STRUCTURAL FUNDS AND REGIONAL CONVERGENCE. SOME SECTORAL ESTIMATES FOR ITALY*

Gianluigi COPPOLA[1], Sergio DESTEFANIS[1]

[1]CELPE Centro di Economia del Lavoro e di Politica Economica, DISES Dipartimento di Scienze Economiche e Statistiche. Università degli Studi di Salerno, Via Ponte Don Melillo, 84084 Fisciano. E-mails: glcoppola@unisa.it ,destefanis@unisa.it

Abstract: In this paper we put to test the impact of the European Structural Funds on the economies of the 20 Italian administrative regions for the 1989-2006 period. The main elements of novelty are that the empirical analysis is carried out by considering separately four sectors (agriculture, energy and manufacturing, construction, services), and that a non-parametric FDH-VP approach is used in order to calculate some Malmquist index numbers of productivity. This allows separating the Funds' effects on factor accumulation from those on total productivity changes. Our evidence implies that the Funds had a weak, but significant, impact on total factor productivity change, but virtually no effect on capital accumulation and employment. Different kinds of Structural Funds are found to have widely different influences, with the European Social Fund, arguably, wielding the strongest impact. (***JEL*: C43, D24**).

Keywords: European Structural Funds, total factor productivity, non-parametric frontiers, Malmquist index.

* We are grateful to Roberto Basile and Sergio Scicchitano for useful comments on a previous version of this paper. The usual disclaimer applies.

1. Introduction

In this paper, we put to test the impact of the European Structural Funds on the economies of the 20 Italian administrative regions. We focus on the impact of these Funds on productivity and factor accumulation. This is a topic with a considerable policy interest. In recent years there has been a lively policy debate (not only in Italy, but also in the rest of Europe)[1] on the role of public investment programmes. The Funds are, especially after the introduction of "Agenda 2000", the main instrument used by the European Community to sustain development in the areas with economic problems. Moreover, since the inception of the EMU, the interest in studies concerned with the economic performance of European regions has considerably increased. In this respect, the Italian case appears to be particularly interesting. Italy is characterised by marked regional heterogeneity. As is well known, the Mezzogiorno[2] regions of Italy have consistently lagged behind the rest of the country in terms of per capita income and economic performance (Allen and Stevenson, 1974; Putnam, 1993; Paci and Saba, 1998).

The main element of novelty in the present work vis-à-vis the existing literature (Boldrin and Canova, 2001; Garcìa–Solanes and Maria-Dolores, 2002a, 2002b; Aiello and Pupo, 2007) resides in the fact that the empirical analysis is carried out by considering separately four sectors (agriculture, energy and manufacturing, construction, services). Furthermore, a non-parametric approach (FDH-VP, see Kerstens and Vanden Eeckaut, 1999; Destefanis and Storti, 2002; Destefanis, 2003) is used for the measurement of technical efficiency: By relying on these efficiency measures, some Malmquist productivity index numbers are calculated for three periods broadly

[1] See for instance Ministero dell'Economia (2001), as well as Boldrin and Canova (2001) and the references there provided. A classic reference is Biehl (1986). The main topics of the debate are effectively summed up in Tondl (2004).

[2] These regions are Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia and Sardegna.

corresponding to the programming periods of the Structural Funds (1989-93, 1994-99, 2000-06).[3] The index numbers are computed separately for the 20 Italian administrative regions and the four above named sectors. Then, standard regression techniques are adopted in order to establish whether the Funds have influenced factor accumulation and productivity changes. In this phase of our analysis we rely (for the first time in the literature, to the best of our knowledge) on Structural Funds data from the Spesa Statale Regionalizzata (Ministero dell'Economia e delle Finanze, various years).

The remainder of the paper is organised as follows. Section 2 presents the institutional set-up of the Funds, describing the EU Objectives, the different types of Funds and their evolution across the years 1989-2006, with special emphasis on Italy. Section 3 provides a survey of the empirical literature existing on the argument. Section 4 illustrates the empirical procedures and the data, while the results of the empirical analysis are shown and commented in Section 5. Section 6 concludes and sets out some implications for future research.

2. European Structural Funds: the Institutional Set-up

It does not seem feasible to progress to a closer integration of the EU countries without fostering an ever greater economic and social cohesion among them. Yet, there remain even today some very deep economic and social gaps (both across countries and regions) that undermine unity and cohesion of the Union. Even in the former 15-country Union, the GDP per capita of the richest areas (Hamburg, Paris) was ten to twelve times higher than that of the poorest regions of Greece or Portugal. In the face of these gaps, the creation of a monetary and economic union requires an ever greater effort toward convergence, lest the weakest areas to be permanently marginalised. Indeed, the

[3] Inclusion of more recent data in the study is hindered by the limited availability of regional accounting data.

monetary union leaves little leeway for country-level monetary (exchange-rate adjustments are no longer possible) as well as fiscal policy. The importance of economic and social cohesion is only made greater by the forthcoming enlargement of the EU to ten new countries from Central, Eastern and Southern Europe. Hence the necessity of assessing the expediency and effectiveness of the development policies enacted through the Structural Funds.

As is well known, there is a variety of different programmes that are gathered under the label of Structural Funds.

1) the European Regional Development Fund (ERDF), created in 1975 with the aim of reducing regional imbalances in the EU. It targets the less developed regions and mainly finances projects involving investments in physical capital (private and public), support to small and medium firms, R&D;

2) the European Social Fund (ESF), created in 1986 with the aim the aim of promoting the training and the educational attainment of the labour force, as well as other forms of active labour market policies;

3) the European Agricultural Guidance and Guarantee Fund (EAGGF), dating back to 1962 and a part of the Common Agricultural Policy. It aims to accelerate the adjustment of agricultural structures and to contribute to the development of rural areas;

4) the Financial Instrument for Fisheries Guidance (FIFG), created in 1994 and replacing a number of precedent smaller programmes concerning the fishing industry.

In the rest of the paper we will not deal with the impact of the FIFG, given its very specific nature. Also, we will not consider another important instrument of the EU's development policy: the Cohesion Fund. This fund, created in 1993 after the Maastricht Treaty, supports particular projects of member states (not regions) with a GDP per capita lower than 90% of the EU mean. Since Italy does not satisfy this criterion, it is not a beneficiary of the Cohesion Fund, which consequently is not relevant to the

present paper.

The institution of Agenda 2000 taking place in 1999 corresponds to the 4th reform in the Funds system. The 1st reform of the Structural Funds occurred in 1984. However, the real turning point in the EU development policy came in 1988, after the entry in the EU of Spain and Portugal (taking place in 1986). The 1988 reform has been characterised by the following elements:

1) the doubling of financial resources from 1989 to 1992;

2) a closer dialogue between the European Commission and the regional and national administrations, through the presentation of development plans;

3) the definition of the five basic Objectives within which the various Funds must interact.

Originally, these Objectives were the following:

Objective 1: Economic and structural adaptation of less developed regions; it includes all regions with GDP per capita lower than 75% of the EU average in the last three years. In Italy it includes Abruzzo (until 1996), Molise (until 2006), Campania, Puglia, Basilicata, Calabria, Sicilia and Sardegna;

Objective 2: Economic recovery of regions affected by industrial crisis (as defined by three eligibility criteria). In Italy it includes provinces (NUTS3 areas) in Abruzzo, Emilia Romagna, Friuli Venezia Giulia, Lazio, Liguria, Lombardia, Marche, Piemonte, Toscana, Trentino Alto Adige, Umbria, Valle d'Aosta e Veneto;

Objective 3: Fighting long-term unemployment. The territorial target of this Objective (as well as of the following one) covers the whole EU;

Objective 4: Facilitating the adaptation of workers to industrial changes and to changes in the production systems;

Objective 5: Speeding up the adjustment of industrial structures. Objective 5a covers the whole EU, while the territorial target of Objective 5b (focusing on marginalised

areas) is constituted by areas with high share of agricultural employment, low level of agricultural income, low population density and/or significant depopulation trend.

In the 3rd Reform of the Fund system, taking place in 1993, the changes are much less radical than in 1988. The most important novelties are:

1) financial resources are still doubled;

2) some changes in the Objectives, aiming to put them in closer touch with the problem of unemployment:

- the new Objective 3 includes the functions of former Objectives 3 e 4 in the aim of facilitating the introduction in the labour market of persons otherwise risking to be marginalised;
- the new Objective 4 must guarantee (through the ESF) the adaptation of workers to industrial transformations and to the evolution of the production systems;
- Objective 5b also includes the aid to modernisation and restructuring of the fishing industry, through the institution of the FIFG.

