

da Silva, Alexandre Manoel Angelo; da Silva Vieira, Roberta; Mont'alverne Duarte, Angelo José

## Article

# Efficiency of municipal legislative chambers

EconomiA

### Provided in Cooperation with:

The Brazilian Association of Postgraduate Programs in Economics (ANPEC), Rio de Janeiro

*Suggested Citation:* da Silva, Alexandre Manoel Angelo; da Silva Vieira, Roberta; Mont'alverne Duarte, Angelo José (2015) : Efficiency of municipal legislative chambers, EconomiA, ISSN 1517-7580, Elsevier, Amsterdam, Vol. 16, Iss. 1, pp. 60-75, <https://doi.org/10.1016/j.econ.2015.03.001>

This Version is available at:

<https://hdl.handle.net/10419/179587>

### Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

### Terms of use:

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

## Efficiency of municipal legislative chambers

Alexandre Manoel Angelo da Silva<sup>a,\*</sup>, Roberta da Silva Vieira<sup>b</sup>,  
Angelo José Mont'alverne Duarte<sup>c</sup>

<sup>a</sup> Técnico de planejamento e pesquisa do Instituto de Pesquisa Econômica Aplicada (Ipea), Brazil

<sup>b</sup> Técnica de planejamento e pesquisa do Instituto de Pesquisa Econômica Aplicada (Ipea), Brazil

<sup>c</sup> Doutor em Economia pela Escola de Pós-Graduação em Economia da Fundação Getúlio Vargas (EPGE/FGV), Brazil

Available online 14 March 2015

### Abstract

A novel study of Brazilian city council efficiency using the non-parametric estimator *FDH* (free disposal hull) with bias correction is presented. In regional terms, study results show a concentration of efficient councils in the southern region. In turn, those in the northeastern and southeastern regions are among the most ineffective councils. In these latter two regions, most councils could at least double their outputs while maintaining the same volume of inputs. Regarding population size, for cities with up to 500,000 inhabitants, more than 60% of city councils could at least quadruple their output. Regarding inefficiencies revealed through non-discretionary variables (environmental variables), the study results show a correlation between councilor education levels and city council efficiency. © 2015 National Association of Postgraduate Centers in Economics, ANPEC. Production and hosting by Elsevier B.V. All rights reserved.

*JEL classification:* C10, C14, H70

*Keywords:* Efficiency, City councils; *FDH*

### Resumo

Neste artigo, analisa-se pioneiramente a eficiência das câmaras legislativas municipais brasileiras, a partir do estimador não paramétrico *FDH* (Free Disposal Hull), com a respectiva correção de seu viés. Em termos regionais, os resultados obtidos mostram grande concentração de câmaras eficientes na região Sul. Por sua vez, dentre as câmaras ineficientes, destacam-se as das regiões Nordeste e Sudeste. De fato, nestas duas regiões, a maioria das câmaras poderia ao menos duplicar a produção mantendo o mesmo nível de insumos. Do ponto de vista populacional, nas cidades com até 500.000 habitantes o percentual de câmaras municipais que podem pelo menos quadruplicar seu produto é maior do que 60%. Em relação à explicação das ineficiências por meio de variáveis não discricionárias (variáveis ambientais), indica-se que quanto maior for o grau de escolaridade média dos vereadores, maior é a eficiência da câmara legislativa onde atuam.

© 2015 National Association of Postgraduate Centers in Economics, ANPEC. Production and hosting by Elsevier B.V. All rights reserved.

*Palavras chave:* Eficiência; Câmara Legislativa Municipal; *FDH*

\* Corresponding author.

*E-mail addresses:* [alexandre-manoel.silva@ipea.gov.br](mailto:alexandre-manoel.silva@ipea.gov.br) (A.M. Angelo da Silva), [roberta.vieira@ipea.gov.br](mailto:roberta.vieira@ipea.gov.br) (R. da Silva Vieira), [ajmd@uol.com.br](mailto:ajmd@uol.com.br) (A.J.M. Duarte).

Peer review under responsibility of National Association of Postgraduate Centers in Economics, ANPEC.

<http://dx.doi.org/10.1016/j.econ.2015.03.001>

1517-7580 © 2015 National Association of Postgraduate Centers in Economics, ANPEC. Production and hosting by Elsevier B.V. All rights reserved.

## 1. Introduction

In the period prior to Real Plan implementation in Brazil, which was marked by high inflation rates, applied economics literature was heavily focused on issues of inflation. With the advent of price stability and consequent revenue losses due to seigniorage, concerns over public spending expansion grew significantly.

With the start of the floating exchange regime, which increased Brazilian public debt by approximately 18% points of the GDP, the Brazilian Government reluctantly initiated fiscal adjustments. Annual primary surplus targets were 3.75% of GDP from 1999 to 2002, 4.25% of GDP from 2003 to 2007, and 3.8% of GDP for 2008. Throughout this period of fiscal adjustment, debates between Brazilian experts on increased public financing of public spending intensified.

Tax burdens were increased to fulfil primary surplus goals and initiate public spending expansion. As tax collection levels rose, it became evident that economic growth would soon be compromised. In turn, public spending cuts were proposed as a means of alleviating tax burdens.

As it is difficult to change the allocation of public expenditures in Brazil, i.e., public spending for free allocation is limited,<sup>1</sup> public spending improvements were suggested. In microeconomic terms, this can be translated as follows: offering more public services (products) with the same inputs (labor, equipment, etc.).

Consequently, numerous Brazilian applied economics studies have empirically measured issues of public spending efficiency to promote effective public spending. Evaluations of several segments of the Brazilian public sector have been conducted in various empirical studies.<sup>2</sup>

Most, or perhaps all, of these studies<sup>3</sup> conduct efficiency analyses of public organizations related to executive branches. However, it is critical to not only assess executive branch performance, but also legislative and judiciary<sup>4</sup> performance.

While numerous studies have evaluated local executive power at the municipal scale,<sup>5</sup> none have examined the efficiency of local legislative production, despite the fact that city councils implement local public policies and thus enact effective (or ineffective) internal policies and incentives.

To address this gap, we examine local legislative production efficiency through a study of the 2005 city council census using the Interlegis platform. From census data, product and input vectors are built to determine production plans for city councils based on microeconomic theory.

After city council production plans are established, council efficiency scores are determined using econometric methods. We then show whether alleged council inefficiencies are attributable to non-discretionary variables, which are identified based on the Interlegis census, FINBRA (a report produced by the National Treasury Secretariat concerning Brazilian municipality expenditures and revenues) and IPEADATA.

Therefore, this article has two specific goals. We first determine which councils more efficiently allocate public resources by region and population size. From proposed production plans, we thus produce city council efficiency rankings by region and population size.

Using city council efficiency scores obtained, we perform a regression analysis to determine specific areas of city council inefficiency. For this regression, explanatory variables used are non-discretionary, environmental variables,<sup>6</sup> and the explained variable is a vector that includes only inefficient council scores.

We also investigate whether city council inefficiency is attributable to councilor education levels. Ferraz and Finan (2008) noted that more highly educated politicians exhibit superior legislative performance. Thus, it is hypothesized

---

<sup>1</sup> For example, in 2003, according to a technical study conducted by the Ministry of Planning, Budget and Management/Federal Budget Secretariat (Ministério do Planejamento, Orçamento e Gestão/Secretaria de Orçamento Federal; Brasil, 2003), only roughly 11% of Union expenditures were freely allocated (discretionary).

<sup>2</sup> See Marinho (2003), Gasparini and Melo (2004), Souza Júnior and Gasparini (2006), Santos et al. (2007), Ribeiro (2008) and Arvate et al. (2008).

<sup>3</sup> Throughout our review of existing literature, we found no articles that estimate the efficiency of public organizations of Brazilian legislative authority.

