Performance evaluation of expenditure in primary care: the case of Brazil's southeastern cities

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Abstract

This study aimed to analyze the performance of cities of Brazil's southeastern region on primary care expenditure, from 2007 to 2010. In order to do the performance analysis we used the technical efficiency scores produced by the Data Envelopment Analysis (DEA) methodology and the Ray and Desli Malmquist Index as the quantitative metrics. Before starting the cities' efficiency analysis, the cluster analysis was applied to group similar cities. This study proposes an analytical model of the comparative performance of 1097 cities, based on the National Primary Care Policy. The efficiency scores obtained highlights the disparities in the allocation of resources and lost in productivity through the years analyzed. This fact could be justified due the absence of procedures of relative comparison between cities and the decentralization of public expenses in public healthcare. The results shed light on the possibility to improve the quantity of primary care services, given the current level of expenditure.

Keywords: Primary Care. Performance. Public Expenditure. DEA. Malmquist Index.

Resumo

Este estudo teve como objetivo analisar o desempenho dos municípios da região sudeste do Brasil na alocação de recursos em atenção básica, de 2007 a 2010. A fim de fazer a análise de desempenho foram usados escores de eficiência técnica da Análise Envoltória de Dados (DEA) e índice de Malmquist de Ray e Desli. Mas, antes da análise de eficiência, a análise de *cluster* foi aplicada para agrupar os municípios semelhantes. Assim, este estudo propõe constituir um modelo de análise do desempenho de 1097 cidades, com base na Política Nacional de Atenção Básica. Os escores de eficiência obtidos destacam as disparidades na alocação de recursos e o baixo desempenho dos municípios. Este fato pode ser justificado devido ausência de procedimentos de comparação relativa entre os municípios e a descentralização dos gastos públicos na área de saúde pública. Os resultados lançam luz sobre a possibilidade de aumento da oferta de serviços em atenção básica, dado o nível atual de recursos alocados.

Keywords: Atenção básica. Desempenho. Gastos públicos. DEA. Índice de Malquist.

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Introduction

In order for SUS to become effective, primary care needs to be strengthened. It is being capable of solving around 80% of the health needs and problems, also highlighting the importance of prevention and immunization in this care level. (BRASIL, 2007; ELIAS et al., 2006)

However, in Brazil there are still citizens which do not possess access to primary care service, for various reasons, among them the low relation between supply and demand for these services. The limitation of public resources may be considered as a restricting factor to the increase in the offer of healthcare services, requiring that the public administrator allocate efficiently his resources instead of seeking the increase of budget sources. (FLEURY; BARIS, 2001; FLEURY; BAHIA, AMARANTE, 2007)

According to the Brasil (2008) the results which Brazil has obtained in the healthcare area are below the expected results considering the invested amount of money. Little by little, the public policy makers begin to admit that money may not have been well invested. Among the main possible solutions for the problem we can state: increase the amount of financial resources – probably unviable due to the resource limitation – or increase the efficiency in resource allocation.

Focusing on the above highlighted problems and seen the increasing of efficiency as a feasible solution for the improvement of the results which Brazil has obtained in healthcare area, this study was carried out to answer the following question: what is the comparative performance of cities in the southeastern region of Brazil in primary care expenditure? According to Selden and Sowa (2004) and Scott and Davis (2007), the idea of performance is focused, typically, in the outputs and outcomes of programs or policies. According to Farrel (1957) and Charnes, Cooper and Rhodes (1978) technical efficiency is the ability to produce more outputs with a given amount of inputs and according Scott and Davis (2007) could be applied as a performance assessments.

It is justified that the evaluation of efficiency in public resources allocation may serve as an instrument to support public managers' decision making as well as identifying benchmark cities so that the inefficient cities may looking for the best practices from efficient cities. In performance analysis, according to Greiling (2006), benchmarking is designed to make learning easier as a continuum and systematic process of measuring products, services and practices aiming at correcting failures and improving results. This idea of a comparison between units of analysis by relative efficiency scores is found in the performance analysis literature. (BEHN, 2003; GREILING, 2006; SELDEN; SOWA, 2004; SCOTT; DAVIS, 2007)

Given the problems proposed and the justifications for conducting this study, this study was carried out to analyze the comparative performance of cities in the southeastern region of Brazil in primary care expenditure, from 2007 to 2010. More specifically, we separated the groups of the most similar cities according to characteristics which could have influence on expenditure efficiency scores and then applied the proposed efficiency model by Data Envelopment Analysis and Ray and Desli Malmquist Index.

