How far are Portuguese prisons inefficient? A non-parametric approach

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Abstract

In Portugal, as worldwide, especially in the past decades, crime has become an issue of increasing interest both for society and researchers. The global growth of criminality had several repercussions in the prison system. The most direct one was the overcrowding of prisons. This situation required a great amount of investment to increase the capacity of Portuguese prisons. Simultaneously, the value for money associated with the prisons' budget has turned itself more and more relevant. These circumstances together emphasize the importance of assessing the prisons' performance. This study measures the efficiency of Portuguese prison facilities by means of the non-parametric benchmarking approach of data envelopment analysis (DEA). However, due to the limitations of this technique, a bootstrap methodology is also applied in order to add more robustness to the results. Furthermore, a recent procedure is computed to evaluate congestion. The results show relevant levels of inefficiency in the Portuguese prison facilities, which represent an excess of several millions of Euros spent inadequately in this sector.

Keywords: Bootstrap; Congestion; DEA; Efficiency; Portugal; Prison facilities

1. INTRODUCTION

European countries, mainly since the mid 1990's, have faced a "threatening" growth of criminality, which have lead to a significant expansion of the prison population. According to Balassone et al. (2008) and based on Walmsley (1999 and 2007), the value estimated for prison inmates rise in Europe was about 17% for the period between 1997 and 2006.

In global terms, the Portuguese situation corroborates the European picture. Although not so markedly (between 1998 and 2003 criminality rose of 10% and after 2003 there was a slight decrease, as shown in figure 1 (INE, 2008). However, this only happened as a result of changes in the criminal law.

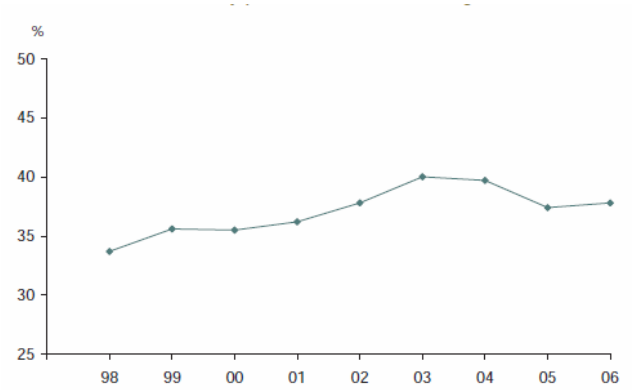

Figure 1 - Crime rate recorded by police authorities in Portugal

Many are the reasons pointed out by governors and researchers, among other stakeholders, to explain the global growth in criminality (Saridakis, 2004). In this sense, criminologists draw a distinction between 'deterministic' and 'policy-driven' explanations (Balassone et al., 2008). The former focus on issues related to the variations in the crime rate, demographic changes and social and economic determinants, including child poverty, family breakdown, poor education and unemployment. The "policy-driven" explanations consider the increase of prison inmates as a combination of changes in public attitudes towards imprisonment and more rigorous legislation, resulting in longer and severe sentences, although there is no evidence that these instruments are more effective in reducing crime.

Like in other European countries, in order to deal with the growth of prison population (Walmsley, 2001), the Portuguese Government decided to build more prisons, boosting the capacity but, even so, not avoiding the inmates overcrowding in some particular cases (DGSP, 2009). Beyond the huge investments that were inherently associated, the simultaneous increase of the operational costs nowadays represents an important share in the State budget (Pratt and Maahs, 1999).

All these circumstances, coming up together, transformed this sector into a significant issue for the Portuguese Government, pointing out the importance and the usefulness of measuring the performance of the Portuguese prison facilities (Gaes et al., 2004). Besides identifying the benchmarks in the sector, this kind of analysis can instigate

(fundamentally) the (inefficient) prisons to become more efficient, which is of great relevance concerning all the (monetary) resources involved in this sector (Avio, 1998). One of the most successful methodologies of performance evaluation consists in the application of the non-parametric benchmarking technique of data envelopment analysis (DEA). This methodology, being a mathematical programming technique, develops an (efficient) frontier to which each prison is compared, obtaining from that comparison its relative efficiency. It has the advantage of letting data "speak by itself" because unlike parametric techniques, such as stochastic frontier analysis, it does not rely on any specific functional form. Moreover, DEA deals easily with multiple inputs and outputs, points out the targets for each variable and allows for the identification of a group of efficient organizations (prisons in this case) to each inefficient organization with a similar combination of inputs and outputs.

The main contributions of this paper are threefold. The first one is related to the performance evaluation of prison facilities itself since so few examples appear in the literature. The second contribution concerns the application of recent non-parametric techniques regarding the efficiency measurement and the evaluation of the congestion phenomenon, respectively the bootstrap and Tone and Sahoo approaches. And, finally, this study might be useful for the Portuguese prison sector to improve its performance as well as for other countries worldwide. After this brief introduction, the paper reviewed the major studies on performance evaluation of prisons found in the literature. Next, the prison system in Portugal is characterized followed by the description of the methodologies adopted and the presentation of the results of their application. Afterwards, the results are discussed and analyzed. The study ends with the most important conclusions.

2. PERFORMANCE EVALUATION LITERATURE REVIEW

The literature on performance evaluation is not very abundant. Without taking into account partial productivity methods, like performance indicators, the number of performance studies is scarce. We only found seven studies, five in academic journals, one as a book chapter and the other as a working paper.

