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April 2011

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Abstract

This paper demonstrates an evaluation of welfare policies and regional allocation of public investment using Data Envelopment Analysis (DEA). Specifically, the efficiency of the welfare policies of the Greek prefectures for the census years of 1980, 1990 and 2000 are compared and analyzed. The paper using bootstrap techniques on unconditional and conditional full frontier applications determines whether the government investments have been used efficiently by the local authorities in order to stimulate regional welfare among the Greek prefectures. Our empirical results indicate that there are major welfare inefficiencies among the prefectures over the three census years. The analysis reveals that the population density among the Greek prefectures hasn't been taken into account in regional welfare planning over the years. In addition, the paper demonstrates empirically how the new advances in DEA analysis can be incorporated into different stages of regional planning investment and evaluation. In addition, the impact of external factors can be directly measured and evaluated accordingly.

Keywords: Regional development; Welfare policies; Conditional DEA; Bootstrap techniques; Kernel density estimation.
JEL Classification: C02**,** O18, P25

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1. Introduction

It is generally accepted that the level of welfare and economic development are not uniform across regions. On the contrary, they differ substantially. Governments may be tempted to reduce these differences through the allocation of public capital. As such policy-makers may be motivated by efficiency considerations [1]. Welfare planning and urban policy can play a significant role in addressing disadvantages among regions [2]. Melachroinos and Spence [3] emphasise the fact that regional variations in capital expansions can be associated with the emergence of new inequalities, which in turn can raise planning issues that can be a key factor underlying regional growth prospects.

In many countries, governments have tried to establish policies able to reduce regional economic and welfare discrepancies by using welfare investments as a policy tool. It has been argued that public capital (like infrastructures) have a positive contribution on regional productivity [4]. For the case of Greece, Karkazis and Thanassoulis [5] assess the effectiveness of regional development policies of the Greek Governments. Greece used the Development Act 1262 of 1982 in order to make the differentiations and disparities in economic development more uniform. The main target behind those policies was the economic development of the prefectures with a direct impact on regional welfare and thus to the citizens' living standards. In the case of Greece different policies and implications for economic development of the prefectures have been observed due to the entrance of Greece into the European Union. However the public investment policies adopted have produced imbalanced effects over the Greek regions [6].

According to Carrera et al. [7] recent literature has explored the effectiveness of public investment in reducing the observed differences in income levels across regions. In contrast to those studies, this study provides empirical evidence of the efficiency of welfare policies in relation to prefectures' population density and economic development. For that reason the latest developments of Data Envelopment Analysis (DEA) have been applied in order to obtain efficiency scores of the Greek prefectures for three census years (1980, 1990, 2000) evaluating government's investment effect on regional welfare over the last three decades. To our knowledge for the first time, an application of conditional DEA, bootstrap techniques and kernel density estimations has been applied in order to measure regional welfare efficiency using a number of inputs and outputs seeking regional comparisons. This is achieved with the simultaneous use of multiple criteria, which determine welfare efficiency for each prefecture and combining them into a single performance measure.

This paper is organized a follows. Section 2 presents a review of the existing literature. In section 3 the various variables that are used in the formulation of the proposed model are presented. In section 4 the technique adopted both in its theoretical and mathematical formulation is presented. Section 5 discusses the empirical findings of our study. The final section concludes the paper commenting on the derived results and the implied policy implications.

2. Literature Review

Different studies evaluating welfare, regional and economic development policies have used Data Envelopments Analysis. MacMillan [8] was the first to establish the applicability of DEA on regional analysis and planning. Among other studies, Zhu [9] using various variables (like housing monthly rental, cost of loaf of French bread, cost of martini, number of population with bachelor's degree, number of doctors, number of museums, number of libraries), measures the quality of life across 15 US domestic and 5 international cities using the CCR DEA model [10]. Without a priori knowledge of factor relationship, a multi dimensional quality of life measure was demonstrated.

Furthermore, Siriopoulos and Asteriou [11] following the theoretical basis of the neoclassical model of economic growth found the existence of economic dualism across the southern and northern regions of Greece. Tsionas [12] examining the regional convergence in Greece found that Greek regions have started the process of real convergence having important implications for Greek regional policy.

Additionally, Maudos et al. [13] using DEA evaluated technical efficiency as a source of convergence for the Spanish regions. They found that there are important differences of efficiency among the regions. They further suggest that the effort of policy makers for the Spanish regions must be given to the improvement of the efficiency of use of productive factors in each sector of activity, rather than reallocating resources among sectors. Afonso and Fernandes [14] examined the efficiency of 51 Portuguese municipalities using DEA and found a wide dispersion in performance. They suggest that more spending does not necessarily correspond to better local living standards.

Athanassopoulos and Karkazis [15] using DEA and by entering the concept of regional efficiency examined the case of 20 prefectures of Northern Greece and found regional planning inefficiencies. Their results indicate that only 3 out of 20 prefectures have both socio-demographic and economic profiles been utilized effectively. Finally, Halkos and Tzeremes [6] based on the neoclassical model of growth using DEA methodology have examined for time period of 2003-2006 the economic efficiency of all the Greek prefectures. Their results indicate that there are significant regional economic inefficiencies among the Greek prefectures indicating significant regional policies inefficiencies.

Our work is among those lines using inputs and outputs, which are fundamental elements of welfare policy evaluation. De Borger et al. [16] using DEA methodology have proved that DEA has the advantage of evaluating municipalities' efficiencies as well as their determinants. However, most of DEA studies lack explanation of the estimated inefficiencies in a more systematic way [16]. Therefore, this paper using new advances of DEA methodologies investigates and analyzes more systematically the efficiency scores and the influence of external factors which can shape prefectures' welfare state.

3. Data

The various indicators of each region differ as one indicator may be high and another may be low. This implies that it is important to weight the various indicators in order to obtain an indicator, which will help us to understand the current conditions of the regional development of each area. The main issue is how to weight these indicators in a realistic and representative way and thus to take into consideration the external (environmental) factors influencing them.

