

Furtado, Bernardo

Conference Paper

Balancing investments in public service personnel and its healthcare provision output: an efficiency analysis for Brazilian municipalities

53rd Congress of the European Regional Science Association: "Regional Integration: Europe, the Mediterranean and the World Economy", 27-31 August 2013, Palermo, Italy

Provided in Cooperation with:

European Regional Science Association (ERSA)

Suggested Citation: Furtado, Bernardo (2013) : Balancing investments in public service personnel and its healthcare provision output: an efficiency analysis for Brazilian municipalities, 53rd Congress of the European Regional Science Association: "Regional Integration: Europe, the Mediterranean and the World Economy", 27-31 August 2013, Palermo, Italy, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:

<https://hdl.handle.net/10419/124113>

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.

Balancing investments in public service personnel and its healthcare provision output: an efficiency analysis for Brazilian municipalities

Bernardo Alves Furtado, PhD¹

Institute of Applied Economic Research (IPEA)

Abstract. Brazil has constitutionally adopted a Unified Health System (SUS) since 1988. SUS is designed so that central government, states and municipalities together offer public, free for all, full health coverage. The complexity and territorial arrangement of SUS have been developed in such a way that each government body has its specific obligations within the system. This legal framework establishes that the municipalities are competent and responsible for providing basic health attention under general guidance of federal policy. Within this context, the objective of this paper is to estimate how efficiently and under which determinants municipalities' personnel expenditures are correlated to increases in health service provision results in the period 2000-2010. In order to do that, firstly, spatial exploratory analysis is applied to data from two different official sources on municipal personnel expenditure. The spatial analysis enables insights into the quality of the expenditure information as well as its heterogeneous spatial distribution. The data used comes from (a) municipal data demanded by the National Treasury and Accountancy Justice Department and (b) labor social information compiled by the Ministry of Labor. Secondly, a Data Envelopment Analysis (DEA) is performed to evaluate municipal expenditure against health provision indicators. Finally, a regression is fitted to identify which elements suggested in the literature are the most influential on the technical efficiency for the Brazilian municipalities. The results confirm (a) that there are high-levels of heterogeneity related to levels of expenditure and basic health achievements; (b) that health provision has not improved for nearly half of the municipalities; (c) that spatial patterns of efficiency are not immediately correlated to economic performance, but are specific to local idiosyncrasies; (d) and that determinants of efficiency are concentrated on two main factors: growth rate of population and GDP. In general, the analysis demonstrates that public provision of services in Brazil is highly heterogeneous with a lack of clear spatial pattern, nor clear determinants. This, in turn, generates cases of local expertise that can be used as benchmarking, but it also makes explicit deficiencies that should be specifically tackled by public policy design.

Keywords. Municipalities, Efficiency, Personnel expenditure, Spatial analysis, Brazil

JEL Codes. R51, H11, H51

¹ Corresponding author: bernardo.furtado@ipea.gov.br.

1. Introduction ²

The Brazilian Unified Health System (SUS) was established by the Constitution in 1988. It was planned to be a “regionalized and hierarchical network constituting a unified system” (BRASIL, 1988). SUS was also designed to provide full coverage, in a decentralized structure and with community involvement. Since its establishment, legislation and actual government procedures and practices within SUS have been updated and ameliorated ³ to better comply with the constitutional mandate. The municipalities – within the decentralized scheme – are responsible for health basic care, whereas states and federal entities focus on more complex health assistance procedures. ⁴

Given the SUS context, the objective of this paper is to gather details on the financial and personnel municipal framework and the produced results in terms of basic health services provision. Thus, this is a structure-descriptive paper that intends to shed light on the patterns of efficiency and its determinants on health achievements for the heterogeneous group of municipalities in Brazil. Data Envelopment Analysis (DEA) is used in a first stage to enable construction of an efficiency indicator. Then a determinant analysis follows – using a typical regression to further understand the elements that compose the estimated efficiency.

There is precise, numerous and spatially-detailed data available for current public policy studies in Brazil. However, there are not as many analyses that are able to associate efficiency of public administrations, especially at the subnational level (Afonso; Romero; Monsalve, 2013). In fact, an intriguing question in the literature is how public expenditure and health provision correlate (Pita Barros, 1998) or what the main determinants of the efficiency of the expenditure are (Afonso; Schuknecht; Tanzi, 2010; Paradekar, 2006). Specifically to the analyses of health and education as services Hauner and Kyobe (2008) advocate that efficiency actually decreases with the level of expenditure. Some of the advantage of Taiwan in health provision efficiency was based on its smaller expenditure in personnel (Wang; Chen; Huang, 2011).

In this proposal we characterize the municipalities’ ability to perform public services in terms of two broad components related to the monetary size and quality of the workforce; and another one specific to investment on basic health care. Thus, not only immediate expenditure on service is considered as attribute, but also we are aiming at associating the

² This paper presents intermediate results in a project that is still being developed.

³ Further legal basis were provided by Laws 8080/90 and 8.142/90 (http://portal.saude.gov.br/portal/saude/area.cfm?id_area=169).

⁴ For details of the Unified Health System we refer the reader to Paim et. al. (2011), Piola et. al. (2009) and the site of the Healthy Ministry in Brazil at www.saude.gov.br.

personnel capacity at the municipality level with produced results. This association of personnel and output can work both ways: (a) it might take a better paid, larger workforce to achieve a mean delivery of output, as well as (b) achieve similar levels of service with a smaller, more poorly paid workforce. Besides that, we understand that the working force of a given municipality is a central element in producing better or worse results. Therefore, the need to clarify likely correlations among monetary values and service provided. Finally, we focus on the dynamics of the achievements of the municipalities as we look into the observed change for inputs and output, rather than absolute level variables.

The idea of this study is to compose a panorama of personnel expenditure data at the municipality level that together with health specific expenditure can be used as input to a health system that provides as output better numbers of children survival.

Besides this introduction, the data used is described in section II, the methodology is detailed in section III. In section IV the results are presented and discussed and section V concludes the paper.

2. Methodology and models

a. DEA

Data Envelopment Analysis (DEA) has been used for some time in the literature when there is a need for comparison among firms and industries (Banker; Charnes; Cooper, 1984; Bogetoft; Otto, 2011; Farrell, 1957; Lavado; Lagrada; Gozun, 2011). DEA has also been applied to evaluate efficiency of municipal bodies (Borger, De; Kerstens, 1996) and Brazilian subnational level (Boueri; Carvalho; Silva, 2009; Gasparini; Miranda, 2011; Miranda, 2006).

In this study we take advantage of the fact that DEA enables the use of multiple inputs that together constitute one output. Further, we do not have to impose *a priori* information on the data, especially given the fact that we have no knowledge of the technology set used to transform inputs into output. All input variables are within the realm of decision-making of the municipality. DEA is useful in the sense that it lets us use the flexibility of a non-parametric method to explore the data⁵.

In the application, we make the weakest assumption of no rescaling – that is, variable returns to scale (vrs).⁶ We also used an input-output model which seeks to simultaneously increase inputs and outputs combined in one single measure, called by Bogetoft and Otto as a

⁵ Thus, being preferable in the case at hand then the Stochastic Frontier Analysis (Bogetoft; Otto, 2011).

⁶ We are also assuming convexity and free disposability. VRS is also called BBC model, following Banker et. al. (1984).

“graph hyperbolic measure of technical efficiency” (2011, p. 31).⁷ All estimations were made in software R, using the library “Benchmarking” by Peter Bogetoft and Lars Otto.

Basically, we model the evolution in time (2000-2010) of indicators of personnel payment and health expenditure as inputs and health provision as output (equation 1). Personnel payment is characterized as both (a) the average annual growth rate (2000-2010) of the monthly salary paid to public workers of each municipality $\Delta(\text{mean}_{\text{salary}})$, and (b) the average annual growth rate (2002-2010) of monthly payroll of each municipality weighted by population $\Delta(\text{payroll}_{\text{per capita}})$. Health expenditure is characterized by the average annual growth rate (2000-2010) of total municipal expenditure in health, also weighted by population $\Delta(\text{HealthExpenses}_{\text{per capita}})$.