In terms of the techniques adopted, the study of prison's performance diverges evenly between the utilisation of parametric and non-parametric approaches. Until now, three studies (Trumbull and Witte, 1981, Panci, 1999, Gyimah-Brembong, 2000 and Balassone et al., 2008) were developed applying parametric methods. Trumbull and Witte (1981) estimated a cost function for a sample of 6 federal correctional institutions in the US between 1976 and 1978. Panci (1999) estimated both a production and a cost function for a sample of 107 Italian prisons in 1996. Both studies followed a simple regression approach (Feldstein, 1967) and do not report estimates of an efficiency frontier. In addition, Panci (1999) presented some indicators for individual prisons comparing them with an efficient frontier.

Gyimah-Brembong (2000), adopting a cost function approach, evaluated the performance of prisons in Florida for the year 1997/98. In addition, the author encompasses in this analysis the treatment of the operational environment through

variables as the health care personnel per inmate, the age of the prison and the ratio of black inmates. Like in other studies, relevant signs of inefficiency were found.

More recently, Balassone et al. (2008) analyzed an unbalanced panel of 142 Italian penitentiaries for the time period 2003-2005. Using a stochastic cost frontier analysis, they determined significant technical inefficiency levels, mainly attributable to overstaffing. The chief source of inefficiency is identified in unexploited economies of scale. Both average prison size and technical efficiency are smaller in the South of Italy than in the rest of the country. All studies found out significant economies of scale in their samples.

Regarding the non-parametric approaches, only Ganley and Cubbin (1992), Butler and Johnson (1997) and Nyhan (2002), in some way, evaluated the performance of prison facilities. All of them applied the DEA model. Ganley and Cubbin (1992) estimated the technical efficiency of 33 UK local prisons and remand centres for the financial year 1984/85. They determined an average technical inefficiency equal to 0.88 (assuming variable returns to scale). The chief cause of inefficiency was associated with the excess of staff.

Butler and Johnson (1997) developed their study not only to demonstrate the usefulness of DEA in evaluating the performance of justice administration, but also to measure the efficiency of 22 Michigan Prisons with 1992 data. That application was used to see which prisons were inefficient, providing some insights into the service supplied and identifying targets for performance levels.

The studies of Ganley and Cubbin (1992) and Butler and Johnson (1997) use similar output considerations, diverging by the number of prisoner days in a year in Ganley and Cubbin (1992) and the yearly number of prisoners confined per facility in Butler and Johnson (1997). The major differences between them regard the inputs, whereas Ganley and Cubbin (1992) only used expenditure data as proxies for inputs, separating labour expenses from other costs, Butler and Johnson (1997) employed direct measures of the quantity of inputs (number of staff and number of beds) together with the total expenditure.

Finally, Nyhan (2002) used DEA to evaluate de performance of 35 juvenile justice facilities in the state of Florida in US. In addition to the determination of the efficient facilities and the estimation of targets for the inefficient ones, the authors promoted a comparison between the state-operated and privately contracted facilities. Privately contracted facilities show a slightly superior performance when compared with the state-operated ones.

3. PORTUGUESE PRISON SYSTEM

3.1 Institutional framework

The Portuguese prison facilities are under the supervision of the Directorate General of Prison Services (DGSP), which constitutes an auxiliary body of the judiciary

administration (part of the Ministry of Justice). Although DGSP has administrative autonomy, it stays under the State's direct administration, following the organic law of DGSP stated in Law no. 125 of 2007.

The DGSP has the task of managing the prison system (guiding services of arrestment and execution of punishments; supervise the prison's organization and operation), ensuring life conditions compatible with human dignity and contributing to the public order and social peace through the maintenance of community safety and creating conditions for social reintegration of inmates, allowing them to lead their life in a socially responsible way. Moreover, DGSP has also the attribution of conducting studies and investigations regarding the treatment of offenders.

Under the management of the DGSP, the Portuguese prisons are distinguished according to three different classifications, such as security level, internal organisation and availability of services and facilities (Eiras, 2007). These classifications are presented in table 1.

Table 1 – Classification of the Portuguese prisons

Internal Organisation	Security*	Services and facilities
Central	Maximum	Medical services
Special	Closed	Vocational training
Regional	Open	Labour occupation
	Mixed	Education
		Sport and socio-cultural activities

* The classification of establishments' security is the responsibility of the Minister of Justice, upon proposal of the Director-General;

The prison facilities are designed to take prisoners into custody and execute the punishments complying with all security measures. In Portugal, there were 50 prisons in 2008, divided in 17 Central prisons, 4 Special prisons and 29 Regional prisons. Their classification depends on the length of the inmates' sentence. The Central prison's responsibilities comply with custodial measures longer than 6 months; while the Special prison's attribution relies on internment of inmates in need of special care, that is, young adults up to 25 years, women and sick inmates, the latter integrated in prison hospitals. Finally, the Regional prisons deal with preventive or inmates sentenced to terms not exceeding 6 months. Note that Regional prisons are financially dependent on the central services.

Figure 2 presents the geographical distribution of prisons facilities in the Portuguese territory (DGSP, 2009).

Given the geographical distribution of the judicial districts (according to the division of the courts in XIX century) and the prison facilities location (also largely a reflection of the past), each district court has the following distribution of prison facilities: i) Oporto: 14 prisons; ii) Coimbra: 11 prisons; iii) Évora: 10 prisons and iv) Lisbon: 15 prisons.

