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By

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Abstract

Our research is based on the effect of fiscal policies on the Greek prefectures. Using DEA methodology we compare the efficiency of the prefectures over the last three decades. Moreover, we determine where the resources are distributed in an efficient way and /or have been used efficiently by the local authorities in order to stimulate regional development and provide quality of life to the Greek citizens. The efficient prefectures seem to have definite and strong characteristics, which are determined and discussed in detail. Our empirical results imply that the resources of a prefecture don't necessarily ensure the efficiency of this prefecture.

JEL Classification Codes: O18, P25

Keywords: Data Envelopment Analysis; Regional Development; Living Standards; Greek Prefectures

1. Introduction

It is generally accepted that the level of economic development is not uniform across regions. On the contrary, it substantially differs. This plays an important role and stimulates internal migrations from less developed prefectures too more developed ones. As human activities are related to economic development and are affected by regional development, the way of measurement of the conditions of regional development is really essential and important in the determination of a country's socio-economic policies.

In many countries, governments have tried to establish policies able to reduce regional economic discrepancies. Georgiou (1992) and Karkazis and Thanassoulis (1998) 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 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.

Similar policies can be found in other countries like Italy (facing migration moves from South to North parts of the country) and the UK. Mishan (1988) assesses the performance of public expenditure policies using cost-benefit analysis (CBA). Meen and Andrew (2004) analysed the impact of fiscal policies on UK's regional development from the perspective of population distribution. In a similar way, Newton (1972) applied CBA to assess the performance of specific types of public investment on a regional basis. But CBA due to its additive nature limits its ability in measuring performance on a comparative basis, as we are interested in the benefits relative to costs and not to the absolute net benefits.

In this paper a non-parametric analytic technique for the evaluation of prefectures' performance is applied. Specifically, the Data Envelopment Analysis (hereafter DEA) technique is employed, which is a non-statistical method relying on linear programming. It provides a measure of relative technical efficiency of different decision-making units (hereafter DMUs) operating and performing in the same or similar tasks. The technique's main advantage is that it can deal with the case of multiple inputs and outputs as well as factors, which are not controlled by individual management.

Another advantage of this non-parametric technique, and in general of all the non-parametric techniques, is that we skip most of the usual difficulties, which arise by the use of parametric methods in the analysis of ratios. That is, we skip problems like the necessity to determine the functional form[1] or to determine the statistical distribution of the ratios. Additionally, when we refer to the analysis of ratios problems arise if the numerator or the denominator takes negative values, while the manipulation of outliers is not clear. On the contrary, using the proposed technique these difficulties can be overcome and the most efficient prefectures can be found in relation to the empirical data in use. Then the less efficient prefectures can be compared to the most efficient ones.

Thus, in this study applying DEA to the Greek prefectures, we obtain the efficiency scores and the optimal output (ratios) levels for inefficient prefectures for the last three decades (1980, 1990, 2000). For the first time, we use a number of inputs and outputs in a DEA framework formulation seeking efficiency comparisons with the simultaneous use of multiple criteria, which determine efficiency for each DMU, forming a rounded judgment on DMU efficiency taking into consideration a variety of efficiency dimensions and combining them into a single performance measure.

Specifically, DEA provides us with an overall objective numerical score, ranking, and efficiency potential improvement targets for each one of the inefficient units. The comparison of relative efficiency of all prefectures is carried out, relying on the derived efficiency ratio for every prefecture, as the solution of the mathematical model. The higher a prefecture's efficiency ratio in relation to the corresponding ratio of another prefecture the higher is the efficiency of this prefecture.

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 and discussed. In section 4 the technique adopted both in its theoretical and mathematical formulation is presented. In section 5 the empirical findings of our study are obtained. The final section concludes the paper discussing the derived results and the implied policy implications.

2. Literature Review

DEA is a very important tool for analysing efficiency gains and provides a way for multidimensional measure. Charnes et al. (1989, 1994) have developed DEA models analysing the efficiency in terms of economic development of 28 Chinese cities. An extensive use of the models provided by Charnes et al. (1989) can be found in Sueyashi (1992) and Macmillan (1986, 1987) who measured the regional economic planning in the USA. Byrnes and Storbeck (2000) applied a multi-unit DEA analysis to regional economic development policy to Chinese cities. They used the data from Charnes et al. (1989), but in their model they had one output (value of gross industrial output) and two inputs (size of labour force and level of investment/ capital) recorded for the years 1983 and 1984. Moreover, in their study they measure the efficiency of the city with different types of measurement models introduced by Färe and Primont (1984). All of these studies were output based DEA models with variable returns.

Karkazis and Thanassoulis (1998) measured the effectiveness of policies for economic development in terms of private investment in Northern Greece. They used an output based DEA model with variable returns to scale and data for five years 1987-1991 with two inputs (public investments and investment incentives) and one output (private investment into service industry and agriculture). Chang et al. (1995) used DEA combined with Malmquist productivity index approach expressed by Färe et al. (1992). They evaluated the change of regional development in Taiwan area using indicators[2] for two years (1983 and 1990). They found that the larger the value of their indicators, the greater was the degree of development in that region.

Zhu (2001) used similar indicators for 15 US domestic cities and 5 international cities in order to demonstrate how DEA can be used for measuring the quality of life. High- and low-end housing monthly rental, cost of loaf of French bread, cost of martini, class A office rental (US \$ / ft^2) and number of violent crimes were used as inputs while median household income, number of population with bachelor's degree, number of doctors, number of museums, number of libraries and number of 18-hole golf courses were used as outputs. The purpose was to measure the quality of life across cities using the CCR model (Charnes et al., 1978). Without a priori knowledge of factor relationship, a multi dimensional quality of life measure was demonstrated.

Other approaches measure living standards by several economic development indexes (Quality of Life indexes) by satisfying a set of parameters. By using GDP and other indicators such as life expectancy and literacy rates economists have developed a methodology based on a technical literature measuring QOL (Atkinson and Bourguignon 1982, Dasgupta 1988, Kakwani 1993, Dowrick et al. 1998, Dowrick et al. 2003, Ditlevsen 2004). However this methodology has been criticised due to the fact that indexes most of the time don't have multidimensionality, thus an ideal index does not exist. The advantage deploying DEA methodology is exactly the fact that it measures multidimensional relationships among several inputs and outputs without an a priori underlying functional form assumption (Zhu 2001).

Previous research on efficiency and productivity of municipalities consists of studies which vary widely in their results and methodologies adopted. A number of studies, close related to ours, has been expressed, amongst others, by Weber and Domazlicky (1999), De Borger and Kerstens (1996), De Borger et al. (1994), Hayes and Chang (1990), Deller (1992), Domazlicky and Webber (1997) and Raab and Lichty (2002). DEA has the advantage of evaluating municipalities' efficiencies as well as their determinants. Most of the studies lack explanation of the estimated inefficiencies in a more systematic way (De Borger et al., 1994).

Domazlicky and Webber (1997) measured the growth rate of total factor productivity for forty-eight US states. Using public and private outputs and private and public sectors labor and capital as inputs, they constructed a Malmquist productivity index, which then was decomposed to changes of technical and scale efficiency as well as technological change. They found that the innovative states tended to use more private and less public capital, and less public labor compared to non-innovative firms.

Moreover, Raab and Lighty (2002) based on the identification of three distinct sub-regions comprising a metropolitan area, emphasize the role of the central urban core in regional economic development through stronger development initiatives between the core and its surrounding areas. Instead of explaining urban growth through cross metropolitan comparisons they explained it through intra-regional transactions. Furthermore, using a DEA additive model, with five inputs (employee compensation, proprietor's income, other proprietary income, indirect business taxes and intermediate imports) and four outputs (household consumption, business investment, government spending and exports) they tested the efficiency levels of counties both within and outside of the urban core. They found support indicating that core counties showed greatest levels of robust efficiency when applying DEA analysis and efficiency drops along with decreasing population densities and income levels as research moves away from the urban core.

Huges and Edwards (2000) using county-level data, tried to capture inter-jurisdictional spillover effects. Using the total property value as an output and fiscal policy as an input (expressed by government expenditure on education, social services, transportation etc.), they evaluated the efficiency of government performance using DEA. They noticed that larger land area tend to be less efficient, probably as a result of diseconomies of scale. This implies that decentralization and decreased spending by the public sector increase efficiency.

Our, work is among these lines using inputs and outputs, which are fundamental elements of regional development as well as of quality of life. Next the data used and the proposed methodology are presented.

3. Data

The implementation of uniform regional development needs an enormous amount of money and most of all the most effective use of resources. This, in turn, requires the knowledge of the relative conditions of the regional development of each area before we proceed to a long run sustainable planning. Information on indices of urban and regional development such as population density, urban planned area as a percentage of total area, number of telephone lines per 1000 people, number of doctors per 1000 people, average income per capita etc is substantial in formulating the regional development plans (Council for Planning and Development, 1990). The knowledge of this information helps authorities to understand the conditions of each area and plan accordingly its development.