The output is given by the average annual growth rate of the percentage of death of children (0 – 4 years old) that could not have been avoided in relation to the total of deaths $\Delta(\% \text{NonAvoidableDeaths})$. *That is, we consider the desired outcome to be when the municipality is proportionally decreasing the number of deaths of children that are clearly avoidable.* As it is, we are able to work with an output that summarizes the quality, not the quantity, of health service provision.

Equation 1 – DEA inputs and output

$$\begin{aligned} \Delta(\text{Mean}_{\text{salary}}) + \Delta(\text{Payroll}_{\text{per capita}}) + \Delta(\text{HealthExpenses}_{\text{per capita}}) \\ = \Delta(\% \text{NonAvoidableDeaths}) \end{aligned}$$

b. Determinants

The determinants chosen to characterize the municipalities in this first exercise came from the literature in efficiency in general and previous workers of municipalities’ efficiency. Thus, we follow the literature on efficiency of public services provision (Afonso; Fernandes, 2008; Balaguer-Coll; Prior; Tortosa-Ausina, 2010, 2007; Furtado, 2012), on educational performance and public expenditure (Paradekar, 2006); efficiency on health considering family income (Sousa; Stošić, 2005) and efficiency on health for Brazil (Miranda, 2006).

Based on the review of this literature, we included in the model the attributes that characterize the municipality at the baseline of our period analysis (2000), plus the growth rates of both population and GDP to help describe the dynamics (equation 2). The variables

⁷ $G = \min \{G > 0 \mid (G_x, \frac{1}{G}y) \in T\}$.

together bring elements of urbanity (proportion of urban population), production (growth rate of GDP), economic purchase power (average families' income), general families' quality of life index (Municipal Human Development Index), size (number of inhabitants), and demographic dynamics (average annual growth rate of inhabitants). The source of the data is the official statistics institute of Brazil (IBGE).⁸

The proportion of urban population (*urban_prop*) is estimated considering the official urban division applied in Brazilian census. The average annual growth rate of GDP (*GDP_growth*) is calculated at constant market prices of 2000, using the implicit price deflator of GDP. Similarly the inhabitants' variation is the average annual growth rate of inhabitants (*delta_pop*) and inhabitants in 2000 (*pop_2000*).

The economic purchase power (*income_2000*) is the average of the municipalities' families' income per capita also in reals (R\$) of 2000. Finally, the Human Development Index at the municipality level is estimated by the United Nations Development Program in Brazil⁹ as the mean of its three sub-indexes: longevity, education and income (*idhm_2000*).

Besides the structural variables, the model also had to account for the heterogeneity of municipalities in Brazil, thus we included a number of *dummies* to express each one of the States, cities with less than 50 thousand inhabitants and a single dummy for the city of Rio de Janeiro (the largest in the sample) (table 1). The state of reference is São Paulo.

Equation 2 – Regression Model

$$\text{Efficiency} = \alpha + \beta_1 \text{Urban}_{prop} + \beta_2 \text{Income}_{2000} + \beta_3 \text{HDI}_{2000} + \beta_4 \text{Pop}_{2000} + \beta_5 \Delta(\text{Population}) + \beta_6 \Delta(\text{GDP}) + \text{Dummies}$$

3. Case study

This section aims at describing and detailing the different data sources used in the paper, the exploratory data analysis made, as well as the results produced. All variation data was calculated by average annual growth rate, thus equalizing data with different time-period. Inflation adjustment was applied to currency values using the IPCA¹⁰ price index.

A summary table of the data used is presented and discussed in the last part of this section.

⁸ Brazilian Institute of Geography and Statistics. www.ibge.gov.br.

⁹ www.undp.org.br

¹⁰ IPCA is the official inflation index for Brazil. All prices were set in reals for September 2010.

a. Data: Mean salary

The mean salary of public workers of the municipalities was extracted from the database of Annual List of Social Information (RAIS). This database is made available every year by the Ministry of Labor and contains information on the formal workforce of Brazil, containing data on salary, schooling, admissions and layoffs, company data, and employee position.

We used the list containing the identification (CNPJ ¹¹) of all 5,565 municipalities' administration information provided by the National Forum of Municipalities.¹² Thus, we estimated for each municipality the mean salary received by all workers classified as public workers.¹³

b. Data: Payroll per capita

Payroll per capita – the sum of all salaries paid to public workers weighted by population – was estimated using information provided by the database collected by the Treasury National Secretary (STN). However, the database does not contain information on a number of municipalities.

In order to work with the complete set of municipalities, we used the database built by Orair et. al. (2011).¹⁴ The authors used state information associated with local legal sources and clustering analysis to estimate the data for the missing municipalities.¹⁵

Given the data available, the average annual growth rate was made for the period 2002-2010.¹⁶

The payroll was estimated using the code 3.1.90.11.00 which provides information on salaries and benefits of public workers.

c. Data: Health expenditure

Total health expenditure per capita per municipality was extracted directly from Health of Ministry.¹⁷

¹¹ CNPJ stands for Legal Entity National Database (*Cadastro Nacional da Pessoa Jurídica*) and it is the main company identification in Brazil.

¹² <http://www.fnp.org.br/>

¹³ Some of the municipalities might not have completely filled in the information on RAIS database. Alternatively, we compared the results of mean salary estimated using census information and the National Classification of Economic Activity – municipal public workers (code 84013). The mean estimated from the census is 12% lower than the mean estimated from RAIS with a very similar distribution. However, as the census is estimated from a sampled population and RAIS is a national database – supposedly – containing all employees, we chose to use the RAIS data.

¹⁴ We greatly acknowledge and thank the sending of the requested original data by the authors.

¹⁵ The imputed information is applied to 160 municipalities in 2002 and 48 in 2010.

¹⁶ Estimates for population in 2002 were based on official information from IBGE.

¹⁷ <http://siops-asp.datasus.gov.br/CGI/deftohtm.exe?SIOPS/serhist/municipio/mIndicadores.def>

d. Data: Deaths

The output is built upon the average annual growth rate of the percentage of death of children (0 – 4 years old) that could not have been avoided in relation to the total of deaths. The Ministry of Health (MS/SVS/DASIS – System of Information of Mortality – SIM) collects information about deaths of children from 0 to 4 years old, classifying them as (a) avoidable causes¹⁸: (a.1) by vaccination, (a.2) by attention provided to expecting mothers, at birth and to the newborns, (a.3) by preventive actions and adequate choice of treatment, (a.4) by health promoting actions; (b) undefined causes and (c) other causes – not clearly avoidable.

The indicator is calculated summing (b) and (c) and dividing by the total for both years 2000 and 2010. Then, average annual growth rate is computed. In the end, we have data that expresses proportionally how much each municipality was able to reduce the death of children which could have been clearly avoidable by active health basic care.

e. Data: Summary and spatial analysis

The DEA was applied to 3,392 municipalities (table 1).

Variable	N	Mean	Std Dev	Minimum	Maximum	Median	p25	p75
MeanSalaryRate	3392	0.055	0.042	-0.757	0.614	0.050	0.027	0.079
PayrollPerCapita	3392	0.164	0.561	-0.939	18.879	0.144	0.122	0.170
HealthExpensesPerCapita	3392	0.100	0.043	-0.050	0.314	0.096	0.072	0.125
NonAvoidableDeathsRate	3392	0.002	0.363	-0.499	0.995	0	-0.104	0.054

Table 1 – summary data for the DEA variables

The annual mean salary growth rate within the period is positive in 96% of the municipalities with a typical normal behavior¹⁹. The distribution in space (figure 1) shows that public workers in the Northeast region received a comparably higher growth rate within the period (0.086) when compared to the Southeast (0.029) and South regions (0.035).

The payroll per capita also shows that there is a larger increase in the size of the payroll of public workers of the municipalities specially in the Northeast, North and Center-West regions (figure 2).

