institutional framework may influence some enterprises and their respective regions to achieve relatively high efficiency scores compared to other, apparently less efficient enterprises and regions. The inefficiency function provides some explanations of this effect (Graph 1).

Graph 1 - Efficiency determinants patterns



Source: Own calculations

The obtained results vary over the period analyzed. In 2003, the variables training level (δ_1), specialized mixed farming (δ_2) and starting new business (δ_5) possess negative signs. The results of the training level coefficient are statistically significant with a value different from 0, and a negative sign. This suggests that the higher education and training of managers and employees has a positive effect over the technical efficiency of agricultural enterprises. Another possible conclusion is related to the age of farmers, which is not considered as a variable in this analysis. The age of producers has increased over the years; they have many years of experience in the agricultural sector with satisfactory production results. By choosing to be a member of a cooperative or producer organization, they become involved in new production technologies and methods, and this decision keeps them in step with other, more innovative enterprises.

There is also a significant relationship between production specialization and the obtained efficiency levels. Specialized strategies contribute to better allocation of production resources and their appropriate utilization in the production process. The results are also consistent with the estimated significant relationship between the agricultural area and the cumulative costs of raw material consumption and service procurement. Although specialization differs over the regions studied, it infers that most enterprises have managed to exploit the benefits of their particular locations.

The coefficients in the inefficiency model acknowledge that institutions and institutional arrangements have a direct and positive influence over the economic efficiency of the observed units. During the first period, institutional incentives and legislative provisions have stimulated new enterprises to enter the agricultural sector. This result is supported by the statistical data that in 2005 the total number of registered agricultural enterprises was about four times more than their primary number at the beginning of the period in 2003[12].

After 2005 the coefficients of the variables for property rights protection (δ_3) and legal enforcement of the contracts (δ_4) confirm the positive effect of contractual arrangements on the efficiency of the decision-making units. In 2007, the effect of legal initiatives for starting business activity also contributed to achieved efficiency levels.

The coefficient of the variable of the total number of registered cooperatives by regions (δ_6) is statistically significant and possesses a negative sign. Cooperatives markedly influence overall sector performance. A substantial source of the cooperatives' impact is found in the common organization of production in terms of quality standards and demand-based quantities, as well as cost minimization and scale economies.

The pairwise elasticity of inputs substitution is calculated for further interpretation of the results and in order to isolate each input's effect on the output (Table 5). The theoretical bases in cases of pairs of inputs considers that "(…) there is a simple correspondence between the cost function setting and the production function setting, since the elasticity of substitution is then equal to the inverse of the elasticity of complementarity"[13]. If the elasticity of complementarity between pairs of inputs is positive, then the conclusion is that these inputs both contribute to the increase of the output level. In case the estimated value is negative the two inputs are substitutes.

[12]The data is obtained from ISTAT, Information System on Agriculture and Livestock
[13]Kohli, Ul. (2010), "Labour productivity: Average versus Marginal", Ch. 6, pp. 103-132 in W.E. Diewert; B.M. Balk, D. Fixler, K. J. Fox and A. O. Nakamura (2010), "Price and productivity measurement", vol. 6, Trafford Press

Table 5 - Estimates of elasticity of complementarity and substitution between pairs of inputs*

Year	b_{12}	b_{13}	b_{14}	b_{15}	b_{23}	b_{24}	b_{25}	b_{34}	b_{35}	b_{45}	SCE
p-complements > 0; p-substitutes < 0											
2003	0,204	-0,743	0,000	**0,238**	**0,569**	**0,673**	**0,279**	**0,668**	- 0,537	**0,403**	0,429
2005	-0,476	-0,241	**0,209**	0,000	**0,563**	-0,469	**0,667**	-0,220	- 0,726	**0,216**	2,444
2007	-0,927	-0,280	**0,390**	0,000	**0,232**	-0,120	**0,523**	-0,973	- 0,221	**0,378**	2,002
Sample mean	-0,400	-0,421	0,299	0,079	0,455	0,028	0,489	-0,175	-0,495	0,332	1,625

* **Note:** b_{12} is elasticity of substitution between AUU and PC, b_{13} is elasticity of substitution between UAA and IC, b_{14} is elasticity of substitution between UAA and AWU, b_{15} is elasticity of substitution between UAA and EAWU, b_{23} is elasticity of substitution between PC and IC, b_{24} is elasticity of substitution between PC and AWU, b_{25} is elasticity of substitution between PC and EAWU, b_{34} is elasticity of substitution between IC and AWU, b_{35} is elasticity of substitution between IC and EAWU, b_{45} is elasticity of substitution between AWU and EAWU