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.

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 Fig. 1a). For the purpose of the analysis we code each of the 51 prefectures as shown in Table 1. This table also provides information on key characteristics of the prefecture (population, area in km^2, area in $miles^2$). These prefectures form thirteen administrative regions, whose basic characteristics are also presented in Table 1.

For our research we use four inputs: 1) Number of hospital beds per 1000 citizens **(NHO)**, 2) Number of doctors per 1000 citizens **(NDO)**, 3) Number of public schools per 1000 students **(NPUS)**, 4) Number of public busses per 1000 citizens **(NPB)** and three outputs: 1) GDP as a percentage of the mean GDP of the country **(GDP)**, 2) Difference of urban rural population **(DUR)** and 3) Number of new Houses per 1000 citizens **(NNH)**.

These variables have been used, measured and criticised by several economists in order to formulate, analyse and explain quality of life and economic/regional development[3]. Correlations and descriptive statistics are also presented in tables 2-3. The indicators can be categorized into four main areas: *Health (NHO, NDO), Education (NPUS), Living Standards (NPB, DUR, NNH) and Economic and Regional Development (GDP).*

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

Prefecture Code	Map Code	Prefectures	Population	Area(km.^{2})	Area(mi.^{2})
C1	AIT	Aitolokarnanias	230,688	5,447	2,103
C2	ARG	Argolidas	97,25	2,214	855
C3	ARK	Arkadias	103,84	4,419	1,706
C4	ART	Artas	78,884	1,612	622
C5	AHA	Axaias	297,318	3,209	1,239
C6	BOI	Boiotias	134,034	3,211	1,24
C7	GRE/KOZ	Grebenon/ Kozanis	37,017/ 150,159	2,338/3,562	903/1,375
C8	DRA	Dramas	96,978	3,468	1,339
C9	DOD	Dodekanisou	162,439	2,705	1,044
C10	EVR	Evrou	143,791	4,242	1,638
C11	EVI	Euvias	209,132	3,908	1,509
C12	EVT	Euritanias	23,535	2,045	790
C13	ZAK	Zakinthou	32,746	406	157
C14	ILI	Ileias	174,021	2,681	1,035
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	ATT	Rest of Attiki	3,522,769	3,808	1,47
C46	FTH	Fdiotidas	168,291	4,368	1,686
C47	FLO	Florinas	52,854	1,863	719
C48	FOK	Fokidas	43,889	2,121	819
C49	HAL	Halkidikis	91,654	2,945	1,137
C50	HAN	Xanion	133,06	2,376	917
C51	HIO	Xiou	52,691	904	349

Administrative region	Population	Area(km.^{2})	Area(mi.^{2})
Aegean North (C51, C31, C42)	198,241	3,836	1,481
Aegean South (C9)	257,522	5,286	2,041
Attica (C37, C45)	3,522,769	3,808	1,47
Crete (C50, C40, C16, C30)	536,98	8,336	3,219
Epirus (C4, C19, C39, C17)	339,21	9,203	3,553
Greece Central (C11, C12, C48, C46, C6)	578,881	15,549	6,004
Greece West (C5, C1, C14)	702,027	11,35	4,382
Ionian Islands (C23, C32, C24,C13)	191,003	2,307	891
Macedonia Central (C49, C15, C25, C36, C38, C43, C18)	1,736,066	18,811	7,263
Macedonia East and Thrace (C8, C10, C20, C41, C35)	570,261	14,157	5,466
Macedonia West (C47, C7, C22)	292,751	9,451	3,649
Peloponnese (C2, C3, C26, C28, C34)	605,663	15,49	5,981
Thessaly (C21, C29, C33, C44)	731,23	14,037	5,42
13 regions	10,262,604	131,621	50,82

Table 2: Descriptive Statistics of the selected variables

Variable	N	Mean	StDev	Minimum	Maximum
1980					
NHO	51	4,260	2,725	0,519	15,792
NDO	51	1,2694	0,6831	0,4741	4,5592
NPUS	51	11,787	4,699	3,046	28,201
NPB	51	1,4668	0,4728	0,6465	3,0852
GDP	51	95,14	22,33	64,17	201,86
DUR	51	8201	95001	-624367	65575
NNH	51	13,515	6,960	5,650	45,144
1990					
NHO	51	3,391	1,929	0,607	9,647
NDO	51	2,017	1,086	0,902	6,349
NPUS	51	10,358	3,899	3,251	27,419
NPB	51	2,421	0,820	0,872	5,313
GDP	51	93,26	18,06	67,40	174,73
DUR	51	-61530	442539	-3072922	57620
NNH	51	11,52	7,24	2,82	38,37
2000					
NHO	51	3,229	1,594	0,977	6,692
NDO	51	2,946	1,280	0,760	7,480
NPUS	51	9,868	3,347	4,363	24,292
NPB	51	1,936	0,808	1,118	6,322
GDP	51	100,00	30,23	60,41	227,94
DUR	51	-61530	442539	-3072922	57620
NNH	51	9,452	5,363	4,056	30,142

Table 3: Correlation coefficients

Correlations: 1980

	NHO	NDO	NPUS	NPB	GDP	DUR
NDO	0,501					
NPUS	-0,255	-0,376				
NPB	0,453	0,387	-0,167			
GDP	-0,060	0,029	-0,372	0,344		
DUR	-0,298	-0,632	0,341	-0,118	-0,028	
NNH	-0,128	-0,239	-0,111	0,265	0,340	0,073

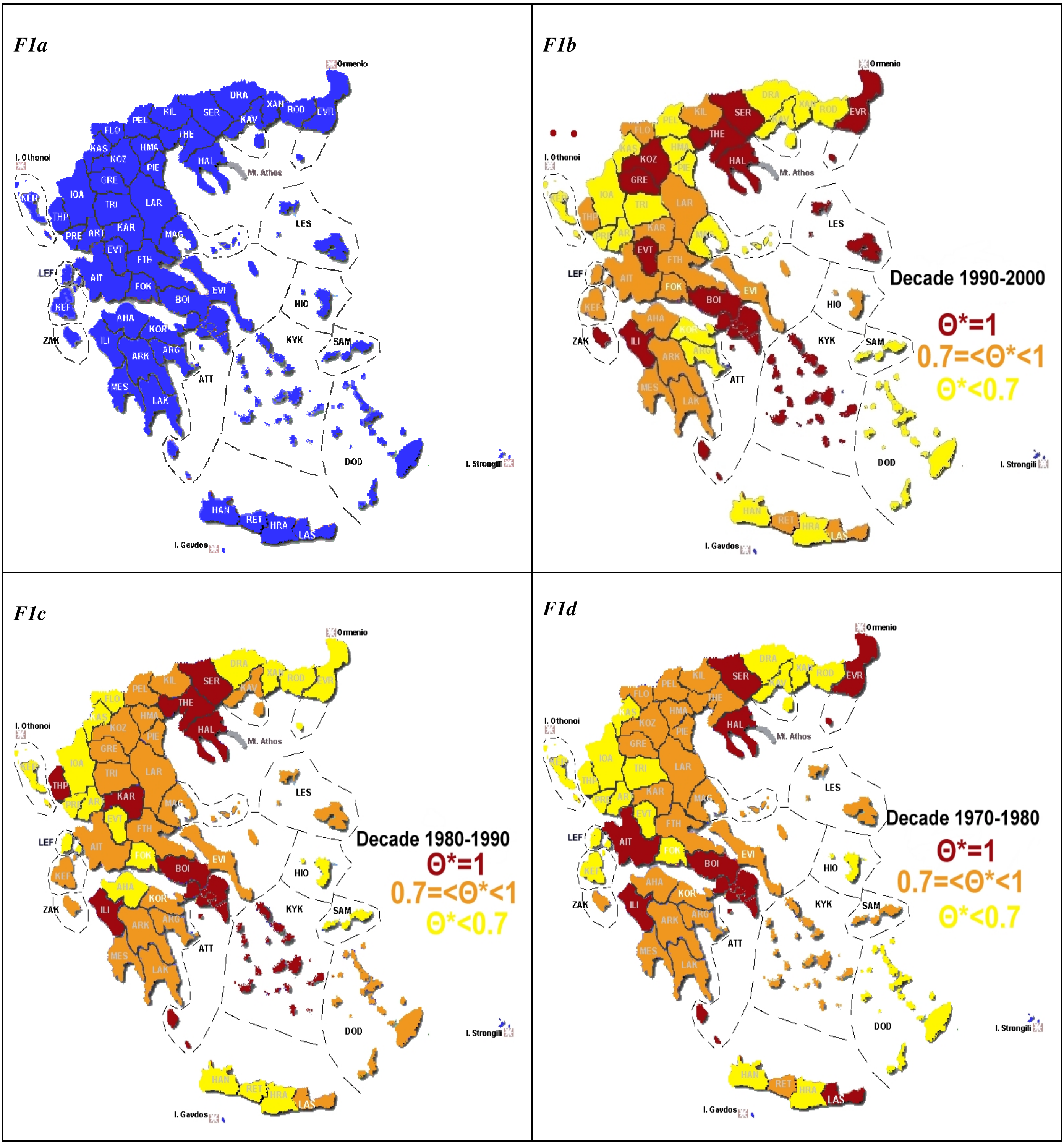
Correlations: 1990

	NHO	NDO	NPUS	NPB	GDP	DUR
NDO	0,636					
NPUS	-0,293	-0,412				
NPB	0,490	0,403	-0,230			
GDP	0,131	0,099	-0,352	0,278		
DUR	-0,405	-0,689	0,336	-0,503	-0,151	
NNH	-0,013	-0,094	-0,008	0,227	0,315	0,099