The total health expenditure per capita on basic health care in each municipality follows a normal pattern²⁰, however, its growth rate is heterogeneously scattered throughout the country (figure 3).

¹⁸ <http://tabnet.datasus.gov.br/cgi/defthtm.exe?sim/cnv/inf10br.def>

¹⁹ See figure 8 in the annexes.

²⁰ See figure 9.

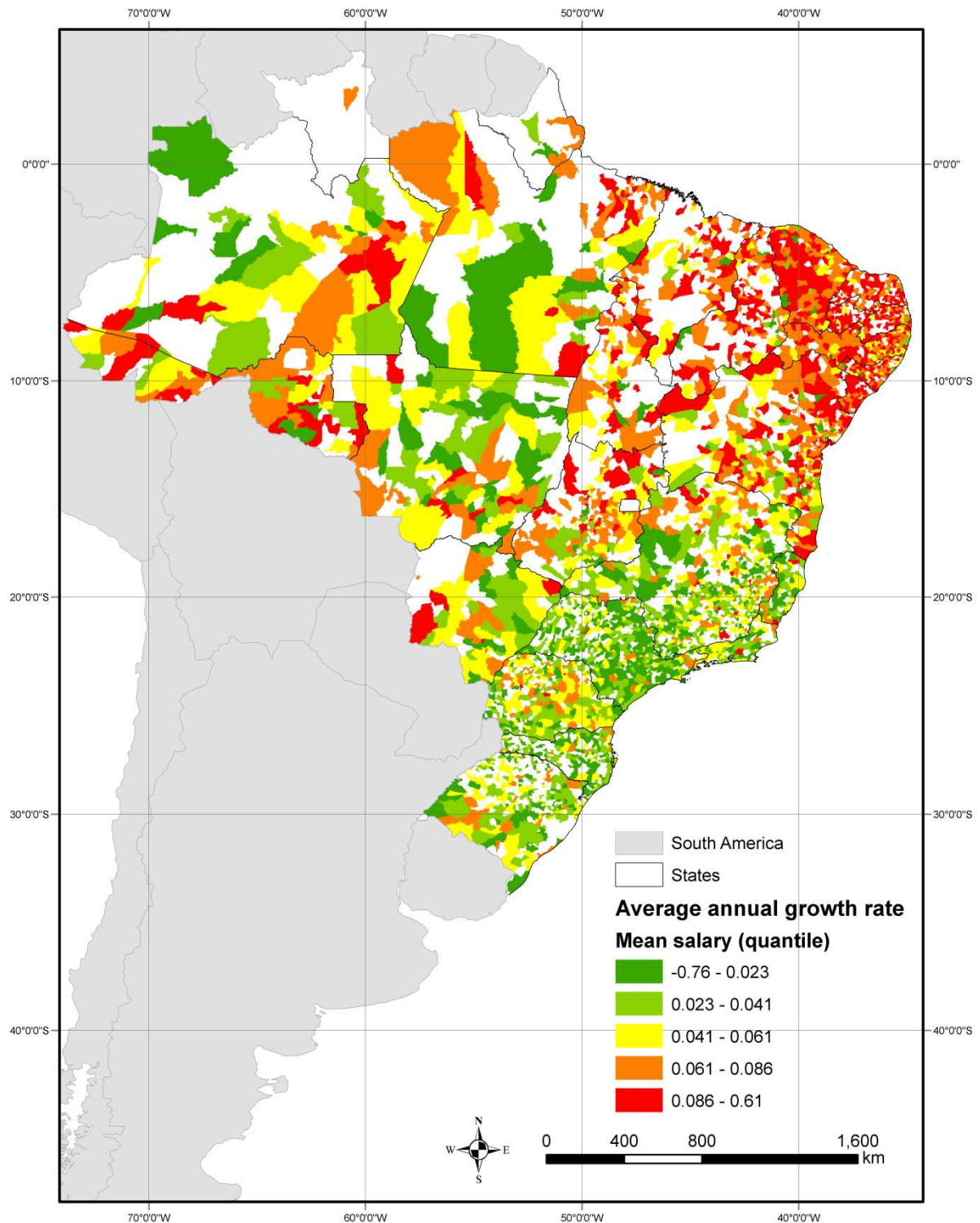


Figure 1 – Spatial distribution of average annual growth rate of city public workers mean monthly salary

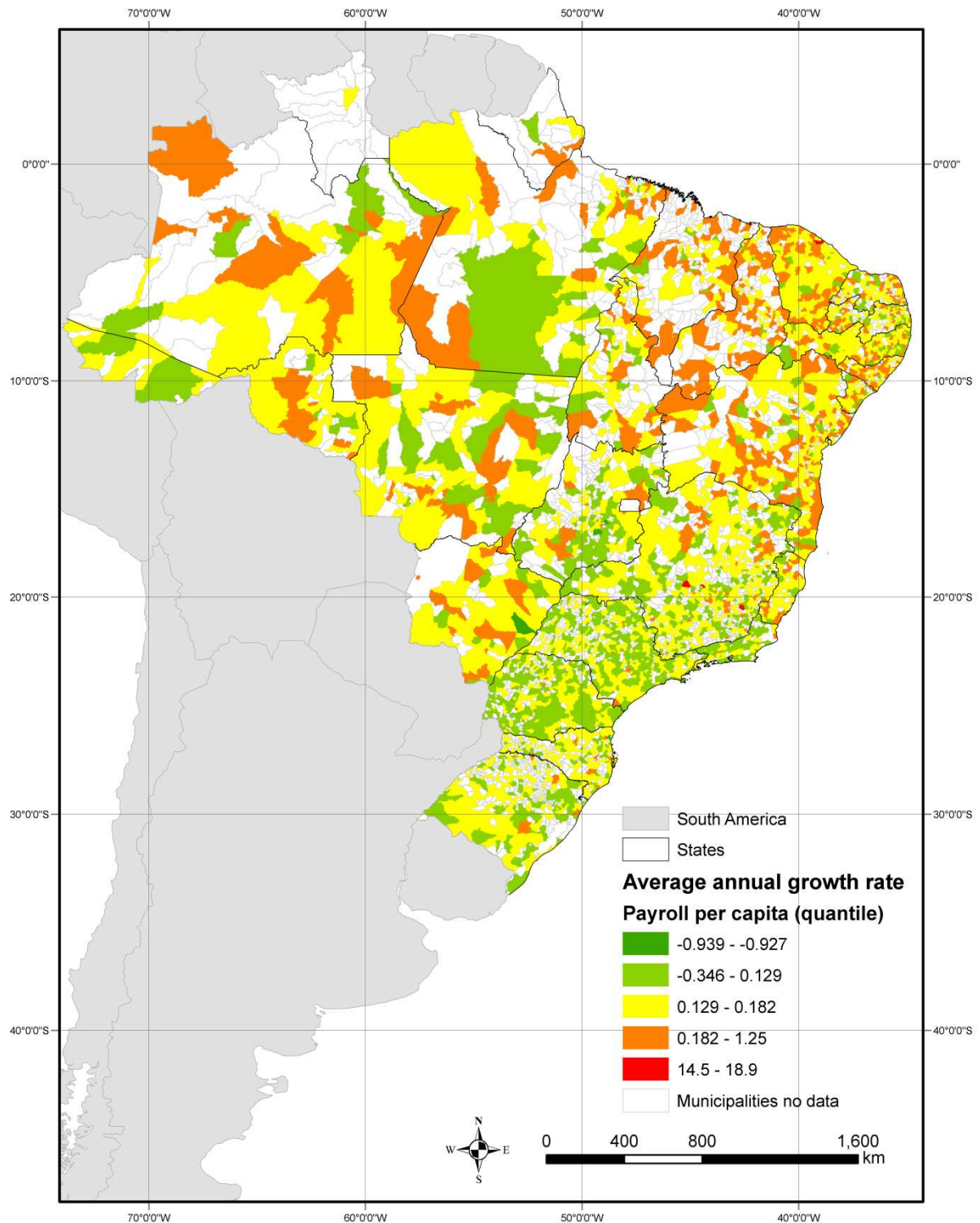


Figure 2 – Spatial distribution of average annual growth rate of municipalities' payroll per capita