The values of the elasticity between inputs for utilized agricultural area and annual working unit (b_{14}), permanent crops and intermediate consumption (b_{23}), permanent crops and employed annual working unit (b_{25}), and annual working unit and employed annual working unit (b_{45}) are calculated to be higher than 0 and suggest positive cross elasticity of demand. It should be noted that the estimated results are positive but less than unity. Following theoretical explanations this means that the increase in the quantity of the first input would increase the usefulness of the other input in the pair thereby improving the marginal product of the decision-making unit. According to the calculations, the positive joint contribution of the inputs for utilized area and annual working units is represent by the 0,29 per cent increase of the final outputs. In the case of permanent crops and intermediate consumption their pair would increase the output level by 0,45 per cent. The same relationship is estimated for the joint contribution of permanent crops and employed annual working unit, and annual working unit and employed annual working unit, which contribute to the output increase at an estimated 0, 49 and 0,33 per cent respectively. The values of the elasticity between the utilized agricultural area and permanent crops (b_{12}), utilized agricultural area and intermediate consumption (b_{13}), intermediate consumption and annual working unit (b_{34}) are less than 0, which suggests that they are substitute inputs.

The mean technical efficiency of the 21 regions in Italy is estimated to be 69,7 per cent (table 6). During the observed period, agricultural enterprises produced 70 per cent of the maximum attainable output.

Table 6 - Mean efficiency value (2003 – 2007)

Regions	**Efficiency results**					
	Cobb-Douglas		Translog		Inefficiency model	
	Average	Std.dev	Average	Std.dev	Average	Std.dev
Piemond	0,689	0,059	0,924	0,038	0,638	0,408
Valle d'Aosta	0,596	0,209	0,875	0,119	0,559	0,143
Liguria	0,783	0,188	0,925	0,071	0,403	0,232
Lombardy	0,856	0,124	0,969	0,036	0,972	0,023
Provincia Autonoma Bolzano	0,795	0,106	0,881	0,085	0,512	0,147
Provincia Autonoma Trento	0,549	0,240	0,878	0,077	0,551	0,085
Veneto	0,801	0,209	0,974	0,003	0,765	0,320
Friuli-Venezia Giulia	0,865	0,031	0,958	0,047	0,361	0,420
Emilia-Romagna	0,682	0,187	0,958	0,034	0,926	0,086
Tuscany	0,721	0,184	0,812	0,024	0,631	0,145
Umbria	0,545	0,291	0,966	0,025	0,613	0,399
Marches	0,576	0,268	0,947	0,055	0,531	0,355
Lazio	0,704	0,128	0,828	0,142	0,590	0,359
Abruzzo	0,681	0,209	0,958	0,053	0,871	0,177
Molise	0,667	0,210	0,802	0,247	0,552	0,411
Campania	0,902	0,082	0,909	0,140	0,626	0,326
Puglia	0,597	0,229	0,906	0,098	0,689	0,436
Basilicata	0,588	0,268	0,858	0,113	0,513	0,148
Calabria	0,690	0,024	0,869	0,131	0,567	0,433
Sicily	0,754	0,132	0,889	0,121	0,694	0,284
Sardinia	0,594	0,198	0,917	0,112	0,594	0,415

Source: Own calculations

Estimates of technical efficiencies based on the frontier production function show a relatively high efficiency level (Table 7).

Table 7 - Mean efficiency coefficients

Production function	**2003**	**2005**	**2007**	**Average**	**Std.dev**
Cobb-Douglas	0,782	0,667	0,642	0,697	0,075
Translog	0,942	0,928	0,862	0,905	0,035
Inefficiency model	0,37	0,731	0,779	0,627	0,07

Source: Own calculations

The results imply that more than 90 per cent of agricultural enterprises operate close to the efficient production frontier. Taking into consideration institutional influence and included variables in the inefficiency model, the mean efficiency results have also undergone positive trends from the lowest level in 2003 (0,370) to the highest level in 2007 (0,779). The contribution of efficiency changes to total factor productivity results in increased productivity growth.

4. Conclusion

This paper draws attention to the opportunity to evaluate the influence of certain institutional factors and their contribution to the economic efficiency of the agricultural enterprises. Results from the stochastic frontier analysis lead to the generalization that the balanced productivity growth in Italy's 21 regions is supported by the contribution of efficiency change to total factor productivity. The process of specialization appears to reduce production costs. Geographic clustering enhances relationships between producers, their cooperatives, and the final customer. At the same time, the distribution of the labour input has an underlying effect on efficiency growth. Nevertheless, there are some internal organizational lapses towards employment in the enterprises. The allocation of labour in specialized production is not entirely consistent with the inter-firm utilization. One possible solution is a combination of individual responsibility and division of labour for each operation or task performed.