<sup>4</sup> Throughout our review of existing literature, we found only three studies that evaluate Brazilian judiciary organization member efficiency: Sousa and Schwengber (2005,2007) and Yeung and Azevedo (2009).

<sup>5</sup> It is understood that, when assessing Municipality Participation Fund (Fundo de Participação do Município – FPM) expenditure efficiency, this concerns municipal executive branch efficiency in FPM resource spending.

<sup>6</sup> Environmental variables include those not presented to production process participants during the study period.

that: more highly educated councilors make more legislative decisions (law approvals and propositions), decreasing inefficiency.

In addition to this introduction, this article includes four sections. The flowing section elaborates on concepts of efficiency and production and on indicators used to determine efficiency scores and environmental variable coefficients. In Section 3, features of the Interlegis census, production plan, and environmental variables used for the efficiency analysis are described. Section 4 presents the study results. Finally, Section 5 presents conclusions and avenues for future research.

## 2. Efficiency analysis

### 2.1. Features of firm theory

This study examines and comparatively analyzes production processes applied within firms,<sup>7</sup> henceforth represented by city councils. Various methods can be used to compare city councils based on production process outcomes.

These methods generally differ based on measures produced, required data, and “decision maker” economic behaviors. Hence, production frontier estimations only require data relating to inputs and products. Other methods, however, require data on input or product prices or hypotheses on production unit economic behaviors involving profit maximization or cost minimization.

As public policies are not primarily designed to generate profits, it would not be appropriate to ascertain efficiency scores based on the profit function. Additionally, it is not appropriate to assume, in the specific case of Brazilian city councils, that the objective function is to minimize costs, although this may be desirable from a social welfare perspective.

Therefore profit and cost function methodologies for calculating city council efficiency scores are discarded, and the production frontier is used instead. This approach has two advantages: (i) only data on inputs consumed and products generated through production are needed, (ii) it is not necessary to impose economic behaviors (for maximization or minimization) on city councils.

### 2.2. Obtaining efficiency scores

Using this production frontier approach, it is necessary to calculate city council efficiency scores to conduct comparisons. Production plan efficiency  $(x, y)$  can be defined as:

$$\lambda(x, y) = \sup\{\lambda : (x, \lambda y) \in T\}. \quad (1)$$

A production plan  $(x, y)$  is thus considered efficient if  $\lambda(x, y) = 1$ . In this case, efficiency is defined based on the product of fixed  $x$ . It is also possible to define production plan efficiency  $(x, y)$  using:

$$\theta(x, y) = \inf\{\theta : (\theta x, y) \in T\}. \quad (2)$$

In (2), regarding inputs, a production plan is efficient if  $\theta(x, y) = 1$ . From these definitions, it can be concluded that efficiency analyses require information on technology  $(T)$  or on the production frontier  $(\partial T)$ .

### 2.3. Estimation of efficiency scores

Once the use of the production frontier approach has been justified and a means of calculating city council efficiency scores has been established,<sup>8</sup> a council efficiency score estimation approach must be selected. At least two theoretical approaches to efficiency frontier estimation are presented in the existing literature: parametric and non-parametric methods.

In the parametric approach, a functional form for technology  $T$  is defined a priori, i.e., it is assumed that the correct specification of technology is known. However, if the functional form adopted is not correct, results produced will

<sup>7</sup> Information on firm theory can be found in [Mas-Colell et al. \(1995\)](#).

<sup>8</sup> For the purposes of applying firm theory to the public sector, productive units, firms and city councils are treated as synonymous terms in this article.

be econometrically inconsistent. In turn, in the non-parametric approach, an a priori specification of a functional technological form is not needed.

Because technology  $T$  is unknown in the present study, we estimated efficiency scores using a non-parametric approach.<sup>9</sup> Despite being biased, non-parametric *DEA* (Data Envelopment Analysis) and *FDH* methods do not present problems of inconsistency.<sup>10</sup>

Though Brazilian empirical studies have not typically used the *DEA* or *FDH* based on their respective statistical properties,<sup>11</sup> these two methods already offer such properties. *DEA* and *FDH* statistical properties were developed by Gijbels et al. (1999) and Park et al. (2000), respectively. It should be emphasized that *DEA* statistical properties were developed only for bivariate environments, i.e., for production plans containing inputs and products.

The *DEA* and *FDH* differ in that only the former requires convexity.<sup>12</sup> Silva et al. (2007) showed that both methods present unique advantages and limitations in estimating efficiency scores. The authors thus recommend a simultaneous use of both to increase the reliability of results obtained. Thus, the two estimation methods should be viewed as complementary.

However, in this study, statistical properties of nonparametric methods are required. Thus, to build confidence intervals and obtain reliable statistical significance values of estimated efficiency scores, only the *FDH*<sup>13</sup> is used, as it allows for the use of these production plan properties with multiple inputs and products.<sup>14</sup>

### 2.3.1. *FDH* – free disposal hull

Production frontiers estimated from the *FDH* method do not impose convexity restrictions, but an assumption of *Free Disposal*. This assumption claims that it is always possible to add input units without sacrificing production. Rather, additional inputs can be transferred or eliminated without cost. Thus, using this method, one can estimate frontiers with constant, increasing or decreasing scale returns.

Using a random sample  $X_N = \{(x^i, y^i)\}_{i=1,2,\dots,N}$  as the set of inputs and products belonging to a certain technology, as long as real production is unknown, the production frontier estimation via *FDH* is given by:

$$T_{FDH} = \bigcup_{(x_i, y_i) \in X_N} \{(x, y) \in \mathfrak{R} + \mathfrak{p} \times \mathfrak{R} + \mathfrak{q} : y \leq y_i, x \geq x_i\} \quad (3)$$

When estimating the frontier using (3), the input or product is occasionally fixed. Consider  $P(x)$  the set of products that can be produced by  $x$ . Taking  $x_0$  as fixed:  $\hat{P}(x_0) = \{y : (x_0, y) \in T_{FDH}\}$ . Taking  $y_0$  as fixed:  $\hat{L}(y_0) = \{x : (x, y_0) \in T_{FDH}\}$ . In turn, one can estimate the efficiency score for a particular city council department  $(x_0, y_0)$  relative to the frontier  $T_{FDH}$ .

As noted above, it is possible to obtain efficiency scores from both in terms of inputs and products. However, in this study, efficiency scores are obtained only in terms of products because our analysis assumes flexibility in product increase and decrease, but not for inputs. This point is discussed further in the results section.

Regarding products, it is possible to use the *FDH* method to define an estimator  $\lambda_{FDH}$  to obtain the efficiency score of a given city council department  $(x_0, y_0)$  relative to the frontier  $T_{FDH}$ :

$$\lambda_{FDH}(x_0, y_0) = \sup\{\lambda : (x_0, \lambda y_0) \in T_{FDH}\}, \lambda \geq 1 \quad (4)$$

This estimator locates the maximum product for all city council departments that use inputs that are less than or equal to those of the evaluated city council. When  $\lambda = 1$ , the examined city council department meets the production

<sup>9</sup> Parametric methods, as described by Tannuri-Pianto et al. (2009), could also have been applied.

<sup>10</sup> For more information on statistical properties of the *DEA* and *FDH* estimators, see Gijbels (1999) and Park et al. (2000), respectively.

<sup>11</sup> An exception is Silva et al. (2007), which uses both the *DEA* and *FDH* and considers their statistical and econometric properties.

<sup>12</sup> The convexity hypothesis, in turn, prevents the estimated production frontier from the *DEA* from increasing scale returns. Only decreasing and constant scale returns are allowed in the case of the *DEA*.

<sup>13</sup> It is not the *FDH* that is used in the analysis, but a version that corrects the *FDH* estimator bias called the C-*FDH*, as shown below.

