EFFICIENCY ESTIMATES FOR JUDICIAL SERVICES IN BRAZIL: NONPARAMETRIC FDH (*FREE DISPOSAL HULL*) AND THE EXPECTED ORDER-*M* EFFICIENCY SCORES FOR RIO GRANDE DO SUL COURTS´

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RESUMO

Este artigo se propõe a estimar índices de eficiência para as Comarcas da Justiça de Primeiro Grau do Estado do Rio Grande do Sul. Para isto, analisamos a relação entre os insumos (trabalho e estoque de processos) e produtos (casos julgados) mediante a construção de fronteiras de eficiência não-paramétricas. Duas metodologias são aplicadas para estimá-las: FDH (Free Disposal Hull) e a Eficiência Esperada de Ordem-*m*. Os resultados permitem algumas considerações sobre a eficiência administrativa das Comarcas. A fronteira de ordem-*m* oferece resultados mais robustos, já que contorna a "maldição" da dimensionalidade que afeta os métodos não-paramétricos. A perda de eficiência ocorre particularmente nas menores comarcas, o que pode ser explicado pela ausência de trabalho especializado, encontrado nas comarcas maiores, sugerindo a presença de economias de escala. Os dois métodos sustentam estes resultados. Calcula-se, ao final, a redução possível no estoque de processos, para as comarcas ineficientes.
Palavras-chaves: Eficiência Esperada de Ordem-*m*; Free Disposal Hull; Fronteiras Não Paramétricas; Bens Públicos Locais; Sistema Judiciário.

ABSTRACT

In this paper we have attempted to appraise, quantitatively, the efficiency levels of the justice courts in Rio Grande do Sul. For that purpose, we analyzed the relationship between output and inputs by constructing nonparametric efficiency frontiers.Two different techniques of efficiency analysis were used to determine this frontier: the FDH approach and the order-*m* frontier. Our results provided useful insights into the assessment of the administrative efficiency of courts. The expected order-m frontier produces more reliable results as it is not affected by the curse of dimensionality as is the case of most nonparametric measurements. We show also that efficiency losses are particularly important for small courts, thus suggesting the presence of economies of scale. Due to their size, smaller courts do not explore the economies of scale in the production of justice services. They tend to use relatively more resources, as they do not benefit from the specialization, found out in larger courts. This can be inferred by the estimated substantial reducible backlog that characterizes those courts. This is a quite robust result, supported by both methodologies.
Key Words: Order-m Expected Efficiency, Free Disposal Hull; Nonparametric Frontiers; Local Public Services; Judicial Service.
JEL Classification: C5, C6, H4, H7.

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1. INTRODUCTION

Recent studies on development economics claim that the set up of a sound institutional framework contributes to promote and enhance economic prosperity. Here, the judicial and legal systems, vital for enforcing rules and guaranteeing contracts, are crucial determinants for effective economic governance. Several studies show a strong correlation between the rule of law with economic growth and investment as well as democratic governance[1].

In Brazil, judicial reform is one of the main priorities of the latest governments as this reform is seen as an important component of the "second-generation' economic reforms. Among the different issues raised by the judicial and legal reform, the need to increase administrative efficiency of the judiciary is almost consensual. The inefficiency of the judicial system, characterized by sluggishness and high costs, constitutes a major restriction to the modernization of the Brazilian state and economic development. The quest for a more rational use of public funds by increasing productivity of the judicial area is thus becoming a major concern. Indeed, like other public agencies, judicial services – courts decisions - must compete for scarce resources. Hence, it is necessary to establish efficiency criteria that could be used to evaluate justice agencies in general and courts in particular.

A few studies have addressed this issue, using nonparametric efficiency measures. This approach is particularly suited to analyze not-for-profit public sector organizations for several reasons: it produces a single aggregate measures of the relative efficiency of courts, is able to tackle with multiples inputs and outputs, it is independent from a set of a priori weights or prices for inputs and/outputs and can handle external factors outside the control of the unit being evaluated. Lewin, Morey and Cook (1982) applied DEA - Data Envelopment Analysis[2] to compute the efficiency of courts, launching the path for research on this topic. Lately, relevant contributions to this literature include studies by Kittelsen and Forsund (1992), Pedraja-Chaparro and Salinas-Jimenez (1996) and Tulkens (1993), who used FDH - Free Disposal Hull - techniques among others. All those papers simply apply naïve DEA and FDH measurements to assess the performance of courts.

Yet, the use of naïve nonparametric measures may be misleading, as those deterministic models consider that all the observations are feasible with probability one. Inefficiencies due to the presence of atypical observations, measurement errors, omitted variables, and other statistical discrepancies are not taken into account. Consequently, there is no formal description of the incertitude and noise associated with the observed courts. The latter point is particularly serious considering that the non-parametric methods used may be seriously affected by the presence of *outliers* (super-efficient observations) as well as data errors, which may lead to a substantial underestimate of the overall efficiency scores. Therefore, in order to assure credibility of the efficiency indices, it is crucial to

adopt some additional method to correct for such discrepancies. Only then may one hope to obtain estimators that could be useful for the decision making process.

In view of the above, in this paper we compute efficiency scores for Brazilian courts, from the State of Rio Grande do Sul, by using a newly developed non-parametric distance function estimator to assess the technical efficiency. This method, known as the expected order-*m* frontier (Cazal Forens and Simar (2002)), is an alternative benchmark by which to appraise the production units. While keeping its nonparametric nature, the expected order-*m* frontier does not impose convexity on the production set and allows for noise (with zero expected values). Moreover, we will compute FDH measures and compare them with the ones obtained through the order-m efficiency estimates.