The 4th Reform (implemented through the so-called *Agenda 2000*) follows three main axes:

1) financial resources for the 2000- 2006 period are maintained to the level of the 1994-99 period, equal to the 0.46% of the EU's GDP;

2) greater effectiveness of the Funds is searched through:

- a greater concentration of aid (Objectives are now 3 instead of 6);
- a clearer sharing of responsibilities between Commission and member states;
- the strengthening of the procedures of control, monitoring and evaluation;

3) the partial extension of the Fund system to the perspective member states.

The main features of the distribution across periods and regions of the Funds can be understood by observing the three figures below. The order of presentation of the regions is detailed in the Appendix. Roughly, we proceed southwards as we go from left

to right.

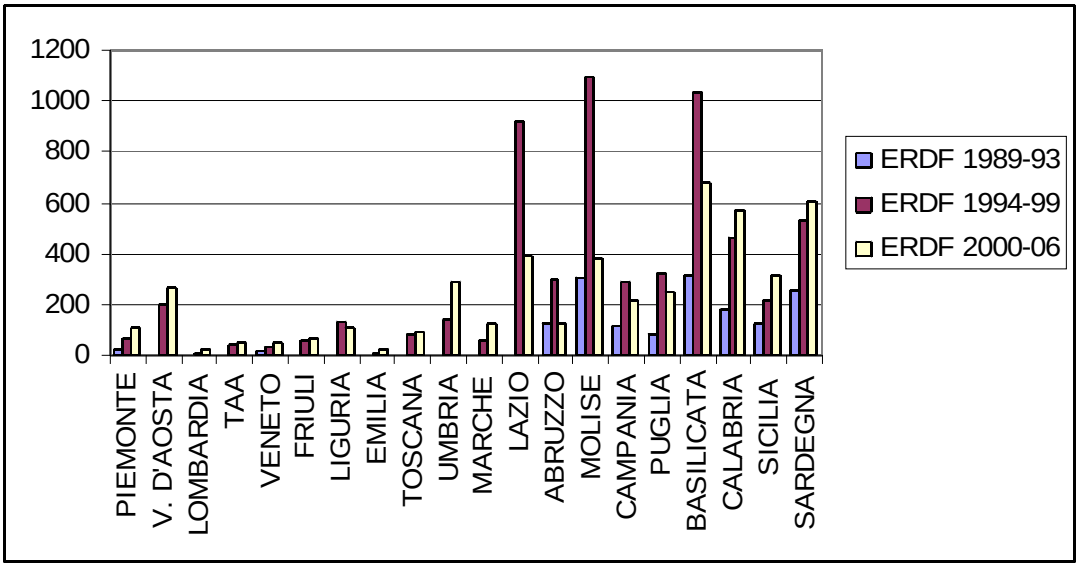

Fig. 2.1 – The ERDF, disbursed funds, by Italian region in euro per inhabitant (1995 prices). Periods 1989-93, 1994-99, 2000-06.
SOURCE: our elaborations on Istat and MEF (*Spesa Statale Regionalizzata*) data.

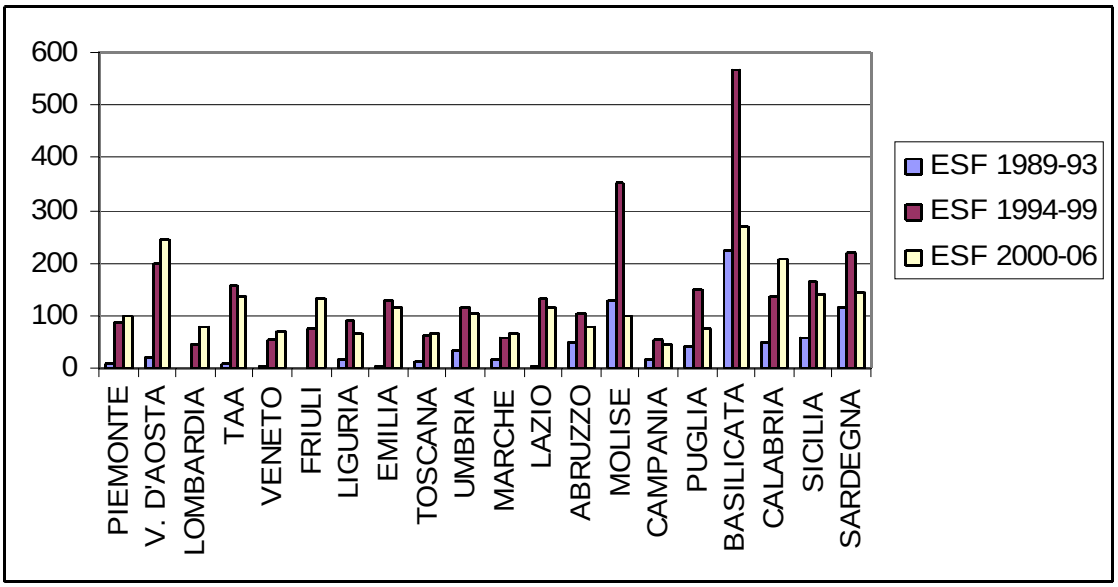

Fig. 2.2 – The ESF, disbursed funds, by Italian region in euro per inhabitant (1995 prices). Periods 1989-93, 1994-99, 2000-06.
SOURCE: our elaborations on Istat and MEF (*Spesa Statale Regionalizzata*) data.

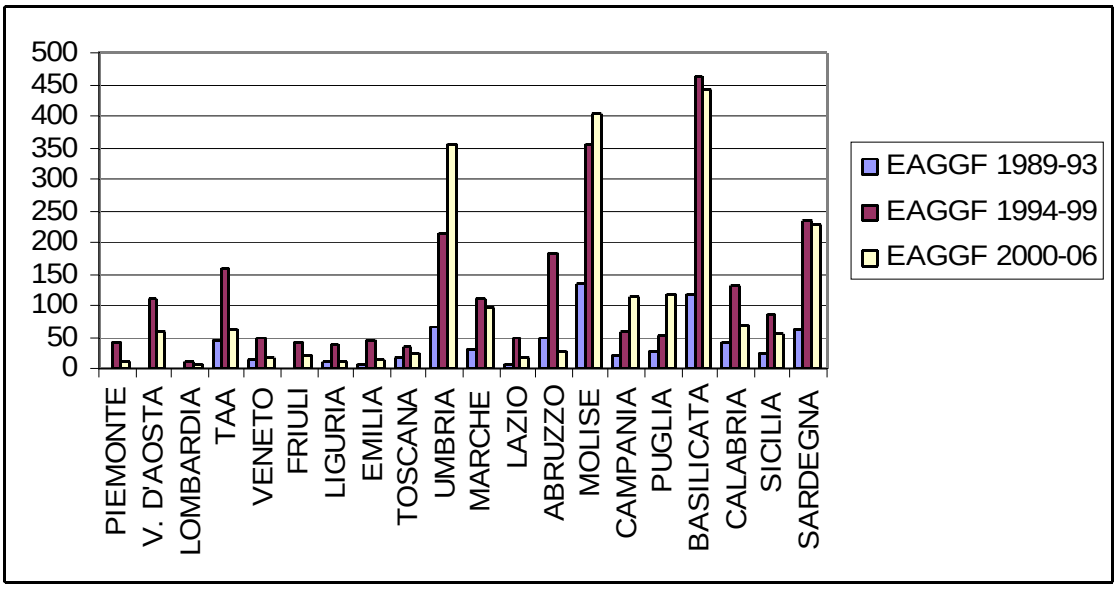

Fig. 2.3 – The EAGGF, disbursed funds, by Italian region in euro per inhabitant (1995 prices). Periods 1989-93, 1994-99, 2000-06.
SOURCE: our elaborations on Istat and MEF (*Spesa Statale Regionalizzata*) data.

Funds per inhabitant are much higher in the Mezzogiorno regions, especially as far as the ERDF is concerned. However, notice that even within the Mezzogiorno there is considerable variability. Particularly high values are obtained for Molise and Basilicata.

It is also instructive to consider the Funds in terms of percentage of the regional GDP. As can be gathered from Table 1, Funds are usually a trifling share of regional GDP, again reaching higher values in the Mezzogiorno and in the smaller regions.