Ibañez and others (2006) state that is important to say that rescuing primary care is a part of the current issue of the feasibility of health systems. The increasing healthcare costs have brought governments and private institutions which work in this field to place primary care as a central point aiming to preventing health problems and treating them in a more efficient manner. Again, the improvement of the expenditure efficiency in primary care could be a good solution to health results. Likewise, this study propose an efficiency model to assess the expenditure efficiency on Brazilian primary care.

The research and data collection strategy

From the population of 1668 cities in Southeastern region of Brazil we chose only cities which had at least one Family Health Team – the group of physician, nurses, nurse assistants and other professionals - classified as the main strategy according the National Primary Care Policy. Afterwards, after an exploratory analysis of the data, we excluded from the sample those with inconsistent variables and with the absence of some observation for one or more analyzed years (2007-2010). It was excluded 570 cities because of that.

The final sample was comprised of about 70% of the cities in Minas Gerais, 60% of the cities in the State of Espírito Santo, 50% of the cities in Rio de Janeiro and 52% of the cities in São Paulo. In some cases, existing secondary data create an opportunity for evaluative and simplified comparisons. The performance measures may contribute not only to indicate the organizations are making mistakes but also to indicate when they are doing well. Performance measures provide justification for the existence of the organizations. (BEHN, 2003; GREILING, 2006; HALACHMI, 2005)

For data collection and analysis, the National Primary Care Policy from 2006 was established as the reference public policy. By this definition, the analysis period was from 2007 - the first year of this policy - to 2010, due to this being the last year with available data in the researched databanks. All of these variables were collected during the period from July to September 2011.

Analysis procedures

In order to do the performance analysis as the quantitative measure we used in this study the technical efficiency scores produced by the Data Envelopment Analysis (DEA) methodology. But, before starting the cities' efficiency analysis the cluster analysis was applied to group similar cities according to Short and others (2007) and Ferguson, Deephouse and Ferguson (2000). It becomes necessary that the compared units were similar in order to avoid spurious comparisons and group the most similar cities and separating the most distinct. Therefore, it will be possible to compare similar measures according to the discussion which approaches the concepts of benchmarking in the literature. (BEHN, 2003; GREILING, 2006)

In the cluster analysis we used the non-hierarchical k-means method quoted in Maroco (2003) and Hair and others (2005) for partitioning the city groups. This method was utilized due to the fact that it is an advantage in relation to the hierarchical methods because to the ease which it can be applied to very sizable data matrixes and there is no need to calculate and store a new dissimilarity matrix in each step of the algorithm. According to Maroco (2003) the probability of a wrong classification of a given subject in a given cluster is lower in the non-hierarchical methods. (MAROCO, 2003)

According to Sugar and James (2003), a fundamental problem in cluster analysis is to determine the best number of groups. In order to determine this number that shall be used in the study we employed the Calinski and Harabaz index whose equations are in Milligan and Cooper (1985) and Sugar and James (2003). According to Milligan and Cooper (1985), the Calinski and Harabaz index is considered a robust index for defining the number of clusters.

After the definition of the clusters, the measuring of efficiency was performed through the use of the Data Envelopment Analysis (DEA) methodology, output-oriented supposing variable returns to scale (CHARNES; COOPER; RHODES, 1978; BANKER; CHARNES; COOPER, 1984) according with the equation 1

Equation 1

$$
\begin{aligned}
& Max\,\theta^{VRS} \\
& \text{Subject to:} \\
& \sum_{j=1}^{n} \lambda_j x_j \leq x_{i0,},\ i = 1,2,\ldots,m \\
& \sum_{j=1}^{n} \lambda_j y_{\dot{r}} \geq \theta^{VRS} y_{i0,}\ r = 1,2,\ldots,s \\
& \sum_{j=1}^{n} \lambda_j = 1 \\
& \sum_{j=1}^{n} \lambda_j \geq 0, \forall j
\end{aligned}
$$

In the Equation 1 the Decision making units (DMU) represented by the cities use *m* inputs, *s* products; *j* is associated with the analyzed DMU_0 and *n* corresponds to the total number of DMU; x_{ij} is the consumed quantity of the input *i* (*i* = 1,2, ..., m) by DMU_j; y_{rj} is the quantity produced of the product *r* (r = 1,2,3 …*s*) for DMUj; λ_j is the weight of the composition of the analyzed DMU_0 virtual (projection on the efficient frontier); θ^{VRS} is the efficiency score output-oriented supposing variable return to scale.