This paper is organized as follows. Section 2 presents and discusses FDH and the expected order-m frontier. Section 3 presents the data base and discusses the inputs and outputs associated to the court services. Section 4 provides nonparametric efficiency measures consisting of FDH and the m-frontier calculations. Finally, Section 5 draws some lessons and conclusions from the experience of the Brazilian courts.

2. FDH EFFICIENCY MEASUREMENTS AND THE EXPECTED FRONTIER OF ORDER-*M*

Data Envelopment Analysis (DEA) approaches rely on hypotheses very restrictive on the structure of the production set, such as convexity. Weaker assumptions have been proposed by Deprins, Simar and Tulkens (1984). They postulate that the frontier of the production set is simply the boundary of the free disposal hull (FDH) of the data set. Strong disposability of inputs and outputs is maintained as well as variable returns to scale but no convexity hypothesis is required. In this method - henceforth referred to as FDH - the frontier is obtained by comparing inputs and outputs so as to establish the dominant points. An observation is declared inefficient if it is dominated by at least another observation, domination, here, meaning the ability to produce more output with less input. Consequently, if an observation is not dominated by any other it is declared FDH efficient. By construction, every inefficient observation is necessarily dominated by one or several observations. Below, we will describe, formally, this approach.

Production theory (Shepard (1970)) states that a set of p inputs $\in R_+^p$ used to produce a set of q outputs $y \in R_+^q$ describes the production set of attainable points (x, y):

$$(1) \quad \Psi = \{(x,y) \in \Re_+^{p+q} \mid x \text{ can produce } y\}.$$

Thus the production process is defined through the joint distribution of (X,Y) on R_+^q x R_+^q, where in deterministic frontier models, Prob ((X,Y) $\in$ Ψ) = 1. The radial (output oriented) efficiency frontier is defined by:

(2) $\partial P(x) = \{y \mid y \in P(x), \lambda y \notin P(x) \ \forall \ \lambda > 1\}.$

Thus, the Farrel output measure of efficiency for a firm which uses (x_0, y_0) is given by:

(3) $\lambda(x_0, y_0) = \sup\{\lambda \mid \lambda y_0 \in P(x_0, y_0)\} = \sup\{\lambda \mid (x_0, y_0) \in \Psi\}.$

Notice that $\partial P(x) = \{y \mid \lambda(x, y) = 1\}.$

Different assumptions can be made about Ψ including convexity and free disposability. As $\partial P(x)$ is unknown, the efficiency measures $\lambda(x_0, y_0)$ have to be estimated. One estimator of Ψ from a random sample of production units $\{(X_i, Y_i) \mid i = 1,\ldots,n\}$ is the above mentioned FDH (Free Disposal Hull), derived, from the seminal work of Farrel. This approach estimates the attainable set as the smallest set containing all the data points. This set is given by:

(4) $\Psi_{FDH} = \{(x, y) \in \Re_+^{p+q} \mid y \le Y_i, x \ge X_i, i = 1,\ldots,n\}.$

The efficiency scores estimators, for a production unit using (x_0,y_0) are obtained by plugging Ψ_{FDH} in the place of Ψ. Those scores may be represented as the boundary of Ψ_{FDH}, in the output direction. It can be defined as:

(5) $\tilde{\lambda}(x_0, y_0) = \max_{i=1,\ldots,n}\{\min_{j=1,\ldots,p}[\frac{y_i^j}{y_0^j}]\}.$

Here, $\tilde{\tilde{\lambda}}(x_0, y_0)$ measures the radial distance, in the output space, between the point y_0 and the free disposal hull f the points $Y^1, \ldots, Y^n$.

Notice that the FDH methodology is particularly suited to detect the most obvious cases of inefficiency as this technique is very assertive regarding the measurement of inefficiency. To each court declared FDH-inefficient, it is possible to find at least one court in the sample that presents a superior performance relative to the first (dominated) municipality.

At this point, some aspects of the FDH methodology deserve special attention: efficiency by default and outliers:

In the absence of a sufficient number of similar courts ("pairs") with which one given court can be compared, this court, instead of creating a relationship of the type dominant/dominated, is declared efficient by default. This ranking of efficiency does not result from any effective superiority but is due to the lack of information that would allow pertinent comparisons. In addition, by construction, the FDH concept of efficiency by default applies both to the court that presents the lowest level of spending and to those

with the highest values for at least one output indicator. This extreme form of the sparsity bias that characterizes the FDH technique leads to lack of discrimination among production units, thus constitutes a serious shortcoming of the FDH approach.

As for outliers, by definition, nonparametric frontiers are defined by the extreme values of the dimensional space of inputs and outputs. Thus, the appearance of outliers, atypical observations which differ significantly from the rest of the data, may considerably influence efficiency computations. It is thus necessary to verify whether the divergence does not result from evaluation errors. However, once one is convinced of the reliability of the data set, this kind of information may provide valuable information.

Recent work established the statistical properties of the FDH estimator (Kneip, Park and Simar (1998), Simar and Wilson (2000)) thus making inference possible either by using asymptotic results or by means of bootstrap. Simar and Wilson (2000) present a survey on this issue as well as a detailed examination of the statistical properties of the nonparametric estimators in a multivariate context. Finally, FDH estimators, as other nonparametric measures, due its slow convergence rate, suffer from the curse of dimensionality (Simar (2000)). This point is particularly damaging for our study given the relatively high dimensionality of our application - six outputs and three inputs – for a rather limited number of courts.