	ERDF 1989-93	ERDF 1994-99	ERDF 2000-06
PIEMONTE	0,14%	0,21%	0,29%
V. D'AOSTA	0,00%	0,38%	0,30%
LOMBARDIA	0,00%	0,02%	0,02%
TAA	0,00%	0,09%	0,05%
VENETO	0,09%	0,15%	0,08%
FRIULI	0,00%	0,15%	0,10%
LIGURIA	0,00%	0,33%	0,24%
EMILIA ROMAG.	0,00%	0,02%	0,04%
TOSCANA	0,00%	0,31%	0,08%
UMBRIA	0,00%	0,54%	0,97%
MARCHE	0,00%	0,27%	0,33%
LAZIO	0,00%	0,05%	0,13%
ABRUZZO	0,94%	0,53%	0,29%
MOLISE	2,63%	2,95%	1,19%
CAMPANIA	1,19%	0,70%	0,94%
PUGLIA	0,79%	0,86%	0,74%

BASILICATA	3,27%	3,16%	2,09%
CALABRIA	1,98%	1,25%	1,62%
SICILIA	1,20%	0,45%	1,12%
SARDEGNA	2,23%	1,31%	1,85%

	ESF 1989-93	ESF 1994-99	ESF 2000-06
PIEMONTE	0,06%	0,19%	0,16%
V. D'AOSTA	0,09%	0,37%	0,44%
LOMBARDIA	0,00%	0,05%	0,15%
TAA	0,04%	0,27%	0,25%
VENETO	0,02%	0,11%	0,14%
FRIULI	0,00%	0,17%	0,27%
LIGURIA	0,10%	0,19%	0,13%
EMILIA ROMAG.	0,02%	0,21%	0,19%
TOSCANA	0,08%	0,13%	0,12%
UMBRIA	0,22%	0,24%	0,28%
MARCHE	0,12%	0,08%	0,14%
LAZIO	0,03%	0,09%	0,05%
ABRUZZO	0,39%	0,25%	0,19%
MOLISE	1,10%	1,08%	0,24%
CAMPANIA	0,15%	0,10%	0,23%
PUGLIA	0,40%	0,45%	0,13%
BASILICATA	2,30%	2,12%	1,09%
CALABRIA	0,53%	0,43%	0,21%
SICILIA	0,57%	0,51%	0,40%
SARDEGNA	0,98%	0,64%	0,46%

	EAGGF 1989-93	EAGGF 1994-99	EAGGF 2000-06
PIEMONTE	0,01%	0,06%	0,01%
V. D'AOSTA	0,00%	0,06%	0,03%
LOMBARDIA	0,00%	0,01%	0,01%
TAA	0,23%	0,20%	0,08%
VENETO	0,07%	0,05%	0,02%
FRIULI	0,00%	0,06%	0,02%
LIGURIA	0,06%	0,04%	0,01%
EMILIA ROMAG.	0,04%	0,04%	0,01%
TOSCANA	0,10%	0,07%	0,02%
UMBRIA	0,44%	0,52%	0,97%
MARCHE	0,20%	0,20%	0,24%
LAZIO	0,05%	0,03%	0,02%
ABRUZZO	0,36%	0,45%	0,04%
MOLISE	1,13%	1,82%	0,60%
CAMPANIA	0,21%	0,23%	0,21%
PUGLIA	0,28%	0,21%	0,47%
BASILICATA	1,23%	1,38%	1,69%
CALABRIA	0,44%	0,36%	1,29%
SICILIA	0,24%	0,31%	0,40%
SARDEGNA	0,54%	0,81%	0,75%

Tab. 2.1 – The European Structural Funds, disbursements by Italian region, as a share of regional GDP. Periods 1989-93, 1994-99, 2000-06.
SOURCE: our elaborations on Istat and MEF (*Spesa Statale Regionalizzata*) data.

3. An Overview of the Empirical Literature

The main work on the economic impact of Structural Funds is the study carried out on European regions data by Boldrin and Canova (2001). They look for three kinds of evidence. First they want to ascertain whether regional differences in income per capita, labour productivity and total factor productivity are increasing or decreasing over time (they consider the period from 1980 to 1996). Boldrin and Canova compute for this purpose measures of β-convergence, σ-convergence and apply non-parametric tests to see whether the empirical distribution of these variables changes over time. The evidence found convinces Boldrin and Canova that regional disparities do not much move in either sense. Italy is however a partial exception in the sense that Southern regions have somewhat lagged behind other regions in the period under scrutiny.

Boldrin and Canova proceed then to assess which are the main factors affecting the evolution of these inequalities. In their view, if regional differences in labour productivity and income per capita are mainly driven by differences in total factor productivity, this is favourable evidence for the "convergence view" of the neo-classical approach to growth (and the rationale for interregional transfers is consequently weakened). On the other hand, the view, often sponsored by the European Commission, that there is a built-in tendency for economic regions to drift apart is validated if regional differences in labour productivity and income per capita are mainly driven by differences in factor endowments and the existence of increasing returns. Their reading of the evidence, mainly based on a descriptive analysis of capital-labour ratios, labour productivity, income per capita and total factor productivity, is that the elements claimed to be the source of agglomeration effects and growing inequality do not help explaining differences in growth rates. On the other hand, regional differences in

income per capita can be accounted by a combination of three factors: total factor productivity, rate of employment and share of agriculture on GDP.

Boldrin and Canova finally consider the direct impact of Structural Funds on regional differences in productivity. Still mainly relying on non-parametric tests, they compare the changes over time for the empirical distribution of regional productivities, and find that recipient and non-recipient regions behave much in the same manner. Their conclusion is that there is no sign of a direct impact of Structural Funds on productivity. Accordingly, they maintain that there is little economic rationale for regional policies fostering growth through transfers of public resources. These policies could then be rationalised in terms of redistributive practices, motivated by the nature of the political equilibria on which the EU is built.

Boldrin and Canova's paper is well constructed and thought-provoking. It certainly provides evidence to the effect that no *large* effects of the Structural Funds are likely to exist. In some respects, however, their analysis is not entirely convincing. In particular, the analysis of the elements that determine regional differences in labour productivity and income per capita would gain from further evidence: for instance, no measurement of returns to scale is attempted. Also, the assessment of the direct impact of Structural Funds relies too much on an empirical instrument (the assessment of changes in the empirical distributions of productivities) which cannot simultaneously allow for the action of different (and possibly contrasting) factors.

An empirical approach allowing to assess the impact of Structural Funds on productivity along with the eventual impact of other factors is the estimation of Barro-type regressions testing explicitly whether β-convergence is a function of Structural Funds. This approach is utilised in the works by Garcìa–Solanes and Maria-Dolores (2002a, 2002b). Garcìa–Solanes and Maria-Dolores (2002a) focus on EU member states as well as regions. In the first case, the data include the two programming periods 1989-

93 and 1994-99, while in the second case the analysis stops in 1996 for reasons of data availability. The authors perform in both cases a dynamic β-convergence test in an equation with fixed effects allowing each country or region to converge to an idiosyncratic steady-state. Crucially, they include in their Barro-type regressions the amounts of Funds distributed to countries or regions during the two programming periods. They take into account an aggregate measure of Structural Funds per inhabitant, as well as measures of ERDF, ESF and EAGGF Funds per inhabitant. Their results indicate that the inclusion of Funds in the regressions increases the estimated speed of convergence and has a significant impact on the steady-state growth implied by the equation. These effects are stronger for the country (as opposed to the region) regressions.

In a refinement of the analysis Garcìa–Solanes and Maria-Dolores (2002b) allow for the fact that Funds are not randomly distributed across regions, implying the possible existence of a selection bias in the above estimates. They do so by nesting the β-convergence test within the switching model approach first proposed in Quandt (1972) and Goldfeld and Quandt (1972). They find that, even allowing for this possible bias, the Funds have a positive impact on growth.

Aiello and Pupo (2007) focus on the territorial effects of EU spending from 1996 to 2007. An important feature of their work, vis-à-vis previous studies, is that they use data on *actually spent*, rather than *accredited, funds*. Their empirical analysis is based on panel estimates of an expanded neoclassical growth model where Structural Funds are included among the variables that explain the convergence across Italian regions. Using various dynamic panel estimators, Aiello and Pupo find that the Funds, although having a stronger impact in the South compared to the Centre-North, have not significantly contributed to regional convergence in Italy.

In our paper, the Garcìa–Solanes and Maria-Dolores studies are very much taken as a

benchmark. There are however some important differences. First, we use sectoral data, in order to better understand the way in which the Funds impact on different industries. Second, also in the aim of providing useful policy indications, we analyse separately the effects of Funds on factor accumulation and on the variations in total factor productivity. Furthermore, we split the latter in technical change, variations in pure technical efficiency, variations in scale efficiency through the calculation of Malmquist indexes of productivity (Fare et al., 1994; 1997; Ray and Desli, 1997; Balk, 2001). The channels trough which the Funds can affect the variations in total factor productivity are then also assessed in separation.