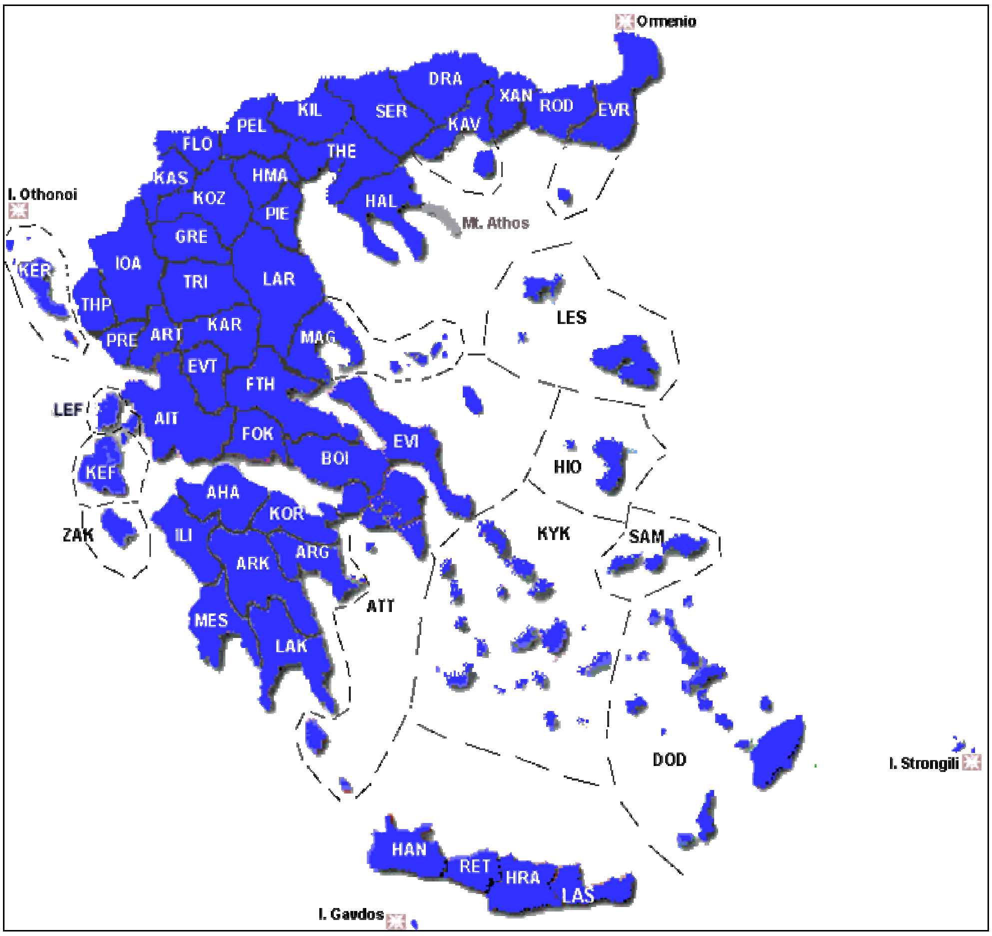
The National Statistical Service of Greece has recorded the data used here. They refer to the Census of the last three decades (1980, 1990, and 2000) for all Greek prefectures (see Figure 1). The data are provided by All Media Database [17] (Profile of Greek Regions)[2]. For the purpose of the analysis we code each of the 50 prefectures as shown in Table 1. This table also provides information on key characteristics of the prefectures (NUTS 3) (population, area in km^2, area in $miles^2$). These prefectures form thirteen administrative regions (NUTS 2), whose basic characteristics are also presented in Table 1. The region of Attica is the most populated region with 3.522.769 citizens, whereas the region with the lower levels of population are been recorded for the region of North Aegean (containing the prefectures of C50-HIO, C31-LES and C42-SAM) with 198.241 recorded citizens[3].

[2] The data can be retrieved from: http://www.economics.gr.
[3] All the population data are recorded for the year 2000.

Table 1: Codes, names and general information of theGreek prefectures and regions

Prefecture Code	Map Code	Prefectures	Population	Area (km.²)	Area (mi.²)	Administrative region	Population	Area (km.²)	Area (mi.²)
C1	**AIT**	Aitolokarnanias	230,688	5,447	2,103	**Aegean North** (C51, C31, C42)	198,241	3,836	1,481
C2	**ARG**	Argolidas	97,25	2,214	855	**Aegean South** (C9)	257,522	5,286	2,041
C3	**ARK**	Arkadias	103,84	4,419	1,706	**Attica** (C37)	3,522,769	3,808	1,47
C4	**ART**	Artas	78,884	1,612	622	**Crete** (C50, C40, C16, C30)	536,98	8,336	3,219
C5	**AHA**	Axaias	297,318	3,209	1,239	**Epirus** (C4, C19, C39, C17)	339,21	9,203	3,553
C6	**BOI**	Boiotias	134,034	3,211	1,24	**Greece Central** (C11, C12, C48, C46, C6)	578,881	15,549	6,004
C7	**GRE/KOZ**	Grebenon/ Kozanis	37,017/ 150,159	2,338/3,562	903/1,375	**Greece West** (C5, C1, C14)	702,027	11,35	4,382
C8	**DRA**	Dramas	96,978	3,468	1,339	**Ionian Islands** (C23, C32, C24,C13)	191,003	2,307	891
C9	**DOD**	Dodekanisou	162,439	2,705	1,044	**Macedonia Central** (C49, C15, C25, C36, C38, C43, C18)	1,736,066	18,811	7,263
C10	**EVR**	Evrou	143,791	4,242	1,638	**Macedonia East and Thrace** (C8, C10, C20, C41, C35)	570,261	14,157	5,466
C11	**EVI**	Euvias	209,132	3,908	1,509	**Macedonia West** (C47, C7, C22)	292,751	9,451	3,649
C12	**EVT**	Euritanias	23,535	2,045	790	**Peloponnese** (C2, C3, C26, C28, C34)	605,663	15,49	5,981
C13	**ZAK**	Zakinthou	32,746	406	157	**Thessaly** (C21, C29, C33, C44)	731,23	14,037	5,42
C14	**ILI**	Ileias	174,021	2,681	1,035	**13 regions**	10,262,604	131,621	50,82
C15	**HMA**	Imathias	138,068	1,712	661				
C16	**HRA**	Irakleiou	263,868	2,641	1,02				
C17	**THP**	Thesproteias	44,202	1,515	585				
C18	**THE**	Thessalonikis	977,528	3,56	1,375				
C19	**IOA**	Ioanninon	157,214	4,99	1,927				
C20	**KAV**	Kavalas	135,747	2,109	814				
C21	**KAR**	Karditsas	126,498	2,576	995				
C22	**KAS**	Kastorias	52,721	1,685	651				
C23	**KER**	Kerkiras	105,043	641	247				
C24	**KEF**	Kefallonias	32,314	935	361				
C25	**KIL**	Kilkis	81,845	2,614	1,009				
C26	**KOR**	Korinthias	142,365	2,29	884				
C27	**KYK**	Kikladon	95,083	2,572	993				
C28	**LAK**	Lakonias	94,916	3,636	1,404				
C29	**LAR**	Larisas	269,3	5,351	2,066				
C30	**LAS**	Lasithiou	70,762	1,823	704				
C31	**LES**	Lesvou	103,7	2,154	832				
C32	**LEF**	Leukadas	20,9	325	125				
C33	**MAG**	Magnisias	197,613	2,636	1,018				
C34	**MES**	Messinias	167,292	2,991	1,155				
C35	**XAN**	Xanthis	90,45	1,793	692				
C36	**PEL**	Pellas	138,261	2,506	968				
C37	**ATT**	Region Attikis	3,522,769	3,808	1,47				
C38	**PIE**	Pierias	116,82	1,506	581				
C39	**PRE**	Prebezas	58,91	1,086	419				
C40	**RET**	Rethimnon	69,29	1,496	578				
C41	**ROD**	Rodopis	103,295	2,543	982				
C42	**SAM**	Samou	41,85	778	300				
C43	**SER**	Serron	191,89	3,97	1,533				
C44	**TRI**	Trikalon	137,819	3,367	1,3				
C45	**FTH**	Fdiotidas	168,291	4,368	1,686				
C46	**FLO**	Florinas	52,854	1,863	719				
C47	**FOK**	Fokidas	43,889	2,121	819				
C48	**HAL**	Halkidikis	91,654	2,945	1,137				
C49	**HAN**	Xanion	133,06	2,376	917				
C50	**HIO**	Xiou	52,691	904	349				