2.1 The Expected Frontier of Order-*m*

Together, the above mentioned problems may be serious enough to jeopardize the FDH naïve estimates. To correct these problems some additional procedure is required in order to make FDH estimates more robust. Various approaches have already been proposed in the literature to cope with this problem. Wilson (1993, 1995) introduced descriptive methods to detect influential observations in nonparametric efficiency calculations. More recent developments of this important issue include the order-*m* frontiers (Simar (2003), Cazals, Florens and Simar (2002)). The order-*m* approach, based on the concept of expected maximal output function (or minimum input function), yields frontiers of varying degrees of robustness. The order-*m* frontiers allows for statistical inference while keeping its nonparametric nature. Below we will briefly describe this approach.

Consider a fixed integer *m*. For a given level *x* of input and output, define the expected value of maximum of *m* random variables ($Y^1, ..., Y^m$), drawn from the conditional distribution of the output *Y*, given $X \leq x$. Formally, we have:

$$(6) \quad \psi_m = E[\max(Y^1,...,Y^m) \mid X \leq x] = \int_0 [1 - (F_c(y \mid x)^m] dy$$

The above expression may be seen as the expected maximum production among *m* firms that use less than *x* as input level. Its nonparametric estimator is:

$$(7) \quad \tilde{\psi}_{m,n} = E[\max(Y^1,...,Y^m) \mid X \leq x]$$

As $\psi_{m,n}(x)$ in unknown, it can be estimated by plugging the empirical distribution function in place of the unknown population distribution. Expression (7) may be computed through

$$(8) \quad \psi_m = \int_0 [1 - (\tilde{\tilde{F}}_c(y \mid x)^m] dy$$

Where $\tilde{\tilde{F}}$ stands for the empirical distribution function. For the multivariate case, consider m, a q-dimensional random variables $Y^1,...,Y^m$, generated from the conditional distribution of Y, given $X \leq x_0$. Defining the random variable:

$$(9) \quad \tilde{\lambda}_m(x_0, y_0) = \max_{i=1,...,m} \left[\min_{j=1,...,p} (Y^{i,j} / y_0^j) \right]$$

Here λ_m measures the radial distance, in the output space, between the point y_o and the free disposal hull of the random points $Y^1,...,Y^m$, now generated from the conditional distribution of Y given $X \leq x_0$.

To compute nonparametric estimates of the order-m frontier, following, Cazals et al. (2002), we substitute the empirical distribution functions for the unknown population distributions. In that case, we have;

$$(10) \quad \tilde{\lambda}_{m,n}(x_0, y_0) = \tilde{E}[\tilde{\lambda}_m(x_0, y) \mid X \leq x_0]$$

The expectation $\tilde{E}$ is computed from the empirical conditional distribution Y, given $X \leq x_0$. In multivariate applications, we solve the numerical integration by using a simple Monte-Carlo procedure that works as follows:

[1] For a given level of x_0, draw a random sample of size m, with replacement among those y_i, such as $x_i \leq x_0$ and denote this sample $(Y_b^1,...,Y_b^m)$

[2] Compute (9) $\tilde{\lambda}_m^b = \max_{i=1,...,m} \left[\min_{j=1,...,p} (Y_b^{i,j} / y_0^j) \right]$

[3] Repeat this step B times do this b = 1, …, B, for B large enough

[4] Then, compute the empirical mean among the B samples as: $\bar{\lambda}_{m,n}(x_0, y_0) = \frac{1}{B} \sum_1^B \tilde{\lambda}_m^b(x_0, y_0)$

Here the relationship with the FDH estimator is:

$$\lim_{m \to \infty} \lim \bar{\lambda}_{m,n}(x_0, y_0) = \bar{\lambda}_n(x_0, y_0) = \bar{\lambda}_{FDH,n}(x_0, y_0) = \max_{i|xi \leq x0} \{\min_{j=1,...,p} [\frac{y_i^j}{y_0 j}]\}.$$

Hence, when m → ∞, the expected order-*m* estimator tends to the FDH. Notice that rather than measuring a firm performance relative to a potential unreliable *maximum feasible output* for the firm's observed inputs, the expected order-m frontier measures its

performance relative to the *expected maximum output* among *m* firms using input quantities no greater than those of firm analyzed.

3. DATA

The implementation of the methodologies outlined above requires information about inputs and the quantity of services provided by courts (outputs). The Brazilian judicial system has three levels. We will analyze only the lowest level. Information on the activities of those courts was provided by the Tribunal of Justice of the State of Rio Grande do Sul. The data set is composed by 161 courts, for two years: 2002 and 2003. Those courts serve 497 municipalities, as they provide services for more than one municipality, from a defined geographical area. Notice some municipalities have only one court whereas other courts involve more than one municipality.

Courts offer several services that are highly heterogeneous with at least six types of cases as shown in table 1. For each court, the following information is provided: new cases, settled cases, unsettled pending cases (from the previous year) and the backlog (unsettled pending cases, from the current year). After a careful choice, six output indicators and three inputs were retained. The outputs we obtained by aggregating civil and criminal settled cases into six categories: civil cases, criminal cases, civil minor offenses, criminal minor offenses, children and youth cases and criminal executions. As for inputs, we do no have any information on capital and commodity inputs. Hence, we considered labor inputs, disaggregated into two classes – judges and clerical staff, and the stock of cases (new cases more unsettled pending cases, from the previous year). Yet, this should not jeopardize the relevance of our results as the judicial system is highly labor-intensive. The summary statistics for inputs and outputs are provided in Table 1.