The output orientation was applied because the objective of the cities must be to increase the primary care services production and not to reduce the budget allocated in the field. Also, quoted authors have discussed the scarcity of resources for this sector, indicating that the increase in expenditure efficiency is necessary. (FLEURY; BARIS, 2001; WORLD BANK, 2007; BRASIL, 2008)

The Data Envelopment Analysis is able to classify the analyzed units by indexes from 0 to 100% through mathematical programming. So it was possible to rank the cities and compare them. The structures of the classic models are found in Charnes, Cooper and Rhodes (1978), Banker, Cooper and Rhodes (1984) and Banker and Thrall (1992) that show the classic models in Data Envelopment Analysis.

The supposition of variable return to scale was tested by the Theorem 2 of Banker (1996) quoted by Ray (2004) which has shown itself to be a consistent analysis. After the application of the above mentioned test, comparing the scores according to Ray (2004), we did not notice a prevalence of only one type of return to scale. In this case, the quoted authors recommend the assumption of variable returns to scale (VRS).

In this study we have a panel of efficiency scores for verifying both changes in the productivity and difference in efficiency scores over the years. According to Banker et al. (2005) the Malmquist index was proposed by Caves, Christensen and Diewet (1982) with the objective of measuring changes in productivity between two periods of time by the distance between a DMU and the frontier of production for each period. This calculation to measure the productivity changes are interesting in a context in which multiple inputs and outputs, as well as longitudinal dependent panel coexist.

Ray and Desli (1997) define the Malmquist index computed in the presence of variable returns to scale according to Equation 2:

Equation 2

$$\text{Ray and Desli (1997) Malmquist Index} =$$
$$= \left[\frac{D^{t}_{VRS}(x^{t+1}, y^{t+1})}{D^{t+1}_{VRS}(x^{t+1}, y^{t+1})} \times \frac{D^{t}_{VRS}(x^{t}, y^{t})}{D^{t+1}_{VRS}(x^{t}, y^{t})} \right]^{\frac{1}{2}} \times \frac{D^{t+1}_{VRS}(x^{t+1}, y^{t+1})}{D^{t}_{VRS}(x^{t}, y^{t})} \times$$
$$\times \left[\frac{\dfrac{D^{t}_{CRS}(x^{t+1}, y^{t+1})}{D^{t}_{VRS}(x^{t+1}, y^{t+1})}}{\dfrac{D^{t}_{CRS}(x^{t}, y^{t})}{D^{t}_{VRS}(x^{t}, y^{t})}} \times \frac{\dfrac{D^{t+1}_{CRS}(x^{t+1}, y^{t+1})}{D^{t+1}_{VRS}(x^{t+1}, y^{t+1})}}{\dfrac{D^{t+1}_{CRS}(x^{t}, y^{t})}{D^{t+1}_{VRS}(x^{t}, y^{t})}} \right]^{1/2}$$

Where the ratio outside the brackets $\frac{D^{t+1}_{VRS}(x^{t+1}, y^{t+1})}{D^{t}_{VRS}(x^{t}, y^{t})}$ indicates the change in technical efficiency, i.e., how far the DMU is from the maximum production observed, between year t and t+1. The geometric mean of two ratios in brackets

$\left[\frac{D^{t}_{VRS}(x^{t+1}, y^{t+1})}{D^{t+1}_{VRS}(x^{t+1}, y^{t+1})} \times \frac{D^{t}_{VRS}(x^{t}, y^{t})}{D^{t+1}_{VRS}(x^{t}, y^{t})} \right]^{\frac{1}{2}}$ captures the shift in the production frontier. Note that $D^{t}_{VRS}(x^{t}, y^{t})$ =1 happens if and only if (x^{t}, y^{t}) is in production frontier. According to Farrell (1957) that occurs when production is technically efficient.

$D^{t}_{VRS}(x^{t+1}, y^{t+1})$ is a function of maximum ratio expansion of output vector y^{t+1} given the inputs x^{t+1} practicable in relation to the frontier of period *t*. $D^{t+1}_{VRS}(x^{t}, y^{t})$ is a function of maximum ratio expansion of output vector y^{t} given the inputs x^{t} practicable regarding the boundary of period *t+1*. E $D^{t+1}_{VRS}(x^{t+1}, y^{t+1})$ is a function of maximum expansion ratio of the output vector of y^{t+1} given the inputs x^{t+1} practicable regarding the frontier of period *t+1*.