3.2 Prison service in numbers

In 2008, the prison facilities available had the capacity to deal with 12,294 prison inmates. This means that, unlike before 2006, in global terms, the inmates overcrowding was no longer observed, as it is demonstrated in figure 3 (based on INE, 2008). The population in Portugal in that year was about 10.7 million. The decrease of inmate population since 2005 cannot be explained by a reduction of criminality but due to a reform in penal law, e.g. with the implementation of domiciliary detentions.

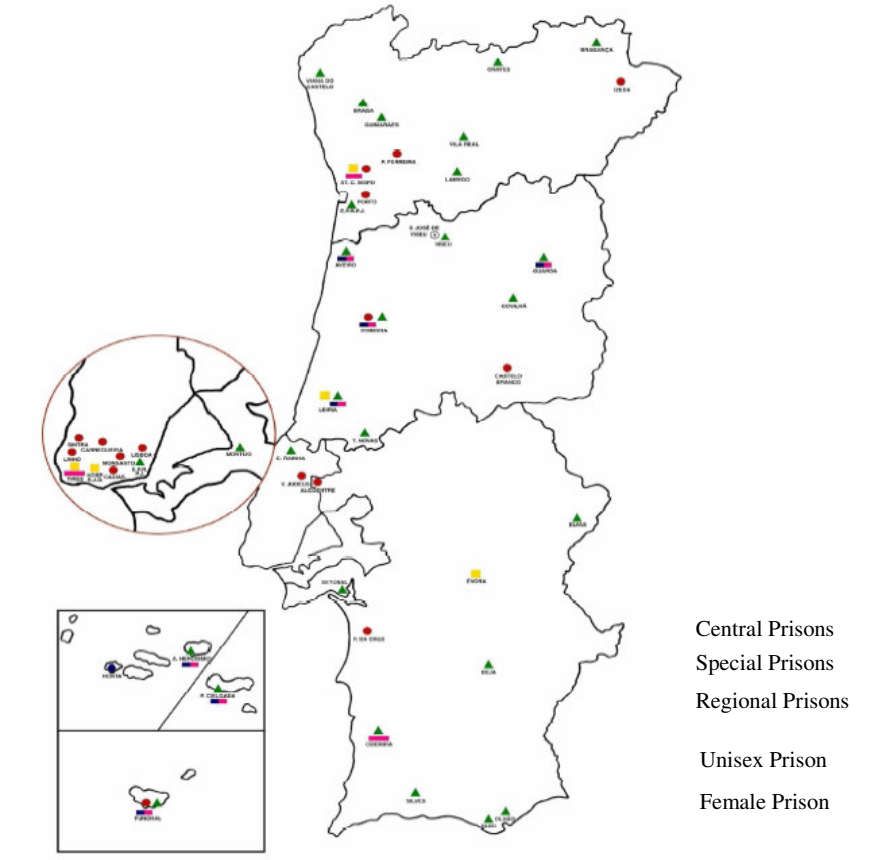

Figure 2 – Geographic distribution of Portuguese prison facilities

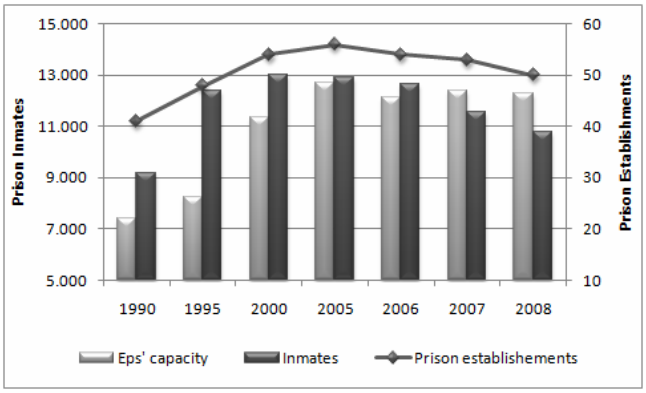

Figure 3 – Number of prison inmates and establishments and their capacity

Regarding the female inmate population, there was a slight reduction in quantity terms. Indeed, the volume of women inmates, which was stable at 7% since 2003, in 2008, decreased to 6%.

As far as foreigners are concerned, nowadays they represent 20.3% of the inmate's population (DGSP, 2009). Notice that foreign inmates have grown gradually. In particular, since 2001 until the end of 2008, they increased 8.4%. Regarding their origins by continent, Africa with 57.6%, particularly the Portuguese-speaking African countries, is in the first place, followed by Europe (23.7%), particularly those of Spanish, Romanian and Ukrainian origins. Finally, South America (17.4%) comes third, where the natives of Brazil and Venezuela surpass all other nationalities.

In global terms, the prison population has low educational levels. This is expressed by the fact that more than 10% of the inmates have no schooling at all and 60% of the remainder inmates only have the lower levels of basic education (DGSP, 2009).

Questions related to deaths and security in Portuguese prisons have been a matter of struggle by the Authorities in charge. As a result, there was a reduction in the number of deaths and escape attempts by inmates. The number of deaths (68 for 2008) decreased year after year since 2003 and remained always below one hundred. It is worth taking into account the health conditions that the majority of inmates show where they enter the prison facility, the morbidity of the diseases involved and the volume of people who are reported (considering the prison population incoming and outgoing each year). This circumstance reflects a great effort that the prison services have made in improving medical care and assistance to the prison population.