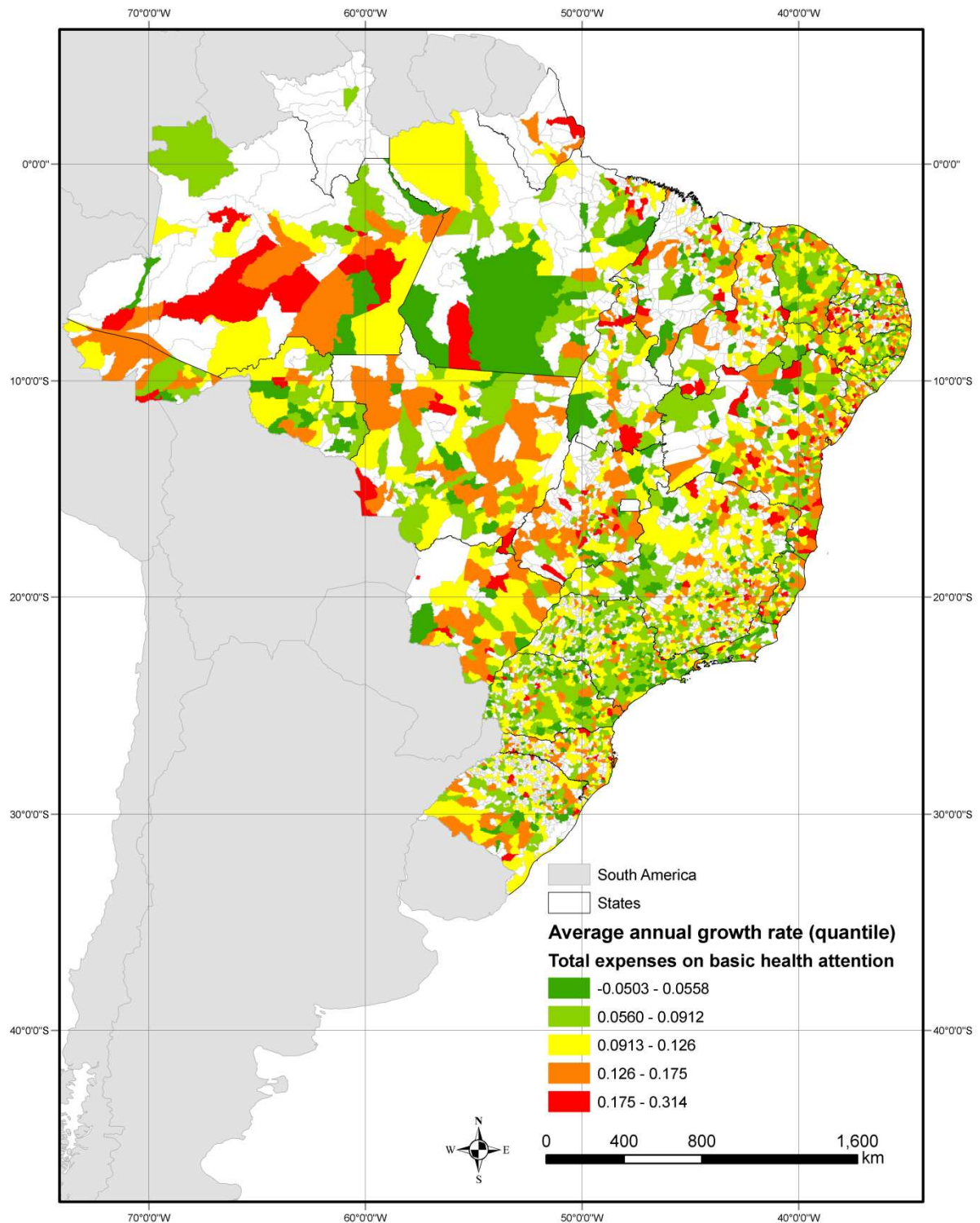


Figure 3 – Spatial distribution of average annual growth rate total expenditure on basic health attention

Given the (auspicious) fact that the number of inhabitants and children death is small for a high number of municipalities, 435 of them did not have changes in the analyzed period, thus having value zero for output. Further, 122 municipalities presented a decrease in the

original indicators from 1 in 2000 to 0 in 2010, making the growth rate equal to -0.499. Finally, 114 municipalities had increases of one unit, from 2000 to 2010, which resulted in a growth rate of 0.995 (figure 4).

Those numbers indicate that the average annual growth rate of percentage of non-avoidable deaths of children worsened in 46.5% of the municipalities; nearly 13% of the municipalities maintained the same level of non-avoidable deaths and only about 41% increased their growth rates.

These numbers result in a heterogeneous spatial pattern with a predominance of negative results in the Northeast region (-0.062), opposed to positive values in all other regions (Center-West held the best result at 0.082) (figure 5).

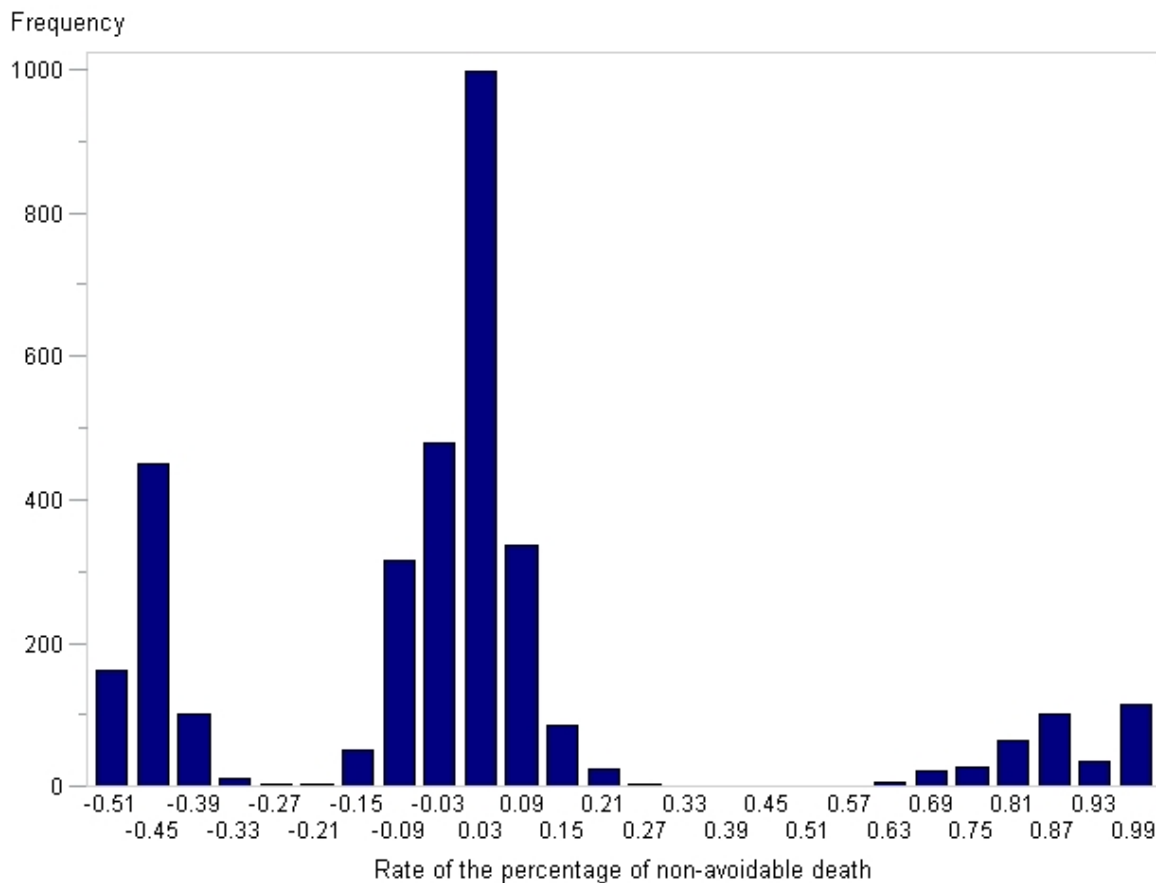


Figure 4 – Histogram of the growth annual rate of the percentage of non-avoidable deaths of children.