In the situation of $x^{t} = x^{t+1}$ and $y^{t} = y^{t+1}$ in which there has been no change in the inputs and outputs through the periods, the signal of productivity index does not change and $\text{Malmquist index} = 1$. The CRS and VRS symbols are the abbreviation of constant returns to scale and variable returns to scale, respectively.

According Fare and others (1994) productivity gain is found when the Malmquist index is greater than 1. The deterioration of performance over time is associated with the Malmquist index less than 1. To calculate productivity change among DMUs is necessary to calculate the eight different linear programming problems: $D^{t}(x^{t}, y^{t})$, $D^{t+1}(x^{t}, y^{t})$, $D^{t}(x^{t+1}, y^{t+1})$ and $D^{t+1}(x^{t+1}, y^{t+1})$ all assuming constant returns to scale and variable returns to scale.

In the analysis of this study's results, all the statistic tests are found at the end of each table. In these tables we shall also describe the results of the sample distribution normality tests, in order to justify the application of parametric or non-parametric hypotheses tests.

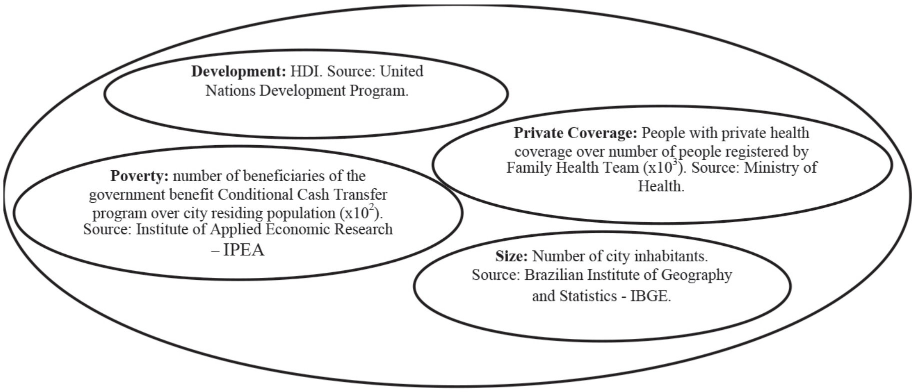
This study agrees with Elias and others (2006) and Brasil (2008) when they discuss that the analysis of health must take into consideration the "Social Space", considering that society has different access to the consumption of goods, including health services. In this discussion we include the fact that the characteristics of the analyzed regions such as the demographic and epidemiologic profile should be taken into consideration.

The grouping of similar cities make possible for a given inefficient city in its expenditure to be compared to other cities with similar characteristics, or the most similar possible. Another advantage of obtaining groups of cities with the most similar characteristics possible is the fact that this comparison offers better benchmarking for the inefficient cities.

What will define how similar the groups are internally are the variables inserted to characterize them. In this study, the model for ranking the cities was built from four dimensions considered to be important for primary care in health and may have impact on the expenditure of distinct cities: private coverage, development, size and poverty. Figure 1 describes the four dimensions.

Private health coverage was considered the most important dimension for the separation between the groups. In order to explain the importance of this dimension we quote the arguments of **Wibulpolprasert,** Tangcharoensathien and Kanchanachitra **(2008) who state that most of the population in development countries do not have any access to private health services, which makes the access to health, immunization and medicine more difficult.**

Figure 1 – Dimensions for characterizing the cities



Source: Elaborated by the author.

In this direction, individuals with private health coverage may need less the services offered by Brazilian Unified Health System than individuals who do not have any access to private services. The arguments of Ibañez and others (2006), Henrique and Calvo (2009) and Machado, Lima and Viana (2008) converge towards the existence of a relation between poverty and access to health services. The individuals who do not possess any private coverage will need to refer themselves to the public primary care services.

As a manner of giving a higher weight to this dimension, the cities were divided in 2 groups according to that city's percentage of private coverage before introducing the further dimensions. Through the exploratory data analysis we established that it would be feasible to build two groups with an approximate number of cities.

Therefore, the first group – labeled group A - was comprised by cities with 10% or less of the population registered by the Family Health Team covered by the private services. The other group – labeled group B - was formed by the cities with more than 10% of the population with private coverage. It is considered that the first group has a higher dependency on public primary care services than the second one. After the separation approximately 56% of the cities were put in group A and 44% were in group B.

Between the four dimensions inserted for characterizing the groups, poverty was represented by the proportion of population benefited by the Conditional Cash Transfer program called "Bolsa Família". These are people who seek public health services according Ibañez and others (2006), Conill (2008) and Henrique and Calvo (2009). These quoted authors consider that this part of the population is found in areas with higher nutrition risk, lower education, living and basic sanitation conditions and which will depend with a higher frequency on the public health services.