<sup>14</sup> The *DEA* estimator developed in Gijbels (1999) cannot be used for production plans with multiple inputs and products, which is the case for this study. Even in the case of the *DEA*, it is possible to construct confidence intervals using *bootstrap*; however, we not only construct confidence intervals, but also make use of statistical properties of the *FDH* estimator, allowing one to correct its bias.

frontier. In accordance with expression (3), assuming the size of input and product vectors  $p$  and  $q$ , respectively, the  $FDH$  efficiency score estimator algorithm relative to frontier  $T_{FDH}$  is:

$$\lambda_{FDH}(x_0, y_0) = \max_{i: x^i \leq x^1} \min_{j \leq q} \frac{Y_i^j}{y_0^j} \quad (5)$$

This  $FDH$  algorithm is designed to determine an efficiency score of  $\lambda_{FDH}$  among various city council product ratios by comparing examined city councils with all others using the same or fewer inputs, producing  $\lambda_{FDH}$  relative to the maximum product.<sup>15</sup>

### 2.3.2. $FDH$ estimator and corrected $FDH$ estimator ( $C$ - $FDH$ ) properties<sup>16</sup>

After defining  $\lambda_{FDH}$  estimator options, we examined estimator properties in view of our study objectives. When the  $FDH$  method is applied, it is assumed that the constructed technological frontier  $T_{FDH}$  is the actual technology  $T$ . Therefore, according to Park et al. (2000), supposing  $T_{FDH} \subseteq T$ ,  $\lambda_{FDH}(x, y) \leq \lambda(x, y)$  is obtained.

This implies that  $\lambda(x, y) - \lambda_{FDH}(x, y) \geq 0$ , which in probabilistic terms can be written as follows:  $P(\lambda(x, y) - \lambda_{FDH}(x, y) \leq z) = 0, \forall z \leq 0$ . In other words,  $P(\lambda(x, y) - \lambda_{FDH}(x, y) \leq z)$  for  $z > 0$ . In turn, the following equation can be used:

$$P(\lambda(x, y) - \lambda_{FDH}(x, y) \leq z) = 1 - P(\lambda(x, y) - \lambda_{FDH}(x, y) > z) \quad (6)$$

It is possible to manipulate Eq. (6) based on Eqs. (7)–(9) to obtain Eq. (10) based on an assumption of independent observations:

$$P(\lambda(x, y) - \lambda_{FDH}(x, y) \leq z) = 1 - P(\lambda_{FDH}(x, y) < \lambda(x, y) - z) \quad (7)$$

$$P(\lambda(x, y) - \lambda_{FDH}(x, y) \leq z) = 1 - P\left(\max_{i: x^i \leq x^1} \min_{j \leq q} \frac{Y_i^j}{y_0^j} < \lambda(x, y) - z\right) \quad (8)$$

$$P(\lambda(x, y) - \lambda_{FDH}(x, y) \leq z) = 1 - \left[ P\left\{ \min_{1 \leq j \leq m} \frac{Y_i^j}{y_0^j} < \lambda(x, y) - z \text{ ou } x^i > x \right\} \right] \quad (9)$$

$$P(\lambda(x, y) - \lambda_{FDH}(x, y) \leq z) = 1 - [1 - P(x^i \leq x \text{ e } y_j^i \geq \lambda(x, y) - z y_j)]^N \quad (10)$$

In Eq. (10), one can observe consistency in estimator  $\lambda_{FDH}(x, y)$ , i.e.,  $P(\lambda(x, y) - \lambda_{FDH}(x, y) \leq z) \rightarrow 1$  when  $N \rightarrow \infty, \forall z > 0$ . From this equation and other theoretical manipulations, Park et al. (2000) showed that the difference between the true efficiency score ( $\lambda$ ) and  $FDH$  estimator ( $\lambda_{FDH}$ ) follows a Weibull asymptotic distribution:

$$\lambda(x, y) - \lambda_{FDH}(x, y) \sim \text{Weibull}(N\mu^{p+q}, p + q) \quad (11)$$

In Eq. (11),  $\mu$  should be estimated based on data. After using the Weibull distribution to estimate  $\mu$ , Park et al. (2000) determined the estimator  $\lambda_{FDH}$  bias and obtained the following estimator that corrects this bias<sup>17</sup>:

$$\lambda_{FDH-C}(x, y) = \lambda_{FDH}(x, y) - c_1 \hat{\mu}^{-1} n^{-1/p+q} \quad (12)$$

As a result, by means of estimator  $\hat{\mu}$ , it is possible to obtain unbiased efficiency scores and to construct confidence intervals for these scores from percentiles of the Weibull distribution, forming the following confidence interval:

$$[\lambda_{FDH}(x, y), \lambda_{FDH}(x, y) + \hat{\mu}^{-1} n^{-1/p+q} z_{1-\alpha}] \quad (13)$$

In (13),  $z_\alpha = (-\log(1 - \alpha))^{(1/p+q)}$ , where  $\alpha$  is the level of significance. Therefore, using Eq. (11), it is possible to measure  $FDH$  efficiency score statistical significance by way of a known probability distribution (Weibull). This approach differs from the  $DEA$  method, for which, in the case of production plans with multiple inputs and products, confidence intervals are determined strictly via *bootstrap*.

<sup>15</sup> In the present study, we apply the  $FDH$  standard estimation procedure (correcting for inconsistency, as noted in the following section), and we do not correct outliers, as described in Cazals et al. (2002).

<sup>16</sup> Based on Martins-Filho (2008).

<sup>17</sup>  $c_1 = \Gamma((p + q + 1)/(p + q))$ , where  $\Gamma$  is the Gamma function and  $c_1$  is the first point in the Weibull distribution.

#### 2.4. Environmental variable coefficient estimation

In theory, from an econometric perspective, this article employs a two-step procedure. First, relative efficiency is measured. Second, a regression of the efficiency score against different variables from those used in the first stage is performed. These variables are called non-discretionary, environmental or exogenous variables of the production process.

The objective of this procedure is to explain obtained inefficiencies while emphasizing that such explanations (environmental variables) do not technically form the production plan because they are exogenous to the production process. Rather, they do not account for decision maker choices, i.e., they are non-discretionary variables.

In empirical applications of this two-step procedure, several models had already been used in the second stage, such as censored models (*Tobit*) and lognormal models. According to [Simar and Wilson \(2007\)](#), these models cannot be applied in the second stage because nonparametric estimators (*DEA* and *FDH*) are serially correlated.

In fact, disruptions to frontier observations change estimated efficiency values for other observations. Hence, if the second stage is estimated using *Tobit*, the conventional inference is inconsistent.<sup>18</sup> To correct this inconsistency, [Simar and Wilson \(2007\)](#) presented two algorithms that use the *bootstrap* procedure.

The first algorithm corrects second-stage inference inconsistency but does not address non-parametric estimator bias. The second algorithm is more complete as it also addresses non-parametric estimator (*DEA* or *FDH*) bias. Because the *FDH* estimator used in this article already addresses bias, environmental variable coefficients were estimated using the first algorithm.