Looking at Table 1, the first remarkable thing is the fact that the mean is much higher than the median thus indicating that the courts are highly heterogeneous. For instance, the minimum staffing of judges is to have one judgeship and two employees whereas the largest one has 167 and 918, respectively.

Table 1 – Summary Statistics for Input and Output - Courts in Rio Grande do Sul - 2002-2003

Outputs - Settled Cases	**Min**	**Median**	**Mean**	**Max**	**Total**
1. Civil Cases (Vara Única Cível)	135	1.009	3.551	245.891	1.143.54
2. Criminal Cases (Vara Única Criminal)	3	109	319	14.011	102.562
3. Civil Minor Offenses (Juizado Especial Cível)	40	460	1.113	44.742	358.371
4. Criminal Minor Offenses (Juizado Especial Criminal)	19	494	1.245	46.675	401.041
5. Children and Youth Cases (Juizado da Infância e Juventude)	11	148	363	11.937	116.804
6. Criminal Executions (Execuções Criminais)	1	45	189	14.954	60.749
Inputs					
Post as Judges	1	1	4	167	1.172
Office Staff	2	10	27	918	8.654
Stock of cases	1.333	6.619	17.937	862.937	5.775.73

4. EFFICIENCY RESULTS: FDH AND THE EXPECTED ORDER-M FRONTIER

We will present efficiency estimates based on both FDH and order-*m* results. Notice that we pooled observations over time, thus, estimating a single frontier. This supposes an unchanging production set throughout the two periods 2002-2003, which seems a reasonable assumption. Firstly, we will report the FDH results. After, we will discuss the results obtained through the expected order-m frontier and will compare both measurements.

4.1 FDH Efficiency measures for Courts of Rio Grande Sul

Detailed FDH results are presented in tables 2. Firstly, as expected, the FDH approach declares 57% of the courts efficient. Notice that this approach declares as efficient by default a significant number of courts. On average, 45 % of the efficiency courts are classed in that category. This extreme form of the sparsity bias that characterizes the FDH technique leads to an overestimation of the number of efficient units and thus constitutes a serious shortcoming of this method.

Finally, except for the first two classes, efficiency tends to increase with court size, thus, suggesting the presence of economies of scale for courts services. Such a finding could be due to the presence of minimum staff courts. Yet, it should be more careful examined as the presence of outliers may distort this result. Notice also that a significant number of efficient courts are efficient by default. As expected this proportion with the size of the courts; indeed, for the largest courts, all courts fall into this category. This extreme form of the sparsity bias leads to a significant overestimation of the number of efficient units and thus constitutes a serious shortcoming of the FDH approach.

- Table 2 - Rating of the Courts of Grande do Sul - FDH Approach – 2002-2003 -

# of cases	# Courts	Efficient Courts						Inefficient Courts	
		Efficient Courts		Efficient and Dominating Courts		Courts Efficient by *Default*			
		#	%	#	%	#	%	#	%
0-4999	43	5	11,63	4	80,00	1	20,00	38	88,37
3000-4999	70	30	42,86	26	86,67	4	13,33	40	57,14
5000-9999	90	56	62,22	46	82,14	10	17,86	34	37,78
10000-19999	61	42	68,85	20	47,62	22	52,38	19	31,15
20000-49999	41	34	82,93	5	14,71	29	85,29	7	17,07
+ 50000	17	16	94,12	0	0,00	16	100,00	1	5,88
Total	322	183	56,83	101	55,19	82	44,81	139	43,17

4.2 Expected *Order-m* Efficiency Estimates for Courts of Rio Grande Sul

We computed the order-m efficiency estimates for all courts, using different values for m, ranging from 75 to 2000. Those frontiers are nested so that the order-m frontier is below the order-m´ with m´ > m. An important issue here concerns the choice of *m.* Even if, as Cazals, Florens and Simar (2002) note, the value for this parameter is quite arbitrary, they add that "a few values of m could be used to guide the manager of the production unit to evaluate its own performance." Indeed, as shown by Figures 1-3, efficiency order-*m* estimates for individual courts using different values of *m* are highly correlated.