Correlations: 2000

	NHO	NDO	NPUS	NPB	GDP	DUR
NDO	0,642					
NPUS	-0,380	-0,421				
NPB	0,117	0,217	-0,127			
GDP	0,207	0,110	-0,258	0,296		
DUR	-0,341	-0,599	0,292	-0,229	-0,143	
NNH	-0,159	-0,016	-0,110	0,245	0,011	0,101

Figure 1: Maps of Greece and Greek prefectures illustrating efficient prefectures per decade, according to their efficient scores.



4. The Technique

We may think of DEA as measuring the technical efficiency of a given prefecture by calculating an efficiency ratio equal to a weighted sum of outputs over a weighted sum of inputs. For each DMU these weights are derived by solving an optimization problem which involves the maximization of the efficiency ratio for that DMU subject to the constraint that the equivalent ratios for every DMU in the set is less than or equal to 1.

That is, DEA seeks to determine which of the N DMUs determine an envelopment surface or an efficient frontier. DMUs lying on the surface are deemed efficient, while DMUs that do not lie on the frontier are termed inefficient, and the analysis provides a measure of their relative efficiency. As mentioned, the solution of the model dictates the solution of (N) linear programming problems, one for each DMU. It provides us with an efficiency measure for each DMU and shows by how much each of a DMU's ratios should be improved if it were to perform at the same level as the best performing prefectures in the sample. In this way we extract an efficiency ratio for each prefecture, which shows us by how much the ratios of each prefecture could be improved so as to reach the same level of efficiency with that of the most efficient prefectures in the sample.

The fundamental feature of DEA is that technical efficiency score of each DMU depends on the performance of the sample of which it forms a part. This means that DEA produces relative, rather than absolute, measures of technical efficiency for each DMU under consideration. DEA evaluates a DMU as technically efficient if it has the best ratio of any output to any input and this shows the significance of the outputs/inputs taken under consideration.

4.1 DEA models (CRS vs VRS)

Under the restriction of Constant Returns to Scale (hereafter CRS), Charnes et al. (1978) specify the linear programming problem representing the fitting of an efficient production surface to the data. An extension allowing for Variable Returns to Scale (hereafter VRS) is provided by Banker et al. (1984). The latter assumption requires an additional constraint on the solution, compared with the constant returns to scale case and the resulting efficiency estimate will be greater than that obtained under constant returns to scale. Thus, where the methods yield different values, the index obtained under variable returns takes account of scale related effects and therefore represents pure technical efficiency alone, whereas the constant returns to scale measure represents overall technical efficiency, in which pure technical and scale efficiency are combined.

Banker et al. (1984) show that the index of overall efficiency is equal to the product of the scale and pure technical efficiency indices. Hence, an index of scale efficiency can be obtained by manipulating the DEA results obtained under the assumption of constant and variable returns. Moreover, following Banker (1984), a measure of the local returns to scale properties of the technology can be obtained by aggregating the weights applied to the peer DMUs in constructing the hypothetical DMU used in the calculation of overall efficiency. Given the assumption of constant returns to scale (CRS), the size of the prefecture is not considered to be relevant in assessing its efficiency. Under the assumption of constant returns to scale (CRS) introduced by Charnes et al. (1978) small prefectures (in terms of population), can produce outputs with the same ratios of input to output, as can larger prefectures. This is because the assumption implies that there are no economies (or diseconomies) of scale present, so doubling all inputs will generally lead to a doubling in all outputs.

However, this assumption may be inappropriate for regional development and policy implications on quality of life amongst the Greek prefectures, because economies of scale (or increasing returns to scale, IRS) may exist. Based on this assumption doubling all inputs should lead to more than a doubling of output in terms or higher rates of regional development. For other prefectures, might become too large (in terms of population and absorption of resources) and diseconomies of scale (decreasing returns to scale, DRS) could set in. In this case, a doubling of all inputs will lead to less than doubling of outputs. It would be to the local administrations' advantage to ensure that its development (through the efficient use of the resources) is of optimal size -neither too small if there are increasing returns nor too large if there are decreasing returns to scale.

4.2 Advantages and limitations of DEA methodology

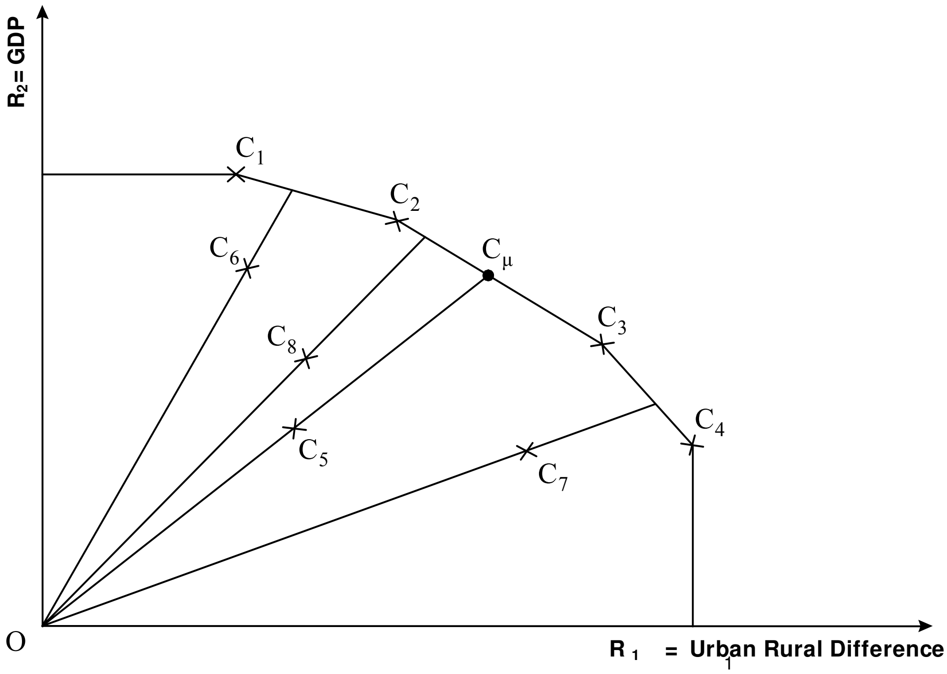
DEA modelling can incorporate multiple inputs and outputs. In order to calculate technical efficiency, information on output and input is required. This makes it particularly suitable for analysing the efficiency of fiscal policies on regional development. Possible sources of inefficiency can be determined as well as efficiency levels. The technique, gives the ability to decompose economic inefficiency into technical and allocative inefficiency. Furthermore, it allows technical inefficiency to be decomposed into scale effects. By identifying the 'peers' for the prefectures, which are not efficient, DEA provides a set of potential role models that the policy makers of the prefectures can look at, for ways of improving the effect of their fiscal policies on regional development and quality of life.

However, some major disadvantages when using this technique have to be mentioned. Having a deterministic nature DEA produces results that are particularly sensitive to measurement error. If one prefecture's inputs are understated or its outputs overstated, then that prefecture can distort the shape of the frontier and reduce the efficiency scores of nearby prefectures. It only measures efficiency relative to best practice within the particular sample. Thus, it is not meaningful to compare the scores between two different studies because differences in best practice between the samples are unknown.

DEA scores are sensitive to input and output specification and the size of the sample. There are different rules as to what the minimum number of prefectures in the sample should be; one rule is that the number of prefectures in the sample should be at least three times greater that the sum of the number of outputs and inputs included in the specification (Nunamaker, 1985). Despite the limitations, DEA is a useful tool for evaluating the effect of policies on regional development and quality of life amongst the Greek prefectures.