For the first algorithm, estimation involves the following steps:

1. When using observation data  $(x_i, y_i, z_i)$  where  $z$  is an environmental variable,  $\hat{\theta}_i = \hat{\theta}(x_i, y_i, \psi_{FDH}) \forall i = 1, \dots, n$  is calculated;
2. The maximum likelihood method is used to obtain an estimate  $\hat{\beta}$  of  $\beta$  and an estimation of  $\hat{\sigma}_\varepsilon$  of  $\sigma_\varepsilon$  in truncated regression  $\hat{\theta}_i$  in  $Z_i$  using  $m < n$  observations, where  $\hat{\theta}_i > 1$ ;
3. Steps i to iii involve repeated  $L$  times to obtain a *bootstrap* set of estimations  $A = \{(\hat{\beta}^*, \hat{\sigma}_\varepsilon^*)_{b=1}^L$ :
  - i. For each observation ( $i = 1, \dots, m$ ), remove  $\varepsilon_i$  from the normal distribution  $N(0, \hat{\sigma}_\varepsilon^2)$ , truncated to the left  $(1 - Z_i \hat{\beta})$ ;
  - ii. For each  $i = 1, \dots, m$ , compute  $\hat{\theta}_i^* = Z_i \hat{\beta} + \varepsilon_i$ ;
  - iii. Use the maximum likelihood method to estimate the truncated regression of  $\hat{\theta}_i$  on  $C_i$ , producing estimations of  $(\hat{\beta}^*, \hat{\sigma}_\varepsilon^*)$ ;
4. Use *bootstrap* values calculated in step iii and original estimations  $\hat{\beta}$  and  $\hat{\sigma}_\varepsilon$  to construct confidence intervals for each element of  $\beta$  and  $\sigma_\varepsilon$ . Suppose that the intention is to estimate  $\beta_j$ , the  $j$ -th element of  $\beta$ , which is estimated from  $\hat{\beta}_j$ , the  $j$ -th element of  $\hat{\beta}$ .

If the distribution of  $(\hat{\beta}_j - \beta_j)$  is known, it is trivial to find  $a_\alpha, b_\alpha$  values such that  $Pr(-b_\alpha \leq (\hat{\beta}_j - \beta_j) \leq -a_\alpha) = 1 - \alpha$  for some  $\alpha, 0 < \alpha < 1$ , such as  $\alpha = 0.05$ . Because the distribution of  $(\hat{\beta}_j - \beta_j)$  is unknown, the  $j$ -th element of  $\hat{\beta}$  can be used to find  $a_\alpha^*, b_\alpha^*$  such that  $Pr(-b_\alpha \leq (\hat{\beta}_j^* - \beta_j^*) \leq -a_\alpha) \approx 1 - \alpha$ , improving the approximation when  $L \rightarrow \infty$ . When replacing  $a_\alpha^*, b_\alpha^*$  with  $a_\alpha, b_\alpha$ , an estimation of confidence intervals given by  $[\hat{\beta}_j + a_\alpha^*, \hat{\beta}_j + b_\alpha^*]$  is generated.

The final issue to discuss with respect to environmental variable coefficient estimation is related to the number of replications,  $L$ , needed to construct confidence intervals. [Simar and Wilson \(2007\)](#) recommend using 2000 replications, and this approach is followed in the present study.

### 3. Data description

Our use of efficiency and production frontiers and indicators for obtaining efficiency scores and legislative city council environmental variable coefficients have been presented and justified. This section presents general

<sup>18</sup> This same statement applies for second stage estimations made through the Ordinary Least Squares (OLS) model because efficiency scores estimated using the FDH-C technique (employed as the dependent variable in the second stage) are serially correlated in an unknown manner, which can often lead to OLS estimator inconsistency.

Table 1  
Descriptive statistics.

Variables	Number of observations	Min.	Max.	Mean	SD*
<i>Interlegis census variables not used in the efficiency analysis</i>					
Respondent mean length of service	4728	3.00	32.50	8.44	6.66
Percentage of female councilors	4920	0.0%	100.0%	12.9%	11.7%
Average councilor age	4599	23	67	42.32	4.54
Percentage of male councilors	4920	0.0%	100.0%	87.1%	11.7%
Mean number of terms in office	4788	1.00	6.00	1.90	0.50
Percentage of female civil servants	4837	0.0%	100.0%	50.2%	23.2%
Percentage of male civil servants	4837	0.0%	100.0%	49.8%	23.2%
Average civil servant age	4351	23.00	67.00	35.84	6.21
Mean civil servant education level (years of study)	4549	4.00	17.00	11.28	1.88
Percentage of personnel cost relative to the total for the chamber	3768	0.00%	100.00%	53.46%	27.23%
Percentage of maintenance cost relative to the total for the city council	3768	0.00%	96.26%	19.69%	15.41%
<i>Variables used in the explanation of inefficiency (environmental variables)</i>					
Mean councilor education level (years of study)	4582	2.00	17.00	9.75	2.21
GDP per capita	2162	1427.21	100,763.77	8441.18	8038.33
Cost per councilor	2162	711.11	1,424,764.42	68,424.96	103,885

Source: 1° LEGISLATIVE CENSUS 2005-SENADO-INTERLEGIS, IBGE and STN/FINBRA.

characteristics of the Interlegis census and of environmental variables used and describes the two products and six inputs applied in this study.

### 3.1. General characteristics of the Interlegis census and of environmental variables

The database used in this study covers all city councils. These data were drawn from the first legislative census, which was conducted in 2005 by the Interlegis Special Secretariat, an agency affiliated with the Federal Senate. The census survey includes 10 sections focusing on issues such as council technological and physical infrastructure, civil servant and of parliamentary education levels, and council legislative and financial capacities.

Most census questions provide two additional answer options: “I don’t know” or “no answer”. These entries were eliminated from descriptive data shown in Table 1 and from our efficiency analyses of city council production plans, as they were treated as “missing” values.

To familiarize the reader with the Interlegis census database, descriptive statistics of the first city council census are presented in Table 1. Table 1 also lists variables cataloged in the FINBRA and IPEADATA, which were used to explain inefficiency scores.

To obtain numerical data, categorical variable manipulations of the Interlegis census were conducted. For instance, the variable for council servant age, which is presented in this census as the number of people for each range, is instead presented as a mean value for each age range.

This mean value was obtained from the midpoint of the age range weighted by the number of people (relative to the total) for the corresponding range. Values for the following categorical variables presented in Table 1 were obtained following this approach: mean councilor length of service and mean councilor age.

The following rubric based years of study was used to determine mean education levels: incomplete primary education, four years, completed primary education, eight years, incomplete secondary education, 10 years, secondary education, 11 years, incomplete higher education, 13 years, completed higher education, 15 years, completed *latu sensu* or *stricto sensu* graduate program, 17 years.

According to Table 1, on average, 87.1% of the councilors are male, are of 42 years of age and have an incomplete secondary education. The councilors have served, on average, for 1.9 terms in city council. For city council servants,



the gender discrepancy is much smaller, and women are the majority, on average, the female percentage is 50.2%. These civil servants are, on average, 35 years of age and have a complete secondary education.

Regarding to city council expenditures (Table 1), personnel costs (relative to total expenditures) reached 53.5%, i.e., relative to all city council resources. In turn, maintenance costs (relative to all city council resources) account for approximately 19.7%.

Regarding environmental variables, only the mean councilor education level was exclusively obtained from the Interlegis census. GDP *per capita* values are cataloged in the IPEADATA. In turn, the 'Expense per Councilor' variable was calculated from two sources: the number of councilors based on the Interlegis census, and city council expenditures taken from the 2004 FINBRA report based on the legislative function category.

The mean councilor education level variable was used following Ferraz and Finan (2008). These authors found that more educated politicians exhibit better legislative performance, and thus it is anticipated that this variable exogenous to legislative procedures per se could improve city council efficiency.

GDP *per capita* values are used to test whether city councils are more or less efficient depending on municipality wealth. In turn, costs per councilor (total city council expenses divided by the number of councilors) are used to assess whether public spending allocated to city council departments affect efficiency.

In addition to these three environmental variables, *dummies* were used for each Brazilian macro-region (the northern, northeastern, southern, southeastern and midwestern regions) to explain inefficiencies. To support our estimations, a dummy for the southern region was excluded. Thus, for example, the northeastern region *dummy* coefficient captures to what degree, on average, city councils are more or less effective depending on the sign of the coefficient relative to the southern region. The goal is to determine whether there are effects idiosyncratic to the northeastern region that render it more or less efficient than the southern region.