4. The Empirical Framework

In principle, Structural Funds have a twofold economic impact. First, these transfers increase income in the benefited regions, producing a Keynesian (or demand) effect on output and employment. This impact is likely to be short-lived. However, the transfers may also increase the productive capacity of these regions, which is actually their main aim (European Commission, 2000; p. 155). The latter impact can be gauged by assessing the relationship between the Funds and factor accumulation, as well as variations in total factor productivity. We consider in this section how the latter can be measured. A short presentation of the data-set follows.

4.1) The Malmquist Index

It is well known that the calculation of Malmquist productivity index numbers across two sub-periods yields estimates for the variations in total factor productivity as well as in their components: technical change, variations in pure technical efficiency, variations

in scale efficiency. Yet, when the production technology presents non-constant returns to scale, there is no consensus in the literature on how scale effects should be allowed for. Here we follow the approach suggested in Balk (2001). The variations of total factor productivity are measured against a constant-returns to scale benchmark, which is the only way to obtain a productivity index respecting some basic index properties Then, technical change is evaluated as the shift of the true production frontier (eventually showing non-constant returns to scale), while the variation of technical efficiency is decomposed in the variation of pure technical efficiency (with respect to the true frontier) and the variation of scale efficiency. The latter is measured keeping technology constant, that is evaluating variations in the scale efficiency obtained for different input values on the same production frontier (see on this Balk, 2001). Formally, in order to simplify our analysis, let us assume a single-output production process.[4] Denote then by $D^s(x_t, y_t)$, the following output-oriented distance function:

(4.1) $D^s(x_t, y_t)=inf\{\theta: (x_t, y_t/\theta) \in T_s\}$.

Similarly, define

(4.2) $\Delta^s(x_t, y_t)=inf\{\theta: (x_t, y_t/\theta) \in \Theta_s^{CRS}\}$

where Θ_s^{CRS} is a benchmark constant-returns to scale technology defined along the ray corresponding to optimal production scale. The Malmquist index measuring variations in total factor productivity in the interval $\Delta t=[t,t+1]$ admits the following decomposition:

(4.3) $M_{t,t+1}=DTE\times TC\times DSE$

where

(4.4) $$DTE = \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)}$$

[4] The single-output assumption does not imply any loss of generality since an analogous decomposition holds for the multi-output case (see Balk, 2001).

is the (relative) variation in pure technical efficiency, and measures the extent to which any observation gets closer to the frontier from one period to the other.

$$(4.5)\ TC = \left[\frac{D^t(x_{t+1},y_{t+1})}{D^{t+1}(x_{t+1},y_{t+1})} \times \frac{D^t(x_t,y_t)}{D^{t+1}(x_t,y_t)}\right]^{1/2}$$

measures technological change, that is the shift in the frontier, measured across two periods as the geometric mean of the frontier shifts occurring at either data points. Finally

$$(4.6)\ DSE = \left[\frac{\Delta^t(x_{t+1},y_{t+1})/D^t(x_{t+1},y_{t+1})}{\Delta^t(x_t,y_t)/D^t(x_t,y_t)} \times \frac{\Delta^{t+1}(x_{t+1},y_{t+1})/D^{t+1}(x_{t+1},y_{t+1})}{\Delta^{t+1}(x_t,y_t)/D^{t+1}(x_t,y_t)}\right]^{1/2}$$

is the (relative) variation in scale efficiency. Expression (4.6) can be perhaps best appraised through the graphical example provided in Fig. 4.1. As usual, we consider a one-input one-output technology.

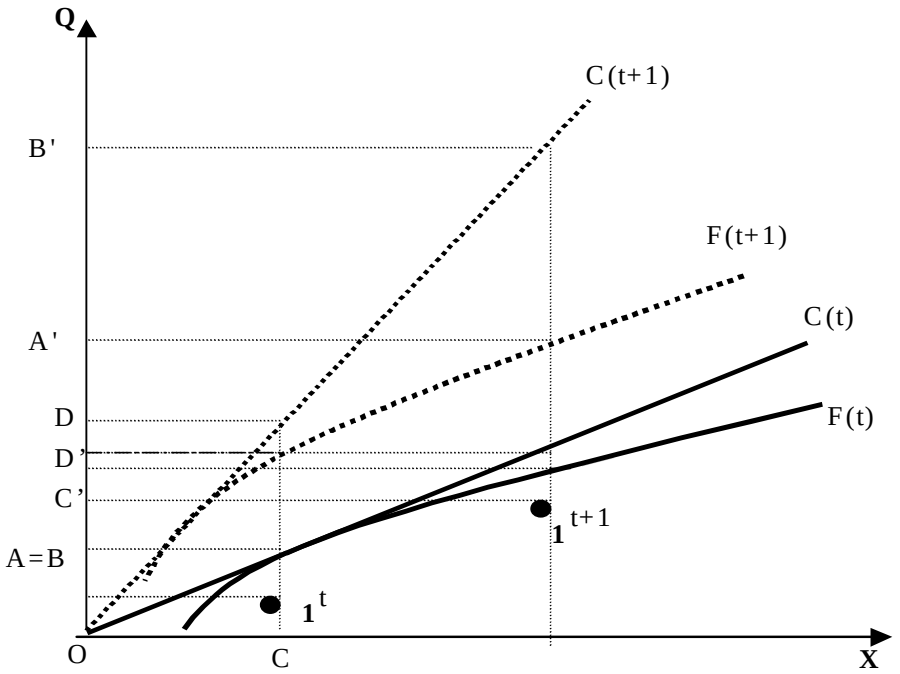

Figure 4.1. The measure of the variations in scale efficiency

F(t) denotes the true frontier at time t and C(t) the virtual CRS frontier (providing the optimal scale for any observation at time t). F(t+1) and C(t+1) are the same concepts at

time t+1. Considering observation 1 in t and t+1, the relative variations of scale efficiency as measured by Balk (2001) are given by the following formula:

$$(4.7)\quad \mathrm{DSE} = \left(\frac{\frac{OC'}{OD'}}{\frac{OA}{OB}} \right)^{1/2} \times \left(\frac{\frac{OA'}{OB'}}{\frac{OC}{OD}} \right)^{1/2}$$

Now, if one assumes that labour and the stock of physical capital are the only inputs, it is possible to write down the following expression (a similar approach was used in Kumar and Russell, 2002):

(4.8) $DOUTPN = M_{t,t+1} \times DKAPN \times RES$

The relative variation of output per labour unit (*DOUTPN*) is decomposed into the relative variation of TFP (as measured by $M_{t,t+1}$), a component linked to the relative variation of the stock of capital per labour unit (*DKAPN*), and a residual component (RES). Hence it is possible to write:

(4.9) $DOUTPN = DTE \times TC \times DSE \times DKAPN \times RES$

where *DTE*, *TC* and *DSE* are measured along the above suggested lines. Expression (4.9) allows one to consider jointly the impact on the relative variations in output per labour unit of (the relative variations in) the stock of capital per labour unit and of the components of TFP relative variations. The impact of Structural Funds on each of these elements can then be assessed through regression techniques. Obviously, we still have to find out appropriate measures for the *DTE*, *TC* and *DSE* components of the Malmquist index. Below we consider for this purpose some developments in the quantitative analysis of production.

4.2) The FDH-VP Approach

The so-called non-parametric approach to the quantitative analysis of production provides empirical counterparts of (4.1) and (4.2) without supposing the existence of a

functional relationship between inputs and outputs. Beginning with the seminal contribution of Farrell (1957), this approach is used to build the frontier of a production set (which satisfies only a limited number of restrictive assumptions which are specified a priori). The frontier is supported by some of the observed producers, which are defined efficient.

Non-parametric methods are divided between those that impose upon the production set the hypothesis of convexity (usually gathered under the label of Data Envelopment Analysis, or DEA) and those that do not need this assumption (the Free Disposal Hull - FDH - approach proposed in Deprins, *et al*., 1984, Tulkens, 1993). In the latter case, the only property imposed on the production set is strong input and output disposability, while in DEA the additional hypothesis of convexity is made. More formally, in FDH, for a given set of producers *Y*o , the reference set *Y* (*Y*o) is characterised, in terms of an observation i, by the following postulate:

(4.10) ($\mathbf{X}^i$, $\mathbf{Y}^i$) observed, ($\mathbf{X}^i + \mathbf{a}$, $\mathbf{Y}^i - \mathbf{b}$) $\in$ *Y* (*Y*o), $\mathbf{a}, \mathbf{b} \geq 0$

where **a** and **b** are vectors of free disposal of input and output, respectively. In other words, due to the possibility of free input and output disposability, the reference set includes all the producers which are using the same or more inputs and which are producing the same or less output in relation to observation *i*.