4.3 Mathematical formulation

Let us now consider the problem diagrammatically. Assume that we examine the efficiency of eight prefectures (C_1, C_2, … ,C_8). To simplify things, we use two efficiency ratios: (a) GDP as a percentage of the mean GDP of the country and (b) the difference of urban rural population. Suppose that prefectures that achieve the optimal efficiency are C_1, C_2, C_3 and C_4. The efficient frontier is determined from the segments that pass through points C_1, C_2, C_3 and C_4. Prefecture C_5 is not lying on the frontier and it is considered either as less efficient or not efficient. Point C_μ on the surface, which determines the optimal level of efficiency, represents the combination of the two ratios R_1 and R_2 in the same proportion as prefecture C_5 and thus it is considered as the reference point, which is used for the measurement of relative efficiency of prefecture C_5. C_μ is a linear combination of C_2 and C_3. That is the reference subset for prefectures C_5 is prefectures C_2 and C_3. The portion by which C_μ prevails C_5 shows us the size of inefficiency. The degree of efficiency for prefecture C_5 is found by the ratio of the distances OC_5/OC_μ.



Let us now consider the problem from the mathematical point of view. The N under consideration prefectures produce a vector of outputs R_i in the form of the mentioned financial ratios. The matrix of outputs R_i (with i=1,2,3,…,m) is known for each prefecture n (with n=1,2,….,N). The n+1 variables to be determined are a set of weights[4] (λ), ($\lambda=\lambda_1, \lambda_2, \ldots, \lambda_\kappa)^{\ell}$ placed on each of the prefectures in forming the efficiency frontier for prefecture (ℓ) and an efficiency measure Θ^{ℓ}.

Then the linear program for each prefecture can be written as:

$$\begin{aligned} \max \quad & \vartheta_\ell \\ \text{subject to} \quad & \sum_{n=1}^{N} \lambda_n R_{in} \geq \vartheta_\ell R_{i\ell} \quad (\mathrm{i} = 1, 2, \ldots.., \mathrm{m}) \\ & \sum_{n=1}^{N} \lambda_n = 1 \\ & \vartheta_\ell \geq 0 \\ & \lambda_n \geq 0 \quad (\mathrm{n} = 1, 2, \ldots.., \mathrm{N}) \end{aligned}$$

The efficiency score for each prefecture is given by $\Theta_\ell * = \dfrac{1}{\vartheta_\ell}$, and it is positive and less than or equal to one. DMUs with Θ* value of unity are deemed efficient while DMUs with a Θ* score of less than one are considered as inefficient. The optimal weights

$(\lambda_1^*, ..., \lambda_n^*)^{\ell}$ of the reference group in the solution set a feasible target for improvement in each ratio (R_i) for prefecture ℓ.

$$\hat{Y}_{i\ell} = \sum_{n=1}^{N} \lambda_n^* R_i \quad \text{or} \quad \hat{Y}_{i\ell} = R_{i\ell}\Theta_\ell^* + s_{i\ell}$$

where ($s_{i\ell}$) is the slack on ratio (i) and reflects the non-proportional residual output slack, while (Θ_ℓ^*) reflects the proportional output augmentation. In the number of cases where a DMU exhibited a negative ratio, the constraint associated with the negative ratio was amended to the following:

$$\sum_{n=1}^{N} \lambda_n R_{in} \geq R_{i\ell}$$

This ensures that the reference group exhibits performance not worse than a reference prefecture on the ratio on which this prefecture has negative performance along the lines suggested by Banker and Morey (1986) and Smith (1990).

The analysis of weights is particularly instructive when we consider prefectures, which seem to be efficient (Θ^*=1). The weights indicate whether this efficiency is a result of exceptional performance in just one or two dimensions. A prefecture may choose to concentrate on just one output producing an exceptional performance along that dimension. Then whatever the performance along other outputs this prefecture will be deemed efficient. There is simply no other prefecture with which to compare it. This is a drawback of DEA and shows the difficulty of interpreting apparent efficiency in prefectures adopting unusual patterns of outputs (or inputs). The weights derived in this way show the importance given on the output by the prefecture under consideration. DEA makes no judgments about the validity of such values and limits the search for optimal performance amongst comparison groups adopting similar values.

5. EMPIRICAL RESULTS

According to the derived results from the solution of the model, it emerges that the annual efficiency ratios of the Greek prefectures range from 0.4256 to 1. Twelve prefectures are considered to be efficient for the year 2000, ten for the year 1990 and nine for the year 1980 in the case of CRS. Specifically, as can be seen from Table 4, efficient prefectures are considered to be those with efficiency ratio equal to one ($\Theta^*=1$). In all years the most efficient prefectures are c6, c14, c43 and c49 in the case of CRS and c6, c14, c18, c21, c43, c45 and c49 in the case of VRS[5].

The first column in Table 4 represents the prefectures, the second, fifth and eighth columns the efficiency scores, the third, sixth and ninth columns the reference set for the inefficient prefectures compared to the efficient ones, whereas the fourth, seventh and tenth columns show the rank of prefectures according to their efficiency. The same column shows us how many times the efficient prefectures constitute a reference and comparison criterion for the inefficient prefectures (the numbers in parentheses). That is, how many times the specific prefecture appears to be a member of the reference set.

At this point it is worth mentioning that a prefecture which appears to be in the efficient frontier for the less efficient prefectures, the most times, is considered to be the Global leader. By counting the times each prefecture appears to be in the reference set (Table 4), we notice that prefecture C_6 is the most efficient in the case of CRS and for the years 1980 and 1990. That is, this prefecture appears 38 times (more than all the other efficient prefectures) to be part of the reference set in the year 1980 (CRS) and 40 times in the year 1990 (CRS). This means that its performance is greater on average in all dimensions of efficiencies as they are described in our model compared to the other efficient sample prefectures. Similarly, in the case of CRS C_{49} in 1990 (35) and in 2000 (16) and C_7 in 2000 (40) are the most efficient prefectures.

Table 4: Rankings and benchmarks per prefecture in the case of Overall efficiency

Dmus	CRS 1980			CRS 1990			CRS 2000		
	Scores	Benchmarks	Rank	Scores	Benchmarks	Rank	Scores	Benchmarks	Rank
c1	1		1(3)	0,7569	6,14,49	27	0,74776	7,14,43,49	31
c2	0,73722	6,14, 49	29	0,75773	6, 49	26	0,66058	6,7,45,49	39
c3	0,82395	6,10,14	22	0,85949	6,14,49	19	0,9059	7,13,14,49	24
c4	0,552	6,14,43,49	44	0,65428	17,21,49	36	0,5897	7,12,14,49	44
c5	0,72517	10,45	30	0,61262	6,18,45	41	0,70733	7,10,13	32
c6	1		1 (38)	1		1 (40)	1		1(17)
c7	0,79437	1,6,43,49	24	0,93035	6,49	12	1		1 (32)
c8	0,47359	6,10,45	48	0,58049	6,45,49	45	0,4745	6,7,45,49	49
c9	0,66765	6,37,49	37	0,91828	6,45,49	14	0,67645	7,18,45	35
c10	1		1 (27)	0,59047	6,17,49	43	1		1 (9)
c11	0,89671	1,6,43,49	16	0,8619	6,27,49	18	0,97156	6,14,27,49	15
c12	0,51573	6,10,14,49	47	0,57507	6,17,49	46	1		1 (3)
c13	0,92119	10,14,30,45,49	15	0,83925	6,45,49	21	1		1 (24)
c14	1		1 (23)	1		1 (8)	1		1 (19)
c15	0,81183	6, 10	23	0,90589	6,45,49	16	0,63435	6,7,10,13	41
c16	0,40953	6, 10	51	0,61337	6,45,49	40	0,46701	7,18,45	50
c17	0,69167	6, 14, 30, 49	33	1		1 (12)	0,8537	13,14,49	26
c18	0,8491	6, 37, 45	18	1		1 (1)	1		1 (3)
c19	0,56425	6, 14, 43, 49	43	0,45985	6,17,49	50	0,42977	7,10,13,31	51
c20	0,59961	6, 37	41	0,88283	6,45,49	17	0,56522	7,13,45	45
c21	0,99456	6, 10, 14, 43	10	1		1 (4)	0,93475	7,12,14,49	20
c22	0,53646	6, 10, 14, 45, 49	45	0,45735	6, 49	51	0,48572	6,7,14,31,49	48
c23	0,61875	6, 45, 49	39	0,63084	6,45,49	39	0,53003	7,49	47
c24	0,52428	6, 10, 30, 45	46	0,74109	6,45,49	28	0,96624	13,45,49	16
c25	0,7429	6, 10, 14, 43	28	0,72935	6,17,49	30	0,87262	7,13,14,31	25
c26	0,93864	6, 10, 43, 49	13	0,94372	6, 49	11	0,99146	6,7,14,49	13
c27	0,82754	6, 14, 49	20	1		1 (3)	1		1 (1)
c28	0,70622	6, 10, 14, 43	32	0,79237	6,14,21,49	24	0,91733	13,14,49	21
c29	0,75835	6, 10, 45	27	0,73893	6,17,49	29	0,7562	6,7,10,13,31	30
c30	1		1 (6)	0,91915	6, 49	13	0,94684	7,14,43,49	18
c31	0,86632	6, 10, 14, 43, 49	17	0,70359	6,14,49	32	1		1(13)
c32	0,47137	6,10, 30, 45	49	0,56977	6,17,49	47	0,78134	7,10,13, 31	29
c33	0,71287	6,10, 45	31	0,79056	6,45,49	25	0,69236	7,10,13	33
c34	0,98477	6,10,14	12	0,81839	6,14,49	22	0,97181	7,13,14,49	14
c35	0,58945	6, 10	42	0,66664	6,17,49	35	0,65178	6,10,13,31	40
c36	0,93528	6,14, 43, 49	14	0,81641	6,17,49	23	0,61758	6,7,13,14,31,49	43
c37	1		1 (3)	1		1 (0)	0,91527	7,18	22
c38	0,78365	6,10, 45, 49	25	0,91227	6,45,49	15	0,67372	6,13,45,49	37
c39	0,66862	6,10,14,30,45,49	36	0,65147	6,27,49	37	0,67471	6,7,13,49	36
c40	0,99392	10,14,49	11	0,68422	6,17,49	33	0,96588	6,13,31	17
c41	0,67476	6,10,14	35	0,54457	6,17,49	48	0,68305	6,7,13,14,31	34
c42	0,76789	6,10,14,30	26	0,58865	6,14,27	44	0,66298	6,7,13,14,31	38
c43	1		1 (12)	1		1 (0)	1		1 (2)
c44	0,60226	6,10,14,43,49	40	0,71074	6,17,49	31	0,55292	6,7,13,14,31	46
c45	1		1 (14)	1		1 (13)	1		1 (7)
c46	0,82544	1,6,14,43	21	0,85687	6,49	20	0,94555	6,7,14,49	19
c47	0,83167	6,10,14	19	0,64996	6,14,21	38	0,90824	6,7,13,14,31	23
c48	0,64017	6,14,49	38	0,67256	6,14,21,49	34	0,82597	7,12,14,49	27
c49	1		1 (21)	1		1 (38)	1		1 (20)
c50	0,45782	6,10,45	50	0,59418	6,45,49	42	0,63307	7,10,13	42
c51	0,68772	45, 49	34	0,47637	6,45,49	49	0,80775	7,10,13,31	28