The estimated inefficiency model confirms expectations that specialized mixed farming improves land utilization. Institutional influence in terms of the legal enforcement of contracts contributes to enterprises' empowerment and collective action. However, this result should be taken with precaution in relation to land input. Contract farming does not benefit the poorest part of the rural population but rather absentee landlords and large-scale producers. The last but not least conclusion is that cooperatives prove to be dynamic and influential organizational structures. Their contribution to overall technical efficiency is through the balancing market demand and producers' production choice by implementing fair-pricing and quality standards.

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Appendix A

Author	Analysis and Results
Johnson, A. (2006)	Foreign direct investment should exert positive effects on economic growth in developing countries which suffer from low productivity and capital stock deficiencies.
Blonigen, B. (2005)	Foreign direct investments (FDI) lead to an increase rate of economic growth.
Meon, P.G.; Weill, L. (2005)	Applied Stochastic Frontier Analysis (SFA) to study how difference in quality of institutions (control of corruption, strength of the law, quality of the regulatory framework) may explain cross-country differences in aggregate efficiency.
Wijeweera, AL.; Villano, R.; Dollery, B. (2004)	Applied SFA to study the relationship between FDI and the rate of growth of GDP. The result show that FDI inflows exert a positive impact on economic growth only in presence of a highly skilled labor force, corruption has negative impact; trade openness gains efficiency.
Fulginiti, L. E.; Perrin, R.K.; Bengxin, Yu (2004)	Used panel data on output and conventional agricultural inputs for 41 SSA countries to study productivity during political conflicts and wars for the period 1961-1999. The used institutional variables are: colonial heritage, independence; armed conflict; political rights/civil liberties.
Adkins, L.C.; Meomaw, R., Savvides, A. (2002)	Estimate production frontier and study to extend economical and political institutions contribute to the technical inefficiency, output growth, TFP growth.
Rodric, D. (2000)	Identified 5 types of institutions that permit adequacy of the market: institutions for property rights; regulatory institutions; institutions of macroeconomic stability; institutions for social insurance; institutions for conflict management.
Sedik, D; Trueblood, M.; Arnade, C. (1999)	Took different approach to study farm restructuring in Russia for the period 1991-1995 by concentrating on technical efficiency. Efficiency scores are explained by economic and institutional factors: farm size, softness of budget constraint; deterioration in terms of trade and region level specialization.
De Mello, L.R. (1999)	Foreign direct investments' (FDI) contribution depends on host country characteristics (skilled labor).
Bauer, P.W.; Berger, Al.N.; Ferrier, G.D.; Humphrey, D.B. (1998)	Set consistency conditions for regulatory analysis of financial institutions which include: efficiency levels, ranking, and identification of best and worst firms, time, competitive market conditions, and standard non-frontier measures of performance. Applied four approaches – DEA, SFA, TFA and DFA
Borensztein et al. (1998)	Foreign direct investment (FDI) has positive impact on GDP and is a function of the human capital.
Dowson, J. (1998)	Economic growth is associated with economic freedom, because the latter has positive effect on investment and Total factor productivity (TFP).
Edwards, S. (1998)	Determinants of the TFP growth are the initial per capital GDP, the initial level of human capital and the degree of openness.
Rodric, D. (1997)	Political factors affect economic performance, democracy is associated with stable long-run growth rates; better short-run stability; ability to deal with adverse shock; higher wages.
Moroney, J.R., Lovel, C.A.K. (1997)	First applied SFA to compare productive performance of planned and market economies. EE Countries were no more that 76% as efficient as the western European economies during 1978-1980.
Bergson, A. (1987, 1989, 1991)	Planned economic tend to use capital and land less efficiently (CRS, dummy variable technical efficiency)

Appendix B - Loglikelihood results of translog production function and inefficiency model

