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THE DISTRIBUTION OF AGRICULTURAL FUNDS TOWARDS UNDEVELOPED AREAS: EVIDENCE FROM ITALY

Greta Falavigna, Alessandro Manello
and Sara Pavone

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The distribution of agricultural funds towards undeveloped areas: evidence from Italy[1]

Greta Falavigna

CNR-CERIS;
Via Real Collegio, 30, 10024 Moncalieri (TO), Italy ,
Tel.: +39.011.6824941
Fax: +39.011.6824966
e-mail: g.falavigna@ceris.cnr.it

Alessandro Manello

CNR-CERIS,
Via Real Collegio, 30, 10024 Moncalieri (TO), Italy.
Tel.: +39.011.6824946
Fax: +39.011.6824966
e-mail: a.manello@ceris.cnr.it

Sara Pavone

University of Insubria & CNR-CERIS,
Via Real Collegio, 30, 10024 Moncalieri (TO), Italy.
Tel.: +39.011.6824950
Fax: +39.011.6824966
e-mail: s.pavone@ceris.cnr.it

ABSTRACT: The present working paper aims analyses efficiency and productivity growth of agricultural production in Italy. Appling a recent tool from environmental management field, the Directional Distance Function (DDF), global performance indicators has been estimated for 102 Italian provinces considering both quantities produced and emissions of ammonia, from fertilizers usage, as undesirable output. Therefore, productivity enhancements can come from the contraction of pollution and from the expansion of desirable outputs, in this case agricultural products. Our shows that huge differences among Italian macro emerge by considering both efficiency and productivity dynamics. This evidence is interpreted in light the amount of public fund distributed by Rural Development Programs over the period 2000-2006 and our findings suggest that a larger amount of resources were distributed to more disadvantaged areas. Then we can conclude that the flows of public fund seems to follow the right direction, highlighting interesting policy implications for future actions.

KEYWORDS rural development, agricultural performance, productivity growth, public funds.

JEL CODES: O13, O47,Q18, Q28

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SUMMARY

1. INTRODUCTION

During the last decade, the issue of rural development remain one of the most common issues European agricultural policies and it is motivated by the fact that more than the 90% of the entire European territory can be classified as rural. Moreover, it is estimated that the 56% of European population reside in these areas. These simple figures show the necessity to preserve support economical and agricultural activities localized in disadvantaged regions. The concept of rural development is increasingly important in policy and research (it is a sector in which a lot of public funds are invested), but it cannot be pursued at all cost.

In fact, one of the more easy way to boost land productivity and stimulating economic development in disadvantaged areas could be the indiscriminate usage of fertilizers. Nitrogen fertilizers, the most common and cheaper, are one of the biggest source of ammonia (NhO_3) release into the environment (ISPRA, 2011) even if they can increase production per hectare. However, increasing the environmental sustainability of agricultural sector is one of the main objectives of many EU policies: the so called Common Agricultural Policy (CAP) has among its objectives, the achievement of high standards of environmental care and land protection. One of the most important operative instruments of these policies, the so called Rural Development Programs (RDPs), for example in the period 2000-2006, includes a specific measure called "F", which is created in order to stimulate the adoption of environmental friendly practices. At the same time, other EU directives has been introduced with the specific aim of protecting the environment and then, to encourage the adoption of sustainability criteria and certifications also in the agricultural field (2004/35/CE). As a matter of fact, on the webpage of the European Commission[2] there is the clear incentive for farmers to produce preserving the environment. To acknowledge this directives, each Country of European Union promulgated Agricultural policies with the aim to translate in national laws the eco-sustainability issues. Starting from this point of view, many authors analyzed the effects of the implementation of these directives, simulating possible scenarios, as the work of Bartolini *et al.* (2007), where the impact of the water policy, relating to the directive EC 60/2000, is studied.

The general aim of increasing productivity and efficiency in agricultural industry has been studies by many works in the recent empirical literature. In doing this, many authors focused their work on the analysis of interactions of ecological and economic factors in the field of Land Degradation (LD), considered as the variable the most representative in both environmental projections and policy strategies (Salvati and Zitti, 2008). An interesting analysis on performance of rural district in relation to the Land Degradation field has been done by Salvati and Carlucci (2011). They approached the topic starting from the definition of productivity and economic indexes as the share of agriculture in total product and the per capita value added. As suggested by Salvati and Carlucci (2011), Italian rural districts are numerous and slightly different from physical and socioeconomic point of view. These diversities, i.e. climate, landscape, size, urbanization, can be very significant considering the agricultural productivity and also the level of land degradation, mainly due to the usage of fertilizers and mineral additions to agriculture.