As it can be seen from the mathematical formulation, the feasible target for the improvement of every ratio is achieved by summing up the products of the weights (λ_i) and the respective ratios (R_i)[6]. The ratios used for each prefecture's efficiency as well as the feasible target for improving any ratio are shown in Table 5. We notice that for the prefectures forming the efficient frontier, there is no difference between the real ratios and the feasible targets. On the other hand, there is a possibility of improvement for all prefectures whose efficiency, according to Table 4, is less than 1.

Table 5: Targeted values per variable in the case of CRS and for the year 2000

DMUs	NHO	NDO	NPUS	NPB	GDP	DUR	NNH	DMUs	NHO	NDO	NPUS	NPB	GDP	DUR	NNH
c1	2,1655	2,46403	9,8877	1,57288	78,836	38117	5,3113	**c27**	0,97678	2,89	11,8475	6,32243	123,756	44515	22,3505
	2,13854	**2,03354**	**9,85337**	**1,55531**	**105,424**	**50975**	**8,33382**		**0,97678**	**2,89**	**11,8475**	**6,32243**	**123,756**	**44515**	**22,3505**
c2	1,65453	2,72	8,1967	2,29744	87,671	14262	12,2814	**c28**	2,37863	2,61	12,729	1,37499	72,406	48921	11,1906
	1,65472	**2,0133**	**8,19518**	**2,29201**	**132,718**	**21590,2**	**18,5929**		**1,66021**	**2,59796**	**12,1444**	**1,36339**	**78,9323**	**53330,1**	**12,1873**
c3	5,60592	2,65	10,6345	1,62689	97,328	48937	8,4481	**c29**	3,26883	2,71	8,0938	1,51089	104,299	-34555	6,6451
	2,08376	**2,13682**	**10,5961**	**1,60797**	**107,429**	**54020,1**	**9,32665**		**3,27625**	**2,69432**	**8,08329**	**1,49233**	**137,933**	**25016,8**	**8,79496**
c4	2,6237	2,06	12,9813	1,7534	62,108	31458	4,3643	**c30**	3,70812	4,25	8,0032	1,76889	124,929	39881	9,2506
	2,08377	**2,04586**	**12,9424**	**1,59488**	**105,315**	**53345,6**	**7,40756**		**2,8074**	**1,85618**	**7,97741**	**1,74872**	**131,941**	**42120,2**	**9,77491**
c5	4,73064	4,89	7,8526	1,52112	88,117	-106982	10,3411	**c31**	2,55687	3,34	12,1942	1,12722	114,858	38556	7,8722
	3,4081	**3,15061**	**7,84273**	**1,51192**	**124,581**	**19005,5**	**14,6116**		**2,55687**	**3,34**	**12,1942**	**1,12722**	**114,858**	**38556**	**7,8722**
c6	1,86902	1,78	10,0915	2,45642	227,942	8324	6,0571	**c32**	4,44326	3,68	10,8932	1,7773	112,901	14390	14,5739
	1,86902	**1,78**	**10,0915**	**2,45642**	**227,942**	**8324**	**6,0571**		**3,76415**	**3,66678**	**10,887**	**1,7626**	**144,516**	**30883,9**	**18,6487**
c7	4,79977	2,1233	7,8284	2,33351	206,798	40658	10,3896	**c33**	4,86968	3,26	7,3772	1,78265	106,933	-64817	7,8214
	4,79977	**2,1233**	**7,8284**	**2,33351**	**206,798**	**40658**	**10,3896**		**3,83659**	**2,50897**	**7,35953**	**1,76259**	**154,449**	**27486,5**	**11,2983**
c8	2,53907	3,06	7,548	2,56792	76,35	-4506	6,29	**c34**	2,88903	2,61	9,3039	1,22685	72,576	42504	8,831
	2,53934	**1,90086**	**7,5389**	**2,14292**	**160,907**	**-9496,32**	**13,2599**		**1,48747**	**1,93932**	**9,27156**	**1,21502**	**74,6745**	**43737**	**9,08242**
c9	6,69224	2,33	7,6737	2,47802	136,213	-30686	7,7866	**c35**	2,42499	2,94	10,9432	1,59048	94,653	10310	6,8724
	4,60887	**2,31917**	**7,66021**	**2,30999**	**201,359**	**-17568,3**	**11,5224**		**2,44551**	**2,91644**	**10,9456**	**1,57892**	**145,246**	**24739,7**	**10,5536**
c10	3,26071	4,35	8,9728	1,14493	105,25	9195	11,1145	**c36**	2,68867	2,03	8,3637	1,61869	79,486	22060	5,9466
	3,26071	**4,35**	**8,9728**	**1,14493**	**105,25**	**9195**	**11,1145**		**2,6796**	**2,01498**	**8,34192**	**1,60118**	**128,708**	**35720,1**	**9,63146**
c11	1,10163	2,41	8,6292	1,89183	101,55	26766	10,7792	**c37**	6,13162	7,48	4,8119	3,22079	122,902	-3072922	5,8009
	1,09844	**1,52378**	**7,09192**	**1,88948**	**104,523**	**27549,5**	**11,0985**		**6,38877**	**6,07258**	**5,07535**	**1,93411**	**134,092**	**-558253**	**8,70935**
c12	1,55992	0,76	24,2915	1,65351	71,775	18129	4,0558	**c38**	5,23697	1,65	7,1181	1,6173	77,948	-2009	8,4408
	1,55992	**0,76**	**24,2915**	**1,65351**	**71,775**	**18129**	**4,0558**		**1,4317**	**1,65313**	**6,47574**	**1,6205**	**115,7**	**-2981,96**	**12,523**
c13	2,7169	3,28	8	1,48661	80,987	12083	30,1423	**c39**	2,03855	1,79	10,8893	1,90377	77,191	19801	10,715
	2,7169	**3,28**	**8**	**1,48661**	**80,987**	**12083**	**30,1423**		**2,6971**	**3,42812**	**11,6957**	**3,55829**	**165,232**	**41109,7**	**27,6775**
c14	1,14855	2,02	11,6493	1,1175	65,914	57620	4,8011	**c40**	2,81927	2,78	10,5161	1,24487	112,081	17535	8,9216
	1,14855	**2,02**	**11,6493**	**1,1175**	**65,914**	**57620**	**4,8011**		**2,24925**	**2,75615**	**10,2387**	**1,22913**	**116,068**	**27560**	**9,25067**
c15	2,33954	2,89	6,5696	1,51792	84,299	-18975	5,3963	**c41**	2,19259	2,6	17,2264	1,47977	74,803	14433	11,1253
	2,33812	**1,8784**	**6,56211**	**1,51163**	**132,891**	**14266,7**	**8,50534**		**2,18661**	**2,59908**	**8,97528**	**1,47888**	**109,524**	**21130,3**	**16,2747**
c16	5,10788	5,44	7,7655	2,41377	96,14	-28992	4,9609	**c42**	3,48664	3,33	14,9671	1,81213	103,65	25279	9,5653
	5,13707	**2,62521**	**7,76912**	**2,34186**	**205,843**	**-27066,9**	**10,639**		**3,50347**	**3,30559**	**11,7804**	**1,79065**	**156,365**	**38129,6**	**14,4363**
c17	1,86587	2,36	9,8259	1,7357	60,414	32020	17,7041	**c43**	2,70262	2,72	9,0964	1,58773	73,876	52703	5,5794
	0,971165	**1,38629**	**10,6209**	**0,685942**	**619,938**	**248743852**	**18,8245**		**2,70262**	**2,72**	**9,0964**	**1,58773**	**73,876**	**52703**	**5,5794**
c18	6,69109	6,73	4,6795	2,29906	132,226	-676393	8,9287	**c44**	3,36842	2,55	12,021	1,98483	85,561	27052	6,4978
	6,69109	**6,73**	**4,6795**	**2,29906**	**132,226**	**-676393**	**8,9287**		**3,34504**	**2,53137**	**10,895**	**1,96191**	**154,742**	**48926,1**	**11,7515**
c19	6,07969	5,74	11,084	2,30852	82,44	14061	8,4939	**c45**	1,37395	1,53	4,3634	1,46998	106,254	-162102	12,5779
	5,01895	**4,09416**	**11,0666**	**2,28972**	**191,832**	**32717,8**	**19,7571**		**1,37395**	**1,53**	**4,3634**	**1,46998**	**106,254**	**-162102**	**12,5779**
c20	4,4673	3,28	7,022	2,48873	92,981	-3646	7,6868	**c46**	1,98019	2,13	8,3342	1,7005	114,931	35364	5,7056
	3,71036	**2,12796**	**7,00408**	**1,97768**	**164,508**	**-6450,7**	**13,6**		**1,96638**	**1,75398**	**8,3134**	**1,68851**	**121,545**	**37400,3**	**9,40241**
c21	2,73273	1,86	11,3764	1,3818	83,926	45866	5,2802	**c47**	1,77111	2,01	13,7911	1,29638	96,286	24513	7,3401
	1,77659	**1,84479**	**11,3376**	**1,32506**	**89,7769**	**49067,7**	**5,65324**		**1,76625**	**1,9982**	**8,59374**	**1,28697**	**106,02**	**26989,7**	**8,08319**
c22	2,33713	2,23975	10,7776	2,43068	101,554	12373	4,0948	**c48**	2,27819	1,56	16,2478	1,9261	87,734	30302	8,595
	2,33016	**2,06006**	**10,7643**	**2,42511**	**209,076**	**25473,5**	**8,43389**		**2,10681**	**1,57065**	**15,9337**	**1,93811**	**106,229**	**36686,6**	**10,4273**
c23	5,42978	3,53	7,7747	3,52757	95,722	22331	6,0639	**c49**	1,42048	2,12	8,2034	2,34522	105,525	50470	23,109
	3,96257	**2,06763**	**7,75312**	**2,26974**	**180,6**	**42131,9**	**13,0503**		**1,42048**	**2,12**	**8,2034**	**2,34522**	**105,525**	**50470**	**23,109**
c24	3,41876	2,4	8,9666	2,25385	102,79	21648	24,0579	**c50**	6,52317	4,11	7,8772	2,0547	110,234	-13419	8,5978
	1,72002	**2,40362**	**8,34374**	**2,25627**	**106,384**	**33230,7**	**24,8908**		**4,25418**	**2,48789**	**7,85623**	**2,03199**	**174,129**	**32506,8**	**13,5813**
c25	3,57079	2,86	9,4974	1,65065	113,212	39770	7,4897	**c51**	3,23922	2,91	9,1667	1,27322	91,927	-7812	8,6691
	2,86151	**2,11315**	**9,46331**	**1,62764**	**129,735**	**45575,3**	**8,58608**		**2,82934**	**2,89027**	**9,16384**	**1,25591**	**113,827**	**27478**	**10,7409**
c26	1,41634	2,44	9,3364	1,81731	119,759	37585	7,114								
	1,40047	**1,85101**	**9,31914**	**1,81193**	**120,785**	**37908,6**	**10,6653**								