Figure 1: Order-*m* Efficiency Estimates: (1) (x) m=350 versus (y) m=400

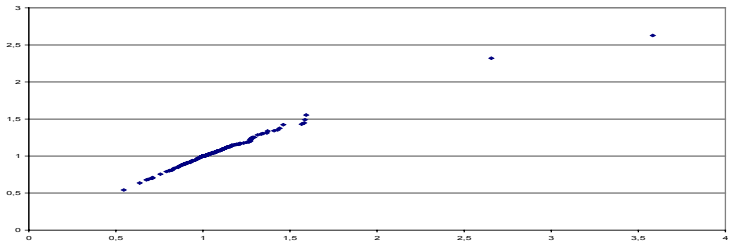


Figure 2: Order-*m* Efficiency Estimates: (1) (x) m=500 versus (y) m=600

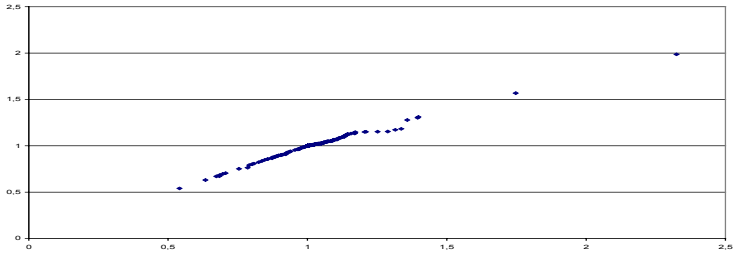
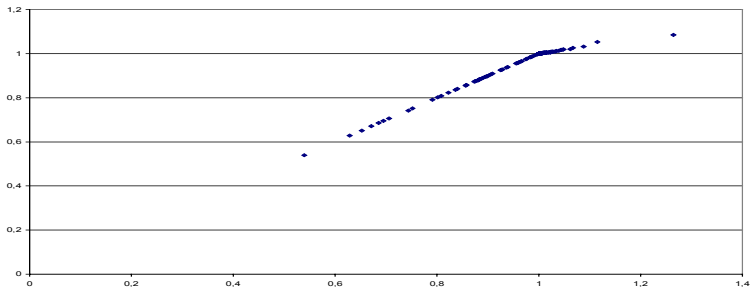
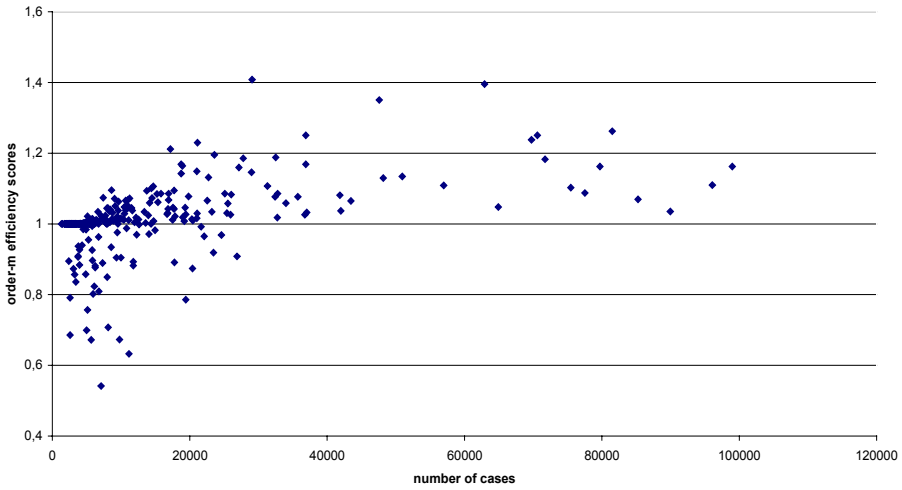


Figure 3: Order-*m* Efficiency Estimates: (x) m=1000 versus (y) m=1300



For that reason, for the sake of space, we will present most of our results using m = 500. Figure 4 shows order-m efficiency scores for m = 500, arranged by increasing court sizes. Those estimates reflect the extent to which the court uses a given input to produce its expected maximum output level. A score larger than one indicates that the court produces more than expected maximum level from its observed inputs whereas a score inferior to one means that the court produces less than its expected maximum.

Figure 1: Order-m efficiency estimates for Courts - Rio Grande do Sul 2002-2003 (m=500)



Notice that the courts below the frontier are the smaller ones, thus, suggesting the presence of economies of scale for courts services. Such a finding could be due to the presence of minimum staff courts. Observe also that even for m = 500 a significant number of courts lies above the frontier (efficiency = 1). Some of those observations are natural candidates for outliers and should be more carefully examined.

Table 3 shows descriptive statistics for order-m efficiency scores grouped by court size. Notice that, except for the first class, scores tends to increase with size corroborating the scale effect already visualized in figure 1. Observe that higher efficiency estimates exhibited by the two first class may be explained by the fact many courts in this range have just one judgeship – the minimum staffing of judges. Later, we will discuss this point in more details.

Table 3: Descriptive Statistics for Order-m Efficiency Scores for Rio Grande do Sul Courts: 2002-2003

Table 3: Descriptive Statistics for Order-m Efficiency Scores for Rio Grande do Sul Courts: 2002-2003

# of Cases	# Courts	Mean	Median	Standard deviation	Maximum	Minimum
0-2999	43	0,9854	1	0,0587	1	0,6856
3000-4999	70	0,9844	1	0,0400	1,0052	0,8364
5000-9999	90	0,9724	1,0013	0,0970	1,0953	0,5418
10000-19999	61	1,0261	1,0346	0,0853	1,2118	0,6320
20000-49999	41	1,0838	1,0659	0,1077	1,4080	0,8743
+ 50000	17	1,2973	1,1618	0,4211	2,6526	1,0349
Total	322	1,0182	1	0,1439	2,6526	0,5418

4.3 Outliers and Efficiency by Default in Nonparametric Efficiency Measurements: Order-*m* Expected and FDH Efficiency Estimators

By definition, nonparametric frontiers are defined by the extreme values of the dimensional space of inputs and outputs. Thus, the appearance of atypical observations, which differ significantly from the rest of the data, may influence efficiency computations. It is thus necessary to verify whether the divergence does not result from evaluation errors. However, once one is convinced of the reliability of the data set, this kind of information may provide valuable information.