### 3.2. Production plans: products and inputs

The Interlegis census was employed based on the assumption that city council products are the result of council inputs. Therefore, numerical variables that reflect city council production plans were selected, i.e., council products and inputs.

The following six inputs were used: number of councilors, number of civil servants, number of telephones, number of fax machines, available Internet connection and legislative system computerization. In the case of legislative production, two products were considered: the number of bills presented by parliamentarians and the total number of bills approved by councils of a parliamentary, executive or popular nature.<sup>19</sup>

Some census questions were not included in the council production plans. Information regarding the number of computers in each city council department were not used because these data were presented in ranges.

Technological resources available to employees are central to an analysis of legislative production, and the number of available computers is a good proxy in this regard. However, transforming such information (the range of the number of computers) into numerical data would affect the results considerably. The arbitrary midpoint of each range (as input) would have significantly altered the efficiency scores.

In Chart 1, the number of computers is shown based on ranges used in the census. It should be noted that 78% of the municipalities fall within the first range (city councils with one to five computers).

Another potential variable of council input that could also serve as proxy for technological resources available to employees is information regarding the number of computers connected to the Internet. However, because no answer was given for this variable for more than 50% of the city councils examined, its use was impractical.

Given these impossibilities, to determine technological resources available to city council staff, two variables were employed: available Internet connection and legislative system computerization. Internet connection is a binary variable with only two possible answers: available or not available.

For legislative system computerization, we aim to identify whether legislative processes, administrative processes or parliamentary activities involve computerized procedures (systems). This input was constructed based on three

<sup>19</sup> In Brazil, the two major responsibilities of a legislative council are to legislate and supervise. Thus, it was only possible to identify a legislative function product. No Interlegis census variable addresses the supervisory function.

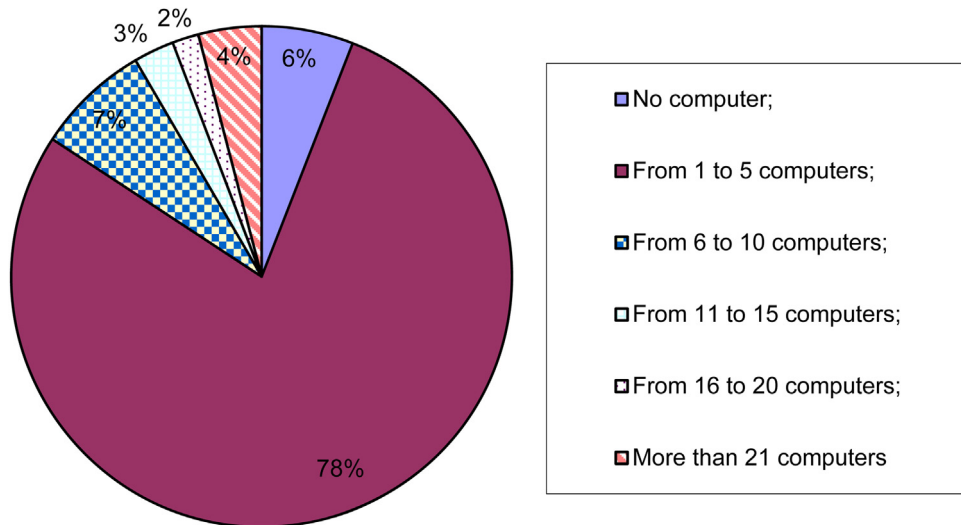


Chart 1. Number of computers in city councils.

items. A weight of one was assigned for each system identified. In this case, city council scores range from zero (no computerized systems) to three (all systems are computerized).

Regarding product data, bills authored by the executive or by popular initiative were not used because they do not originate from city council inputs. Conversely, as parliamentary, executive and popular bill approvals depend directly on council inputs, the number of bills approved is considered a council product.

Table 2 presents descriptive statistics for variables used as inputs and products for the 3878 city councils used to obtain efficiency scores.

In Table 2, the total of 3878 city councils arises from the elimination of all councils holding any one of the two products equal to zero and all the councils in which the variable number of councilors is less than nine, which is impossible, according to the article 29 of the Constitution.

Table 3 list the input and product variables under four population ranges. On range 1, are listed the city councils of municipalities with up to 20,000 inhabitants. On range 2, the councils located in municipalities that have between 20,000 and 100,000 inhabitants. On range 3, those located in municipalities that have between 100,000 and 500,000 inhabitants. On range 4, are the councils in municipalities with more than 500,000 inhabitants.

Table 2  
Inputs and products used in the estimation.

Variables	Min.	Max.	Mean	SD*
<i>Inputs</i>				
Number of councilors	9	50	9.30	1.42
Number of civil servants	0	1472	14.16	40.72
Number of telephones	0	221	4.20	10.22
Number of fax machines	0	96	0.95	2.30
Internet connection (binary variable)*	0	1	0.83	0.38
Legislative system computerization	0	3	1.61	1.21
<i>Products</i>				
Number of bills presented by parliamentarians	1	620	11.49	28.48
Number of approved bills**	1	806	29.26	32.36

Source: 1st LEGISLATIVE CENSUS 2005-SENADO-INTERLEGIS.

\* Obs. Zero denotes that a connection to the Internet is not available and 1(one) means available connection.

\*\* It is the sum of the approved bills of parliamentary, popular and executive origin.

Table 3  
Inputs and products used in the estimation, according to population ranges.

Variables	Range	Min.	Max.	Mean	SD*
Number of councilors	Range 1	9	19	9.01	0.22
	Range 2	9	14	9.25	0.47
	Range 3	10	30	12.69	2.53
	Range 4	19	50	23.63	8.05
Number of telephones	Range 1	0	64	2.12	2.67
	Range 2	0	78	5.58	7.01
	Range 3	0	193	24.51	31.57
	Range 4	0	221	40.44	64.48
Number of fax machines	Range 1	0	5	0.73	0.48
	Range 2	0	14	0.92	0.74
	Range 3	0	50	3.37	6.20
	Range 4	0	96	12.94	25.09
Connection to the Internet (binary variable)*	Range 1	0	1	0.79	0.40
	Range 2	0	1	0.89	0.31
	Range 3	0	1	0.92	0.27
	Range 4	0	1	0.75	0.45
Computerization of legislative system	Range 1	0	3	1.52	1.22
	Range 2	0	3	1.77	1.16
	Range 3	0	3	2.08	1.03
	Range 4	0	3	2.44	0.81
Number of civil servants	Range 1	0	107	6.44	5.66
	Range 2	0	226	18.32	17.92
	Range 3	0	1472	80.52	132.03
	Range 4	0	712	302.75	233.97
Number of bills submitted by the parliamentarians	Range 1	1	170	6.24	10.11
	Range 2	1	612	13.96	25.41
	Range 3	2	400	60.03	63.67
	Range 4	24	620	196.75	179.31
Number of approved bills**	Range 1	1	260	24.33	21.66
	Range 2	1	392	34.09	32.83
	Range 3	5	806	68.43	78.81
	Range 4	31	500	104.38	114.94

Source: 1st LEGISLATIVE CENSUS 2005-SENADO-INTERLEGIS.

Obs.: Zero means that Internet connection is not available and one denotes connection availability.

\*\* The sum of approved bills of parliamentary, popular and executive origin. Population ranges are distributed as follows: range 1 = municipalities of up to 20,000 inhabitants ( $n=3654$ ), range 2 = municipalities of between 20,000 and 100,000 inhabitants ( $n=1241$ ), range 3 = municipalities of between 100,000 and 500,000 inhabitants ( $n=203$ ), range 4 = municipalities with over 500,000 inhabitants ( $n=32$ ).