Let us take as an example Fig. 4.2, where we are considering a technology with one input (X) and one output (Y). The input-output pairs correspond with a cross-section of producers examined at a given point in time. Beginning with observation B, we define every observation located at its right and/or below it (i.e. with more input and same output, or with less output and same input; or else with more input and less output, as F) as dominated by B.

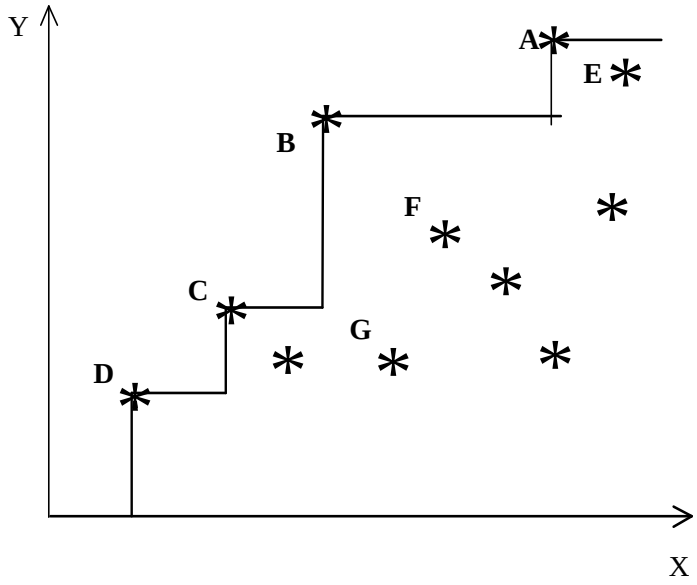

Figure 4.2. The FDH Technology

In the FDH approach, this comparison is carried out for every observation, and the observations dominated by other producers are considered inefficient. Those units which are not dominated by any other observation are considered instead efficient producers, belonging to the frontier of the reference set.

The adoption of FDH allows us to leave behind the hypothesis of convexity of the production set typical of DEA. This means that the frontier obtained through FDH is likely to fit more closely the data than the one obtained through DEA, if the reference set is characterised (at least locally) by the existence of non-convexities.[5] Also, as the frontier of the reference set is made up of actually existing units (rather than by a convex hull), FDH will be less sensitive to the presence in the reference set of outliers (or of erroneously measured values) than DEA. More precisely, the piece of frontier influenced by the presence of the outlier will be smaller with FDH than with DEA. One problem with traditional FDH is that some observations may be efficient because they

[5] It has been observed (Mundlak *et al*., 1999; Mundlak, 2000) that in cross-country (or cross-region) productivity comparisons one must rely on empirical aggregate production frontiers obtained from unobservable micro frontiers. In this case, when the available technology includes more than one technique, a modification of the environment faced by producers may lead to changes in technique (as well as to changes in the output-input mix for a given technique), and the hypothesis of convexity may not be respected for the observable aggregate production frontiers.

are located in an area of the production set where there are no other observations with which they can be compared (*efficiency by default*). This problem is particularly relevant when small data-sets (like ours) are used. To avoid this problem, we use a refinement of the FDH, the FDH-VP (variable-parameter FDH) proposed by Kerstens and Vanden-Eeckaut (1999). This approach imposes more structure on the production set: each observation is compared not only to any other observation but also to their smaller or larger proportional replicas. In this paper we use an output-oriented[6] FDH-VP approach to calculate the *DTE*, *TC* and *DSE* components of the Malmquist index of productivity.

4.3) The Data

In order to compute technical efficiency measures and, then, Malmquist productivity index numbers, we rely on a baseline production set with value added as output and number of labour units and stock of private capital as inputs. Regional data for these variables are considered for four industries: agriculture, energy and manufacturing, construction, services. The latter cannot be split in market and non-market services because the allocation of these services to different industries considerably changed with the new SEC95 national accounting (see for instance Collesi, 2000). Consistent pre- and post-SEC95 series for value added and number of labour units were generously provided by Roberto Basile of ISAE, Rome. Series for the capital stock were constructed following the procedure followed in Paci and Pusceddu (2000).

In order to examine the employment performance of Italian regions, it seems appropriate to focus on the employment rate (more precisely, the relationship between labour units and resident population), both for the entire regional economy and for the

[6] We do not claim any hard theoretical ground for this choice. However, if we take an input orientation, in a two- or three input space the commonly adopted Debreu-Farrell measure of efficiency may not measure technical efficiency (in the sense of Koopmans, 1951) exhaustively. See on this Lovell (1993).

four sectors under examination. This measure is less affected than the unemployment rate by discouraged-worker effect, and it is easy to calculate both at the sectoral and the aggregate level. The resident population series was reconstructed using the procedures suggested in Monterastelli and Golinelli (1990).

Series for the Structural Funds were taken from the series *Spesa statale regionalizzata* of the Ministero dell'Economia e delle Finanze. The series were deflated using a regional GDP deflator and divided by the regional number of inhabitants. It must be stressed that these series relate to the amounts disbursed by the various regions, as taken from the *Spesa Statale Regionalizzata*. More precisely, these data are directly available from 1994 onwards. From 1989 to 1993, we relied on the Funds accredited to the various regions by the EU (source: *I flussi finanziari Italia*/*UE* - Ragioneria Generale dello Stato, Ministero dell'Economia e delle Finanze, various years), and corrected that amount using information on payment data from the EU. This marks a distinctive change with respect to the analysis in Coppola and Destefanis (2007), where we simply used the Funds *accredited* to the various regions by the EU. It is well known that regions were not able in some instances to disburse these amounts within the prescribed dates. In this sense there is a potentially serious measurement error with the former Structural Fund data we used. On the other hand, relying on the *Conti Pubblici Territoriali*, as done Aiello and Pupo (2007), would considerably restrict the sample of analysis (no such data are available before 1996).

5. Structural Funds, Productivity and Factor Accumulation across the Italian Regions

Some contributions (Kittelsen, 1999; Simar and Wilson, 2000) highlight the possibility that non-parametric frontier methods may run into small-sample problems

for sample sizes close or smaller than 100 observations. Accordingly, FDH-VP is applied not on single years but on four sub-samples roughly corresponding to cyclical phases of the Italian economy: 1982-87, 1988-93, 1994-99 and 2000-06. The basic assumption behind this procedure is that the state of technology does not change appreciably within any one of these sub-samples. The sub-sample means for the technical efficiency scores are then used to compute cross-period Malmquist indices, which turn out to be almost exactly contemporaneous with the Funds programming periods (1989-93, 1994-99, 2000-06).

As explained in Kerstens and Vanden-Eeckaut (1999) and in Destefanis (2003), FDH-VP can also be used to produce a measure of the elasticity of scale of the production frontier. This measure is used here to provide a quantitative assessment of the argument developed in Boldrin and Canova (2001) to the effect that the elements claimed to be the source of agglomeration effects and growing regional inequality (above all, the existence of increasing returns) are not very important. Let us first turn to the results concerning the existence of increasing returns, which according to Boldrin and Canova (2001) are paramount among the elements claimed to be the source of growing regional disparities. Regional cross-period means for the elasticities of scales computed through FDH-VP are reported in Table A.1. From their perusal it clearly appears that energy and manufacturing is the only industry where increasing returns can be said to pervasive. Even there, however, they are not very strong. This evidence clearly supports Boldrin and Canova's claim according to which no strong divergence phenomena are taking place among European regions. That at least some tendency to convergence is at work among Italian regions is also apparent from Table A.2. There we compare the standard errors across the sub-samples under consideration for (the natural logs of) value added per labour unit and capital stock per labour unit revealing the existence of some convergence between the economies of the Italian regions (apparently

driven by what happens in services). This evidence, however, obviously does not clarify what kind of convergence process is going on, and what is the role of regional policies in it.

Once obtained some measures for *DTE*, *TC*, and *DSE* (as well as for *DOUPTN* and *DKAPN*[7]), the impact of the Funds on them is assessed through regression analysis. As is well known (see for instance Blundell and Costa Dias, 2000), the crucial element in impact evaluation is the specification of the counterfactual hypothesis, that is what would have been done by the target areas in the absence of intervention. The fundamental problems in this respect are the omitted variable bias (linked to the difficulty of measuring the effects of intervention separately from other factors) and the selection bias (linked to the fact that Funds are distributed not randomly but on the basis of some criteria, possibly impairing the comparison between target and non-target areas).