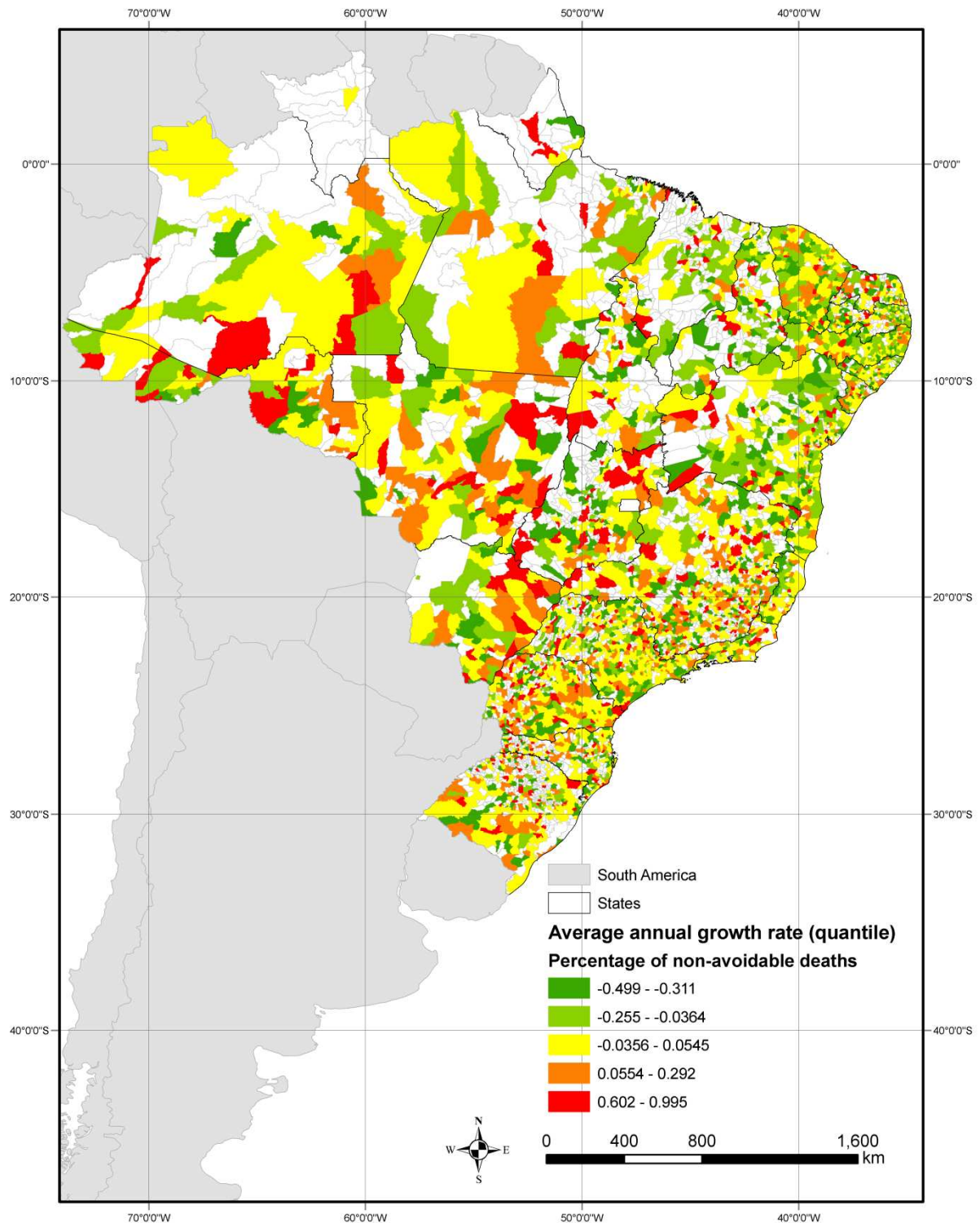


Figure 5 – Spatial distribution of average annual growth rate of the percentage of non-avoidable deaths of children

f. Data: (broad) determinants

Urban proportion in Brazil – like most other indicators – varies incredibly over the municipalities (table 2). In fact, the spectrum might vary from cities that are entirely urban (such as Belo Horizonte) to cities that are nearly all rural. Most of the cities, however, have a higher proportion of urban areas, even though the urban definition in Brazil is broad. Further, population in 2000 is the variable with higher coefficient of variation, followed by the annual average growth rate of population, and of GDP. As a synthetic indicator the Human Index Development varies less, but shows municipalities that are actually quite apart in terms of development with a minimum of 0.467 and a maximum of 0.919.

Variable	Mean	Std Dev	Minimum	Maximum	Median	p25	p75
Urban_prop	0.682	0.215	0.083	1.00	0.708	0.516	0.866
GDP_growth	0.043	0.03	-0.115	0.392	0.04	0.026	0.055
Income_2000	179.23	102.35	30.43	834	165.28	89.03	244.15
Hdim_2000	0.702	0.084	0.467	0.919	0.715	0.632	0.772
Pop_2000	39,734.4	145,795.78	1,189	5,857,904	15,727	8,577.5	30,365
Delta_pop	0.0087	0.014	-0.064	0.112	0.0076	0.0008	0.015
Efficiency	0.116	0.036	0.00	0.29	0.114	0.093	0.137

Table 2 – Descriptive statistics regression model

Table 3 presents the number of observations for each state, the city of Rio de Janeiro and for cities which have less than 50 thousand inhabitants. Smaller cities dominate the sample.

State	Variable	Number of observations
Rondônia	D_12	17
Amazonas	D_13	34
Pará	D_15	71
Amapá	D_16	5
Tocantins	D_17	62
Maranhão	D_21	76
Piauí	D_22	120
Ceará	D_23	171
Rio Grande do Norte	D_24	94
Paraíba	D_25	146
Pernambuco	D_26	173
Alagoas	D_27	78
Sergipe	D_28	57
Bahia	D_29	297
Minas Gerais	D_31	475
Espírito Santo	D_32	64
Rio de Janeiro	D_33	77
Paraná	D_41	269
Santa Catarina	D_42	160
Rio Grande do Sul	D_43	210
Mato Grosso do Sul	D_50	65
Mato Grosso	D_51	85
Goiás	D_52	117
City of Rio de Janeiro	D_RJ	1
Less than 50 thousand	D_50mil	2,824

Table 3 – Dummies in the regression

g. DEA Results

The DEA results reinforce earlier findings (Furtado, 2012) which suggest that lower quality regions perform proportionally better, despite their low absolute levels in the indicators. Actually, given the Law of Diminishing Returns, municipalities that already have comparatively higher achievements in some indicators may have a harder task in increasing those absolute levels observed. Thus, we may hint on a supposed catching up process occurring among municipalities in Brazil in the period of the analysis. Along with these lines, the Northeast, typically the lowest in development in Brazil is the one to score the best mean efficiency, whereas the most advanced – the Southeast – scores the worst (table 4)

Region	Observations	Mean Efficiency
North	228	0.109
Northeast	1,212	0.118
Southeast	1,046	0.093
South	639	0.095
Center-West	267	0.110
Brazil	3,392	0.105

Table 4 – Efficiency mean results

Even considering the fact that poor municipalities might yield results slightly more efficiently than richer areas, there is enough variation among the results (figure 6) so that a comparative ranking can be constructed providing useful information for public policy management.