Figure 1: Map of Greece and Greek prefectures illustrating prefectures' map codes



According to Boussofiane et al. [18, p. 14] the selection of inputs/ outputs used is crucial for DEA methodology and must reflect "*the resources used the outputs secured as well as the environment in which each unit operates*". Therefore, we based our selection of inputs/ outputs used in our study in the fact that all the variables illustrated below have been used and supported by the literature when evaluating/ describing countries' welfare policies[4]. Ayres [19] and Friedly [20] argue that human welfare, in real terms, is associated (among others) with health, housing, education and in general with the provision of better valuable services (like transportation).

[4] For a range of procedural issues on practical application of DEA see Dyson et al. [21].

Thus in our research using four inputs we try to capture the main 'social policy' axes provided by the Greek regional authorities. The first two inputs are the number of hospital beds per 1000 citizens (NHO) and the number of doctors per 1000 citizens (NDO). These two inputs have been used to capture the health care provision of each prefecture. Health care accessibility is an important issue in welfare reform, both because poor health decreases productivity and participation in the labor force [22] but also because child and family wellbeing is dependent in part upon access to quality health services. Furthermore, the number of public schools per 1000 students (NPUS) has been used as an input in order to capture the provision of education for every prefecture. According to Bryden and Hart [23] skills including education, comprise an important exogenous factor of human capital. It consists of the facets of the presence of higher and further education institutions and the level of educational attainment [23]. The latter represents the existing stock of human capital that is available, whilst the former relates to institutions which may contribute positively to improving the current stock of skills in an area.

The number of public busses per 1000 citizens (NPB) has been used as an input in order to capture the transportation services provided for every prefecture. Transportation is an important issue because it knits together many other barriers to employment. Transportation is necessary not only to get to and from a job, but it is also critical for accessing childcare, health care and other activities such as purchasing food. Transportation in rural areas is particularly critical as distances tend to be greater and public bus service is a rarity. Finally, the number of new houses per 1000 citizens (NNH) has been used as input. Several studies highlight housing also as an important human capital factor that may influence economic performance and welfare policies [24]. Access to housing, affordability of housing and housing conditions are partially endogenous and exogenous facets that have been linked to 'well being' and regional welfare [25].

Furthermore, in order to capture the transformation of those 'social policies' into 'welfare' effects one output, GDP per capita (GDP), has been used in our model which captures the economic efficiency/ development of the prefectures. According to Ayres [19] increasing GDP per capita doesn't necessarily imply an increased social welfare. Nevertheless, it provides the ability of citizens to purchase different products and services, which eventually will increase their welfare state. As the literature suggests economic capital is one of the most important factors underpinning successful national and regional welfare policies and the economic performance of prefectures [26]

Finally population density (POPDEN) has been used as an external factor (environmental factor) in order to capture its influence on prefectures' welfare efficiencies. Portnov and Erell [27] suggest that population density is a strong inequality measure which affects regional and interregional policies and thus regional and interregional socio-economic development. In addition, Maeda and Murakami [28] suggest that in general regional planning promotes equal welfare of the people, and therefore it should be evaluated from the inhabitants' standpoint.

Descriptive statistics of the data used here are presented in table 2. The descriptive statistics reveal (when looking at the standard deviations of the inputs/ output) that there are differences on the welfare provision among the Greek prefectures through the years. However, these variables have been used, measured and criticised by several economists in order to formulate, analyse, measure and explain welfare, 'well being', quality of life and economic/regional development.

Table 2: Descriptive statistics of variables used.

1980	NHO	NDO	NPUS	NPB	NNH	GDP	POPDEN
Mean	4.32	1.29	11.91	1.48	13.37	2517.07	188.90
Min	0.52	0.71	3.05	0.65	5.65	1845.80	11.74
Max	15.79	4.56	28.20	3.09	45.14	4650.86	6809.34
Std	2.72	0.68	4.66	0.47	6.95	517.62	956.11
1990	**NHO**	**NDO**	**NPUS**	**NPB**	**NNH**	**GDP**	**POPDEN**
Mean	3.44	2.03	10.46	2.43	11.40	3536.82	188.82
Min	0.61	0.90	3.25	0.87	2.82	2545.96	12.17
Max	9.65	6.35	27.42	5.31	38.37	6892.30	6781.25
Std	1.92	1.09	3.87	0.82	7.27	727.28	952.09
2000	**NHO**	**NDO**	**NPUS**	**NPB**	**NNH**	**GDP**	**POPDEN**
Mean	3.27	2.97	9.98	1.95	9.39	11959.14	202.56
Min	0.98	0.76	4.68	1.12	4.06	7764.06	10.47
Max	6.69	7.48	24.29	6.32	30.14	27738.57	7294.50
Std	1.59	1.28	3.29	0.81	5.40	3516.24	1024.33

4. Methodology

4.1 Efficiency measurement

Trying to measure the efficiency of the welfare investment policies in a context described by Shephard [29] we define a set of $x \in R_+^p$ inputs which are used to produce $y \in R_+^q$ outputs. Then the feasible combinations of (x, y) can be defined as:

$$\Psi = \left\{ (x, y) \in R_+^{p+q} \middle| x \quad can \quad produce \quad y \right\} \tag{1}$$

In an input oriented case in Farrell's context the welfare efficiency of Greek prefectures operating at level (x,y) can then be defined as:

$$\theta(x, y) = \inf\{\theta | (\theta x, y) \in \Psi\} \tag{2}$$

where an inefficient prefecture working at a level (x, y) in order to increase its efficiency needs to reduce proportionally its inputs by $\theta(x, y) \leq 1$. In addition when the prefectures are in the efficient frontier then $\theta(x, y) = 1$.