We deal with these problems by estimating the following fixed-effect regression:

$$(5.1)\ \Delta x_{it} = \alpha_i + \alpha_1 \text{SOUTH} + \alpha_2 \text{PERIOD\_2} + \alpha_3 \text{PERIOD\_3} + \alpha_4 \text{PERIOD\_2*SOUTH} + \\ + \alpha_5 \text{PERIOD\_3*SOUTH} + \alpha_6 x_{it-1} + \alpha_{7j} \text{FUNDS}_{jit} + \alpha_8 z_{it}$$

where *i=1,… 20*, refers to the region, *t=1,2, 3* to the period, *t=1,2, 3* to the Fund types (EAGGF, ERDF, ESF), Δx_{it} are the (percentage) variations in the variable of interest; PERIOD_2 is a dummy variable equal to 1 in the second period (1994-1999); PERIOD_3 is a dummy variable equal to 1 in the third period (2000-2006); SOUTH is a dummy variable equal to 0 for the non-Mezzogiorno regions and to 1 for the Mezzogiorno regions; PERIOD_n*SOUTH are interactive terms. Through these variables we can take into account systematic differences across time and regions and

[7] Values for *DOUPTN* and *DKAPN* are obtained as percentage variations over the sub-sample means of the relevant variable.

deal, at least to some extent, with both omitted variable- and selection bias (basically, Funds are given to the Mezzogiorno regions). Note that these variables can also account, at least to a first approximation, for the share of European Structural Funds that cannot be allocated to any single region.

The adoption of a fixed-effect approach, as suggested in Wooldridge (2002) for purposes of policy evaluation, also aims to counter these problems. Through the x_{it-1} variable[8] we allow for the dynamic structure inherent to the data. Since phenomena of catching-up are usually believed to show up in significant and negative coefficients of x_{it-1}, omission of this variable could potentially lead to seriously biased estimates. Furthermore, this variable also allows to mitigate the omitted variable- and selection bias problems: the disbursement of funds is at least partly linked to the past situation. Having the (current) dependent variable in differences and its lagged counterpart in levels among the regressors does not imply a specification problem, provided that due account is taken of any non-stationarity in means of this variable. In (5.1) this is obtained through dummies *PERIOD_2* e *PERIOD_3*.[9]

$FUNDS_{it}$ are the various funds (ERDF, ESF, EAGGF), included in the equation as in natural logs (adding a unit constant to deal with cases in which funds were equal to zero[10]). In this manner the α_{7j} coefficients can be interpreted as an elasticity. We include all the three Funds together in (5.1) with a view to avoid spurious results.

Finally, the z_{it} variable stands for the capital account expenditures (of national origin) accruing to a given region. Capital account expenditures are deemed of paramount importance as a stimulus to regional growth. It is also well known (Viesti

[8] For technical progress, the lagged values of the state of the state of technology have been approximated by a Tornqvist index of total factor productivity.

[9] From the appropriate unit root tests, whose results are available upon request, no evidence emerges against the hypothesis of stationarity of the regression residuals.

[10] Regressions were also carried out by taking the ratio between the Fund values and their sample means without much change in the results. In future work we aim to consider in greater detail the modelling of variables including zero values.

and Prota, 2008, 2013) that their amount has considerably changed in the period under analysis, mostly decreasing. Hence, omitting this variable (as we did in Coppola and Destefanis, 2007), is a potential source of misspecification.

In Table A.3 we show the main evidence relating to the direct impact of Structural Funds on the our variables of interest: the components of labour productivity change, the employment rate and a measure of variations in total factor productivity obtained through a Tornqvist index.[11] The latter is included among the variables of interest in order to cross-check our evidence about the components of total factor productivity. If we find that these components are influenced by any of the Funds, we should trace back this influence to the Tornqvist index (unless the components are affected with opposite signs).

The reported coefficients in Table A.3 are the α_{7j}'s from (5.1), and the t-ratios are based upon variance-covariance matrices corrected for unknown autocorrelation and heteroskedasticity (obtained through the Newey-West procedure). We also report the estimated coefficients for z_{it}. Beside results for the four sectors, we also produce some regression evidence relating to rates of change in regional GDP's and capital stocks per labour unit, as well as in regional GDP's per capita (denoted as DOUTPC). The results can be summed up as follows.

First of all, it should be noted that z, the capital account expenditures, turn out to have a vary flimsy role in our regressions. Subsequently we present estimates of (5.1) with and *without* z (as the latter estimates may somewhat gain in efficiency. Secondly, it should be noted that, reassuringly, we find some consistency between the Tornqvist index and changes in total productivity change, as computed from the Malmquist index.

By and large, our evidence implies that the Funds had a weak, but significant, impact on total total factor productivity change, but no positive effect on capital accumulation

[11] This index is calculated using the value added, employment and capital stock data, assuming constant return to scale and a labour share of output equal to 0.3.

and employment. The power of our estimates, however, is not very high, being likely to be affected by the relatively small size of our sample. Technical change is positively and significantly affected in Agriculture, Energy & Manufacturing, and in Construction; slightly less in Services. A similar pattern applies to scale efficiency, while technical efficiency only has a strong positive reaction in Services. Often the Funds have a negative impact on capital accumulation. The employment rate, on the other hand, is virtually unaffected by the Funds.

Different kinds of Structural Funds are found to have widely different influences, with the European Social Fund arguably wielding the strongest impact. This is vindicated by the positive impact of the ESF on DOUTPN and DOUTPC. The ERDF, generally endowed with very little significance, has some positive impact on capital growth in Services and in the aggregate economy, distinctly from the other Funds. Indeed, the EAGGF and the ESF often impact negatively on capital growth. Interestingly, the ESF also tends to negatively affect employment growth (not very significantly), and the EAGGF negatively affects virtually all the variables in Construction. An obvious consequence of this finding is that analyses based upon aggregate measures of the Structural Funds, obtained as a sum or a product of the three components, should be considered with caution.

More generally, the size of the impact of the Funds is not very large but is in line with the results obtained by Garcìa-Solanes and Maria-Dolores (2002a, 2002b) as well as Aiello and Pupo (2007). Obvious caveats to these results concern the probable presence of measurement errors in the Funds variables. On the other hand the diagnostic tests (available upon request) are generally satisfactory.

6. Concluding Remarks

In this paper we consider the impact of the European Structural Funds on convergence across Italian regions across the three waves of the Funds concerning the 1989-2006 period. We focus on the impact of Funds on productivity and employment in the Italian regions, considering separately the Funds' effects on four sectors (agriculture, manufacturing, construction, services) of the regional economies. We use a non-parametric FDH-VP approach in order to calculate some Malmquist productivity index numbers.

Our evidence implies that the Funds had a weak, but significant, impact on total factor productivity change, but virtually no effect (in particular, a positive one) on capital accumulation and employment. Different kinds of Structural Funds are -found to have widely different influences, with the European Social Fund, arguably, wielding the strongest impact. The lack of a strong impact of Funds on the productivity of Energy and Manufacturing may help explaining why Boldrin and Canova (2001) do not find significant results for the regional economies considered as a whole. However, we also believe that our empirical procedure allows a better treatment of the omitted variable and selection problems inherent to policy evaluation.

In future work, we plan to extend our dataset to more recent years. Also, developing upon Arcelus and Arocena (2000), we want to attempt a different approach to the decomposition of productivity changes, consistent with the computation of annual measures. This is going to increase the power of our estimates and to allow a more classic dynamic specification of our regressions. A puzzling feature of our estimates which we also want to focus upon in future work is the weak role of (national) capital account expenditure. Arguably, finer expenditure classifications should be considered.

Furthermore, if one takes the view that growth in the Mezzogiorno is constrained by

the scarce availability of some local public goods, such as physical, but also social, infrastructures,[12] one should both control for regional differences in these factors, and ascertain whether their accumulation has been influenced by Structural Funds. An important attempt along the first of these research lines has already been provided by Ederveen et al. (2006): we believe that pursuing both of them in the future is a high priority for the correct assessment of the Structural Funds' impact.

[12] Evidence in favour of this view is provided by D'Acunto et al. (2004).

REFERENCES

Aiello F., Pupo V. (2007), L'impatto della politica regionale dell'Unione Europea. uno studio sulle regioni italiane, *Rivista Italiana degli Economisti*, 14 (3), 421-454.

Allen K., Stevenson A. (1974), *An Introduction to the Italian Economy*, London, Martin Robertson.