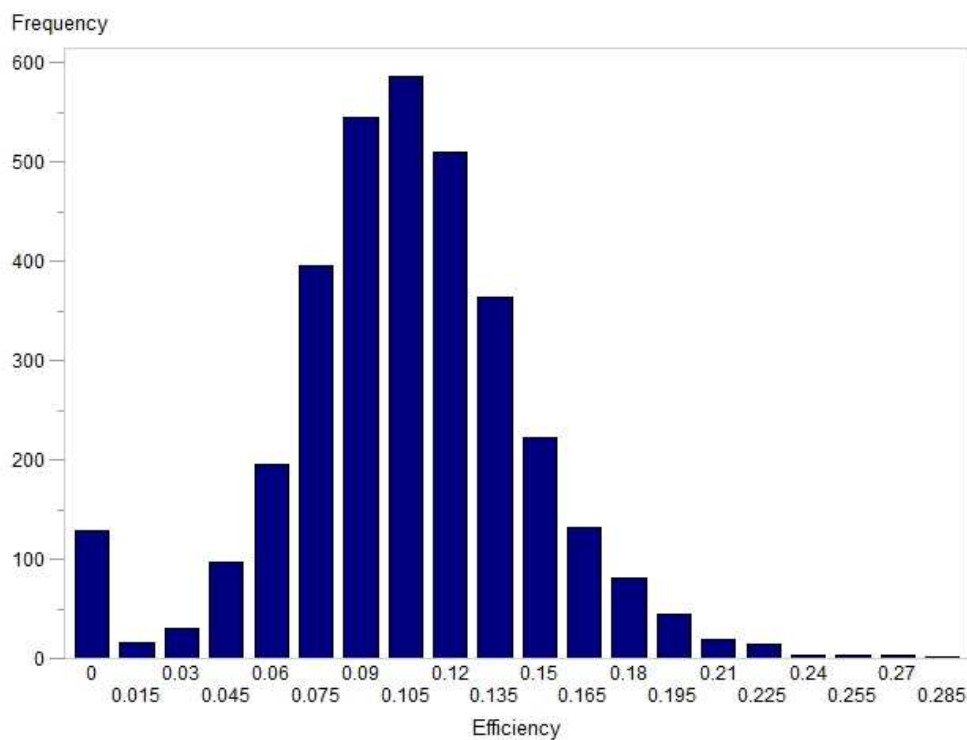


Figure 6 – Histogram of efficiency results by municipalities

The spatial analysis of the efficiency confirms that the Southeast region tend to concentrate more municipalities in green (low efficiency) whereas the rest of the country shows scattered municipalities with orange and red (high efficiency) (figure 7). A question to be further investigated is to try to understand why municipalities in efficient areas are scoring low, or on the contrary, why municipalities in not efficient areas are scoring high.

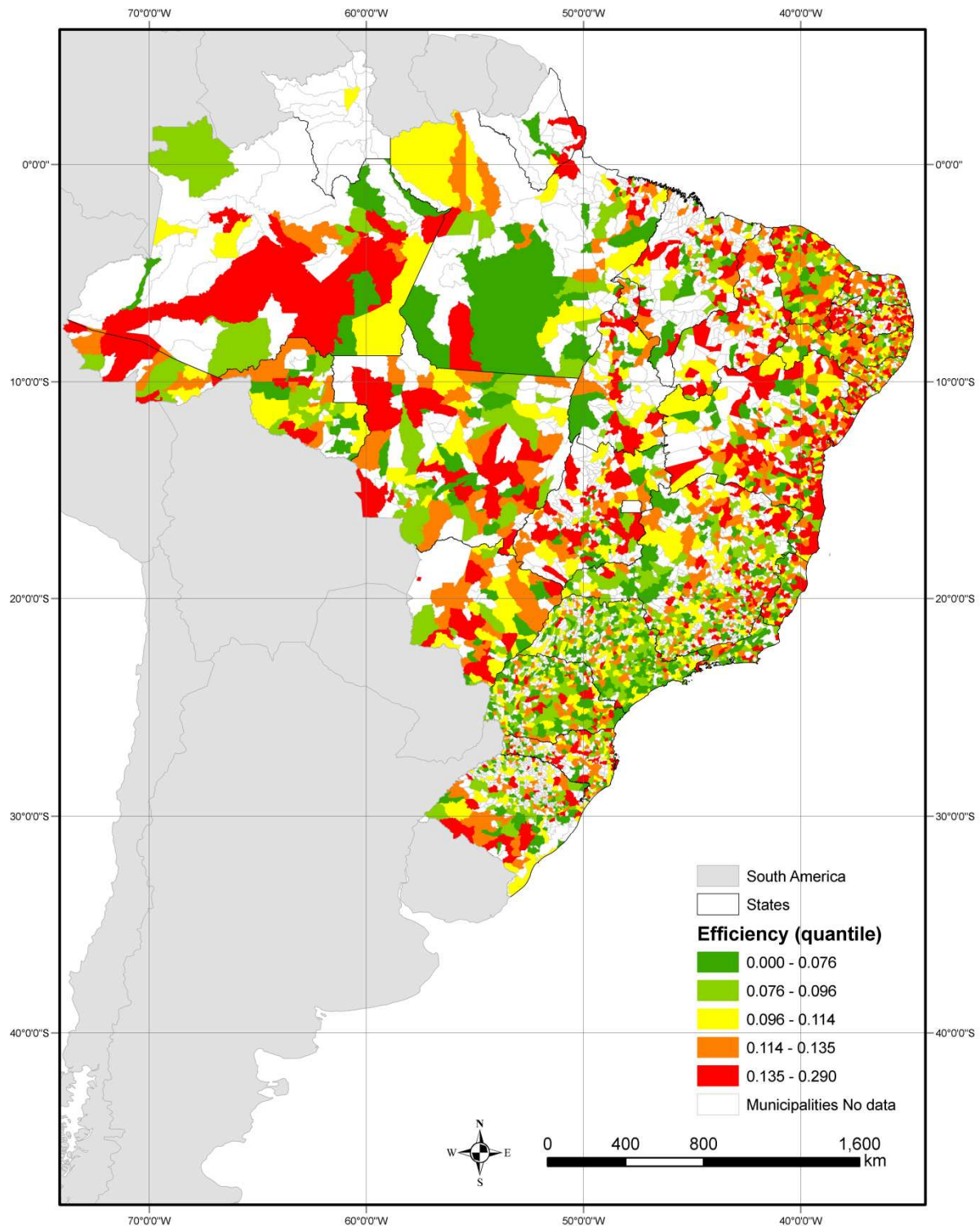


Figure 7 – Efficiency results by municipalities

h. Determinants results

The regression is a (first) simple exercise to start investigating the elements that compose the efficiency (table 5). The model presents an F value of 23,05 (p-value 0.0001) and an Adjusted r-squared of 0.18.

The *dummies* of the states replicate some of the efficiency results (table 3) showing higher coefficients for poorer states located in the North and Northeast regions. Furthermore, the *dummies* show that smaller cities perform worse than larger cities and that the city of Rio de Janeiro has a performance significantly higher than the other municipalities in the sample. The growth rate of population has a negative significant coefficient indicating that cities that received migrants throughout the period comparatively worsened their efficiency in handling basic health care. Population is also negative, although with a value close to zero, indicating that the size of the city – when accounted for smaller cities – is not so relevant.²¹

A relevant finding – from our perspective – is that typical indicators to characterize municipalities, such as Human Development Index or families' income or proportion of urban population were found to be not significant. This might suggest some independence of efficiency in health services providing when compared to more general attributes of municipalities. That is, it might be able to provide reasonable health public services despite general poor indicators.

A variable that proved to be relevant to determine the level of efficiency was the growth rate of GDP. The coefficient of GDP growth rate was found to be highly significant, large in size and positive. All considered, it might indicate that economic growth shall be beneficial to municipalities despite the burdens of rapid urbanization. Analyzed together, the best dynamics of growth seem to be a relevant growth of GDP associated with moderate population growth.