A nonparametric approach (DEA) proposed by Charnes et al. [10] is applied in this paper and assumes free disposability and convexity of the production set Ψ. Furthermore, when evaluating the performance of the prefectures in terms of their welfare efficiency levels over the three decades, input orientation of DEA models have been applied due to the fact that input quantities appear to be the primary decision variables (in terms of welfare investment policies) and therefore the decision makers have most control over the inputs compared to the outputs [30]. Following the notation by Daraio and Simar [31] given a list of *p* inputs and *q* outputs, any productive prefecture can be defined by means of a set of points, Ψ, which forms the production set. Therefore, efficiency measurement of a given prefecture (x, y) relative to the boundary of the convex hull of $X = \{(X_i, Y_i), i = 1...n\}$ can be calculated as:

$$\hat{\Psi}_{DEA} = \left\{ \begin{array}{l} (x, y) \in \Re_+^{p+q} \middle| y \le \sum_{i=1}^{n} \gamma_i Y_i ; x \ge \sum_{i=1}^{n} \gamma_i X_i , \quad for(\gamma_1, ..., \gamma_n) \\ s.t. \sum_{i=1}^{n} \gamma_i = 1; \gamma_i \ge 0, i = 1, ..., n \end{array} \right\} \tag{3}$$

The $\hat{\Psi}_{DEA}$ in (3) allows for variables returns to scale and has been introduced by Banker et al. [32]. According to Charnes et al. [10] constant returns to scale (CRS) is applied when the equality constrained $\sum_{i=1}^{n} \gamma_i = 1$ in (3) is omitted.

For a prefecture operating at a level (x_0, y_0) the estimation of the input oriented DEA model is obtained by solving the linear program illustrated below as (4)-(5):

$$\hat{\theta}_{DEA}(x_0, y_0) = \inf \left\{ \theta \middle| (\theta x_0, y_0) \in \hat{\Psi}_{DEA} \right\} \tag{4}$$

$$\hat{\theta}_{DEA}(x_0, y_0) = \min \left\{ \begin{array}{l} \theta \middle| y_0 \le \sum_{i=1}^{n} \gamma_i Y_i ; \theta x_0 \ge \sum_{i=1}^{n} \gamma_i X_i ; \theta \ge 0; \\ \sum_{i=1}^{n} \gamma_i = 1; \gamma_i \ge 0; i = 1, ..., n \end{array} \right\} \tag{5}.$$

4.2 Efficiency bias correction and confidence internals construction

According to Adler et al. [33] DEA methodology can overestimate the efficiency levels of decision making units due to bias caused by a relatively large number of variables in comparison to the number of observations. However, according to Simar and Wilson [34, 35] this phenomenon can be improved with the use of bootstrap techniques. As such, we perform the bootstrap procedure on the results of input oriented efficiency measurements. The bootstrap procedure is a data-based simulation method for statistical inference [31, p.52]. Suppose we want to investigate sampling distribution of an estimator $\hat{\theta}$ of an unknown parameter θ, where P is a statistical model (data generating process, or DGP) and $\hat{\theta} = \hat{\theta}(X)$ is a statistical function of X. Therefore by the proposed procedure we try to evaluate the sampling distribution of $\hat{\theta}(X)$, to evaluate the bias, the standard deviation of $\hat{\theta}(X)$ and to create confidence intervals of any parameter θ. By generating data sets from a consistent estimator $\hat{\mathrm{P}}$ of P from data $X : \hat{\mathrm{P}} = \mathrm{P}\left(\hat{\Psi}, \hat{f}(.,.)\right)$, we denote $X^{*} = \{(X_i^{*}, Y_i^{*}), i = 1,\ldots,n\}$ the data set generated from $\hat{\mathrm{P}}$.

The estimators of the corresponding quantities of $\hat{\Psi}$ and $\hat{\delta}(x, y)$ (in terms of the Shephard input-distance function [29]) can be defined by the pseudo sample corresponding to the quantities $\hat{\Psi}^{*}$ and $\hat{\delta}^{*}(x, y)$. Using the methodology proposed by Simar and Wilson [34, 35] the available bootstrap distribution of $\hat{\delta}^{*}(x, y)$ will be almost the same with the original unknown sampling distribution of the estimator of interest $\hat{\delta}(x, y)$ and therefore it can be expressed as:

$$\left(\hat{\delta}^{*}(x, y) - \hat{\delta}(x, y)\right)\Big|\hat{\mathrm{P}} \overset{approx.}{\sim} \left(\hat{\delta}(x, y) - \delta(x, y)\right)\Big|\mathrm{P} \qquad (6)$$

A bias corrected estimator can then by defined as:

$$\tilde{\delta}(x, y) = \hat{\delta}(x, y) - \widehat{bias}\left(\hat{\delta}(x, y)\right) = 2\hat{\delta}(x, y) - \frac{1}{B}\sum_{b=1}^{B}\hat{\delta}_{b}^{*}(x, y) \qquad (7)$$

Finally, the bootstrap confidence interval for $\delta(x, y)$ can be defined as:

$$\left[\hat{\delta}(x, y) - \hat{\alpha}_{1-a/2}, \hat{\delta}(x, y) - \hat{\alpha}_{a/2}\right] \quad (8)$$

4.3 Testing for returns to scale

In order to choose between the adoption of the results obtained by the CCR [10] and BCC [32] models in terms of the consistency of our results obtained we adopt the method introduced by Simar and Wilson [36]. Therefore, we compute the DEA efficiency scores under the CRS and VRS assumption and by using the bootstrap algorithm described previously we test for the CRS results against the VRS results obtained such as:

$$H_o : \Psi^{\vartheta} \quad is \quad CRS \quad against \quad H_1 : \Psi^{\vartheta} \quad is \quad VRS \quad (9)$$

The test statistic is given by the equation (10) as:

$$T(X_n) = \frac{1}{n} \sum_{i=1}^{n} \frac{\hat{\theta} crs, n(X_i, Y_i)}{\hat{\theta} vrs, n(X_i, Y_i)} \quad (10)$$

Then the *p-value* of the null hypotheses can be approximated by the proportion of bootstrap samples as:

$$p - value = \sum_{b=1}^{B} \frac{I(T^{*,b} \leq T_{obs})}{B} \quad (11)$$

where B is 2000 bootstrap replications, *I* is the indicator function and $T^{*,b}$ is the bootstrap samples and original observed values are denoted by T_{obs}.

4.4 Testing the effect of external 'environmental' variables on the efficiency scores

In order to analyse the effect of population density on the efficiency scores obtained we follow the probabilistic approach developed by Daraio and Simar [37]. They suggest that the joint distribution of (X,Y) conditional on the environmental factor Z=z defines the production process if Z=z. The efficiency measure can then be defined as:

$$\theta(x, y|z) = \inf\{\theta|F_X(\theta x|y, z) > 0\} \quad (12),$$

where $Fx(x|y,z) = \Pr ob(X \leq x|Y \geq y, Z = z)$. Daraio and Simar [37] then suggested a kernel estimator defined as follows:

$$\hat{F}_{X|Y,Z,n}(x|y,z) = \frac{\sum_{i=1}^{n} I(x_i \leq x, y_i \geq y) K((z - z_i)/h)}{\sum_{i=1}^{n} I(y_i \geq y) K((z - z_i)/h)} \quad (13)$$

where K(.) is the Epanechnikov kernel (other continuous kernels with compact support can be used) and *h* is the bandwidth of appropriate size. Following Simar and Wilson [38] in at first step we need to select a bandwidth h which optimizes in a certain sense the estimation of density Z. For that reason we use the likelihood cross validation criterion [39] using *K-NN* method and thus allowing to obtain bandwidths which are localised, insuring that we will have the same number of observations Z_i in the local neighbor of the point of interest z when estimating the density of Z. At a second step in order to compute $\hat{F}_{X|Y,Z,n}(x|y,z)$ we have to take into account for the dimensionality of x and y, and the sparsity of points in larger dimensional spaces. Thus we expand the local bandwidth h_{Z_i} by a factor $1 + n^{-1/(p+q)}$, increasing with $(p+q)$ but decreasing with n[5]. Therefore, we obtain a conditional DEA efficiency measurement defined as:

$$\hat{\theta}_{DEA}(x, y|z) = \inf\left\{\theta \middle| \hat{F}_{X|Y,Z,n}(\theta x|y,z) > 0\right\} \quad (14).$$