3.3 Performance assessment and accountability

In 2008, the Portuguese Government reformed the Public Administration and, among other aspects, compelled public services to (self) evaluate their performance. This plan, the Assessment Framework and Accountability (QUAR), has the goal of not only identifying the best practices in the sector and instigating the prison service to become more efficient, but also of creating a tool capable of inducing responsibility in their managers. In this regard, DGSP defined five main objectives for the Justice area in Portugal, namely:

1. Optimizing the main mission of DGSP;
2. Improving the functioning of the prison and simplifying the procedures;
3. Upgrading and enhancing the human resources;
4. Modernizing the material and technological resources;
5. Reforming the prison park.

In this sense, the Portuguese prisons, to achieve the strategic objectives mentioned above, have drawn 6 operational objectives, diverging, however, in the number of the performance indicators (encompassing the different domains of effectiveness, efficiency and quality). Those performance indicators are presented in Table 2.

Table 2 – Objectives and performance indicators adopted for Portuguese prisons

Objective / Indicator	Target	Real value	Degree of fulfilment
Obj1. Increase by 10% the number of inspections and searches in prison facilities	102	123	121%
Obj2. Increasing occupancy rates and labour integration of inmates by 2.5%, in order to improve their social reintegration	355	366	101%
Obj3. Increase by 5% the rate of implementation of the Individual Rehabilitation Plan (PIR) to inmates condemned	25	42	126.9%
Obj4. Increase the occupancy rate in school activities / training of prison population by 2.5%, to enhance their personal and social skills	47	76	162%
Obj5. Reduction in 10% of the average time for completion of prisoners investigation	37	30	119%
Obj6. Reduce by 10% the average time of the goods purchasing process	9	6	133%

4. METHODOLOGY

4.1 DEA

The deterministic methodology of DEA is a non-parametric benchmarking technique that uses linear mathematical programming to construct an efficient frontier in order to assess the relative performance of organizational units (prison establishments in this case). As a non-parametric approach, instead of assuming a function to the production or cost frontier (as in parametric methods), the frontier is constituted by the best practices observed in the data set. Therefore, it does not need a prior specification for the weights of each input and output, neither does it require judgments on the production or cost function form. In the presence of an industry with multiple inputs and outputs, the technical efficiency of each operator is assessed by the distance that separates each one from the frontier, that is, by the potential savings obtained by reducing the inputs for the same level of outputs (input orientation) or, vice-versa, by the maximization of outputs for the same level of inputs consumed (output orientation).

The primary model, developed by Charnes, Cooper and Rhodes in 1978 (Charnes et al., 1978), is commonly known as CCR or CRS model, since it assumes constant returns to scale for the production (cost) technology. It can be formulated as a liner program, to which the relative efficiency of the organizations is obtained. For an input orientation, we have:

$$\min \theta_m \tag{1}$$

subject to:

$$\sum_{m=1}^{n} \lambda_m y_{km} - y_{km} \geq 0 \qquad i = 1, 2, ..., l$$

$$\theta_m x_{im} - \sum_{m=1}^{n} \lambda_m x_{im} \geq 0 \qquad k = 1, 2, ..., t$$

$$\lambda_m \geq 0 \qquad m = 1, 2, ..., n$$

Where, *m* is the index representative of each prison facility, θ is the value obtained for the technical efficiency, *x* and *y* correspond to (*l*) inputs and (*t*) outputs, respectively, and λ their associated weights.

Few years later, in the 80s, Banker et al. (1984) introduced the possibility of variable returns to scale (VRS), named BCC or VRS model, by adding to algorithm (1) an additional constraint $\sum \lambda = 1$. Gathering DEA-CCR and DEA-BCC models allows for the computation of scale economies which measure the influence of size on efficiency. Like this, the technical efficiency (TE, obtained from CCR model) can be decomposed into pure technical efficiency (PTE, attained by BCC model) and scale efficiency (SE).

4.2 Bootstrap

DEA is not a panacea for benchmarking, since both technical and practical limitations exist (Nyhan, 2002). Besides being extremely sensitive to outliers, DEA does not determine the relative differences among efficient prisons (Simar and Wilson, 1998). So, in order to mitigate some of those limitations and to confer robustness to the results, a DEA-bootstrap methodology, as proposed by Simar and Wilson (vide Fried et al., 2008), was applied.

In basic terms, the bootstrap consists in the replication of *B* times the traditional DEA with random data obtained from the real data. One will be determining, each time, a particular imaginary frontier that corresponds to a specific set of peers (which works as a benchmark for each prison), representing a particular level of non-observable or non-included variables.

4.3 Evaluation of the congestion phenomenon

The congestion phenomenon has been studied over time through the application of diverse techniques, namely Fare et al. (1985), Cooper et al. (1996) and Tone and Sahoo (2004) approaches (for more details about the different congestion approaches see Simões and Marques, 2009). Although there is divergence of perceptions between them about the best way to compute congestion, its definition remains untouchable, that is, "after a given value the increase in inputs can lead to a decrease in outputs or, vice-versa, a decrease in outputs can lead to an increase in inputs". We opted to apply in this research the most recent one, that is, Tone and Sahoo approach which *a priori*, has more advantages.