Nevertheless, the increase of land productivity due to fertilizers has a huge importance in modern human life, as described by Leip *et al.*

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[2] See the reference to the webpage: http://ec.europa.eu/agriculture/envir/index_en.htm

(2011) and Erisman *et al.* (2008) around 50% of current world population depends from these mineral additions to agriculture. Fertilizers are useful until a certain threshold, then they become a problem and a source of land degradation. Vitousek *et al.* (2009) show that nutrient additions to intensive agriculture are excessive in some regions with consequences for environmental quality and human well-being.

Previous considerations are confirmed by many authors (CEC, 2001; Halberg et al., 2005; Langeveld et al., 2007; Yli-Viikari et al., 2007; OECD, 2008; Hoang and Alauddin, 2010; Powell et al., 2010) that evaluated the environmental performance of farms or systems through the nitrogen use efficiency (Hoang, 2011). Considering the use of pesticides in Italian agriculture, Travisi and Nijkamp (2008) demonstrate that people are well-disposed to pay a premium for agricultural goods produced in environmentally-benign ways.

Following these works, the methodology proposed in this paper aims at evaluating performances of Italian provinces, considering the use of nitrogen fertilizers and their related consequences by applying an extension of Data Envelopment Analysis, born to compute relative productivity indicators. Each local area, province in our case, is considered as an agricultural units which imply standard inputs and fertilizers to produce good outputs such as agricultural products. A significant environmental issue concerns the use of nitrogen fertilizers because their release in the soil produce emissions of ammonia (NhO_3). These kind of environmental pollution, strictly linked to fertilizers through a specific emission factor, have to be monitored and reduced according to Integrated Pollution Prevention and Control (IPPC) principles established at European level. Indeed, to consider jointly the two side of production (good and undesirable outputs), a non parametric Directional Distance Function (DDF) is applied, by solving linear programming problems (Chambers et al., 1996; Chambers et al., 1998; Färe and Grosskopf., 2000). The main methodological point relies in the asymmetric treatment of different category of outputs to discredit local areas which increase their emissions, linked to an increasing usage of nitrogen fertilisers. The DDF framework is widely applied in environmental field since its introduction: Chung et al. (1997) analyze paper and pulp mills, Boyd et al. (2002) consider a small sample of glass US manufacturing firms, Picazo-Tadeo and Prior (2009) and Picazo-Tadeo et al. (2005) focus on Spanish ceramic plants, McMullen and Noh (2007) study transit buses firms. In addiction, we can find applications within the agricultural field to compute global efficiency measure (Färe et al., 2006 or Blanchard et al., 2006). Starting with DDF assumptions also productivity dynamics can be easily investigated through the Malquist-Luenberger TFP indexes (Domazliky and Weber, 2004) which represent the equivalent of Malmquist indexes in standard DEA framework. The resulting TFP growth considers both pollutant reduction and good output expansion as source of productivity growth over time.

In literature, many studies analyze agricultural performances using Data Envelopment Analysis (DEA) and Malmquist productivity indexes (see, for example, Arcelus and Arocena, 2000; Giannetti, 2002; Thirtle et al. 2003), but they do not considered pollution related to fertilizers usage.

This paper presents a preliminary application of the DDF model to the Italian Agricultural industry with the aim of evaluating public regional policies, extending the concept of agricultural production to include pollution due to fertilizers usage. Moreover, this work aims at validating a methodology well-known in environmental field to evaluate efficiency of Italian agricultural systems considering that the fertilizer use positively affects the productivity growth but it is negatively related to the environmental performances. After estimating DDF efficiency scores, the results are interpreted in light of the direction of financial funds, to verify if more undeveloped areas are able to attract more financial resources to reduce their gaps. Finally, our empirical findings can help government to improve or consolidate agricultural policies by providing some additional tools not only based on the sole production but also able to consider land degradation.

The reminder of the article is structured as follows: the second section illustrates the applied methodology, data issue and sources are described in section 4, while results are discussed in section 4. Some conclusive remarks are provided at the end and they close the present study.