Then in order to establish the influence of the environmental variable on the efficiency scores obtained a scatter of the ratios $Q = \frac{\hat{\theta}(x, y|z)}{\hat{\theta}_n(x, y)}$ against Z (in our case population density) and its smoothed non parametric regression line it would help us to

[5] For crucial discussion on kernel selection and bandwidth choices see also Daraio and Simar [31, 37].

analyse the effect of Z on the efficiency scores. As introduced by Nadaraya [40] and Watson [41] the nonparametric regression estimator will take the form:

$$\hat{g}(z) = \frac{\sum_{i=1}^{n} K(\frac{z - Z_i}{h})Q}{\sum_{i=1}^{n} K(\frac{z - Z_i}{h})} \qquad (15).$$

If this regression is increasing it indicates that Z is unfavourable to the efficiency of the prefectures whereas if it is decreasing then it is favourable [37, p.105].

5. Empirical results

Following the methodology proposed by Simar and Wilson [36] this paper tests the model for the existence of constant or variable returns to scale (as previously analysed). In our application we have five inputs and one output and we obtained for this test for the year 1980 a *p-value* of 0.84 > 0.05 for 1990 a *p-value* of 0.82 > 0.05 and for the census year of 2000 a *p-value* of 0.78 > 0.05 (with B=2000). Hence in all the cases we cannot reject the null hypothesis of CRS. Therefore, the results adopted in our study are based on the CCR model[6]assuming constant returns to scale. The efficiency results obtained for 1980 using the methodology proposed by Simar and Wilson [34, 35] are presented on table 3.

Analytically, table 3 presents the efficiency scores of the fifty prefectures, the biased corrected efficiency scores and the 95-percent confidence internals: lower and upper bound obtained by B=2000 bootstrap replications using the algorithm described previously. For the year 1980 nine prefectures are reported to be efficient. These are: C6 (BOI), C10 (EVR), C16 (HRA), C18 (THE), C27 (KYK), C34 (MES), C37 (ATT), C41 (ROD) and C48 (HAL) with efficiency score of 1. In contrast the prefectures with the lowest efficiency scores for 1980 are C23 (KER, 0.53), C24 (KEF, 0.54) and C50 (HIO, 0.58). According to Daraio and Simar [31] when the Bias is larger than the standard deviation (std), the Bias-corrected estimates have to be preferred to the original values (p.153). In that respect the

[6] The results of the BCC model are available upon request.

five prefectures with the higher efficiency scores are C15 (HMA, 0.9), C40 (RET, 0.9), C34 (MES, 0.89), C30 (MAG, 0.88) and C27 (KYK, 0.88). In contrast the five prefectures with the lowest efficiency scores are: C1 (AIT, 0.57), C26 (KOR, 0.56), C50 (HIO, 0.5), C24 (KEF, 0.5) and C23 (KER, 0.45). The mean efficiency scores for 1980 are 0.82 for the original estimates and 0.74 for the Biased –corrected estimates.

Table 3: Efficiency scores, Bias-corrected estimates and confidence internals for 1980

Prefectures	Efficiency scores	Biased corrected efficiency scores	BIAS	STD	LOWER	UPPER
c1	0.65	0.57	-0.22	0.01	0.52	0.64
c2	0.73	0.64	-0.20	0.01	0.58	0.72
c3	0.93	0.87	-0.08	0.00	0.82	0.92
c4	0.80	0.72	-0.14	0.00	0.66	0.79
c5	0.77	0.71	-0.12	0.00	0.66	0.77
c6	1.00	0.84	-0.19	0.02	0.69	0.99
c7	0.67	0.58	-0.21	0.01	0.53	0.66
c8	0.79	0.71	-0.13	0.00	0.66	0.78
c9	0.71	0.62	-0.22	0.01	0.53	0.70
c10	1.00	0.87	-0.15	0.00	0.80	0.99
c11	0.73	0.66	-0.15	0.01	0.60	0.72
c12	0.78	0.73	-0.10	0.00	0.67	0.78
c13	0.84	0.78	-0.09	0.00	0.73	0.83
c14	0.70	0.61	-0.20	0.01	0.54	0.69
c15	0.98	0.90	-0.09	0.00	0.84	0.97
c16	1.00	0.86	-0.17	0.01	0.76	0.99
c17	0.66	0.58	-0.20	0.01	0.52	0.65
c18	1.00	0.87	-0.15	0.01	0.77	0.99
c19	0.64	0.59	-0.13	0.00	0.54	0.63
c20	0.90	0.82	-0.11	0.00	0.76	0.89
c21	0.91	0.85	-0.08	0.00	0.81	0.90
c22	0.74	0.65	-0.18	0.01	0.59	0.73
c23	0.53	0.45	-0.31	0.04	0.39	0.52
c24	0.54	0.50	-0.13	0.00	0.48	0.53
c25	0.94	0.86	-0.10	0.00	0.80	0.93
c26	0.64	0.56	-0.24	0.02	0.50	0.64
c27	1.00	0.88	-0.14	0.01	0.77	0.99
c28	0.75	0.70	-0.09	0.00	0.66	0.74
c29	0.83	0.76	-0.11	0.00	0.71	0.82
c30	0.97	0.88	-0.10	0.00	0.78	0.96
c31	0.74	0.66	-0.17	0.01	0.60	0.74
c32	0.64	0.59	-0.14	0.00	0.55	0.64
c33	0.88	0.80	-0.11	0.00	0.75	0.87
c34	1.00	0.89	-0.12	0.00	0.82	0.99
c35	0.92	0.85	-0.09	0.00	0.80	0.91
c36	0.89	0.81	-0.12	0.00	0.75	0.88
c37	1.00	0.85	-0.18	0.01	0.72	0.99
c38	0.80	0.69	-0.20	0.01	0.61	0.79
c39	0.64	0.58	-0.18	0.01	0.53	0.64
c40	0.97	0.90	-0.08	0.00	0.84	0.96
c41	1.00	0.87	-0.14	0.01	0.79	0.99
c42	0.83	0.77	-0.10	0.00	0.72	0.83
c43	0.92	0.86	-0.08	0.00	0.79	0.91

c44	0.74	0.67	-0.15	0.00	0.62	0.73
c45	0.87	0.80	-0.10	0.00	0.75	0.86
c46	0.91	0.84	-0.08	0.00	0.80	0.90
c47	0.92	0.85	-0.08	0.00	0.79	0.91
c48	1.00	0.84	-0.19	0.02	0.69	0.99
c49	0.90	0.83	-0.10	0.00	0.77	0.90
c50	0.58	0.50	-0.27	0.02	0.45	0.58
Mean	0.82	0.74	-0.14	0.01	0.68	0.82
Min	0.53	0.45	-0.31	0.00	0.39	0.52
Std	0.14	0.13	0.05	0.01	0.12	0.14