It is worth mentioning that Table 4 must be read along with Table 5, as both Tables refer to the case of CRS. For instance, let us examine prefecture 2 (C_2). By looking first at Table 4, we notice that the reference set of C_2 is C_6, $C_{7,}$ C_{45} and C_{49}. This means that C_6 defines by 0.1793, C_7 by 0.044, C_{45} by 0.0998 and C_{49} by 0.6833 feasible improvement targets of all C_2's ratios. So, as it is shown in Table 5, the feasible target for the respective C_2's ratios will be given as the sum of the products of the respective weights for the reference set (C_6, C_7, C_{45} and C_{49}) of C_2 multiplied by the matrix-columns that include the ratios of the reference set prefectures. Specifically, the feasible target for every inefficient prefecture (say C_2) can be calculated as:

$$\hat{\Upsilon}_{i2} = \sum_{n=1}^{N} \lambda_n^* R_i$$

Table 6 presents the scale efficiency of all the Greek prefectures. These are computed by dividing the efficiency results derived in the case of CRS by the results derived in the case of VRS. If scale inefficiency exists this may be due to either increasing (IRS) or decreasing returns to scale (DRS). We differentiate IRS from DRS by solving the same Linear programming problem imposing the restriction that the sum of weights is less or equal to 1 allowing for non-increasing returns to scale (NIRS). That is $\sum_{r}^{N} \lambda_{sr} \leq 1$. If the efficiencies derived from the case of VRS equals to the efficiencies derived for the NIRS then we have scale inefficiency due to DRS. If they are not equal then the scale inefficiency is due to IRS.

Table 6: Scale Efficiencies and returns to scale

	SCALE EFFICIENCY 1980	1990	2000	1980	1990	2000
c1	1	0,941699015	0,980257466	CRS	IRS	IRS
c2	1,30604569	0,638539233	1,509798593	DRS	IRS	DRS
c3	0,93722629	0,94332808	1,043812716	DRS	DRS	DRS
c4	0,7572127	0,868161232	1,680022848	DRS	DRS	DRS
c5	1,20248802	1,212911711	1,406192873	DRS	DRS	IRS
c6	1	1	1	CRS	CRS	CRS
c7	0,89227776	0,923510582	0,63435	DRS	IRS	CRS
c8	0,85842748	1,03767552	0,976211877	DRS	IRS	IRS
c9	1,03566669	1,080742254	1,235634679	IRS	IRS	DRS
c10	0,8491	1,578282828	1	CRS	IRS	CRS
c11	0,57566545	0,45985	0,42977	DRS	IRS	IRS
c12	1,35160604	1,208250283	0,66058	DRS	DRS	CRS
c13	0,65087274	0,970889695	0,56522	DRS	DRS	CRS
c14	0,99456	1	0,93475	CRS	CRS	CRS
c15	0,64114638	0,45735	0,48572	IRS	IRS	IRS
c16	1,45386405	1,006895231	1,126046314	DRS	DRS	DRS
c17	0,75641673	0,74109	1,068329574	IRS	CRS	IRS
c18	0,7429	0,72935	0,87262	IRS	CRS	CRS
c19	1,1298298	1,731532788	1,982127149	DRS	DRS	DRS
c20	1,34271158	1,06771445	1,5572443	DRS	IRS	IRS
c21	0,70622	0,79237	0,91733	IRS	CRS	IRS
c22	1,41353986	1,481831308	1,4645956	DRS	DRS	DRS
c23	1,17045003	1,214363423	1,542009941	DRS	DRS	IRS
c24	1,52725384	1,19306603	0,955747567	DRS	DRS	DRS
c25	1,02863928	0,822594788	1,138887307	DRS	DRS	IRS
c26	0,47137	0,586116797	0,78134	CRS	IRS	IRS
c27	0,80851764	0,79056	0,69236	DRS	CRS	CRS
c28	1,05741437	0,911235817	0,99329497	DRS	DRS	DRS
c29	0,77034162	0,769836596	0,818788237	IRS	IRS	IRS
c30	0,93528	0,887006877	0,61758	CRS	IRS	IRS
c31	1,00289838	1,389313401	0,91527	IRS	DRS	CRS
c32	1,61185158	1,312599819	0,832071534	DRS	DRS	DRS
c33	0,9216116	0,822303566	0,967478742	IRS	IRS	IRS
c34	0,552	0,771866078	0,5897	CRS	DRS	IRS
c35	1,67535313	0,999707782	1,479504932	IRS	DRS	DRS
c36	0,67476	0,54457	0,836210274	DRS	IRS	IRS
c37	0,76789	0,58865	0,721500941	CRS	CRS	IRS
c38	1	1	1	IRS	IRS	IRS
c39	0,89447654	1,085563294	0,708453989	DRS	DRS	IRS
c40	1	1,404711402	1	IRS	DRS	IRS
c41	1,2130261	1,506213855	1,344524074	IRS	DRS	IRS
c42	1,07537045	1,029394995	1,30473632	DRS	DRS	DRS
c43	0,64017	0,67256	0,82597	CRS	CRS	CRS
c44	1,51678321	1,397780325	1,733372623	DRS	IRS	DRS
c45	0,72517	0,61262	0,70733	CRS	CRS	CRS
c46	0,51858816	0,69296977	0,63307	DRS	IRS	IRS
c47	0,81414923	0,721893043	0,80775	IRS	DRS	IRS
c48	1,24669625	1,330548053	1,207641958	DRS	DRS	DRS
c49	0,79437	0,93035	1	CRS	CRS	CRS
c50	1,01361214	0,923905777	0,748930663	DRS	DRS	DRS
c51	0,91123122	1,867143816	0,79919897	IRS	DRS	IRS