2. MODELLING AGRICULTURAL PRODUCTION PROCESS WITH EMISSIONS

To model the production process, when ammonia (NhO3) is jointly produced with good outputs, some additional assumption and constraints need to be added to standard DEA approach to production function. Let $x=(x_1,...x_N)\in R_+^N$ be a vector of inputs, $y=(y_1,...y_N)\in R_+^M$ a vector of good outputs and $b=(b_1,...b_N)\in R_+^N$ a vector of bad outputs such as pollutions. Starting from the classical assumptions on technology and input-output sets we assume that undesirable outputs are jointly produced with good outputs.

This hypothesis is called *null jointness*, in notation:

$$(y,b)\in P(x) \text{ and } b=0\rightarrow y=0 \qquad (1)$$

No production level are compatible with zero emissions of ammonia, because at least some quantities of fertilizers are implied. Another assumption largely accepted is the so called *weak disposability assumption*: if there are some outputs, which are undesirable it is reasonable to assume that bad outputs could not be reduced without reducing also good outputs. This is also the case of NhO_3: if inputs are assumed to be fixed, each contraction in ammonia comes with reduction in fertilizers usage and then a reduction in produced quantities. Classical assumption of free disposability does not hold anymore for all outputs, but only for the subset of good outputs. In notation weak disposability in (y,b), where $0\le\alpha\le1$ and P(X) is the production possibility set:

$$(x,y,b)\in P(X)\Rightarrow(x,\alpha y,\alpha b)\in P(X) \qquad (2)$$

Then, weak disposability implies that good and bad outputs can be proportionately contracted, but only good outputs can be freely reduced without costs. Other standard assumptions on the output set holds in the case of pollution, such as inactivity, compactness and free disposability in inputs. Moreover, also free disposability remains valid for the subset of desirable outputs y:

$$(x,y,b)\in P(X)\Rightarrow(x,y,\alpha b)\notin P(X),=$$
$$\Rightarrow(x,\alpha y,b)\in P(X) \qquad (3)$$

The Directional Output Distance Function (DODF) gives the maximum feasible proportional contraction in bad outputs and expansion in good outputs along a pre-assigned direction. DODF, defined on P(X), takes a value equal to 0 for efficient firms which contribute to the frontier identification and increase with inefficiency. Theoretical properties and duality correspondences are explored in Färe and Grosskopf (2000); the first natural extension to the bad-outputs problem appeared in the empirical application by Chung *et al*. (1997). The directional output distance function is defined as follows:

$$\vec{D}(x, y, b; g_y, g_b) = \max\{\beta : (y, b) + (\beta g_y, \beta g_b) \in P(x)\} \quad (4)$$

where $g = (g_y, -g_b)$ is the directional vector and P(X) is the production possibility set estimated via DEA by solving, for each firm, the following linear problem after fixing a particular directional vector g = (y,-b):

$$\begin{aligned} \vec{D}_W(x_0, y_0, b_0; y, -b) &= \max \beta \\ \text{s.t.} \quad x_0 &\geq \mathbf{X}z \\ (1+\beta)y_0 &\leq \mathbf{Y}z \\ (1-\beta)b_0 &= \mathbf{B}z \\ z \geq 0, \beta &\geq 0 \end{aligned} \quad (5)$$

In practice directional output distance function re-scales the observed output vector (y,b) on the frontier following the g direction, then (y,-b) in our case.

Applying DODF the represented production technology immediately derive from reality, without transformations and all the constraints on P(X) could be formulated in linear form, then DEA framework could be used. The value β, estimated for each DMU, represents directly the scaling factor, then the distance from the best practice frontier.

Starting with Färe *et al*. (1989) is common to find comparison of estimate efficiency scores without considering emissions, by computing another model under the hypothesis of free disposability. Linear problems remain as in equation 5, but the last equality is replaced by an inequality with an unchanged directional vector:

$$\begin{aligned} \vec{D}_F(x_0, y_0, b_0; y, -b) &= \max \beta \\ \text{s.t.} \quad x_0 &\geq \mathbf{X}z \\ (1+\beta)y_0 &\leq \mathbf{Y}z \\ (1-\beta)b_0 &\leq \mathbf{B}z \\ z \geq 0, \beta &\geq 0 \end{aligned} \quad (6)$$

In words it is possible to decrease bad outputs without cost: this is equivalent to assume that nor regulation neither a general goal of increasing sustainability of agricultural process exists anymore. Some authors suggest that, by comparing the two sets of results, is possible to create a proxy of the potential good output loss due to regulation (Picazo-Tadeo and Prior, 2009), but this is not among the object of the present work.