Looking at the results for 1990 (table 4) we realise the Bias is larger than the standard deviation (std) and therefore the Bias- corrected results have to be preferred compared to the original estimates. In that respect the five prefectures with the higher efficiency scores are C18 (THE, 0.85), C37 (ATT, 0.75), C17 (THP, 0.75), C6 (BOI, 0.71) and C15 (HMA, 0.70). In contrast the five prefectures with the lowest efficiency scores are C50 (HIO, 0.29), C3 (ARK, 0.29), C28 (LAK, 0.27), C42 (SAM, 0.27) and C31 (LES, 0.25). The mean efficiency scores for 1990 are 0.6 for the original estimates and 0,49 for the Biased –corrected estimates.

Table 4: Efficiency scores, Bias-corrected estimates and confidence internals for 1990

Prefectures	Efficiency scores	Biased corrected efficiency scores	BIAS	STD	LOWER	UPPER
c1	0.43	0.33	-0.73	0.07	0.29	0.42
c2	0.55	0.45	-0.41	0.02	0.40	0.53
c3	0.38	0.29	-0.79	0.08	0.26	0.36
c4	0.56	0.46	-0.41	0.03	0.40	0.54
c5	0.54	0.46	-0.29	0.02	0.42	0.52
c6	1.00	0.71	-0.40	0.03	0.60	0.96
c7	0.42	0.34	-0.61	0.05	0.29	0.40
c8	0.48	0.39	-0.50	0.03	0.35	0.46
c9	0.72	0.59	-0.32	0.02	0.50	0.70
c10	0.60	0.49	-0.37	0.02	0.44	0.58
c11	0.72	0.58	-0.34	0.02	0.50	0.69
c12	0.60	0.49	-0.35	0.01	0.44	0.57
c13	0.41	0.34	-0.51	0.04	0.30	0.40
c14	0.55	0.44	-0.48	0.03	0.39	0.53
c15	0.84	0.70	-0.23	0.01	0.62	0.81
c16	0.52	0.44	-0.35	0.02	0.40	0.51
c17	1.00	0.75	-0.34	0.02	0.66	0.96
c18	0.99	0.85	-0.18	0.01	0.75	0.96
c19	0.41	0.36	-0.35	0.03	0.32	0.40
c20	0.72	0.61	-0.27	0.01	0.54	0.69
c21	0.72	0.62	-0.22	0.01	0.57	0.70
c22	0.53	0.41	-0.56	0.04	0.37	0.52

c23	0.56	0.49	-0.28	0.02	0.43	0.54
c24	0.39	0.33	-0.46	0.03	0.30	0.38
c25	0.62	0.53	-0.27	0.01	0.48	0.60
c26	0.65	0.50	-0.45	0.04	0.43	0.62
c27	0.85	0.68	-0.30	0.02	0.58	0.82
c28	0.34	0.27	-0.76	0.11	0.23	0.33
c29	0.66	0.58	-0.21	0.01	0.53	0.64
c30	0.61	0.53	-0.27	0.02	0.46	0.60
c31	0.33	0.25	-0.95	0.15	0.22	0.32
c32	0.46	0.41	-0.26	0.02	0.37	0.45
c33	0.68	0.58	-0.23	0.01	0.52	0.66
c34	0.40	0.33	-0.58	0.04	0.29	0.39
c35	0.60	0.52	-0.27	0.01	0.47	0.58
c36	0.71	0.63	-0.20	0.01	0.57	0.69
c37	1.00	0.75	-0.33	0.01	0.67	0.97
c38	0.64	0.54	-0.27	0.01	0.49	0.61
c39	0.47	0.39	-0.48	0.03	0.34	0.46
c40	0.68	0.59	-0.23	0.01	0.52	0.66
c41	0.78	0.62	-0.34	0.02	0.54	0.75
c42	0.35	0.27	-0.89	0.11	0.24	0.34
c43	0.48	0.41	-0.35	0.03	0.37	0.47
c44	0.64	0.56	-0.21	0.01	0.50	0.62
c45	0.49	0.39	-0.54	0.03	0.35	0.47
c46	0.79	0.62	-0.35	0.02	0.53	0.77
c47	0.52	0.44	-0.37	0.02	0.39	0.51
c48	0.76	0.63	-0.26	0.01	0.56	0.73
c49	0.49	0.42	-0.37	0.02	0.38	0.48
c50	0.37	0.29	-0.72	0.06	0.26	0.36
Mean	0.60	0.49	-0.40	0.03	0.44	0.58
Min	0.33	0.25	-0.95	0.01	0.22	0.32
Std	0.18	0.14	0.18	0.03	0.12	0.17

Finally, looking the efficiency scores of the prefectures for the year 2000 (table 5) we realise again that the bias is larger than the standard deviation therefore the Bias-corrected values have to be adopted. The five prefectures with the higher efficiency scores are: C40 (RET, 0.9), C13 (ZAK, 0.85), C10 (EVR, 0.83), C27 (KYK, 0.77) and C37 (ATT, 0,76). In contrast the five prefectures with the lowest efficiency scores are: C2 (ARG, 0.4), C7 (GRE/KOZ, 0.33), C4 (ART, 0.32), C8 (DRA, 0.32) and C44 (TRI, 0.32). Finally, the mean efficiency scores for 2000 are 0.65 for the original estimates and 0.54 for the Biased–corrected estimates.

Generally, over the last three decades great inefficiencies and efficiency disparities are reported among the Greek prefectures. As expected Athens which is the capital of

Greece is reported to have higher efficiency scores (1990, 2000), however prefectures' welfare efficiencies seem to decrease over the years. This indicates lack of regional policy implementation among the prefectures' welfare investments. One of the key elements in order to improve the welfare state of a prefecture is the account of population density among the years.