Arcelus F.J., Arocena P. (2000), Convergence and productive efficiency in fourteen OECD countries: A non-parametric frontier approach, *International Journal of Production Economics*, 66, 105-117

Balk B. (2001) Scale Efficiency and Productivity Change, *Journal of Productivity Analysis*, 15, 159-183.

Biehl D. (1986), *The Contribution of Infrastructure to Regional Development. Final Report*, Luxembourg, European Communities Commission.

Blundell R., Costa Dias M. (2000), Evaluation Methods for Non-Experimental Data, *Fiscal Studies*, 21 (4), 427-468.

Boldrin M., Canova F. (2001), Europe's Regions, Income Disparities and Regional Policies, *Economic Policy*, n. 32, 207-253.

Collesi D. (2000), *La distinzione market – non market*, seminar on "La nuova Contabilità Nazionale", Istat, Rome.

Coppola G., Destefanis S. (2007), Fondi strutturali, produttività e occupazione. Uno studio sulle regioni italiane, *Rivista di economia e statistica del territorio*, n. 2, 85-113.

D'Acunto S., Destefanis S., Musella, M. (2004), Exports, Supply Constraints and Growth: An Investigation using Regional Data**,** *International Review of Applied Economics*, 18 (2), 167–188.

Destefanis S. (2003), The Verdoorn Law: Some Evidence from Non-parametric Frontier Analysis**,** in: McCombie J., Pugno M., Soro B. (eds.) *Productivity Growth and Economic Performance: Essays on Verdoorn's Law*, Palgrave Macmillan, Basingstoke.

Destefanis S., Storti G. (2002), Measuring cross-country technological catch-up through variable-parameter FDH, *Statistical Methods and Applications*, 11, 109-125.

Ederveen, S., de Groot, H., Nahuis, R. (2006), Fertile Soil for Structural Funds? A Panel Data Analysis of the Conditional Effectiveness of European Cohesion Policy, *Kyklos*, 59, n. 1, 17-42.

European Commission (2000), *Agenda 2000*, Luxembourg, European Communities Commission.

Färe R., Grosskopf S., Norris M. (1997a), Productivity Growth, Technical Progress and Efficiency Change in Industrial Countries: Reply, *American Economic Review*, 87, 1040-1043.

Färe R., Grosskopf S., Norris M., Zhang Z. (1994), Productivity Growth, Technical Progress and Efficiency Change in Industrial Countries, *American Economic Review*, 84, 66-83.

Farrell M.J., (1957), The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society*, series A 120 (3), 253-290.

Førsund F. (1996), On the calculation of scale elasticity in DEA models, *Journal of Productivity Analysis*, 7, 283-302.

Garcìa-Solanes I., Maria-Dolores R. (2002a), The Impact of European Structural Funds on Economic Convergence in European Countries and Regions, in: *Convergence Issues in the European Union*, Edward Elgar, Aldershot.

Garcìa-Solanes I., Maria-Dolores R. (2002b), Convergencia Real de las Regiones Españolas: El Impacto de los Fondos Estructurales, *Papeles de Economía Española*, n. 93.

Golinelli R., Monterastelli M. (1990), *Un metodo per la ricostruzione di serie storiche compatibili con la nuova contabilità nazionale (1951-1989)*, Nota di lavoro 9001, Prometeia, Bologna.

Goldfeld S.M., Quandt R.E. (1972), *Non-Linear Methods in Econometrics*, North-Holland, Amsterdam.

Kerstens K., Vanden Eeckaut P. (1999), Estimating returns to scale using non-parametric deterministic technologies: a new method based on goodness-of-fit, *European Journal of Operational Research*, 113, 206-214.

Kittelsen S.A.C. (1999), *Monte Carlo simulations of DEA efficiency measures and hypothesis tests*, Memorandum n. 9, Department of Economics, University of Oslo.

Koopmans T.C. (1951), Analysis of Production as an Efficient Combination of Activities, in: *Activity Analysis of Production and Allocation*, Koopmans T.C. (ed.), Wiley, New York.

Kumar S., Russell R.R. (2002), Technological Change, Technological Catch-up, and Capital Deepening: Relative Contributions to Growth and Convergence, *American Economic Review*, 92, 383-416.

Lovell C.A.K. (1993), Production frontiers and productive efficiency, in: *The Measurement of Productive Efficiency: Techniques and Applications*, Fried H., Lovell C.A.K., Schmidt S. (eds.), Oxford University Press, London.

Ministero dell'Economia e delle Finanze (2001), "*Quarto Rapporto del Dipartimento per le Politiche dello Sviluppo 2000-2001*", Rome.

Ministero dell'Economia (various years), "*La Spesa Statale Regionalizzata*", Rome.

Mundlak Y. (2000), *Agriculture and Growth: Theory and Measurement*, Harvard University Press, Cambridge, Mass. .

Mundlak Y., Larson D.F., Butzer R. (1999) Rethinking Within and Between Regressions: The Case of Agricultural Production Functions, *Annales d'Economie et de Statistique*, n. 55-56, 475-501.

Paci R., Saba A. (1998), The empirics of regional economic growth in Italy. 1951-1993, *International Review of Economics and Business*, 45, 515-542.

Paci R., Pusceddu N. (2000), Una stima dello stock di capitale per le regioni italiane 1970-94, *Rassegna Economica Quaderni di Ricerca*, n. 4, 97-118.

Putnam R.D. (1993) *Making Democracy Work. Civic Traditions in Modern Italy*, Princeton University Press, Princeton, NJ.

Quandt R.E. (1972), A New Approach to Switching Regressions, *Journal of the American Statistical Association*, 78, 306-310.

Ray S., Desli E. (1997), Productivity Growth, Technical Progress and Efficiency Change in Industrial Countries: Comment, *American Economic Review*, 87, 1033-1039.

Simar L., Wilson P. (2000), Statistical Inference in Nonparametric Frontier Models: The State of the Art, *Journal of Productivity Analysis*, 13, 49-78.

Tondl G. (2004), EU Regional Policy, in Van der Hoek M.P. (a cura di), *Handbook of Public Administration and Public Policy in the European Union*, Taylor & Francis, New York. 810-844.

Tulkens H. (1993), On FDH efficiency analysis: some methodological issues and applications to retail banking, courts and urban transit, *Journal of Productivity Analysis*, 4, 183-210.

Viesti G., Prota F. (2008), *Le nuove politiche regionali dell'Unione Europea*, il Mulino,

Bologna.
Viesti G., Prota F. (2013), *Senza Cassa. Le politiche per lo sviluppo del Mezzogiorno dopo l'Intervento straordinario*, il Mulino, Bologna.
Wooldridge, J.M., 2002. Econometric Analysis of Cross Section and Panel Data. MIT Press, Cambridge MA.

APPENDIX

The 20 administrative regions: order of presentation and territorial partition		
NORTH:	CENTRE:	MEZZOGIORNO:
1) *Piemonte*	9) *Toscana*	13) *Abruzzo*
2) *Valle d'Aosta*	10) *Umbria*	14) *Molise*
3) *Lombardia*	11) *Marche*	15) *Campania*
4) *Trentino Alto Adige*	12) *Lazio*	16) *Puglia*
5) *Veneto*		17) *Basilicata*
6) *Friuli Venezia Giulia*		18) *Calabria*
7) *Liguria*		19) *Sicilia*
8) *Emilia Romagna*		20) *Sardegna*

TABLE A.1 **- Regional measures for the Elasticity of Scale***

Regione	*Agriculture*	*Energy & Manufacturing*	*Construction*	*Services*
Piemonte	0,84	1,03	0,92	1,01
Valle d'Aosta	1,20	1,10	1,07	1,00
Lombardia	0,81	0,99	0,90	1,00
Trentino A A	0,80	1,10	1,04	1,00
Veneto	0,80	1,00	0,91	1,01
Friuli V G	0,80	1,08	0,99	1,00
Liguria	1,03	1,05	0,93	1,01
Emilia Romagna	0,80	1,08	0,90	1,00
Toscana	0,80	1,05	0,93	1,01
Umbria	1,09	1,08	1,08	1,01
Marche	0,82	1,01	1,00	1,01
Lazio	0,80	1,03	0,90	1,00
Abruzzo	0,93	1,08	0,90	1,01
Molise	1,20	1,10	1,10	1,01
Campania	0,80	1,07	0,90	1,01
Puglia	0,80	1,04	0,90	1,00
Basilicata	0,89	1,10	1,06	1,00
Calabria	0,80	1,10	0,94	1,01
Sicilia	0,80	1,08	0,90	1,01
Sardegna	0,80	1,10	1,04	1,00
Media	**0,88**	**1,06**	**0,97**	**1,01**

*The elasticity of scale measures the percentage increase in output due to a unit percentage increase of all inputs. Values greater than (equal to, less than) one indicate the presence of increasing (constant, decreasing) returns to scale. The elasticity of scale was calculated using the formula suggested in Førsund(1996): the ratio between the natural logs of, respectively, input- and output-oriented technical efficiency scores.