The more general concept of distance allows to re-define TFP indexes within the DDF frame work following the approach proposed by Chung et al. (1997). The so called Malmquist-Luenberger (ML) can be easily derived by comparing over time the relative position of each DMU in respect to the best practice frontier in *t* and *t+1*. Weber e Domazlicky (2001) suggest the following:

$$ML_t^{t+1} = \left[\frac{(1+\vec{D}_0^t(x^t, y^t, b^t; y^t, -b^t))}{(1+\vec{D}_0^t(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}))} \cdot \frac{(1+\vec{D}_0^{t+1}(x^t, y^t, b^t; y^t, -b^t))}{(1+\vec{D}_0^{t+1}(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}))} \right]^{\frac{1}{2}} \quad (7)$$

This version of TFP indexes maintains the most important characteristics of standard Malmquist indexes, but productivity could increase over time through two channel. The classical way, by increasing the production of desirable outputs in relation to inputs, but also with contraction on ammonia emissions in the soil, maintaining also for the dynamics, an asymmetric treatment of the two outputs category (Kumar, 2006).

ML indexes is built as a geometric mean of two components - one is based on technology at time *t* and other one on technology at time *t+1* - that are the ratio of DODF's calculated on quantities at time *t* and *t+1*. Values smaller than one indicate contraction of productivity over the period, while values grater than one represent productivity growth. Malmquist-Luenberger indexes could be decomposed in two parts, one representing the efficiency gain over the time period (EFF) and one accounting for the technical progress in the production function (TECH):

$$EFF_t^{t+1} = \frac{1+\vec{D}_0^t(x^t, y^t, b^t; y^t, -b^t)}{1+\vec{D}_0^{t+1}(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1})} \quad (8)$$

The EFF component represents the catch-up effect of inefficient provinces with respect to the new t+1 frontier, potentially this component of TFP growth should be highly correlated with public funds distribution and it should be the engine of the convergence process.

$$TECH_t^{t+1} = \left[\frac{(1+\vec{D}_0^{t+1}(x^t, y^t, b^t; y^t, -b^t))}{(1+\vec{D}_0^t(x^t, y^t, b^t; y^t, -b^t))} \cdot \frac{(1+\vec{D}_0^{t+1}(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}))}{(1+\vec{D}_0^t(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}))} \right]^{\frac{1}{2}} \quad (9)$$

The TECH component describes the frontier shift occurred from t and t+1 and it represents a proxy of the technological progress in agricultural practice between the two time periods. The term could be equal to one if the analyzed DMU is efficient in both periods; values smaller than one indicate a deterioration of the technical possibilities in that portion of the frontier. These case are uncommon and they are normally attributed to the estimation method, unable to distinguish between EFF and TECH in case of fully efficient subjects.

3. DATA AND RELATED ISSUES

The directional output distance function is estimated using aggregated annual data for the agricultural systems of Italian provinces coming from AgriISTAT database from the Italy's National Statistics Institute (Istat, 2012). The information collected comes from institutional sources for agricultural statistics and allow us to create a detailed picture of inputs implied and, at the same time, outputs obtained by the whole agricultural sector for the period 2003-2010. The period is chosen according with public financing period, in order to catch the effects of European funds allocated during the scheduled period 2000-2006. The unit of observation are 110 Italian provinces, but 7 of them became effective after 2003, while for one of them data are not complete. This results in an balanced panel of 102 Decision Making Units (DMU), for which complete data on inputs, outputs and emissions are observed. To produce the good outputs vector, that is composed by cereal-rice-oilseed, vegetable-fruit and feed, each units a different types of soil are under cultivation. This paper focuses on land productivity, that can be increased using fertilizers. We remind that, among them, nitrogen fertilizer are the most common. Data for the total amount of fertilizers for cultivations come from AgriISTAT, and all information are released for each type of organic or chemical component (Istat, 2012).

The usage of nitrogen fertilizers implies the release in the environment of a bad output (NhO3) and they represent the first source (72%) of total ammonia production in 2009, as it is reported by the Institute for Environmental Protection and Research (ISPRA, 2011).