For comparing the results derived in our analysis we form three different groups of prefectures according to their efficiency scores. In this way, group 1 is formed by those prefectures that are efficient ($\Theta^*=1$), group 2 includes prefectures with scores less than 1 and more than 0.7 ($0.7\leq \Theta^*<1$) and the last group includes prefectures with scores less than

0.7. All the groups along with the prefectures are presented in Table 7. The rank of prefectures in table 7 is according to their efficiency scores in each year. As it appears, in the last three decades we have an increase of efficient prefectures (group 1), where over the same period we have a decrease for the prefectures of group 2. At the same time, the number of the most inefficient prefectures is stable for the last three decades (group 3).

Table 7: *Groups of prefectures according to their efficiency scores*

Group (1) $\Theta^*=1$			Group (2) $1 > \Theta^* \geq 0,7$			Group (3) $\Theta^* < 0,7$		
1990-2000	1980-1990	1970-1980	1990-2000	1980-1990	1970-1980	1990-2000	1980-1990	1970-1980
C7	c6	c6	c26	c26	c21	c33	c40	c17
C13	c49	c10	c34	c7	c40	c41	c48	c51
C49	c45	c14	c11	c30	c34	c9	c35	c41
C14	c17	c49	c24	c9	c26	c39	c4	c39
C6	c14	c45	c40	c38	c36	c38	c39	c9
c31	c21	c43	c30	c15	c13	c42	c47	c48
c10	c27	c30	c46	c20	c11	c2	c23	c23
c45	c18	c1	c21	c11	c31	c35	c16	c44
c12	c37	c37	c28	c3	c18	c15	c5	c20
c18	c43		c37	c46	c47	c50	c50	c35
c43			c47	c13	c27	c36	c10	c19
c27			c3	c34	c46	c4	c42	c4
			c25	c36	c3	c20	c8	c22
			c17	c28	c15	c44	c12	c24
			c48	c33	c7	c23	c32	c12
			c51	c2	c38	c22	c41	c8
			c32	c1	c42	c8	c51	c32
			c29	c24	c29	c16	c19	c50
			c1	c29	c25	c19	c22	c16
			c5	c25	c2			
				c44	c5			
				c31	c33			
					c28			

Let us now compare the groups between them (groups 3 with 2, 2 with 1 and 3 with 1) in order to establish the main factors/ variables affecting their efficiency. In doing so, we observe that there is a decrease in the number of hospitals (NHO) as well as in the number of doctors (NDO) for the first decade. Then for the other two decades there is a slice increase. In the case of the number of public schools (NPUS), there is a decrease in the first two decades and an increase in the last one. Over the three decades the number of busses (NPUS) among the Greek prefectures is fluctuating, with a minor decrease for the first decade and then an increase. Comparing GDP among the three groups over the decades we observe that there is a substantial increase between the groups and over the decades. The same behaviour has been also observed in the case of new houses (NNH). However, in the case of DUR the less efficient prefectures have an increase of rural population whereas the efficient prefectures have more balanced population with a trend of an increase in urban population over the decades.

Table 8 presents the percentage changes in inputs and outputs for the year 2000 for each of the inefficient prefectures in order for them to become efficient. Let us clarify that by cutting services in certain areas to increase efficiency means that we use inputs more efficiently as there are interactions between them as well as second round effects. These multiple input ratios are used in order to maximize the output levels of prefectures.

As can be seen, the inefficient prefectures (the majority) need to use efficiently the number of hospital beds in order to become efficient. For instance the prefecture of Messinia (C34, MES[7]) need to decrease the number of hospital beds (NHO) by 48.5%, whereas the prefecture of Keffalonia (C24, KEF) needs to decrease them by 49.6% and the prefecture of Arkadia (C3, ARK) by 62.8%. The biggest increase in hospital beds by 32.3% is observed in the prefecture of Prebeza (C39, PRE) in order to become efficient.

Looking at the number of doctors (NDO) we realise that for most of the prefectures their current levels require a reduction in order to become efficient. The prefecture of Kerkira (C23, KER) needs to decrease the current number of doctors by 41.4% and the prefectures of Imathia (C15, HMA) and Lasithiou (C30, LAS) by 51.7% and 56.3% respectively. Similarly, an increase in doctors by 0.68% and 91.5% needed to be taken for the prefectures of Fokida (C48, FOK) and Prebezas (C39, PRE) respectively

Moving on to the public school provision (NPUS) policies must have the effect of a small decrease in the number of schools provided for the majority of the prefectures. The limited number of students enrolled in these schools explains this probably. More specifically, the prefectures of Trikala (C44, TRI) and Evia (C11, EVI) need to decrease the current number of public schools provided by 9.3% and 17.8% respectively. The major decrease is observed in the prefecture of Rodopis (C41, ROD) with a

Table 8: Percentage change (per indicator/variable) for achieving efficiency (year 2000)

Prefectures	Scores	Rank	NHO	NDO	NPUS	NPB	GDP	DUR	NNH
c7	1	1(32)	0	0	0	0	0	0	0
c13	1	1 (24)	0	0	0	0	0	0	0
c49	1	1 (20)	0	0	0	0	0	0	0
c14	1	1 (19)	0	0	0	0	0	0	0
c6	1	1 (17)	0	0	0	0	0	0	0
c31	1	1 (13)	0	0	0	0	0	0	0
c10	1	1 (9)	0	0	0	0	0	0	0
c45	1	1 (7)	0	0	0	0	0	0	0
c12	1	1 (3)	0	0	0	0	0	0	0
c18	1	1 (3)	0	0	0	0	0	0	0
c43	1	1 (2)	0	0	0	0	0	0	0
c27	1	1 (1)	0	0	0	0	0	0	0
c26	0,99146	13	-1,12049	-24,1389	-0,18487	-0,29604	0,856721	0,8609818	49,91988
c34	0,97181	14	-48,5132	-25,6966	-0,3476	-0,96426	2,891452	2,9009034	2,847016
c11	0,97156	15	-0,28957	-36,7726	-17,8149	-0,12422	2,927622	2,9272211	2,962186
c24	0,96624	16	-49,6888	0,150833	-6,94645	0,107372	3,496449	53,504712	3,462064
c40	0,96588	17	-20,2187	-0,85791	-2,63786	-1,26439	3,557249	57,171372	3,688464
c30	0,94684	18	-24,2905	-56,3252	-0,32225	-1,14026	5,612788	5,6147037	5,667849
c46	0,94555	19	-0,69741	-17,6535	-0,24957	-0,70509	5,754757	5,7581156	64,79266
c21	0,93475	20	-34,9885	-0,81774	-0,34106	-4,10624	6,971499	6,980552	7,064884
c28	0,91733	21	-30,2031	-0,4613	-4,59266	-0,84364	9,01348	9,0126939	8,906582
c37	0,91527	22	4,193835	-18,8158	5,474968	-39,9492	9,104815	-81,833154	50,13791
c47	0,90824	23	-0,2744	-0,58706	-37,6863	-0,72587	10,10947	10,103618	10,1237
c3	0,9059	24	-62,8293	-19,3653	-0,36109	-1,16296	10,37831	10,387028	10,39938
c25	0,87262	25	-19,8634	-26,1136	-0,35894	-1,394	14,59474	14,597184	14,6385
c17	0,8537	26	-47,9511	-41,2589	8,090862	-60,4804	926,1496	776739,01	6,328478
c48	0,82597	27	-7,52264	0,682692	-1,93318	0,62354	21,08077	21,069896	21,31821
c51	0,80775	28	-12,6537	-0,67801	-0,0312	-1,35955	23,82325	-451,74091	23,89867
c32	0,78134	29	-15,284	-0,35924	-0,05692	-0,8271	28,00241	114,62057	27,95957
c29	0,7562	30	0,226993	-0,5786	-0,12985	-1,22842	32,24767	-172,39705	32,35256
c1	0,74776	31	-1,24498	-17,471	-0,3472	-1,11706	33,72571	33,73298	56,90735
c5	0,70733	32	-27,9569	-35,5703	-0,12569	-0,60482	41,38135	-117,76514	41,29638
c33	0,69236	33	-21,2147	-23,0377	-0,23952	-1,12529	44,4353	-142,40631	44,45368
c41	0,68305	34	-0,27274	-0,03538	-47,8981	-0,06014	46,41659	46,402688	46,28549
c9	0,67645	35	-31,1311	-0,46481	-0,1758	-6,78082	47,82657	-42,748159	47,97729
c39	0,67471	36	32,30482	91,51508	7,405435	86,90756	114,056	107,61426	158,3061
c38	0,67372	37	-72,6617	0,189697	-9,02432	0,197861	48,43229	48,430065	48,36271
c42	0,66298	38	0,4827	-0,73303	-21,2914	-1,18535	50,85866	50,835081	50,92365
c2	0,66058	39	0,011484	-25,9816	-0,01854	-0,23635	51,38187	51,382695	51,39072
c35	0,65178	40	0,846189	-0,80136	0,021931	-0,72682	53,45103	139,95829	53,56498
c15	0,63435	41	-0,0607	-35,0035	-0,11401	-0,41438	57,64244	-175,18682	57,61429
c50	0,63307	42	-34,7835	-39,4674	-0,26621	-1,10527	57,96306	-342,24458	57,9625
c36	0,61758	43	-0,33734	-0,7399	-0,26041	-1,08174	61,92537	61,922484	61,96583
c4	0,5897	44	-20,579	-0,68641	-0,29966	-9,04072	69,56753	69,577214	69,73077
c20	0,56522	45	-16,944	-35,1232	-0,2552	-20,5346	76,92647	76,925398	76,92668
c44	0,55292	46	-0,69409	-0,73059	-9,36694	-1,15476	80,85576	80,859456	80,85352
c23	0,53003	47	-27,0215	-41,4269	-0,27757	-35,6571	88,67136	88,67001	115,213
c22	0,48572	48	-0,29823	-8,02277	-0,1234	-0,22915	105,8767	105,87974	105,9659
c8	0,4745	49	0,010634	-37,8804	-0,12056	-16,5504	110,7492	110,74834	110,8092
c16	0,46701	50	0,57147	-51,7425	0,046616	-2,97916	114,1076	-6,6401076	114,4571
c19	0,42977	51	-17,4473	-28,6732	-0,15698	-0,81437	132,6929	132,68473	132,6034