Size was another variable to be considered. This is because according to Henrique and Calvo (2009) and Conill (2008) the implantation of primary care programs were predominant in smaller cities, in which high complexity care did not fulfill the population's needs. So, we expect that cities with a smaller population size will have a more developed primary care system than those in bigger cities.

The last dimension to be considered was development represented by the Human Development Index (HDI). This variable was chosen because it took into consideration, in composing the index, not only GDP, but longevity and education. This variable allows for the identification of cities with a more structured health system highlighting the relation between longevity and health. It is necessary to state that education is an important component for prevention and promotion of health (BRASIL. Ministério da Saúde, 2007; ELIAS et al., 2006; IBAÑEZ, 2006)

After the definition of the clusters we inserted some more variables available by Ministry of Health for additional characterization the cities. These variables are related to the cities' infrastructures as the following ones:

- Proportion of houses with water piping (x102);
- Proportion of houses with garbage collection (x102);
- Proportion of houses with sewage piping (x102);
- Proportion of houses made of bricks (x102);
- Proportion of houses which have electricity (x102).

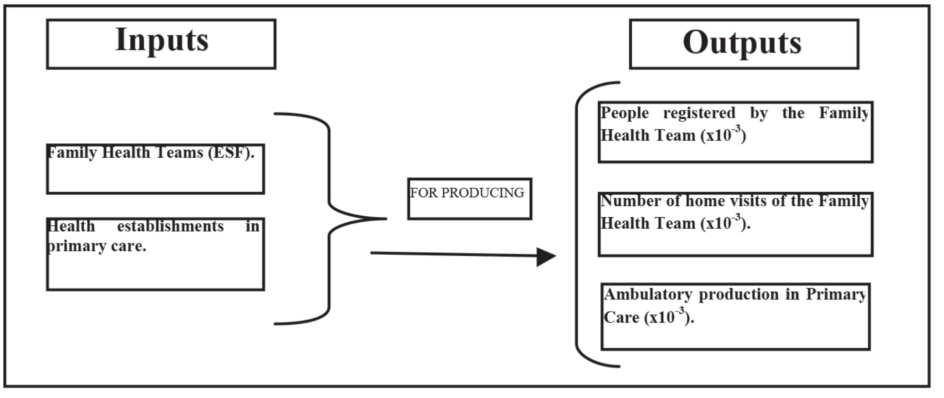
According to the World Bank (2007) these variables were used because other factors such as the access to drinking water and sanitation may also have an influence on comparisons between expenditures and results. Wibulpolprasert and others (2008) affirm that apart from the reduction in child mortality and immunization for achieving the objectives of primary care it is necessary the access to drinking water and basic sanitation.

It was possible to perform the relative technical efficiency analysis after group the similar cities. According to Brasil (2007) primary care resources should be allocated for paying the Family Health Team and maintaining the primary health units. In this direction, the allocation of resources for the primary care will be represented by the number of Family Health Teams and number of health establishments. These two variables according to National Primary Care Policy represent the primary care main expenditure i.e resource allocation.

In the new organization of primary care, the cities became managers of the local systems, responsible for fulfilling the Primary Care principles, organizing and executing actions in its territory. The resource allocation model for performance evaluation in Figure 2 was built by two inputs and three outputs. For allocating resources, the National Primary Care Policy quoted by the Brasil (2007) proposes that cities should be responsible for maintaining the Family Health Team – the main strategy - and the necessary infrastructure including material resources, equipment and sufficient inputs for the set of proposed actions. Therefore, the expenditure efficiency model was represented by the number of Family Health Team and the number of health establishments as inputs.

Relating to the justification for formulating this model we may quote as a reference the work of Starfield (1998) which characterized primary care as the "entrance door" which gives accessibility to population health needs. So, the first output was characterized by the number of people registered by the Family Health Team. According to Henrique and Calvo (2009), this variable is important for resource allocation because primary care coverage is just around a third of the country's population. Also, according to Elias and others (2006) and Brasil (2007) the population registration has the importance of enabling the program to know about morbidity characteristics and thus act towards prevention and promotion of health.

Figure 2 – The model of technical efficiency in expenditure on primary care



Source: elaborated by the authors.

According to Brasil (2007) at least the Health Family Team are comprised of a doctor, a nurse, a nursing assistant and community health agents. The Health Family Team are responsible for maintaining the family and individual records updated and using the data for analyzing the health situation taking into consideration the social, economical, cultural, demographic and epidemiologic characteristics of the territory.