Table 1 reports descriptive statistics for the variable used in the efficiency computation; the different type of cultivations are characterized by

Tab 1. Descriptive statistics of inputs and outputs data

	Mean, 2003	Mean, 2010
Inputs: Soil surfaces cultivated in hectares (1000s)		
Cereals, rice and oilseed	86.79	64.54
Fruit and vegetable	11.62	10.31
Feed	61.11	59.48
Outputs: production quantities in quintals (1000s)		
Cereals, rice and oilseed	4,380	3,394
Fruit and vegetable	2,342	2,455
Feed	7.09	7.23
Bad output: emission quantities in quintals (1000s)		
NhO3 emissions	7.17	3.95

different yield rate that are accounted for by maintained soil surfaces separated for farming destination.

As it has been anticipated above, the Common Agricultural Policy (CAP) has among its objectives the achievement of high standards of environmental care. Our works tries to explore the role of the first new generational Rural Development Programs (period 2000-2006). The current RDPs will not be considered (period 2007-2013) because there are not valid indicators to evaluate the policy’s impact yet.

In 1997 the European Commission published the Agenda 2000 that defined the development framework of the European Union ,describing required policies in the context of an enlarged Union. In this strategic document were declared the desirable reforms of the CAP and the Community's objectives-.The main issues can be summarized as follows: competitiveness, environment, food safety and Union’s position in WTO negotiation.

The action program changed the existing European rural policies and introduced three tools: the Rural Development Programs (RDPs), the Regional Operation Program (ROP) and the Leader Program. The first tool is the one on which this working paper focuses the attention.

The rural development program is a tool for sustaining European rural areas. It is possible to identify three lines of actions: economic, environmental and social. Measures finalized to stimulate economic activities concern investments for: diversification of agricultural activity; the growth of firms and their competitiveness; the improvement of production, transformation and commercialization processes. Considering environmental issue, the main goal is the protection of the agricultural environment with in depth attention to measures for financing investments to reduce pollution, for protecting the consumers’ health, for increasing the number of production methods to respect the environmental conservation and to safeguard biodiversity. Finally, there are some measures focus on other complementary aspects of the agriculture that are necessary to realize a local development integrated, i.e. the village renewal, the protection of cultural heritage and an increasing social cohesion. The RDPs, therefore, are formed of several measures and each measure grants specific investments (i.e. new

Tab 2. EU rural funds and their distribution among Italian macro regions

Macro Area	N	Rural Development Program		Regional funds	
		F measure (mln of €)	Incidence (% total EU funds)	€ per Km^2	€ per capita
Northern Italy	21	120	42%	7,019	40
Central Italy	13	256	69%	10,226	89
Southern Italy	45	124	40%	6,080	30
Italian Isles	23	130	65%	8,587	65

machineries, training courses, quality certifications, etc.).

In Europe a common rural policy has been established with the aim to guarantee a coherent and sustainable framework, but each State and each Region has a degree of freedom to adjust the policy to the national or regional specificities and to define its RDP. During the period 2000-2006, for example, some Governments decided to have one national RDPs (e.g. France, United Kingdom, Greece) whilst others chosen to realize in each Region a specific RDP (e.g. Germany, Italy, Spain). It is also crucial remember that funds assigned to this policy come out in part from the central European budget and in part from the National or Regional budgets.

As has been said in the introduction this study focuses the attention on Italian RDPs and, in particular, as we shall see, the analysis aims at verifying the impact of the agri-environmental measures. Before describing objectives pursed by the agri-environmental measures, it is necessary to highlight again that in Italy each Region (and the two autonomous provinces Trento and Bolzano) implemented a specific RDP. Even if differences in the way policies are implemented exist, in this paper some simplifications are assumed. Comparing all Italian RDPs, the strategic role of agri-environmental measures appears clear. Indeed, considering the planning 2000-2006, they pursued the application of integrated productions, biological productions and the adoption of other environmentally-friendly farming techniques. Public funds can be granted to farmers that subscribed environmental commitments related to the conservation of the environment and maintaining the countryside or to preservation of the welfare of farm animals.

Table 2 shows the amount of payments allocated for agri-environmental investments (EAGGF Fund) among Italian macro areas and the incidence on the total of payments. We have also estimated the amount of funds per surface and per capita. Findings suggest that considering the amount of funds per surface and per capita, certain regions receive grants significantly above the average. In particular, pay attention to huge funds per surface obtained by Basilicata, Apulia and Sicily but also by Calabria, Umbria and Sardinia, especially if compared to the national average. Furthermore, if the national average of funds per capita is around 39€, it is interesting to note the high amount of funds in Basilicata (282€) and Sardinia (121€).