percentage decrease of 47.8%. On the other hand, there is a need for increase in public schools provided in some prefectures like Thesproteias (C17, THP), Prevezas (C39, PRE) and Attikis (C37, ATT) by 8%, 7.4% and 5.4% respectively.

In the case of public busses (NPB) reductions in their number is recommended for the inefficient prefectures in order to become efficient. For instance, the prefectures of Kerkira (C23, KER), Attiki (C37, ATT) and Thesproteias (C17, THP) the decrease is coming up to 35%, 39.94% and 60.48% respectively. Exceptions are Fokida (C48, FOK), Pierias (C38, PIE) and Prebeza (C39, PRE) where an increase in the provision of public busses by 0.62%, 0.19% and 86.9% is recommended.

Furthermore, in the case of GDP for all the inefficient prefectures an increase in their current levels is required in order to become efficient. The smallest increase of 0.85%, 2.89%, and 2.92% is suggested for Korinthia (C26, KOR), Messinias (C34, MES) and Evias (C11, EVI) respectively. Similarly, the greatest increase of 114.1%, 132.6% and 926.14% is noticed in Irakleiou (C16, HRA), Ioanninon (C19, IOA) and Kilkis (C25, KIL) respectively.

Moreover, observing the difference between urban and rural population, we notice that there is a tendency towards an increased gap due to the increase in the rural population. An increase in the difference of urban and rural population is suggested for the prefectures of Ioanninon (C19, IOA), Dramas (C8, DRA) and Kastorias (C22, KAS) by 132.6%, 110% and 105% respectively. But, the largest decreases are required for the prefectures of Xiou (C51, HIO), Imathias (C15, HMA) and Xanion (C50, HAN), by 451%, 175.1% and 342.2% respectively.

Lastly, for the inefficient prefectures it is suggested that they must enhance their policies of creation of new houses in all cases. The greatest increase is suggested for the prefectures of Ioanninon (C19, IOA), Irakleiou (C16, HRA) and Prebezas (C39, PRE) by 132.6%, 114.4% and 158.3% respectively. The smallest increase is suggested for the prefectures of Keffalonias (C24, KEF), Evias (C11, EVI) and Messinias (C34, MES) by 3.4%, 2.9% and 2.8% respectively.

6. Conclusions and Policy Implications

In this study, performing an application of DEA to the Greek prefectures, we obtained, among others, the efficiency scores and the optimal ratios levels for inefficient prefectures for the last three decades. In the case of the Greek prefectures the quality of life is strongly associated with the regional development of the particular prefectures. The efficient prefectures seem to have definite and strong characteristics. According to our empirical analysis

- It is clearly defined that two are the factors, which characterize and distinguish the efficient prefectures from the inefficient ones. Namely, the efficient use of resources (in our case NHO, NDO, NPB, NNH) and the high rates of GDP.
- The quantity of the resources of a prefecture doesn't necessarily ensure the efficiency of this prefecture. 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 living standards 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.

Over the last three decades, millions of € have been spend from the Greek governments in order to enhance the economically underdeveloped prefectures. However, capital spillovers have been observed through internal trade between the efficient prefectures and the inefficient ones. At the same time, internal competition among the Greek prefectures, in order to attract as many funds from the Greek governments as possible, has been created. More specifically, in Fig. 1(b, c, d) the development of the Greek prefectures through the three decades is graphically presented.

Clearly we can define the efficient prefectures over the three decades. In the case of Attiki (C37, ATT), we observe that it has been efficient and developed over the three decades. But spillovers through trade have been also observed in the case of Boiotias (C6, BOI), which is geographically located next to the capital of Greece. The cooperation between the two prefectures over the decades has been the reason of efficiency in the case of the prefecture of Boiotias. However, this cooperation has created a competition with the other prefectures around the capital of Greece (Attiki). For instance, the prefectures of Evias (C11, EVI), Korinthias (C26, KOR), Argolidas, (C2, ARG), Fdiotidas (C46, FTH) and Fokidas (C48, FOK), have been inefficient over the three decades even though they are near (geographically) to the Greek capital. Similarly, in Northern Greece, the prefectures of Halkidikis (C49, HAL), and Serron (C43, SER) have been efficient over the decades whereas, their neighbors' prefectures of Dramas (C8, DRA), Kavalas (C20, KAV), Kilkis (C25, KIL), Pellas (C36, PEL), Imathias (C15, HMA) and Pierias (C38, PIE) have been inefficient and underdeveloped over the three decades.

Resource allocation through different policies has been the cause of underdevelopment of the Greek islands, although in the last decade an attempt from policy makers to distribute the resources (funds, capital mainly from EU) to the islands and to inefficient prefectures over the years can be seen. That is the case for the islands of Kikladon (C27,KYK), Xiou (C51, HIO), Lesvou (C31, LES) and the prefecture of Evrou in the mainland (C10, EVR).

All the above findings imply that the Greek policy makers must find those policies that stimulate better and more efficient resource allocation for more effective public provision services. However our intension was to use DEA as a benchmarking tool in identifying the efficient Greek prefectures in terms of living standards and regional development, but in all cases the results should be viewed as indicative rather than definitive of the Greek State's regional and social development policy. The results would thus be strengthened by a more thorough investigation taking into account more factors affecting the social and economic environment of Greece.

ENDNOTES

1. It is usually assumed that the relationship between the variables is linear.

2. The indicators used are pollution density, non-agricultural population as percentage of total population, urban planned area as a percentage of total area, commercial area as a percentage of total area, average current household income, local government expenditure per capita, number of local telephone subscribers per 100 people, piped water supply of population served, number of physicians per 10000 residents, copies of newspaper and magazines sold per 1000 people and the percentage of population over the age of 15 with education of high school or higher.

3. Relying on the exciting literature we have used these ratios as far as they are representative of Health, Education, Living Standards, Economic and Regional Development. Due to high correlation coefficients among the 19 initial selected variables we ended up to the final four input and three output ratios used. The excluded ratios from our analysis were: number of cars, hotel beds, telephone lines, dentists, drugstores, space m^3 of new houses, usage of electricity (all per 1000 citizens), number of academic staff per 1000 students, numbers of primary, high school and lyceum students (all per teacher), percentage of employment and births per citizen.

4. If a prefecture wishes to improve its score it would be best to concentrate on those outputs with the highest weight, as the efficiency score is most sensitive to those outputs.

5. Results on VRS are not presented here but are available to the readers on request.

6. For simplicity, these weights are not presented but are available to the readers on request.

7. These are the prefecture and map codes (see table 1)

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