²¹ A previous test indicated that a dummy for cities with over one million inhabitants was not significant.

Dependent Variable: Efficiency					
Number of Observations	3,392				
Analysis of Variance					
		Sum of	Mean		
Source	DF	Squares	Square	F Value	Pr > F
Model	31	0.828	0.0267	24.49	<.0001
Error	3360	3.66	0.0011		
Corrected Total	3391	4.49			
Root MSE	0.033	R-Square	0.184		
Dependent Mean	0.1163	Adj R-Sq	0.177		
Coeff Var	28.396				
Parameter Estimates					
	Parameter	Standard			
Variable	Estimate	Error	t Value	Pr > t	
Intercept	0.08475	0.01381	6.14	<.0001	
Urban_prop	-0.00089	0.00386	-0.23	0.8178	
Income_2000	-0.00003	0.00001	-1.84	0.0654	
HDI _m 2000	0.02598	0.02148	1.21	0.2267	
Pop_2000	-4,65E-03	6,41E-03	-7.26	<.0001	
Delta_pop	-0.37356	0.04974	-7.51	<.0001	
Delta_GDP	0.21521	0.02130	10.10	<.0001	
D_12	0.04060	0.00852	4.77	<.0001	
D_13	0.03651	0.00634	5.76	<.0001	
D_15	0.01893	0.00467	4.06	<.0001	
D_16	0.06470	0.01496	4.33	<.0001	
D_17	0.01299	0.00480	2.71	0.0068	
D_21	0.02797	0.00494	5.67	<.0001	
D_22	0.03045	0.00424	7.19	<.0001	
D_23	0.02007	0.00370	5.43	<.0001	
D_24	0.01714	0.00423	4.05	<.0001	
D_25	0.04365	0.00409	10.67	<.0001	
D_26	0.01576	0.00370	4.26	<.0001	
D_27	0.02601	0.00491	5.30	<.0001	
D_28	0.03672	0.00513	7.16	<.0001	
D_29	0.02976	0.00321	9.28	<.0001	
D_31	0.01531	0.00231	6.62	<.0001	
D_32	0.02524	0.00447	5.64	<.0001	
D_33	0.00767	0.00413	1.86	0.0633	
D_41	0.00556	0.00263	2.11	0.0346	
D_42	0.02856	0.00315	9.08	<.0001	
D_43	0.01212	0.00284	4.27	<.0001	
D_50	0.03493	0.00443	7.88	<.0001	
D_51	0.02104	0.00395	5.33	<.0001	
D_52	0.02753	0.00350	7.87	<.0001	
D_RJ	0.17582	0.04867	3.61	0.0003	
D_50 _{mil}	-0.00468	0.00190	-2.46	0.0139	

Table 5 – results of the regression: dependent variable *efficiency*

4. Discussion

The exercise proposed in this paper bases itself basically on the variation of the variables (sic) in the period 2000-2010. That is to say that a given level of performance in absolute value does not necessarily yield strong positive results in the analysis made. In this line of thought, all (central) inputs and the output of the DEA were based on average annual growth rates. The regression analysis by itself also emphasized variables that depicted growth rates, namely inhabitants and GDP growth rates. Base variables that typically characterize urban analysis were found to be unimportant for the regression at hand. In sum, the paper focuses on the dynamics observed in the past decade. Thus, it may hint on municipalities that are just now starting to have game-changing dynamics, at least concerning basic health care provision and its counterpart, the expenditure with the system.

5. Final considerations

This paper uses data from a baseline date of 2000 and variation of these data into 2010 to start shedding light on the correlations among personnel expenditure, municipalities' general attributes and its achievements in ameliorating the quality (not the quantity) of basic health attention. We used DEA to generate an efficiency index for a large number of municipalities and then apply econometrics to typical municipalities' descriptors of the phenomena being investigated.

The results indicate that municipalities on the Northeast region perform slightly better on average. However, there is important observed heterogeneity in the data, with higher and lower scores scattered around in the country. All in all, health provision – as depicted by the raw data – has not improved for nearly half of the municipalities.

The regression shows that the relevant variables to explain the efficiency are (a) the growth rate of population on the negative side and (b) the growth rate of GDP on the positive. Typical indicators or urban quality, such as urbanization, population, quality of life and families' income explained very little of the estimated efficiency.

The results presented in this text are preliminary and they suffer from at least two known criticisms. Firstly, in this exercise the subdivision of municipalities within the period of analysis²² was not taken in consideration. Secondly, the demand for data for the DEA reduced the sample from the original 5,565 to 3,392 observations only.

²² 58 new municipalities were created in the period elevating the total to 5,565.

In order to tackle these limitations we want to expand the study so that we use the information on those 3,392 observations and expand them to the complete sample through clustering and imputation. If we can characterize certain behaviors as typical of groups of municipalities that we can associate with attributes, then we can estimate their behavior in efficiency as well.

Further, we also intend to detail the regression exercise including more attributes and a spatial analysis which would bring more information on the aspects that are correlated with better performance in basic health attention provision. Finally, we intend to detail the DEA process, applying super-efficiency, analysis of slacks and a more careful treatment of outliers.

6. References

1. AFONSO, A.; FERNANDES, S. Assessing and explaining the relative efficiency of local government. **Journal of Socio-Economics**, v. 37, n. 5, p. 1946–1979, out. 2008.
2. AFONSO, A.; ROMERO, A.; MONSALVE, E. **Public Sector Efficiency: Evidence for Latin America**. [S.l.] Inter-American Development Bank, 2013. Disponível em: <<http://ideas.repec.org/p/iddb/brikps/80478.html>>. Acesso em: 27 jun. 2013.
3. AFONSO, A.; SCHUKNECHT, L.; TANZI, V. Public sector efficiency: evidence for new EU member states and emerging markets. **Applied Economics**, v. 42, n. 17, p. 2147–2164, 2010.
4. BALAGUER-COLL, M.; PRIOR, D.; TORTOSA-AUSINA, E. Decentralization and efficiency of local government. **The Annals of Regional Science**, v. 45, n. 3, p. 571–601, 2010.
5. BALAGUER-COLL, M. T.; PRIOR, D.; TORTOSA-AUSINA, E. On the determinants of local government performance: A two-stage nonparametric approach. **European Economic Review**, v. 51, n. 2, p. 425–451, fev. 2007.
6. BANKER, R. D.; CHARNES, A.; COOPER, W. W. Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. **Management Science**, v. 30, n. 9, p. 1078–1092, 9 jan. 1984.
7. BOGETOFT, P.; OTTO, L. **Benchmarking with DEA, SFA, and R**. New York: Springer, 2011.
8. BORGER, B. DE; KERSTENS, K. Cost efficiency of Belgian local governments: A comparative analysis of FDH, DEA, and econometric approaches. **Regional Science and Urban Economics**, v. 26, n. 2, p. 145–170, abr. 1996.
9. BOUERI, R.; CARVALHO, A. X. Y.; SILVA, F. R. G. Eficiência tributária dos estados brasileiros mensurada com um modelo de fronteira estocástica geograficamente ponderada. **Textos para discussão**, Ipea. v. 1444, p. 27, 2009.
10. BRASIL. **Constituição da República Federativa do Brasil**. Disponível em: <http://www.planalto.gov.br/ccivil_03/constituicao/constituicaocompilado.htm>. Acesso em: 17 jun. 2013.
11. FARRELL, M. J. The Measurement of Productive Efficiency. **Journal of the Royal Statistical Society. Series A (General)**, v. 120, n. 3, p. 253–290, 1 jan. 1957.