To verify if EU funds finance the most in need area from the land productivity viewpoint, the efficiency and the TFP growth need to be considered.

Tab 3. Average inefficiency scores by macro region

Macro-area	β_{WEAK}		β_{FREE}	
	2003	2010	2003	2010
Northern Italy	0.136	0.126	0.257	0.246
Central Italy	0.476	0.385	1.457	0.763
Southern Italy	0.261	0.295	0.781	0.895
Italian Isles	0.359	0.538	1.535	1.778

4. EMPIRICAL RESULTS

The set of linear programs, assuming weak and free disposability of ammonia emission, as well as ML indexes and its two components, are written and solved using R. Computed efficiency scores for the first and last observation years are reported in table 3, averaged over Italian macro areas. Constant Returns to Scale are assumed, according to linear programs reported in equation 5 and 6, to obtain reliable Malmquist indexes Färe and Grosskopf (1996). Before results interpretation, it should be underlined that efficiency is a relative concept and then, what comes from estimation, is the position of each firm in respect to the best of the sample in a specific time period. Estimated directional distance functions represent the maximal feasible expansion of good outputs and reduction of emissions in each time periods, by maintaining inputs unchanged.

The most efficient agricultural local units show an efficiency score equal to zero, while higher the score, higher the inefficiency.

The first three columns of table 3 reports eco-sustainable measures of productivity, because the production of ammonia is internalized by the model as an undesirable byproduct, together with cereals, rice, oilseeds, fruit, vegetable and feed. Northern Italian provinces are on average more efficient (β_{2003}=0.136 and β_{2010}=0.126) than Southern area and this is true for both the first and the last year considered. However, also for them good margins of improvement persist: physical production could be increased of more than 10% and, at the same time, emissions could be cut by the same proportion. Central agricultural sector is the less efficient (β_{2003}=0.476), but it improve its position, to the second last, in 2010 (β_{2010}=0.385). On the contrary, during the analyzed period, Island's agriculture suffers presenting the highest lost in competitiveness in 2010, as the highest DODF value shows (from β_{2003}=0.359 to β_{2010}=0.538). Considering Southern regions, they present the performance that is in line with global Italy (β_{2003}=0.261 and β_{2010}=0.295).

The last two columns of table 3 describe mean values of efficiency scores when free disposability of bad outputs is assumed. As previous literature suggest (Färe *et al*, 2007 or Domazliky and Weber, 2004), inefficiency increases significantly, but the ranking of macro areas and the main paths previously described, still remain valid.

Table 4 and figure 1 can be read together and they represent the same picture under two points of view. In table 4 the average Malmquist-Luenberger TFP indexes are computed for each macro-area between 2003 and 2010, together with the two components EFF and TECH. Even if ML shows similarities from 2003 to

Tab 4. Malmquist-Luenberger TFP growth among macro regions, 2003-2010

	Weak			Free		
	ML	EFF	TECH	ML	EFF	TECH
Northern Italy	1.047	1.006	1.041	1.034	1.002	1.032
Central Italy	1.116	1.067	1.046	1.349	1.361	0.992
Southern Italy	1.069	0.978	1.094	1.035	0.935	1.107
Italian Isles	1.048	0.875	1.198	1.101	0.947	1.163

Values are computed as geometric mean, by Macroarea

2010 in the decomposition of the productivity growth in the
two sub-components allows us to highlight different path.

While technical progress improves for each macro-area, the efficiency change term presents a deterioration, in particular for the South Italy and Islands cases (EFF^W=0.978 and EFF^W=0.875 respectively). The situation is not different considering free disposability, except for the Center.

Indeed, considering this macro-area productivity growth is particularly high for both the definition of the model (1.116 under weak disposability, while 1.349 under free): the efficiency recovery components play an important role in determining this dynamic (1.067 under weak disposability, while 1.361 under free).

The figure 1 relates the mean values of the efficiency change and the technical progress with the level of per-capita EU funds for F measures of RDP. No macro-areas are in the best quarter on the graph, characterized by both efficiency component and technical progress higher than the Italian average.