Table 4 presents the twentieth more efficient ones, for m = 75, m = 300, and m = 500, ordered according to the results produced when m = 500. Even with m = 500, Porto Alegre still shows an order-m efficiency of 2,05, being thus a super-efficient observation. This is rather surprising as the capital is a clear outlier: while the mean for settled cases (our output) is 6.780, the corresponding figure for Porto Alegre is 375.496, more than 55 times this average. Other super-efficient production units are Uruguaiana, Passo Fundo, Santa Maria, Rio Grande, Caxias do Sul, Canoas and Pelotas.

Notice that all, but two courts - Tapes and Torres – are efficient by default when we use the FDH methodology; consequently, the score 1 is attributed to all of them, even if we are unable to compare them with the other observations. Therefore, by lack of comparisons, the FDH estimator conveys no useful information about those particular courts. This is a serious restriction of the FDH approach as a significant number of the efficient courts fall into this category (almost 45%, as shown in Table 3). On the total, information for 82 efficient by default courts, approximately 26% of the whole set, is just lost. This is particularly damaging as nonparametric methods – especially FDH – are plagued by the curse of dimensionality. Hence, by using the expected order-m frontier, we have $\sqrt{n}$-consistent estimators, thus, avoiding this problem and permitting to rank courts that are efficient by default, hence, allowing for discrimination among them.

Table 4: Order-m Efficiency for Selected Courts of Rio Grande do Sul - 2002-2003

	m = 75		M = 300		m = 500		FDH - Efficiency
	Order-m Efficiency	Rank	Order-m Efficiency	Rank	Order-m Efficiency	Rank	
Porto Alegre	8,3193	2	3,8771	1	2,6526	1	1 - Default
Uruguaiana	2,6484	12	1,6489	5	1,408	3	1 - Default
Passo Fundo	2,7342	8	1,6034	7	1,3952	4	1 - Default
Rio Grande	3,0744	5	1,6253	6	1,3503	5	1 - Default
Santa Maria	3,3094	4	1,756	3	1,2619	6	1 - Default
Alvorada	2,6731	11	1,53	11	1,2504	7	1 - Default
Canoas	3,6968	3	1,6629	4	1,2503	8	1 - Default
Pelotas	2,6423	13	1,4094	13	1,2376	9	1 - Default
Sapucaia do Sul	2,7249	9	1,5426	9	1,2296	10	1 - Default
Camaquã	2,5639	16	1,5459	8	1,2118	11	1 - Default
Ijuí	2,4037	19	1,5357	10	1,1958	12	1 - Default
Torres	2,6142	14	1,4697	12	1,1643	14	1-Dominante
Caxias Do Sul2	2,679	10	1,3039	18	1,162	15	1 - Default
Panambi2	2,4394	18	1,3764	15	1,1061	17	1 - Default
Novo Hamburgo	2,2589	20	1,2395	19	1,1028	18	1 - Default
Tapes	2,8198	6	1,3838	14	1,0735	19	1-Dominante

Also, the higher efficient courts presented in Table 4 are among the largest ones, thus, suggesting that they are able to explore the economies of scale inherent to court services. Finally, due to their size, they tend to be more specialized and less judge intensive, which may contribute to boost their efficiency scores.

Finally, comparing those results with the ones obtained by using the FDH measurement may be useful to highlight the advantages of the order-m expected frontier.This point is illustrated in Table 5, where selected FDH efficient and dominant courts, arranged by the number of dominated courts, are shown together with its corresponding order-m efficient estimators. Consider first the case of Faxinal do Soturno, which dominates 44 in 2003. This court, for a given quantity of resources, has all its output indicators exceeding those of 44 other courts. In addition, this court was also ranked as most dominating in 17 cases. Most dominant courts have a decisive influence on the FDH measurement of the efficiency levels as compared with their pairs they possess the "best technology" thus defining the technological frontier. As they dominate several, removing one of those courts reduces the requirements to belong to the frontier so that courts previously declared inefficient may turn out to be ranked as efficient.

Besides Faxinal do Soturno, the courts of Portão, Canela, Maraú and Guaporé also contribute to build up the boundaries of the technological frontier, as they define the best-practice frontier for the production of justice services. Removing them from the sample will substantially increase the number of efficient courts. This is due to the fact that the concept of efficiency is a relative one and depends not solely on the performance of the court analyzed but also on the achievements of the other ones with which they are compared. Notice that Estância Velha and Nova Petrópolis, in spite of the fact that each

one of them dominates 15 courts, they do not influence the assessment of the efficiency levels as there is no case where they function as most-dominating municipality.

Table 5: Selected FDH Efficient and Dominating Courts: Order-*m* and FDH Efficiency Estimators – 2002-2003

Courts	Order-m Efficiency (m=500)		FDH Efficient and Dominating Courts			
	Score	Rank	Score	# of Dominated Courts	# of cases where the courts is most-dominating	Cases
Faxinal do Soturno	1,0040	145	1	44	17	4.291
Portão	1,0000	203	1	40	10	4.980
São Sepé	1,0000	214	1	37	5	5.543
Arroio do Meio	1,0000	167	1	30	4	4.315
Guaporé	1,0050	138	1	29	19	6.639
Santo Cristo	1,0000	212	1	29	3	5.124
Canela2	1,0600	55	1	23	8	11.482
São Pedro Do Sul	1,0000	214	1	23	3	4.835
Casca	1,0000	177	1	22	2	4.104
Parobé	1,0000	199	1	19	2	6.072
Marau	1,0000	192	1	18	7	5.129
Garibaldi	1,0006	135	1	17	4	6.259
Estância Velha	1,0225	100	1	15	0	8.878
Nova Petrópolis	1,0000	196	1	15	0	3.560

Yet, those measurements may be misleading as they are obtained on the basis of a potential unreliable *feasible maximum output* and, thus, may be not very robust. Looking closer one sees that all those courts do have only one judge. Therefore, they all will have input efficiency regarding judges as there is no observations with less than one judge, but, only some of them will be truly efficient. Thus, this particularity contributes to raise efficiency estimates for those courts. Also, as they are declared efficient only within the sub-sample that excludes units efficient by default (see Section 4.3), the range of comparison is limited and, because of the curse of dimensionality, their score is biased toward one.