		2003			2005			2007		
Variable	Parameter	Coefficient	St. error	T-ratio	Coefficient	St. error	T-ratio	Coefficient	St. error	T-ratio
Stochastic frontier model:										
Constant	β_0	-0,7908*	1,0000	-0,7908	0,6725	0,8839	0,7608	-0,2029*	0,6432	-0,3155
Utilized agricultural area (UAA)	β_1	0,0000	0,2298	0,0000	-0,1172*	0,1206	-0,9722	-0,1238*	0,1809	-0,6845
Permanent Crops (PC)	β_2	0,8247	1,0000	0,8247	0,9692	0,1595	0,6075	0,1031	0,9108	0,1132
Intermediate consumption (IC)	β_3	0,8303	0,3969	0,2091	0,9025	0,4833	0,1867	0,8123	0,4748	0,1710
Annual Working Unit (AWU)	β_4	0,2616	0,1000	0,2616	0,9134	0,2588	0,3528	0,3913	0,1208	0,3236
Emloyed annual working unit (EAWU)	β_5	0,2589	0,2721	0,9515	0,1012	0,2633	0,3844	-0,7683*	0,3692	-0,2080
Time	β_6	0,1466	0,1000	0,1466	0,5647	0,1176	0,4801	-0,8315*	0,7819	-0,1063
0,5*(UAA)^2	β_7	0,4705	0,8233	0,5715	0,3828	0,1189	0,3218	-0,9134*	0,1243	-0,7346
0,5*(PM)^2	β_8	0,1815	0,1000	0,1815	0,2735	0,2323	0,1177	0,1151	0,5962	0,1931
0,5*(IC)^2	β_9	-0,1377*	0,9337	-0,1475	0,4670	0,2609	0,1789	0,9566	0,7573	0,1263
0,5*(AWU)^2	β_{10}	0,1335	0,1000	0,1335	-0,1071*	0,2022	-0,5298	-0,5040*	0,4867	-0,1035
0,5*(EAWU)^2	β_{11}	0,3775	0,3999	0,9438	-0,8212*	0,2204	-0,3725	-0,6061*	0,8856	-0,6843
(UAA)*(PC)	β_{12}	0,2043	0,1000	0,2043	-0,4764*	0,5137	-0,9273	-0,5889*	0,1021	-0,5767
(UAA)*(IC)	β_{13}	-0,7427*	0,5337	-0,1391	-0,2406*	0,8597	-0,2798	-0,1773*	0,4611	-0,3846
(UAA)*(AWU)	β_{14}	0,0000	0,1000	0,0000	0,2093	0,5368	0,3899	0,0000	0,1000	0,0000
(UAA)*(EAWU)	β_{15}	0,2376	0,1000	0,2376	0,0000	0,1000	0,0000	-0,2910*	0,5672	-0,5130
(PC)*(IC)	β_{16}	0,5685	0,7191	0,7905	0,5632	0,2423	0,2324	-0,2454*	0,2914	-0,8421
(PC)*(AWU)	β_{17}	0,6730	0,1000	0,6730	-0,4686*	0,3908	-0,1199	0,7666	0,1292	0,5932
(PC)*(EAWU)	β_{18}	0,2785	0,6693	0,4161	0,6672	0,1276	0,5227	0,1459	0,1341	0,1087
(IC)*(AWU)	β_{19}	0,6684	0,1000	0,6684	-0,2201*	0,2263	-0,9729	-0,9165*	0,5501	-0,1665
(IC)*(EAWU)	β_{20}	-0,5370*	0,9312	-0,5766	-0,7264*	0,3292	-0,2206	-0,2433*	0,3078	-0,7903
(AWU)*(EAWU)	β_{21}	0,4032	0,1000	0,4032	0,2157	0,5706	0,3780	0,6075	0,5817	0,1044
Variance parameters:	s^2	0,1262	1,0000	0,1262	0,0128	0,0474	0,2693	0,0063	0,0566	0,1114
	γ	0,5000	1,0000	0,0500	0,7348*	0,1030	1,3086	0,7181	1,5305	0,1163
Loglikelihood function			3,1885			8,1042			19,2112	
Inefficiency effects model:										
Training level (TrLevel)	δ_1	-0,6378*	0,5959	-0,1070	0,3458	0,6609	0,5232	0,2008	0,1421	0,1412
Specialized mixed farming (SMF)	δ_2	-0,4592*	0,1594	-0,2879	0,1037	0,1241	0,8360	0,3826	0,1144	0,3344
Property right protection (PRP)	δ_3	0,2641	0,8656	0,3051	-0,3030*	0,6375	-0,4753	-0,2213*	0,1734	-0,1276
Legal enforcement of contract (LEC)	δ_4	0,2423	0,1403	0,1727	-0,3307*	0,1132	-0,2921	-0,7365*	0,1230	-0,5987
Starting new business (SNB)	δ_5	-0,9564*	0,1386	-0,6899	0,5733	0,5134	0,1116	-0,3348*	0,2461	-0,1360
Number of cooperatives (C)	δ_6	-	-	-	-	-	-	-0,1872*	0.8617	-0.2173
Variance parameters:	s^2	0,0106	0,0036	2,9043	0,0078	0,0024	3,2043	0,0134	0,0041	3,2485
	γ	1,0000	0,0147	67,8640	1,0000	0,0293	34,1114	0,8354	0,0005	0,6465
Loglikelihood function			20,0499			17,7180			3,2169	

* signifies that the estimated parameters in bold can be accepted at 5% significance level