Table 3 shows that the mean values are increasing in all variables. In other words, higher local population size means greater quantity of inputs and products of city councils. This finding shows that the division in these population ranges will allow the analysis of the results (efficiency scores) in a more homogeneous way.

Given this fact, it is worth mentioning that the FDH estimator only compares units of inputs in equal or lesser amount of those used by the comparison unit, i.e., the efficiency scores are obtained only among “comparable” units. By way of illustration, a chamber that has 20 councilors is compared only with a chamber that has 20 or fewer councilors.

A number of results presented in Table 3 must be highlighted. In 2005, Internet connection was available in 92% of legislative councils of municipalities with a population size of between 100,000 and 500,000 inhabitants, which is a higher percentage than that of cities with more than 500,000 inhabitants (75%). In turn, legislative system computerization is much more prevalent in municipalities with over 500,000 inhabitants relative to other municipalities.

Table 4 presents city council production plan products and inputs from a regional standpoint.

Table 4  
Inputs and products used in the estimation by macro region.

Variables	Region	Min.	Max.	Mean	SD*
Number of councilors	Northern	9	18	9.22	0.83
	Northeastern	9	24	9.28	1.31
	Southeastern	9	50	9.41	1.86
	Southern	9	36	9.24	1.22
	Midwestern	9	21	9.14	0.82
Number of civil servants	Northern	0	338	15.78	26.31
	Northeastern	0	674	14.61	34.84
	Southeastern	0	1472	16.55	56.24
	Southern	0	712	10.50	30.80
	Midwestern	0	350	12.44	25.13
Number of telephones	Northern	0	32	2.75	4.66
	Northeastern	0	172	3.27	7.42
	Southeastern	0	221	5.62	14.37
	Southern	0	150	4.20	9.38
	Midwestern	0	37	3.79	4.90
Number of fax machines	Northern	0	14	0.66	0.96
	Northeastern	0	35	0.68	1.43
	Southeastern	0	50	1.25	2.49
	Southern	0	96	1.05	3.37
	Midwestern	0	3	0.82	0.47
Internet connection (binary variable)*	Northern	0	1	0.56	0.50
	Northeastern	0	1	0.67	0.47
	Southeastern	0	1	0.94	0.24
	Southern	0	1	0.94	0.24
	Midwestern	0	1	0.91	0.29
Legislative system computerization	Northern	0	3	1.86	1.22
	Northeastern	0	3	1.44	1.31
	Southeastern	0	3	1.70	1.13
	Southern	0	3	1.61	1.15
	Midwestern	0	3	1.68	1.17
Number of bills submitted by parliamentarians	Northern	1	81	6.92	10.04
	Northeastern	1	300	8.64	16.58
	Southeastern	1	620	15.83	37.47
	Southern	1	612	11.16	32.41
	Midwestern	1	160	11.26	21.99
Number of approved bills**	Northern	1	392	17.43	28.23
	Northeastern	1	400	14.98	17.97
	Southeastern	1	500	31.78	31.29
	Southern	1	806	47.77	38.42
	Midwestern	1	295	31.04	33.14

Source: 1st LEGISLATIVE CENSUS 2005-SENADO-INTERLEGIS.

Obs.: Zero denotes that Internet connection is not available and one denotes connection availability.

\*\* The sum of approved bills of parliamentary, popular and executive origin.

Regional results presented in Table 4 show that municipalities in the southern region employ, on average, far fewer servants (roughly 10.5) than northern, northeastern and southeastern municipalities, with the latter employing the most servants (16.55) on average. This table also presents interesting results on legislative production.

Parliamentarians in the southeastern region submitted on average 83% more bills than those of the northeastern region and 129% more than those of the northern region. Regarding the number of approved bills, southern region city councils are, on average, 174% and 219% more productive than those of the northern and northeastern regions, respectively.

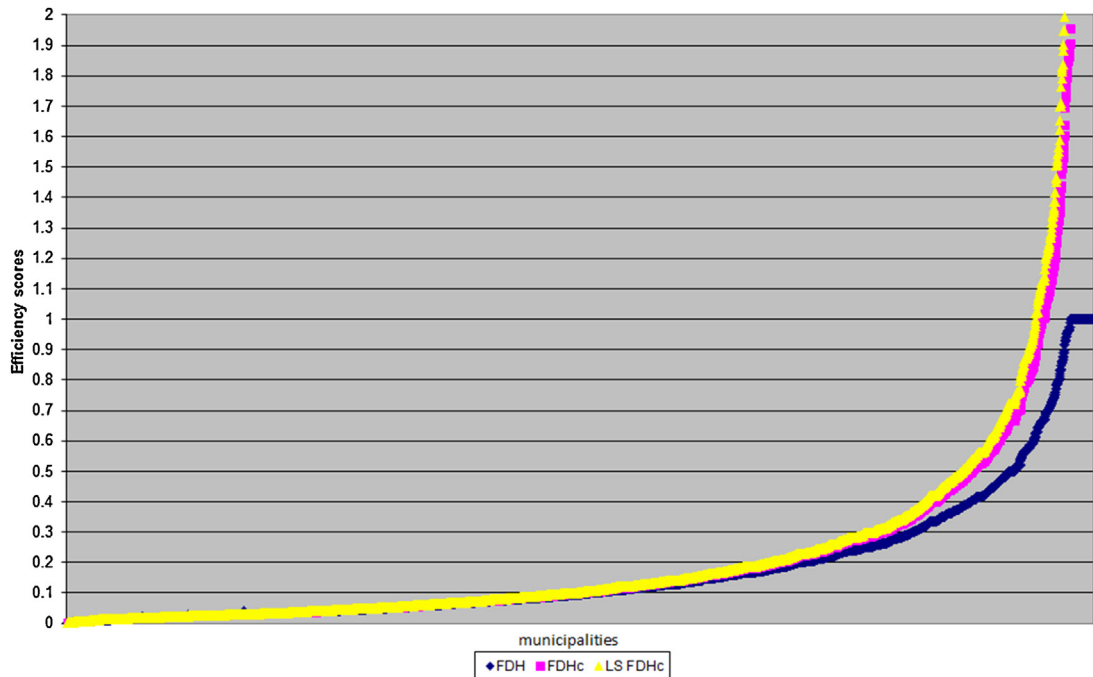


Chart 2. Ranked efficiency scores.<sup>23</sup>

#### 4. Analysis of results

Here, we present an analysis of efficiency scores obtained using the estimator  $\lambda_{FDH-C}$ , which corrects the FDH estimator, and (estimated) coefficients of environmental variables that explain alleged city council inefficiencies. However, before presenting this analysis, we clarify three issues.

First, our efficiency analysis is based on products because, for city councils, product increase and decrease flexibility exists, but not in the case of inputs. Increased council efficiency due to decreased input is unlikely because various legal mechanisms prevent the dissolution of permanent civil servants and/or councilors. Furthermore, political variables also explain the rigidity of aforementioned inputs.

Second, we compare estimated efficiency scores based on population size and region (using the same four ranges described in the previous section).

Third, for the purpose of clarity, the  $\lambda_{FDH-C}$  estimator is reversed in the efficiency score analysis. From this inversion, obtained scores were divided into five intervals. The first four are organized into quartiles and the latter represents the most efficient councils (inverse of  $\lambda_{FDH-C}$  greater than or equal to one). According to Eq. (13), the  $\lambda_{FDH}$  estimator underestimates efficiency, which is corrected via  $\lambda_{FDH-C}$ . This underestimation makes it possible to find an inverse of  $\lambda_{FDH-C}$  that is greater than one.

In our estimation of efficiency scores, correcting the estimator  $\lambda_{FDH}$  bias changed the values ranging from one to roughly 1.4 into a number less than or equal to one when  $\lambda_{FDH-C}$  was obtained. This made the inverse of  $\lambda_{FDH-C}$  greater than or equal to one. In addition, by correcting this bias in conjunction with its confidence interval,  $\lambda_{FDH}$  scores ranging from one to approximately 1.4 are statistically equal. Thus, the confidence interval with the most efficient councils was defined as the one with scores (of the inverse of  $\lambda_{FDH-C}$ ) greater than or equal to one.