Summarizing, as FDH measurements are flawed, the use of the $\sqrt{n}$-consistent order-*m* estimator it is a good alternative. Rather than comparing a given courts outputs with one estimate of the maximum feasible output, this estimator compares the court's observed outputs to what could be expected from any *m* randomly chosen courts using no more inputs than the given court. This procedure is more reliable and it overcomes the curses of dimensionality, typical of nonparametric measurements, provide that *m* is not too large relative to the number of observations. Looking back at Table 5, both Faxinal do Soturno and Guaporé, best performers with the FDH approach, although efficient, rank only 145 and 138 when we use the $\sqrt{n}$-consistent order-*m* estimators

Let us now turn to the discussion of inefficient courts. As already mentioned, FDH estimates are particularly suitable to identify inefficient production units. Table 6 lists some of those courts for the state of Rio Grande do Sul.

Table 6 - Method FDH: Selected Dominated Courts: Rio Grande do Sul

Courts	Efficiency	Dominated by	Population (2002)	Per capita Income (R$ 2002)	Stock of Cases
Gaurama	0,3639	65	21.177	8.857	2.152
Arroio Do Tigre	0,3548	63	20.353	9.374	2.614
Arroio Grande	0,4861	52	19.157	9.066	2.854
General Câmara	0,4435	46	11.878	6.723	2.604
Piratini	0,4460	35	19.743	6.205	2.347
Espumoso	0,3834	35	21.054	9.020	3.783
São Marcos	0,4118	34	19.552	12.672	3.776
Lavras Do Sul	0,4516	33	8.136	10.885	2.430
Seberi	0,5506	32	22.143	8.445	3.766
Tapejara	0,5795	22	26.240	11.229	3.956
Herval	0,3418	21	7.089	8.074	1.333
Santo Augusto	0,5396	19	29.610	9.062	7.120
Tucunduva	0,3785	18	10.724	9.769	1.851
Carlos Barbosa	0,6881	17	26.787	17.365	3.986
Giruá	0,5240	15	21.166	10.306	6.263

A typical example is Guarama, which is dominated by 65 other courts. Furthermore, to reach efficiency, this court have to reduce its present resources by 63,6%, corresponding to the expenses of the its most dominating court, that presents all output indicators superior to those of Guarama. From an administrative point of view, this information has a great relevance. Indeed, this result indicates that Guarama, as well as other courts - particularly, Arroio do Tigre, Arroio Grande, General Câmara and Piratini - could make better use of its resources as several other courts do. This analysis applies also to the other courts listed in Table 6.

Notice that most of these courts are rather small. Except for Santo Augusto and Giruá, they all belong to the first two classes. This fact may reflect not only a scale problem but also the fact that have reported very low output levels. For instance, Herval reported only 1 judgment criminal execution, while for Guarama and Arroio Grande, the corresponding figures are 8 and 2, whereas the mean and the median for the group are, respectively, 189 and 45. These low figures may be explained either by the fact that small cities tend to have less criminal offenses or it may be due to measurement errors; we can argue that small courts work with less qualified clerical staff, thus, making misreporting more likely than in courts where office staffs are more trained. Yet, the FDH does not allow for that kind of noise as they are obtained on the basis of a potential *feasible maximum output.* Finally, as already mentioned, any problem concerning the evaluation of most dominating observations will also affect the levels of inefficiency, as they serve as benchmark for the dominated units.

Table 7 – Selected Inefficient Courts in Rio Grande do Sul: Expected order-m and FDH estimates 2002-2003

Courts	Order-m Efficiency (m=500)		FDH efficiency		Court Size	
	Score	Rank	Score	Rank	Cases	Population
Santo Augusto	0,5409	1	0,5396	20	7.120	29.610
Gramado	0,6340	2	0,6284	31	11.169	30.129
Tupanciretã	0,6730	3	0,6712	40	5.691	25.256
Rio Pardo	0,6838	4	0,6511	33	9.778	49.942
General Câmara	0,6856	5	0,4435	9	2.604	11.878
Crissiumal	0,7063	7	0,7059	48	8.116	19.050
Sananduva	0,7545	8	0,7520	60	5.146	29.386
São Gabriel	0,7861	9	0,7403	58	19.423	62.288
Arroio do Tigre	0,7910	10	0,3548	3	2.614	20.601
Teutônia	0,8246	13	0,6697	39	6.120	38.151
Iraí	0,8364	14	0,6875	44	3.452	8.914
Caçapava do Sul	0,8463	15	0,8402	79	8.005	43.108
Porto Xavier	0,8571	16	0,7121	50	3.280	11.086
Bom Jesus	0,8580	17	0,5769	24	4.891	20.035
Taquara	0,8732	18	0,8550	85	20.439	80.580
Não-Me-Toque	0,8733	19	0,7385	56	3.083	20.211
Giruá	0,8752	20	0,5240	18	6.263	20.686

Looking at the first two columns on Table 7, we have a more realistic picture. The computed inefficiencies by using the order-m expected estimator are no more concentrated only on very small courts. Indeed, among the twentieths more inefficient courts, only three courts belong to the first class – Arroio do Tigre, Porto Xavier and Não-me-Toques. Moreover, the efficiency scores are higher thus producing more credible results.