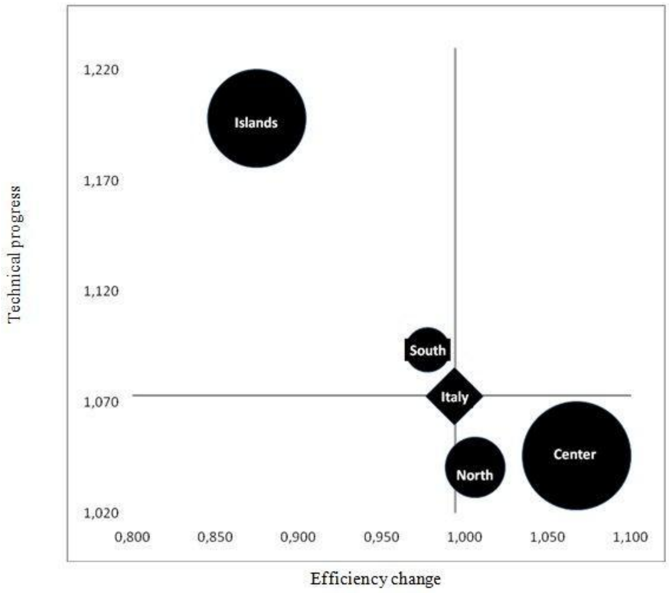

Figure 1. Relative position of macro-areas and their TECH/EFF

On the one hand, North and Center present lower technical progress values than the mean, but on the other hand they show a better catch-up trend. On the contrary, Islands local systems have many problem in keeping up with the technical frontier: the distance with it is increasing over time despite the big injection of EU funds. The dimension of the bullet in figure 1 is proportional to distributed funds per capita within each region. The most problematic position is represented by the agricultural sector in central Italy and Islands: they adsorb a big amount of resources, but they have the poorest performances due to different issues. The flow of public funds is able to create new technological opportunities, but their potential it is not fully exploited

Concerning the convergence issue, the most consistent funds' amount has been distributed to Central regions and Islands, according to table 3, in both pro-capita and surface terms. If the goal of the policy had been achieved, we should observe the best growth dynamics in these areas. Table 4 suggests that only in the case of the Central Italy we observe an higher TFP growth, mainly due to efficiency recovery.

Finally, if we consider the free disposability model, the discussion about the position of the Central regions do not change. Then we can conclude that the convergence process seems only to be confirmed for provinces placed in the Central Italy: they start from a lower level of technical efficiency in 2003 and they are able to recover part of their disadvantage during the seven years period. That evidence it is not stronger when emissions are ignored.

5. CONCLUSIONS

This working paper examines the important question on the sustainability of the Italian agricultural sector by analyzing the relationship between technical efficiency and the production of pollutants from nitrogen fertilizer usage in Italian local agricultural systems. We apply the directional output distance function, computed through an extended DEA model to include bad outputs within land productivity issues. Empirical evidence is interpreted in the light of recent EU funds distributed to increase competitiveness and environmental sustainability of agriculture.

The main results are in line with previous literature: considering bad outputs changes significantly frontiers and reduce mean inefficiency. The average technical performance is similar in 2003 and 2010, but TFP indexes shows a significant growth path and consequently a significant movement of the frontier over time. In particular the technical progress component plays the most important role in determining this evidence. Moreover, this analysis for the first time allows us to extend the debate on the convergence within the Italian agricultural sector by considering also environmental friendly practice as source of productivity enhancement.

According to efficiency analysis, findings show that EU funds seem to go in the right direction and they are assigned to the most problematic area (Center and Islands). Considering Malmquist-Luenberger indexes, we can conclude that the Centre improves its performance, although it started from the worst position; in other terms, we find a weak evidence in favor of convergence.

Finally, we have contributed to the previous literature in the agricultural field applying a relatively new methodology that improves the general quality of results.

In summary, we can conclude that directional output distance function approach is a good and flexible instrument to create productivity indexes in the agriculture field.

For future research line we suggest an in depth investigation on the whole distribution of national and European funds to evaluate public policies efficiency. The database on inputs and outputs could be enlarged and enriched with more detailed information such as labor inputs, desirable product prices, etc.

From a methodological point of view, it would be interested to analyze also the sigma-convergence concept that is different from the beta-convergence considered here. Indeed, this additional tool could give more reliable results about the recovery of the gap among agricultural development in Italy.

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