Tone and Sahoo approach, a new two-stage method, measures the phenomenon congestion using the slacks-based measure (SBM) in the second stage (Tone, 2001). The SBM formulation (in an output orientation) is given by:

$$\max \quad \frac{1}{t}\sum_{k=1}^{t}\frac{c_k^+}{y_{km}} + \varepsilon\frac{1}{l}\sum_{i=1}^{l}\frac{c_i^-}{x_{im}} \qquad (1)$$

Here c_k^+ and c_i^- correspond to the existence or not of congestion, respectively, and ε is an Archimedean value.

Tone and Sahoo approach distinguishes between strong and weak congestion. In a practical view, the former corresponds to the congestion of all inputs whereas the latter occurs when not all the inputs are congested. Other advantage of Tone and Sahoo approach is to establish a relationship between scale economies and congestion. The scale diseconomy (ρ) can be determined by the ratio between the change in y by the change in x. Therefore, it measures the potential increase in output from eliminating the congestion of inputs. However, this is true only for the case of existence of strong congestion ($\rho < 0$).

5. PERFORMANCE EVALUATION

5.1 Model specification and data

Considering the provision of prison services, since the unique objective is the minimization of the resources consumed (and obviously not the instigation of the criminality and consequently the number of prison inmates) for a quality pattern established (Aubyn, 2008), it induces the clear-cut idea of adopting an input orientation for the model. This research was carried out with a set of data from 47 Portuguese prison facilities relative to the year 2007. The data was obtained from DGSP annual reports and questioning people with high knowledge of the sector.

In line with the literature (Ganley and Cubbin, 1992, Butler and Johnson, 1997), the model specification encompass two outputs, respectively the number of inmates in Portuguese prisons and the number of inmates that had participated in training programmes (institutional programmes and/or labour occupation) and two inputs, that is, the number of staff (from administration functions to the prison guards) and the operational expenses of the prison establishment (being subtracted the costs corresponding to the prison staff). The basic statistics for each variable are given in Table 3.

Table 3 - Model statistics

	Mean	Str. Dev.	Median	Min.	Max.
INPUTS					
Operational Expenses (€)	737,968	713,015	354,651	185,759	3,306,000
Staff (no.)	114	83	69	33	337
OUTPUTS					
Inmates (no.)	258	253	137	32	988
Inmates in training programmes (no.)	161	153	103	11	687

5.2 DEA results

As referred to before, two models, CCR and BCC, were computed in order to evaluate the performance of the Portuguese prisons. Notice that the performance results obtained from CCR model correspond to the TE and the PTE is determined by the BCC model. The SE is determined by the ratio between TE and PTE. Table 4 displays the summary of the main results obtained for the Portuguese prison facilities.

Table 4 - Results for the Portuguese prison facilities

Type		Prison	CRS	VRS	SE
Central	1	Alcoentre	0.856	0.860	0.995
	2	Carregueira	0.790	0.793	0.997
	3	Caxias	0.141	0.306	0.461
	4	Coimbra	0.567	0.573	0.990
	5	Funchal	0.605	0.611	0.991
	6	Izeda	0.611	0.621	0.985
	7	Linhó	0.601	0.620	0.968
	8	Lisboa	0.686	0.694	0.989
	9	Monsanto	1.000	1.000	1.000
	10	Paços de Ferreira	0.177	0.298	0.594
	11	Pinheiro da Cruz	0.741	1.000	0.741
	12	Porto	0.943	0.945	0.998
	13	Santa Cruz do Bispo	0.881	1.000	0.881
	14	Santarém	0.664	1.000	0.664
	15	Sintra	0.167	0.569	0.293
	16	Vale de Judeus	1.000	1.000	1.000
Special	17	Leiria	0.864	0.870	0.994
	18	Santa Cruz do Bispo	0.560	0.575	0.973
	19	Tires	0.414	0.425	0.975
Regional	20	Angra do Heroísmo	1.000	1.000	1.000
	21	Aveiro	0.668	1.000	0.668
	22	Beja	0.529	0.698	0.758
	23	Braga	1.000	1.000	1.000
	24	Bragança	0.491	0.829	0.592
	25	Caldas da Rainha	0.673	0.923	0.729
	26	Castelo Branco	0.458	0.622	0.737
	27	Chaves	0.492	0.905	0.543
	28	Coimbra	0.710	0.770	0.922
	29	Covilhã	0.472	0.658	0.717
	30	Elvas	0.486	0.864	0.563
	31	Évora	0.390	0.731	0.534
	32	Faro	0.446	0.577	0.773
	33	Guarda	0.720	0.770	0.935
	34	Guimarães	0.574	0.814	0.705
	35	Lamego	0.494	0.817	0.605
	36	Leiria	0.794	0.859	0.924
	37	Montijo	0.451	0.532	0.849
	38	Odemira	0.752	1.000	0.752
	39	Ponta Delgada	0.967	1.000	0.967
	40	Setúbal	0.638	0.657	0.972
	41	Silves	0.669	0.880	0.761
	42	Torres Novas	0.536	1.000	0.536
	43	Viana do Castelo	0.464	0.798	0.582
	44	Vila Real	0.600	0.796	0.754
	45	Viseu	0.612	0.791	0.774
	46	PJ Lisboa	0.753	0.913	0.825
	47	PJ Porto	0.314	0.950	0.330
		Average	0.626	0.785	0.794
		Standard Deviation	0.229	0.199	0.194
		Median	0.605	0.793	0.881
		Minimum	0.141	0.298	0.293
		Maximum	1.000	1.000	1.000

The inefficiency levels of Portuguese prisons for the year 2007 were meaningful. The average TE value was 0.626. In Portugal, the prison facilities show average potential

savings of TE of about 37%. This means that, on average, each prison could reduce the inputs consumed by 37%, i.e., they could reduce their number of employees and expenses in the percentage referred to by dealing with the same number of inmates and training programmes. It would correspond to a saving of about 12 million of euros in that year and an average reduction of about 1,650 employees.