Inefficiency and Judicial Backlog

Efficiency calculations allows us to compute the efficient delay for each court, i.e., the judicial backlog that could be eliminated only by increasing the inputs - the labor force, in our case. Subtracting this efficient delay from the actual one, it is possible to compute the unnecessary backlog (reducible backlog) that could be suppressed by increasing efficiency. Consider a dominated court, at time t, denoted as k; the efficiency score and backlog (actual delay) for this court are, respectively, λ_t^k, and BL_t^k. The actual backlog is defined by expression (10):

(11) $BL_t^k = BL_{t-1}^k + NC_t^k - SC_t^k$

Where NC_t^k and SC_t^k are, respectively, the new cases and settled cases, in court k, at the year t and BL_{t-1}^k is the pending unsettled cases.

Let $d^*(k)$ be the most-dominating court for k, with $TSC^{d^*(k)}$, the total settled cases for $d^*(k)$. If court k were efficient, it could have reduced its backlog by an amount at least equal to

(12) $BL_t^{k*} = (1- \lambda_t^k)\ \mathrm{TSC}^{d*(k)}$

Where BL_t^{k*} is the delay that would prevails if court k behaved like its dominating firm $d^*(k)$. For this to be possible, its backlog, at time t, should be at least BL_t^{k*}. Here, the avoidable backlog may be computed as:

(13) $RBL_t^k = \min [\, BL_t^{k*}, BL_t^k \,]$

And the non reducible backlog is

(14) $NRBL_t^k = BL_t^k - RBL_t^k$

Expression (14) shows the efficient delay, reducible only by increasing the inputs.
We will use the FDH Scores for computing the efficient backlog. Table 8 shows the actual, efficient (non reducible) and reducible backlog for inefficient courts, ranking according the size of the stock of cases, for the years, 2002 and 2003. Firstly, the total reducible delay is 25,13% and 11,64%, of the actual backlog, respectively, for 2002 and 2003.

Table 8: Backlog Calculations for the Inefficient Courts in Rio Grande do Sul – 2002-2003

Courts by size	Reducible Backlog		Non Reducible Backlog		Actual Backlog	
2002	#	%	#	%	#	%
0-2999	17.435	60,49	11.390	39,51	28.825	100
3000-4999	12.128	32,30	25.420	67,70	37.548	100
5000-9999	12.622	18,58	55.293	81,42	67.915	100
10000-19999	9.902	15,93	52.243	84,07	62.145	100
20000-49999	30	0,27	10.964	99,73	10.994	100
50000	-	-	-	-	-	100
Total	52.117	25,13	155.310	74,87	207.427	100
2003	#	%	#	%	#	%
0-2999	13.076	54,26	11.024	45,74	24.100	100
3000-4999	14.776	22,88	49.816	77,12	64.592	100
5000-9999	12.023	11,91	88.934	88,09	100.957	100
10000-19999	8.775	6,93	117.840	93,07	126.615	100
20000-49999	5.077	5,22	92.188	94,78	97.265	100
50000	69	0,14	48.556	99,86	48.625	100
Total	53.796	11,64	408.358	88,36	462.154	100

Secondly, this reducible backlog decreases with the size of the courts. This result is not surprising because, as previously shown, small courts tend to be more inefficient than its larger counterparts and, hence, a significant part of their backlog is due to inefficiency and may be reduce by using more effectively the existing resources. Finally note that more than three quart of the total actual backlog can not be reduced, unless we increase the personnel - judges and clerical staff. Such an increase is all the more justified as we

did not take into account the backlog of the efficient courts, which, by construction, is not reducible.

5. CONCLUDING REMARKS

In this paper we have attempted to appraise, quantitatively, the efficiency levels of the justice courts in Rio Grande do Sul. For that purpose, we analyzed the relationship between output and inputs by constructing nonparametric efficiency frontiers. Two different techniques of efficiency analysis were used to determine this frontier: the FDH approach and the order-*m* frontier.

Our results provided useful insights into the assessment of the administrative efficiency of courts. The expected order-m frontier produces more reliable results as is not affected by the curse of dimensionality as is the case of most nonparametric measurements.

We show also that efficiency losses are particularly important for small courts, thus suggesting the presence of economies of scale. Due to their size, smaller courts do not explore the economies of scale in the production of justice services. They tend to operate with higher average costs thus bringing about a considerable waste of resources, which can be inferred by estimating the substantial reducible backlog (unsettled pending cases) that characterize those courts. This is a quite robust result, supported by both methodologies.

It is important to stress the exploratory nature of this study. Efficiency scores should be used carefully as more detailed analysis is required to determine if the measured scores reflect genuine technical inefficiencies or if they are explained by the action of others factors. For instance, in some cases, inefficient courts may well be intrinsically different from the dominating ones, and what is regarded as inefficiency could correspond simply to the effects of such court-specific characteristics. In particular, no attempt was made to include variables reflecting the quality of the public services provided by courts. The natural extension of this study is to investigate the determinants of efficiency scores. This is the object of our current research.

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