Table 5: Efficiency scores, Bias-corrected estimates and confidence internals for 2000

Prefectures	Efficiency scores	Biased corrected efficiency scores	BIAS	STD	LOWER	UPPER
c1	0.52	0.44	-0.37	0.02	0.39	0.51
c2	0.51	0.40	-0.56	0.05	0.35	0.50
c3	0.75	0.67	-0.16	0.01	0.60	0.74
c4	0.42	0.32	-0.73	0.08	0.29	0.41
c5	0.66	0.61	-0.13	0.01	0.55	0.65
c6	1.00	0.74	-0.36	0.02	0.63	0.98
c7	0.42	0.33	-0.68	0.06	0.29	0.41
c8	0.42	0.32	-0.74	0.07	0.29	0.41
c9	0.82	0.66	-0.29	0.02	0.58	0.79
c10	0.87	0.83	-0.06	0.00	0.76	0.87
c11	0.69	0.54	-0.39	0.03	0.48	0.66
c12	0.66	0.49	-0.53	0.05	0.42	0.64
c13	1.00	0.85	-0.18	0.01	0.74	0.99
c14	0.62	0.46	-0.53	0.04	0.41	0.60
c15	0.71	0.59	-0.28	0.01	0.54	0.69
c16	0.63	0.50	-0.42	0.02	0.44	0.61
c17	0.57	0.48	-0.31	0.01	0.44	0.55
c18	0.84	0.69	-0.25	0.01	0.62	0.81
c19	0.47	0.41	-0.29	0.02	0.37	0.46
c20	0.52	0.43	-0.39	0.03	0.38	0.50
c21	0.53	0.44	-0.37	0.03	0.39	0.51
c22	0.53	0.42	-0.49	0.04	0.37	0.52
c23	0.57	0.46	-0.40	0.02	0.41	0.55
c24	0.50	0.41	-0.42	0.02	0.37	0.49
c25	0.65	0.60	-0.15	0.01	0.54	0.65
c26	0.92	0.72	-0.30	0.02	0.62	0.89
c27	1.00	0.77	-0.30	0.02	0.67	0.97
c28	0.58	0.53	-0.18	0.01	0.47	0.58
c29	0.68	0.62	-0.15	0.01	0.56	0.67
c30	0.67	0.58	-0.21	0.01	0.53	0.65
c31	0.76	0.71	-0.09	0.00	0.64	0.75
c32	0.51	0.47	-0.16	0.01	0.43	0.51
c33	0.62	0.53	-0.26	0.01	0.48	0.60
c34	0.64	0.58	-0.17	0.01	0.51	0.64
c35	0.56	0.51	-0.20	0.01	0.45	0.55
c36	0.54	0.45	-0.36	0.02	0.41	0.52
c37	1.00	0.76	-0.32	0.02	0.66	0.98
c38	0.57	0.46	-0.42	0.02	0.41	0.55
c39	0.55	0.45	-0.43	0.02	0.40	0.54
c40	1.00	0.90	-0.12	0.00	0.80	0.99
c41	0.55	0.50	-0.21	0.01	0.44	0.55
c42	0.51	0.48	-0.15	0.01	0.44	0.51

c43	0.49	0.41	-0.40	0.03	0.36	0.48
c44	0.39	0.32	-0.58	0.06	0.28	0.38
c45	0.68	0.57	-0.30	0.02	0.51	0.66
c46	0.73	0.66	-0.15	0.01	0.60	0.72
c47	0.53	0.42	-0.51	0.04	0.37	0.52
c48	0.61	0.48	-0.45	0.03	0.43	0.59
c49	0.61	0.52	-0.27	0.01	0.47	0.59
c50	0.72	0.68	-0.09	0.00	0.62	0.72
Mean	0.65	0.54	-0.32	0.02	0.48	0.63
Min	0.39	0.32	-0.74	0.00	0.28	0.38
Std	0.17	0.14	0.17	0.02	0.13	0.16

Adopting the methodology proposed by Daraio and Simar [37] we obtained the welfare efficiency scores taking into account the population density of the prefectures. Table 6 reports the results over the three decades. Again in all the cases the Bias-corrected estimates are preferred compared to the original efficiency scores. For 1980 the five prefectures with the higher efficiency scores are C15 (HMA, 0.74), C17 (THP, 0.79), C36 (PEL, 0.68), C37 (ATT, 0.7) and C48 (HAL, 0.69). In contrast the five prefectures with the lowest efficiency scores are: C47 (FOK, 0.08), C7 (GRE/KOZ, 0.08), C3 (ARK, 0.04), C46 (FLO, 0.02) and C11 (EVI, 0.0014). The mean efficiency scores for 1980 are 0.55 for the original estimates and 0.46 for the Biased –corrected estimates. In addition for the year 1990 the five prefectures with higher efficiency scores are reported to be: C6 (BOI, 0.74), C15 (HMA, 0.72), C18 (THE, 0.71), C26 (KOR, 0.71) and C37 (ATT, 0.68). The prefectures with the lower efficiency scores are reported to be: C8 (DRA, 0.07), C28 (LAK, 0.04), C3 (ARK, 0.03), C47 (FOK, 0.02) and C12 (EVT, 0.01). The mean Biased corrected efficiency scores for 1990 is 0.44 whereas for the original estimates is 0.54.

Finally, for the year 2000 the five prefectures with the highest efficiency scores are C6 (BOI, 0.75), C15 (HMA, 0.74), C38 (PIE, 0.74), C9 (DOD, 0.72) and C23 (KER, 0.71). The prefectures with the lowest efficiency scores are reported to be C8 (DRA, 0.07), C28 (LAK, 0.04), C3 (ARK, 0.04), C12 (EVT, 0.02) and C47 (FOK, 0.02). The mean Biased corrected efficiency scores for 2000 is 0.39 whereas for the original estimates is 0.46. The results report that over the years the efficiency scores appear to be decreasing over the years. The evidence provided indicate that there is a decrease of welfare state among the prefectures over the three census years, indicating (as previously) that there is a lack of planning on implementing regional welfare investment policies among the prefectures. The role of population density is a crucial element of welfare provision among the prefectures and its influence on prefectures' welfare efficiencies needs to be determined.

Table 6: Conditional efficiency scores for the census years of 1980,1990 and 2000

	1980		1990		2000	
Prefectures	θ(x,y)lz	θ(x,y)lz cor.	θ(x,y)lz	θ(x,y)lz cor.	θ(x,y)lz	θ(x,y)lz cor.
c1	0.33	0.28	0.37	0.32	0.23	0.20
c2	0.54	0.46	0.45	0.37	0.41	0.32
c3	0.05	0.04	0.04	0.03	0.04	0.04
c4	0.44	0.38	0.52	0.44	0.38	0.33
c5	0.44	0.39	0.63	0.50	0.84	0.69
c6	0.86	0.71	1.00	0.74	0.98	0.75
c7	0.09	0.08	0.34	0.29	0.30	0.24
c8	0.71	0.60	0.08	0.07	0.08	0.07
c9	0.29	0.25	0.87	0.70	1.00	0.72
c10	0.90	0.83	0.26	0.23	0.26	0.23
c11	0.00	0.00	0.82	0.68	0.53	0.40
c12	0.79	0.65	0.02	0.01	0.02	0.02
c13	0.96	0.82	0.73	0.59	1.00	0.68
c14	0.91	0.76	0.98	0.80	0.72	0.56
c15	1.00	0.74	1.00	0.72	0.95	0.74
c16	0.22	0.20	0.71	0.58	0.89	0.69
c17	1.00	0.79	0.37	0.31	0.08	0.07
c18	0.22	0.18	1.00	0.71	0.90	0.68
c19	0.60	0.52	0.13	0.12	0.13	0.11
c20	0.56	0.47	0.82	0.67	0.59	0.48
c21	0.20	0.18	0.74	0.66	0.35	0.29
c22	0.99	0.83	0.19	0.17	0.18	0.15
c23	0.28	0.25	0.99	0.70	0.90	0.71
c24	0.14	0.12	0.18	0.15	0.29	0.24
c25	0.88	0.74	0.24	0.21	0.19	0.17
c26	0.26	0.22	1.00	0.71	1.00	0.67
c27	0.10	0.09	0.50	0.43	0.61	0.48
c28	0.53	0.46	0.05	0.04	0.05	0.04
c29	0.31	0.27	0.67	0.58	0.56	0.47
c30	0.67	0.58	0.32	0.29	0.30	0.26
c31	0.79	0.70	0.37	0.31	0.55	0.49
c32	0.68	0.57	0.63	0.56	0.49	0.42
c33	0.67	0.55	0.91	0.77	0.79	0.65
c34	0.75	0.66	0.60	0.50	0.52	0.46
c35	0.71	0.62	0.69	0.61	0.53	0.44
c36	1.00	0.68	0.79	0.67	0.56	0.45
c37	1.00	0.70	1.00	0.68	1.00	0.65
c38	0.71	0.60	0.96	0.83	0.89	0.72