5.3 Analysis of results

5.3.1 DEA

The DEA results have shown that the prisons of Monsanto, Vale de Judeus, Angra do Heroísmo and Braga are the most efficient ones, in opposition to the prisons of Caxias, Paços de Ferreira and Sintra which are remarked for being the most inefficient ones.

Only considering the scale effect, if prisons could operate at an optimal scale, it would represent a reduction of input consumption of about 20%. From the 47 prison establishments, 38 of them present increasing returns to scale, 5 decreasing returns to scale and 4 CRS.

When the DEA results are disaggregated according to the organisation level of the Portuguese prisons, such as Central Prisons, Regional Prisons and Special Prisons, the Regional ones stand out as the most efficient and, as expected, the Special prisons as the less efficient ones. This can be observed in Figure 4.

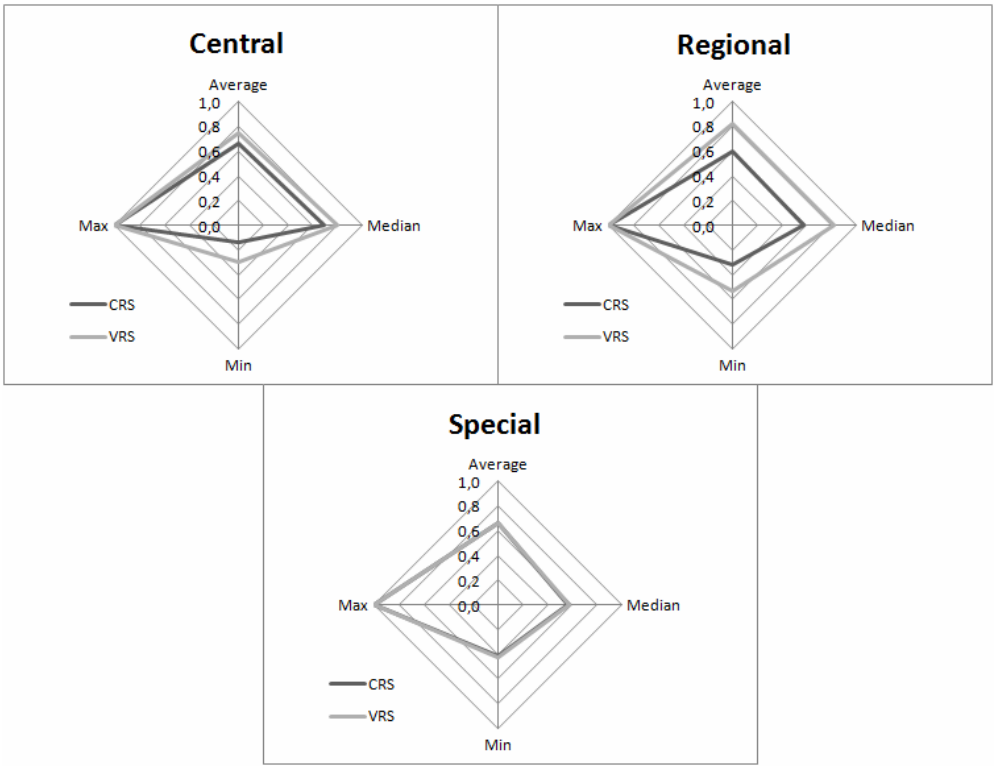

Figure 4 – CRS and VRS efficiencies for Central, Regional and Special prisons

Different types of analysis can be drawn from these results. For instance, the better results of the Regional prisons can be explained through their less complex service, that is, the most dangerous inmates are sent to the central prisons, and, the most particular and troublesome cases, to the Special prisons. This, inevitably, could mean that the Central and, particularly, the Special prisons require more resources. However, if the scale effect is considered (by means of CRS model) there is some balance between the savings originated in a more optimal scale and the increasing of costs due to the great intricacy of the prisons.

5.3.2 Bootstrap

The results obtained from the application of the DEA-bootstrap-VRS model are displayed in Figure 5. A 95% confidence level interval and a *B* of 2000 were adopted.

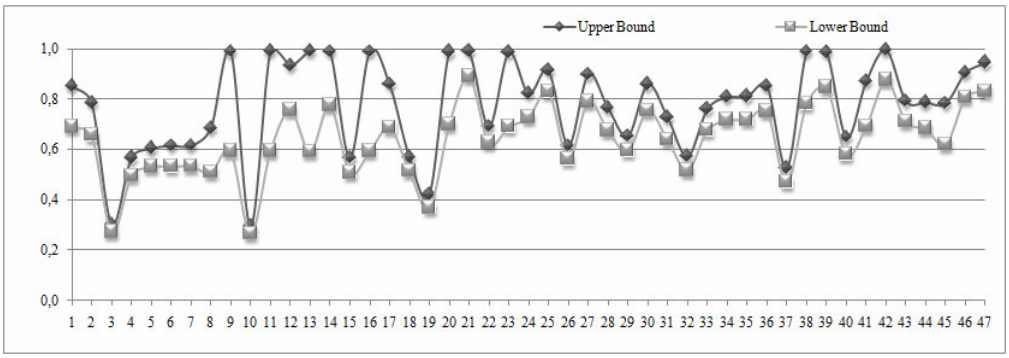

Figure 5 – DEA-bootstrap-VRS model results

The results revealed inefficiency levels higher than the ones obtained by the DEA model. The prisons are, on average, about 29% per cent inefficient using the DEA-bootstrap-VRS model (about 41% in DEA-CRS model). Nevertheless, it should be noticed that the extreme values (best and worst practices) in the Portuguese prisons are generally the same.