TABLE A.2 - σ - Convergence: Value Added per Labour Unit

Period	*Agriculture*	*Energy & Manufacturing*	*Construction*	*Services*	*Total*
1982-87	0,39	0,12	0,12	0,11	0,15
1988-93	0,43	0,13	0,19	0,11	0,14
1994-99	0,42	0,12	0,16	0,09	0,11
2000-06	0,39	0,12	0,21	0,08	0,10

TABLE A.3a – The Impact of Structural Funds (*specification with* z_{it}*)*[†]								
	ERDF		***ESF***		***EAGGF***		***z***	
	Coeff.	T-ratio	Coeff.	T-ratio	Coeff.	T-ratio	Coeff.	T-ratio
				Agriculture				
DOUTPN	**0.01**	0.44	**0.04**	0.73	**0.08**	1.86	**0.31**	2.49
DTE	**0.02**	1.09	**0.00**	0.09	**0.02**	0.53	**-0.02**	-0.32
TC	**-0.00**	-0.15	**0.03**	2.28	**0.01**	0.98	**0.03**	0.76
DSE	**-0.04**	-3.59	**0.07**	2.14	**-0.03**	-0.86	**0.04**	0.51
DKAPN	**-0.03**	-2.27	**-0.04**	-1.27	**0.01**	0.74	**0.00**	0.94
Dtfp	**0.02**	0.79	**0.05**	0.97	**0.07**	1.58	**0.30**	2.35
DER	**-0.01**	-0.50	**-0.02**	-0.51	**-0.04**	-1.70	**-0.01**	-0.11
				Energy & Manufacturing				
DOUTPN	**0.00**	0.44	**0.06**	3.92	**-0.01**	-1.13	**0.03**	1.08
DTE	**0.00**	0.76	**-0.01**	-0.51	**-0.00**	-0.16	**0.02**	0.70
TC	**0.00**	0.42	**0.01**	2.07	**0.00**	0.71	**-0.01**	-0.71
DSE	**0.00**	0.53	**0.01**	1.09	**-0.00**	-0.10	**-0.06**	-2.26
DKAPN	**-0.02**	-1.65	**0.01**	0.34	**-0.04**	-2.66	**-0.03**	-0.45
Dtfp	**0.01**	1.21	**0.05**	2.84	**0.01**	0.91	**0.05**	0.99
DER	**0.00**	0.00	**-0.02**	-0.15	**0.00**	0.09	**0.02**	0.42
				Construction				
DOUTPN	**-0.03**	-1.70	**0.06**	1.58	**-0.05**	2.24	**-0.01**	-0.19
DTE	**-0.00**	-0.24	**-0.01**	-0.48	**-0.03**	-1.33	**-0.11**	-1.97
TC	**0.00**	0.35	**0.02**	2.22	**-0.02**	-2.26	**0.03**	1.50
DSE	**-0.01**	-0.66	**0.04**	1.77	**-0.05**	-1.49	**-0.10**	-1.82
DKAPN	**-0.02**	-1.36	**0.00**	0.15	**-0.01**	-0.77	**-0.11**	-1.79
Dtfp	**-0.02**	-1.34	**0.05**	1.42	**-0.04**	-1.87	**0.02**	0.23
DER	**0.01**	0.50	**-0.02**	-1.31	**0.02**	1.17	**0.00**	0.01
				Services				
DOUTPN	**0.00**	0.15	**0.02**	2.11	**-0.01**	-1.45	**0.01**	0.30
DTE	**-0.01**	-2.75	**0.02**	5.59	**-0.01**	-0.73	**0.02**	0.40
TC	**0.01**	1.62	**0.00**	0.07	**0.01**	2.03	**-0.01**	-1.41
DSE	**-0.00**	-0.10	**-0.01**	-1.53	**0.00**	0.25	**0.01**	0.36
DKAPN	**0.02**	2.36	**-0.02**	-1.32	**0.00**	0.16	**0.07**	1.46
Dtfp	**-0.01**	-1.38	**0.04**	3.62	**-0.01**	-1.37	**-0.02**	-0.58
DER	**0.00**	0.10	**-0.00**	-0.68	**-0.00**	-0.38	**-0.01**	-0.60
				Total				
DOUTPN	**-0.00**	-0.47	**0.03**	3.60	**-0.01**	-1.26	**0.01**	0.50
DKAPN	**0.02**	1.97	**-0.02**	-1.26	**-0.00**	-0.00	**0.04**	1.15
Dtfp	**-0.01**	-1.38	**0.04**	3.62	**-0.01**	-1.37	**-0.02**	-0.58
DER	**0.00**	0.03	**-0.01**	-1.79	**-0.00**	-0.72	**-0.01**	-0.89
DOUTPC	**-0.00**	-0.15	**0.02**	3.33	**-0.01**	-1.90	**0.00**	0.13

[†] This impact, to be interpreted as the elasticity of the dependent variable vis-à-vis a given Fund, is measured by coefficients α_{7j} in (5.1).

TABLE A.3b – The Impact of Structural Funds (*specification without* z_{it}***)***						
	ERDF		***ESF***		***EAGGF***	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
			Agriculture			
DOUTPN	**0.02**	0.51	**0.00**	0.07	**0.11**	2.06
DTE	**0.02**	1.10	**0.01**	0.18	**0.01**	0.46
TC	**-0.00**	-0.10	**0.03**	2.37	**0.01**	1.14
DSE	**-0.04**	-3.49	**0.06**	2.15	**-0.03**	-0.78
DKAPN	**-0.03**	-2.28	**-0.05**	-1.38	**0.02**	0.76
Dtfp	**0.03**	0.75	**0.02**	0.30	**0.10**	1.77
DER	**-0.01**	-0.52	**-0.02**	-0.55	**-0.04**	-1.66
			Energy & Manufacturing			
DOUTPN	**0.00**	0.53	**0.06**	3.90	**-0.01**	-0.82
DTE	**0.01**	0.87	**-0.01**	-0.90	**0.00**	0.04
TC	**0.00**	0.36	**0.01**	2.02	**0.00**	0.56
DSE	**0.00**	0.57	**0.02**	2.47	**-0.01**	-0.89
DKAPN	**-0.02**	-1.60	**0.01**	0.53	**-0.05**	-2.86
Dtfp	**0.01**	1.51	**0.04**	2.67	**0.02**	1.18
DER	**0.00**	0.02	**-0.02**	-1.37	**0.00**	0.21
			Construction			
DOUTPN	**-0.03**	-1.72	**0.06**	1.63	**-0.05**	2.17
DTE	**-0.01**	-0.41	**-0.00**	-0.01	**-0.04**	-1.79
TC	**0.00**	0.46	**0.02**	2.14	**-0.02**	-1.94
DSE	**-0.01**	-0.64	**0.06**	1.99	**-0.06**	-1.61
DKAPN	**-0.02**	-1.27	**0.02**	0.70	**-0.03**	-1.34
Dtfp	**-0.02**	-1.35	**0.05**	1.37	**-0.04**	-1.74
DER	**0.01**	0.50	**-0.02**	-1.35	**0.02**	1.18
			Services			
DOUTPN	**0.00**	0.18	**0.02**	2.13	**-0.01**	-1.39
DTE	**-0.01**	-2.54	**0.02**	5.16	**-0.01**	-0.63
TC	**0.01**	1.56	**0.00**	0.44	**0.01**	1.73
DSE	**-0.00**	-0.08	**-0.01**	-1.86	**0.00**	0.39
DKAPN	**0.02**	2.04	**-0.03**	-1.89	**0.01**	0.56
Dtfp	**-0.01**	-1.11	**0.03**	2.84	**-0.02**	-1.86
DER	**0.00**	0.08	**-0.00**	-0.49	**-0.00**	-0.54
			Total			
DOUTPN	**-0.00**	-0.45	**0.03**	3.66	**-0.01**	-1.72
DKAPN	**0.02**	1.79	**-0.03**	-1.96	**0.00**	0.42
Dtfp	**-0.01**	-1.38	**0.04**	4.06	**-0.01**	-1.68
DER	**-0.00**	-0.00	**-0.01**	-1.70	**-0.00**	-0.91
DOUTPC	**-0.00**	-0.15	**0.02**	3.43	**-0.01**	-1.87