Following these considerations, **Chart 2** ranks inverse of efficiency scores  $\lambda_{FDH-C}$  with respective confidence intervals, i.e., with lower and upper bounds obtained in accordance with Eq. (14) at a significance level of 5% ( $\alpha = 0.05$ ) (a 95% confidence interval).

<sup>23</sup> Although the scale presented in Chart 2 is unclear, we confirm that estimator values fall within the confidence interval as anticipated.

Table 5  
Relative frequency of efficiency scores by interval.

Region	Between 0 and 0.25	Between 0.25 and 0.50	Between 0.50 and 0.75	Between 0.75 and one	Above one
Northern	10%	3%	4%	3%	1%
Northeastern	33%	26%	16%	19%	15%
Southeastern	31%	34%	24%	26%	17%
Southern	18%	26%	51%	47%	58%
Midwestern	8%	10%	5%	5%	8%
Total	2880	534	192	78	194

Table 6  
Relative frequency of efficiency scores by macro-region.

Region	Between 0 and 0.25	Between 0.25 and 0.50	Between 0.50 and 0.75	Between 0.75 and one	Above one	Total
Northern	91%	6%	2%	1%	1%	309
Northeastern	82%	12%	3%	1%	3%	1162
Southeastern	76%	16%	4%	2%	3%	1178
Southern	57%	16%	11%	4%	13%	903
Midwestern	74%	17%	3%	1%	5%	326

Chart 2 plots efficiency scores (accompanied by respective confidence intervals) along a monotonically increasing curve. Hence, from a statistical perspective, it is possible to conclude that based on a 95% confidence interval, higher (smaller) scores are higher (smaller). For example,<sup>20</sup> a score of 0.45 is significantly greater than 0.2.

In addition to efficiency score monotonicity, it should be noted that FDH estimator corrections changed efficiency inferences obtained using the FDH estimator. Several councils considered inefficient through the FDH analysis were rendered effective after this bias correction. This demonstrates that the  $\lambda_{FDH-C}$  estimator more reliably predicts relative efficiency.

Table 5 presents the results in terms of frequency relative to the total number of city councils in each range of the inverse based on the corrected FDH estimator, distributed based on macro-regions: northern, northeastern, southeastern, southern and midwestern. The highest concentration (58%) of efficient city councils is found in the southern region<sup>21</sup>. The highest concentration (33%) of least efficient councils is found in the northeastern region, followed closely by the southeastern region (31%).

The fourth and fifth columns of Table 5 show that the southern region presents the highest percentages. In other words, southern municipalities more frequently occupy the production frontier. Additionally, this region includes more city councils closer to the frontier relative to other regions (47% of all councils with an inverse of  $\lambda_{FDH-C}$  scores between 0.75 and 1).

Fixing rows rather than columns, Table 6 presents complementary information to Table 5. Table 6 presents city council efficiency scores by region. In each region, the highest concentrations of municipalities fall under lower ranges of efficiency (0–0.25). Still, proportionately less inefficient councils are concentrated within the southern region (57%).

Furthermore, Table 6 shows that the southern region includes proportionately more efficient councils (13%) relative to the other regions.

Table 7 presents the relative frequency of city council efficiency scores by population range. For the first three population ranges, the percentage of city councils with scores of up to 0.25 (i.e., municipalities that can at least quadruple their product) is greater than 60%. In municipalities with more than 500,000 inhabitants, numerous councils present efficiency values of zero to 0.25, but this is well below 60%, i.e., approximately 44%.

<sup>20</sup> While this may seem numerically impossible, when efficiency scores are estimated without confidence intervals, there is no statistical certainty that one is different from 1.4, for example.

<sup>21</sup> Note that the notion of efficiency is relative, i.e., a council is more or less efficient relative to other councils present in the sample that use equal or fewer inputs.

Table 7  
Relative frequency of efficiency scores by population range.

Score Range	Up to 20,000 inhabitants	Between 20,000 and 100,000 inhabitants	Between 100,000 and 500,000 inhabitants	More than 500,000 inhabitants
Between zero and 0.25	74%	77%	63%	44%
Between 0.25 and 0.50	14%	13%	20%	25%
Between 0.50 and 0.75	5%	4%	7%	6%
Between 0.75 and one	2%	2%	3%	13%
Above one	5%	5%	8%	13%
Total by range	2628	1065	169	16

Table 8  
Inefficient city councils: explanation based on environmental variables.

Variables	Coefficient	Standard deviation	P-value
Constant	19.4	5.6	0.00
Mean councilor education level (years of study)	−0.97	0.49	0.03
GDP per capita	0.00023	0.00013	0.04
Cost per councilor	−0.000026	0.000011	0.01
<i>Dummies</i>			
Northern Region	24.3	4.2	0.00
Northeastern Region	22.9	3.1	0.00
Southeastern Region	8.4	2.7	0.00
Midwestern Region	7.8	4.1	0.03

Table 7 shows that municipalities with more than 500,000 inhabitants account for a larger proportion of efficient city councils (13%). When observing a range (of the inverse of  $\lambda_{FDH-C}$ ) above one, on average, municipalities with larger populations tend to manage more efficient city councils.

From these findings on the most efficient city councils based on population range, we determine estimated coefficients of environmental variables used to examine ineffective councils: mean councilor education levels, GDP *per capita*, cost per councilor and *dummies* for Brazilian macro-regions.

It should be noted that when estimating environmental coefficients, the regressand was deemed the vector with efficiency scores  $\lambda_{FDH-C}$  and not its inverse and based on only councils below the production frontier, i.e., considering only ineffective cameras. In this case, higher values of  $\lambda_{FDH-C}$  correlate with a greater degree of municipal city council inefficiency.

In Table 8, all variables are statistically significant at the 95% confidence level. In the case of mean councilor education levels, an increase of one year in mean education corresponds with a 0.97 decrease in the  $\lambda_{FDH-C}$  score, i.e., it decreases inefficiency by 0.97, on average. This result reflects those of Ferraz and Finan (2008),<sup>22</sup> who found that more highly educated Brazilian councilors present better legislative performance.

Regarding costs per councilor, for which total city council expenses are divided by the number of councilors, an increase of BRL 1 (one real) reduces council inefficiency by 0.000026. Because this is a very small effect, the impact of increased costs per councilor on city council inefficiency is almost negligible.

With regards to GDP per capita, an increase of BRL 1 (one real) in GDP increases inefficiency by 0.00023. Hence, on the frontier, wealthier municipalities manage more inefficient councils, according to the proposed production plan. Thus, parliamentarians of richer municipalities tend to propose and approve fewer laws. Though the effect of increasing GDP per capita on inefficiency is small, this result was not expected.

In addition to mean councilor education, councilor cost, and GDP per capita values, *dummies* were used for each Brazilian macro-region (northern, northeastern, southern, southeastern and midwestern) in the explanation of

<sup>22</sup> These authors, who also use the Interlegis census, found that higher wages attract more highly educated councilors, which in turn exhibit stronger legislative performance.

inefficiencies. In this case, the dummy for the southern region was excluded to avoid multicollinearity. For example, the northern region dummy coefficient captures the average degree to which northern region location affects council efficiency relative to southern positioning.

It is worth noting that a population variable was not included among the set of environmental variables because the cost per councilor variable, which indirectly includes a standard cost by population range, was already included, as defined in art. 29, item VI of the Federal Constitution of 1988 (CF/88). In addition, two restrictions affect spending limits and use population ranges as a criterion, thus also serving, albeit indirectly, as a means of population scale control. The first restriction, found in art. 29, item IV of CF/88, limits the number of councilors by population range. The second, included in art. 29 of CF/88, limits legislative spending relative to municipality revenues.