5.3.3 Congestion

The congestion results obtained from Tone and Sahoo approach are presented in Figure 6, embracing both the values of congestion and scale diseconomies per prison facility.

It shows signs of congestion for Portuguese prisons ranging between 3.2% (considering all the prisons) and 5.6% (only for the congested ones). As can be observed, 27 prisons revealed congestion inefficiencies, such as the prisons of Alcoentre, Carregueira, Castelo Branco, Caxias, Coimbra, Funchal, Izeda, Linhó, Monsanto, Pinheiro da Cruz, Santarém, Vale de Judeus, Leiria, Santa Cruz do Bispo, Aveiro, Bragança, Caldas da Rainha, Coimbra, Covilhã, Faro, Guarda, Lamego, Leiria, Montijo, Setúbal, Vila Real and Viseu.

In addition, as abovementioned, the Tone and Sahoo approach also enables us to evaluate scale diseconomies, via parameter ρ. In practical terms, it means that if a

decrease of 1% exists in congested inputs, the outputs production has, on average, a potential improvement of about 1.6% (in this case).

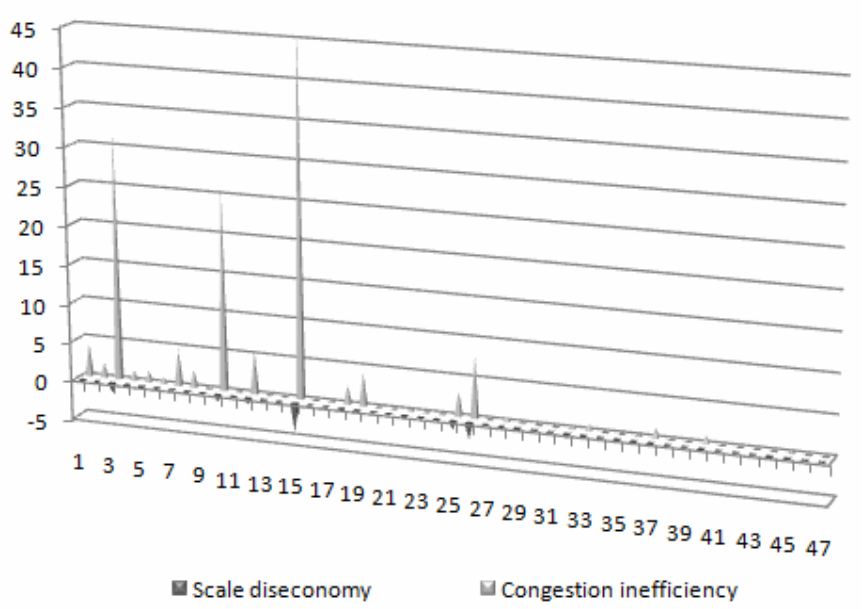

Figure 6 – Congestion inefficiencies and scale diseconomies

Corroborating the results obtained by DEA, we observe higher levels of congestion in Central and in Special prisons, which is directly related to the excess of resources in their organisational structure. Figure 7 shows the congestion inefficiency level per organization type of prisons.

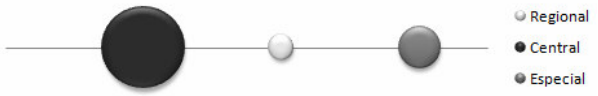

Figure 7 - Congestion inefficiency level per organization type of prisons

These results were as expected, since it would be predictable that the major prisons with higher complexity and more managerial difficulties would have the most intense signs of congestion.

6. CONCLUDING REMARKS

The accomplishment of this study proves once again the importance that benchmarking, in general, and the application of these models, in particular, might have to help the managers to make decisions. Prison officials and state administrators can use the information obtained by DEA to improve the allocation of resources among the prison facilities and their utilization, especially since we are dealing with public money. As prison facilities represent public entities extremely costly to the State, the promotion of efficiency and innovation principles in their administration is essential.

In recent years, the prison sector has gone through some reforms which have increased the interest and importance of this kind of studies in Portugal, trying to determine the best way of providing this service. This research evaluated the performance of 47 Portuguese prisons through the non-parametric frontier method of DEA, pointing out significant levels of inefficiency.

For example, using CRS and VRS models we estimated an average level of 37% and 21% of inefficiency for the Portuguese prisons, respectively. Besides, if prisons operated at an optimal size, they would be able to save about 20% of their costs (inputs consumed) for the same quantity of outputs produced. In addition, on average, prison facilities showed increasing returns to scale.

In particular, if the scale effect is eliminated (applying the VRS model) as it would be expected *a priori*, Regional prisons revealed better performances when compared with the Special and Central prisons. This might be explained by the fact that these facilities deal with less troublesome cases, since the more complicated ones are transferred to the Central and Special prisons.