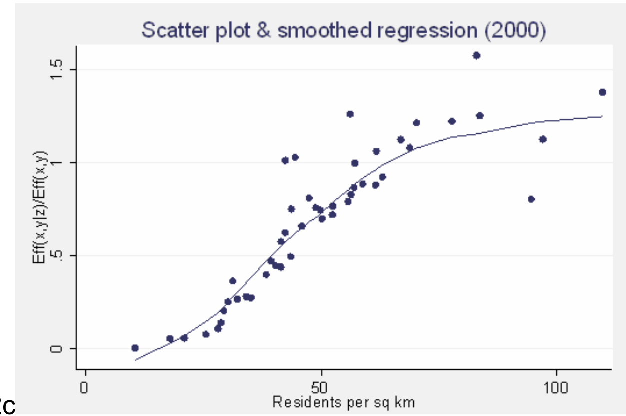
c39	0.42	0.35	0.73	0.61	0.69	0.57
c40	0.45	0.41	0.57	0.52	0.75	0.64
c41	0.83	0.75	0.56	0.49	0.29	0.25
c42	0.63	0.57	0.52	0.42	0.46	0.40
c43	0.37	0.33	0.46	0.40	0.37	0.31
c44	0.27	0.24	0.40	0.36	0.17	0.15
c45	0.13	0.11	0.29	0.25	0.28	0.23
c46	0.02	0.02	0.15	0.13	0.08	0.07
c47	0.09	0.08	0.03	0.02	0.03	0.02
c48	1.00	0.69	0.18	0.16	0.15	0.12
c49	1.00	0.78	0.57	0.47	0.66	0.55
c50	0.61	0.55	0.50	0.43	0.69	0.60
Mean	0.55	0.46	0.54	0.44	0.49	0.39
Min	0.00	0.00	0.02	0.01	0.02	0.02
Std	0.32	0.26	0.31	0.24	0.31	0.24

Following, Daraio and Simar [37] figures 2a-c indicate the effect of population density on prefectures' welfare efficiencies. For the census year 1980 we realize that the population density has a moderate effect on welfare efficiencies which can be regarded as positive. As such population density seem to be taken into account (at least partially) for 1980 and can be regarded that population density plays a role of a "substitutive" input in the production process, giving the opportunity to "save" inputs in the activity of production. However, for the census year 1990 and 2000 we realize that the population density has a clear negative effect on prefectures' welfare efficiencies and acts like an "extra" undesired output to be produced asking for the use of more inputs in production activity [37, p. 105]. It seems that population density fluctuations over the years haven't been taken into account when the Greek regional welfare policies have been designed and implemented. In that respect '*policy makers must concentrate on regional effects of major policy strategies rather than on the regional impacts of individual projects or small programs'* [42, p. 462].

Figures 2: Examining the effect of population density on welfare efficiencies

2a

2b



2c

6. Conclusions and Policy Implications

In this study, performing an application of conditional DEA, bootstrap techniques and kernel density estimations to the Greek prefectures, we obtained, among others, the efficiency scores and the optimal ratios levels for inefficient prefectures for the census years of 1980, 1990 and 2000 in terms of their regional welfare policies. In addition this paper provides a real example of how new advances in DEA methodology as have been introduced by several authors [31, 34, 35, 36, 37] can be used for tackling real regional welfare issues and provide a different way for measuring welfare 'efficiency'. Its unique advantage for combining multiple criteria into a single measurement provides an excellent tool for welfare evaluation.

In the case of the Greek prefectures the regional welfare policies are strongly associated with the regional development and economic efficiency of the particular prefectures. The efficient prefectures seem to have definite and strong characteristics. Population density influences negatively Greek prefectures efficiencies, which suggest a lack of regional welfare investment planning of the regional decision makers. Takahashi [43] suggest that competition of regional governments that make a decision on the investment in their public facilities results in an inefficient outcome. Crihfield and McGuire [44] suggest that there is absence of principles upon which governments can base investment decisions with a direct impact on regional welfare. These results obtained support the findings of Halkos and Tzeremes [6] which emphasize major economic inefficiencies among the Greek prefectures. In addition the results support also the study by Afonso and Fernandes [14] which indicate that the quantity of the resources of a prefecture doesn't necessarily ensure the efficiency of this prefecture if the influence of the external factors (in our case population density) is not taken into account in regional welfare planning.

On the contrary and in order for a prefecture to attract a certain quantity of resources it has to develop the appropriate mechanisms to make efficient use of them. Obviously, the role of governments and policy makers is substantial in stimulating the proper use of the resources provided by these mechanisms. Moreover, if these mechanisms don't exist, they must be created before the recourses are allocated. The policy makers must observe welfare and regional development as a solid parameter, which eventually has a direct effect on the economy. When policies are taken regarding a prefecture's development both the parameters of competition and collaboration with capital spillovers must be taken into account before any development policy is being applied.

The results indicate that there are policy inefficiencies in terms of welfare among the Greek prefectures. Furthermore this study supports the study by Karkazis and Thanassoulis [5] which found significant levels of inefficiencies for Northern Greece indicating policies inefficiencies and development inequalities among the Greek prefectures. Our results on regional welfare inefficiencies come to complement the studies by Siriopoulos and Asteriou [11] and Tsionas [12], which found that there is no real convergence between the Greek regions, which there is strong evidence of the existence of inefficiencies of welfare policies among the regions.

Furthermore, the results of our study come along with the suggestions emphasized by Maudos et al. [13], which indicate that the effort of policy makers must be given to the improvement of the efficiency of use of productive factors in each sector of activity, rather than reallocating resources among sectors. Finally, our suggestion to policy makers for the improvement of regional welfare problems is the adoption of such methodology (and its new advances) for policy evaluation. Most of the times, its deterministic nature can prove to be an absolute advantage for resource allocation and policy evaluation.

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