In this case, there appears to be a factor idiosyncratic to the southern region that renders city councils more efficient than those of other regions. This is also true when considering other environmental variables and inputs of the production plan used to obtain efficiency scores.

From the coefficients obtained, these idiosyncrasies are far more prevalent relative to the northern and northeastern regions than relative to the southeastern and midwestern regions. Such idiosyncrasies, rooted in institutional, political and legal factors, may be difficult to measure quantitatively, as they were not captured in either of the two phases of econometric analysis.

## 5. Conclusions

This article presents a novel use of Interlegis census data for examining Brazilian city council efficiency. The most efficient city councils with regards to legislative production were identified, i.e., the most efficient councils in the allocation of inputs and products.

Based on a given production plan, this study identified regions where the most efficient councils are located and considered degrees of efficiency by population range. In addition, by means of environmental variables, this article provided information on factors (exogenous to legislative procedures per se) that account for city council inefficiencies.

Regionally, the highest concentration of efficient councils is found in the southern region. In turn, the northeastern and southeastern regions present the greater number of less efficient councils. In the northeastern region, for example, roughly one-third of councils could at least quadruple their production without a change in inputs.

Regarding population ranges, for municipalities with up to 500,000 inhabitants, the percentage of cameras with scores equal to or below 0.25 (i.e., municipalities that could at least quadruple their production) is greater than 60%.

With respect to city council inefficiency, an increase in mean councilor education or in costs per councilor decreases council inefficiency. However, the effect of costs per councilor on inefficiency is negligible. In turn, an increase in GDP per capita increases inefficiency, though this increase is almost negligible.

Regarding inefficiencies due to environmental variables, features idiosyncratic to the southern region render city councils in this area more efficient than those employed in other regions. These idiosyncrasies may be related to factors that are difficult to measure quantitatively, i.e., institutional, political and legal factors, as they were not captured in either of the two phases of econometric analysis.

Additional production plans must be estimated to attain more reliable results on alleged city council inefficiencies using other econometric methodologies.

## References

- Arvate, P.R., Mattos, E., Orellano, V., Rocha, F., 2008. *Eficiência dos gastos em saúde: uma avaliação dos municípios do Estado de São Paulo* (Efficiency of expenditures in health: an evaluation of the municipalities in the State of São Paulo). Centro de Estudos de Política e Economia do Setor Público da Fundação Getúlio Vargas de São Paulo [Public Sector Policy and Economic Studies Center of the Getúlio Vargas Foundation: FGV/EESP and FGV/EAESP, CEPESP].
- Brasil, 2003. *Ministério do Planejamento Orçamento e Gestão, Secretaria de Orçamento Federal (SOF). Vinculações de receitas dos orçamentos fiscal e da seguridade social e o poder discricionário da alocação dos recursos do governo federal, vol. 1* (1).
- Cazals, C., Florens, J.P., Simar, L., 2002. Nonparametric frontier estimation: a robust approach. *J. Econ.* 106, 1–25.
- Ferraz, C., Finan, F., 2008. *Motivating politicians: the impacts of monetary incentives on quality and performance*. PUC-RJ, Preliminar, Rio de Janeiro.
- Gasparini, C.E., Melo, C.S.L., 2004. *Equidade e Eficiência Municipal: uma Avaliação do Fundo de Participação dos Municípios – FPM, vol. 8. Tesouro Nacional. (Org.), Finanças Públicas, Editora Universidade de Brasília, Brasília, pp. 337–401.*



- Gijbels, I., Mammen, E., Park, B., Simar, L., 1999. On estimation of monotone and concave Frontier functions. *J. Am. Stat. Assoc.* 94 (445), 220–228.
- Marinho, A., 2003. Avaliação da Eficiência Técnica nos Serviços de Saúde nos Municípios do Estado do Rio de Janeiro (An evaluation of health services technical efficiency in municipalities of the state of Rio de Janeiro). *Revista Brasileira de Economia* 57 (2), 515–534.
- Martins-Filho, C., 2008. Mini-curso em mediação de eficiência e produtividade da SPE/MF: notas de aula (Mini-course on efficiency and productivity mediation of the SPE/MF: class notes). ESAF, Mimeografado [Mimeograph], Brasília.
- Mas-Colell, A., Whinston, M.D., Green, J.R., 1995. *Microeconomic Theory*. Oxford University Press.
- Park, B., Simar, L., Weiner, Ch., 2000. The FDH estimator for productivity efficiency scores. *Econo. Theor. Camb.* (16), 855–877.
- Ribeiro, M.B., 2008. Desempenho e Eficiência do Gasto Público: uma análise comparativa do Brasil em relação a um conjunto de países da América Latina (Performance and efficiency of public spending: a comparative analysis of Brazil in relation to a group of Latin American countries). ESAF, 2008. XIII Prêmio Tesouro Nacional – Qualidade do Gasto Público, Brasília (DF), Brasília.
- Santos, F.B.C., Cribari-Neto, F., Sousa, M.C.S., Uma, 2007. Análise da Eficiência do Gasto Público Municipal no Brasil (An analysis of the efficiency of municipal public spending in Brazil). *Revista Brasileira de Estatística* 68, 7–55.
- Silva, T.L., Martins-Filho, C., Pontual, E.R., 2007. Análise dos Modelos não Paramétricos DEA e FDH e de seus Procedimentos para Inferência (An analysis of the nonparametric DEA and FDH models and procedures for inference). In: Fortaleza. Anais do XII Encontro Regional de Economia do Nordeste. XII Encontro Regional de Economia do Nordeste[*nl*]Regional Economic Meeting of the Northeastern Region.
- Simar, L., Wilson, P., 2007. Estimation and inference in two-stage, semi-parametric models of production processes. *J. Econ.* 136, 31–64.
- Sousa, M.C.S., Schwengber, S.B., 2005. Efficiency Estimates for Judicial Services in Brazil: Nonparametric FDH and the Expected Ordem-M Efficiency Scores for Rio Grande do Sul Courts. Encontro da ANPEC.
- Sousa, M.C.S., Schwengber, S.B., 2007. Mensurando o Custo Eficiência na Justiça do Trabalho - Ganhos de Escala e o Trade-Off entre o Primeiro e o Segundo Grau (Measuring cost efficiency in the labor courts – scale gains and trade-offs between the first and second degree). In: Ministério da Fazenda-STF. (Org.). Finanças Públicas – XI Prêmio do Tesouro Nacional – 2006. Editora Universidade de Brasília, Brasília, pp. 801–829.
- Souza Júnior, C.V.N., Gasparini, C.E., 2006. Análise da Equidade e da Eficiência dos Estados no Contexto do Federalismo Fiscal Brasileiro (Analysis of state fairness and efficiency in the context of Brazilian fiscal federalism). *Estudos Econômicos*, vol. 36, (4). Instituto de Pesquisas Econômicas, São Paulo – SP, Brasil, pp. 803–832.
- Tannuri-Pianto, M.E., Sousa, M.C.S., Arcoverde, F.D., 2009. Fronteiras de Eficiência Estocásticas para as Empresas de Distribuição de Energia Elétrica no Brasil: uma Análise de Dados de Painel S (Frontiers of Stochastic Efficiency for Electric Energy Distribution Companies in Brazil: a Panel Data Analysis). ARCOVERDE, f. d. *Estudos Econômicos*, vol. 39 (1). Instituto de Pesquisas Econômicas, São Paulo, pp. 221–247.
- Yeung, L.Tai, Azevedo, P.F., 2009. Beyond conventional wisdom and anecdotal evidence: measuring efficiency of Brazilian courts. Encontro da ANPEC.