Another objective of this paper was to find out the influence of the congestion phenomenon in the prison efficiency. To fulfil it, we computed the recent TS approach. This approach highlighted signs of congestion of 3.2% and 5.6% when the whole set of Portuguese prison facilities is considered and when only the sample of the congested ones are taken into account, respectively.

According to this approach, 27 Portuguese prisons show signs of congestion. Therefore, for these prisons, the results should constitute an alert regarding the expansion of their services. Although more research is required, especially in the presence of congestion signs, when technical inefficiency is computed, there are consequences that cannot be disregarded.

The application of benchmarking in prisons may be used by the managers to establish budget targets, avoid personal excess, provide a basis for contract renewal or termination, and assist in developing strategies for improving the performance of inefficient providers. Rankings as outcomes of benchmarking exercises may also be very useful for this purpose. Policy makers will need improved analytic tools to enhance decision making, where DEA and other new robust methods might have an important role addressing this need, providing managers with means to reveal the efficiency of existing programs, to highlight their need for greater resources, or to justify downsizing strategies.

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REFERENCES

Aubyn, M. (2008). Law and order efficiency measurement – A literature review. *Working paper* no. 19, School of Economics and Management, Technical University of Lisbon, Portugal.

Avio, K. (1998). The economics of prisons. *European Journal of Law and Economics*, 6(2), 143-175.

Balassone, F., Camilletti, M., Grembi, V., Zanardi, A. (2008). Evaluating the efficiency of the Italian penitentiary system. *Working Paper* no. 136, Econpubblica, Centre for Research on the Public Sector, Comercial University Luigi Bocconi.

Banker, R., Charnes, A., Cooper, W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, 30(9), 1078-1092.

Butler, T., Johnson, W. (1997). Efficiency evaluation of Michigan prisons using data envelopment analysis. *Criminal Justice Review*, 22(1), 1-15.

Charnes, A., Cooper, W., Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2(6), 429-444.

Cooper, W., Thompson, R., Thrall, R. (1996). Introduction: extensions and new developments in DEA. *Annals of Operational Research*, 66(1), 3-45.

DGSP (2009) *Relatório de actividades de 2008*. Direcção Geral de Serviços Prisionais, Portugal.

Eiras, B. (2007). Uma janela para o mundo: bibliotecas e bibliotecários em meio prisional. In *9º Congress of Librarians Archivists and Documents*, 28-30 March, Portugal.

Färe, R., Grosskopf, S., Lovell, C. (1985). *The measurement of efficiency of production*. Kluwer-Nijhoff, Boston.

Feldstein, M. (1967). *Economic analysis for health service efficiency: Econometric studies of the British National Health Service*. North-Holland: Amsterdam.

Flegg, A., Allen, D. (2009). Congestion in the new British universities: a further analysis. *Journal of Operational Research and Society of Japan*, 52(2), 186-203.

Fried, H., Lovell, C., Schmidt, S. (2008). *The measurement of productive efficiency and productivity change*. Oxford University Press, New York.

Gaes, G., Camp, S., Nelson, J., Saylor, W. (2004). *Measuring prison performance: Government privatization and accountability*. AltaMira Press, California, USA.

Ganley, J., Cubbin, J. (1992). *Public sector efficiency measurement. applications of data envelopment analysis*. London: North Holland.

Gyimah-Brembong, K. (2000). Cost efficiency in Florida prisons. In J. Blank (Ed.) *Public Provision and Performance*, North-Holland, Amsterdam, 221-246.

INE (2008). *Statistical yearbook of Portugal 2007*. Statistics Portugal (INE), Lisbon, Portugal.

Nyhan, R (2002). Benchmarking tools: an application to juvenile justice facility performance. *The Prison Journal*, 82(4), 423-439.

Panci, A. (1999). E*fficienza dell'amministrazione penitenziaria: Parte I. Ministero del Tesoro, del Bilancio e della Programmazione Economica*. Commissione Tecnica per la Spesa Pubblica.

Pratt, T., Maahs, J. (1999). Are private prisons more cost-effective than public-prisons? A meta-analysis of evaluation research studies. *Crime & Delinquency*, 45(3), 358-371.

Saridakis, G. (2004). Violent crime in the United States of America: A time-series analysis between 1960–2000. *European Journal of Law and Economics*, 18(2), 203–221.

Simar, L., Wilson, P. (1998). Sensitivity analysis of efficiency scores. How to bootstrap in nonparametric models. *Management Science*, 44(1), 46-61.

Simões, P., Marques, R. (2009). Influence of congestion efficiency on the European seaports performance: Does It matter? *Transport Reviews* (forthcoming).

Tone, K. (2001). A slacks-based measure of efficiency in data envelopment analysis. *European Journal of Operational Research*, 130(3), 498-509.

Tone, K., Sahoo, B. (2004). Degree of scale economies and congestion: A unified DEA approach. *European Journal of Operational Research*, 158(1), 755-772.

Trumbull, W., Witte, A. (1981). Determinants of the costs of operating large-scale prisons with implications for the costs of correctional standards. *Law & Society Review*, 16(1), 115-137.

Walmsley, R. (1999). *Word prison population list*. Kings College, London.

Walmsley, R. (2001). World prison population: facts, trends and solutions. *United Nations Paper* no.15, HEUNI - European Institute for Crime Prevention and Control.

Walmsley, R. (2007). *Word prison population list*. Kings College, London.