12. FURTADO, B. A. Heterogeneidades em Receitas Orçamentárias, Eficiência e seus Determinantes: evidências para municípios brasileiros em 2010. **Textos para discussão**, v. 1796, p. 58, 2012.
13. GASPARINI, C. E.; MIRANDA, R. B. Transferências, equidade e eficiência municipal no Brasil. **Planejamento e Políticas Públicas**, v. 0, n. 36, 17 out. 2011.
14. HAUNER, D.; KYOBE, A. Determinants of government efficiency. **IMF Working Paper**, v. 228, p. 27, 2008.
15. LAVADO, R. F.; LAGRADA, L. P.; GOZUN, B. C. Using DEA to assess the efficiency of public health units in providing health care services. **Applications of Management Science**, v. 14, p. 237–248, 6 abr. 2011.
16. MIRANDA, R. B. Uma avaliação de eficiência dos municípios brasileiros na provisão de serviços públicos usando “data envelopment analysis”. *In: Boletim Fiscal*. Brasília: IPEA, 2006. p. 32–42.
17. ORAIR, R. O. *et al.* Uma metodologia de construção de séries de alta frequência das finanças municipais no Brasil com aplicação para o IPTU e o ISS: 2004-2010. **Pesquisa e Planejamento Econômico**, v. 41, n. 3, p. 471–508, 2011.
18. PAIM, J. *et al.* The Brazilian health system: history, advances, and challenges. **The Lancet**, v. 377, n. 9779, p. 1778–1797, 2011.
19. PARADEKAR, S. Efficiency of Brazilian Municipalities. *In: Inputs to a strategy for Brazilian cities: a contribution with a focus on cities and municipalities*. Brasil: World Bank Publications, 2006. v. 2p. 105–136.
20. PIOLA, S. *et al.* Saúde no Brasil: algumas questões sobre o Sistema Único de Saúde (SUS). **Working Papers (CEPAL)**, p. 77, 2009.
21. PITA BARROS, P. The black box of health care expenditure growth determinants. **Health economics**, v. 7, n. 6, p. 533–544, 1998.
22. SOUSA, M.; STOŠIĆ, B. Technical Efficiency of the Brazilian Municipalities: Correcting Nonparametric Frontier Measurements for Outliers. **Journal of Productivity Analysis**, v. 24, n. 2, p. 157–181, 2005.
23. WANG, C.-H.; CHEN, P.-C.; HUANG, H.-C. Health care efficiency and determinants—A comparison of Taiwan and OECD countries. **Journal of Information and Optimization Sciences**, v. 32, n. 1, p. 213–231, 2011.

7. Annexes

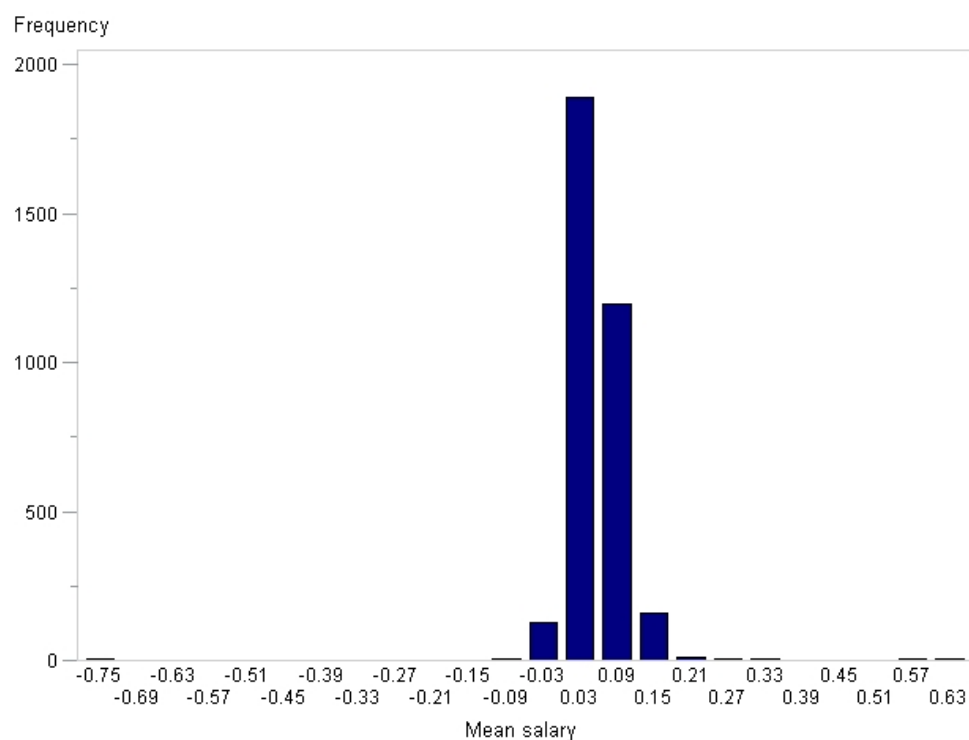


Figure 8 – Histogram of annual growth rate of monthly mean salary paid by municipalities

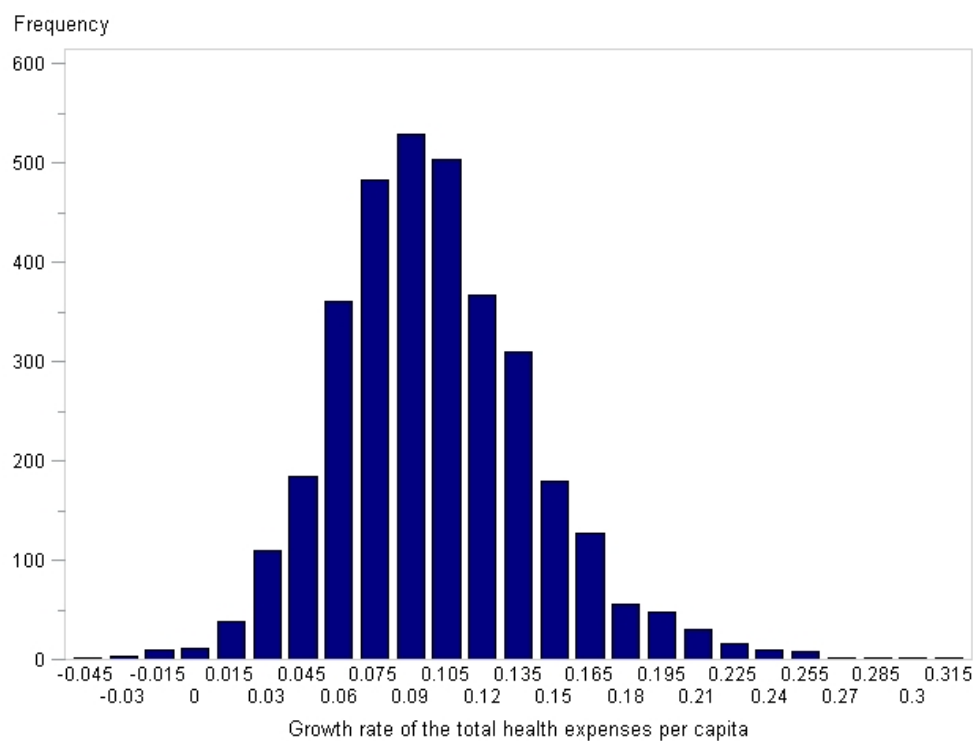


Figure 9 – Histogram of the growth rate of total health expenditure per capita

States	Number of observations	Mean Efficiency
Paraíba	146	0,134
Amazonas	34	0,128
Bahia	297	0,124
Sergipe	57	0,122
Piauí	120	0,120
Acre	17	0,120
Maranhão	76	0,117
Mato Grosso do Sul	65	0,116
Amapá	5	0,115
Alagoas	78	0,115
Ceará	171	0,112
Espírito Santo	64	0,112
Pernambuco	173	0,110
Goiás	117	0,108
Pará	71	0,108
Mato Grosso	85	0,108
Santa Catarina	160	0,108
Tocantins	62	0,106
Rio Grande do Norte	94	0,104
Minas Gerais	475	0,101
Roraima	1	0,100
Rio Grande do Sul	210	0,096
Rondônia	38	0,092
Rio de Janeiro	77	0,092
Paraná	269	0,088
São Paulo	430	0,083

Table 6 – Mean efficiency by states