Starfield (1998) and Brasil (2007) state that the primary care evaluation has to encompass the regular use of the primary care services which is represented by the number of home visits by the Health Family team. Also, Starfield (1998) affirms that primary care should supply the minimum range of adequate services to the population which is represented by the ambulatory production in primary care. In this production we include the primary care procedures performed according to the Table of Procedures, Medicine, Orthesis, Prosthetics and Special Material of Brazilian Unified Health System.

Analysis of the results

In the division of the city groups for the cluster analysis, we labeled as Group A the one with the lower private health coverage, i.e, cities with less than 10% of the population with private coverage. Table 1 shows the division of Group A in two groups of cities as follow: Group 1 and Group 2. As previously mentioned, in the tables we can find the results of the tests performed for choosing and differentiating the groups.

Comparing groups we can affirm that, in general, Group 2, shown in Table 1, presented lower averages for all the variables used to rank them, except for proportion of the population covered by the Conditional Cash Transfer program.

Relatively, Group 2 has the smallest cities, with a population average of 9,929 inhabitants against 27,584 inhabitants of Group 1. Analyzing the quartiles, Group 2 has more cities with lower basic sanitation coverage and infrastructure as well as the dimensions used to split the groups.

We observe that Group 2 was formed by cities with at most 53 thousand inhabitants, while Group 1 has cities with up to approximately 830 thousand inhabitants. Analyzing the quartiles, 75% of the cities in Group 1 have less than 23 thousand inhabitants while in Group 2 there are less than 12 thousand.

We highlight that these differences do not imply that in Group 2 there will be only smaller cities and in Group 1 only the bigger cities. As we inserted 4 dimensions in the cluster analysis, it is possible to have, in a same group, bigger and smaller cities which are then similar by the other dimensions.

Table 1 Descriptive Statistics – Group A split in Group 1 and Group 2*

Gr	Variable	N	Avg	Min	Max	25%	Median	75%
G1	WATER	360	76.17	4.56	100.00	67.97	80.06	90.27
	GARBAGE	360	81.00	23.32	100.00	71.88	83.71	92.88
	SEWAGE	360	68.00	0.00	100.00	55.21	74.21	87.94
	BRICK	360	95.75	46.28	100.00	95.04	98.71	99.61
	ELECTRICITY	360	97.46	0.00	100.00	97.25	98.79	99.42
	PRIVATE	360	47.54	0.00	100.00	24.37	46.26	71.17
	TRANFER	360	5.77	1.23	10.59	4.49	5.80	7.11
	POPULATION	360	27.58	1.20	830.67	4.76	10.40	22.76
	HDI	360	0.76	0.67	0.85	0.74	0.75	0.78
G2	WATER	255	60.35	0.66	99.91	46.69	61.70	74.40
	GARBAGE	255	53.71	0.14	100.00	37.53	54.61	68.75
	SEWAGE	255	41.13	0.00	100.00	15.94	42.10	62.13
	BRICK	255	93.27	34.70	100.00	92.25	97.87	99.32
	ELECTRICITY	255	90.60	50.95	100.00	87.12	94.21	97.96
	PRIVATE	255	20.33	0.00	83.37	4.71	15.36	32.38
	TRANFER	255	10.48	6.77	16.60	9.14	10.33	11.60
	POPULATION	255	9.92	1.65	52.98	4.66	6.95	11.88
	HDI	255	0.67	0.57	0.75	0.65	0.68	0.70

Variables: WATER – proportion of houses with water piping ($x10^2$); GARBAGE – proportion of cities with garbage collection ($x10^2$); SEWAGE – proportion of houses with sewage piping ($x10^2$); BRICK – proportion of houses made of bricks ($x10^2$); ELECTRICITY – proportion of houses which have electricity ($x10^2$); PRIVATE – proportion of population covered by private healthcare assistance ($x10^{-3}$); TRANSFER – proportion of population benefited by the "Conditional Cash Transfer" program ($x10^2$); POPULATION – population living in the city ($x10^{-3}$); HDI – Human Development index; Gr – group.

Tests results: highest pseudo-F of Calinski and Harabaz: 362.71; p-value<0.01 for univariate normality asymmetry and kurtosis test and bivariate and multivariate normality of Doornik-Hansen; p-value<0.01 for differences between the groups G1 and G2 by the Kruskal-Wallis non-parametric test.

Source: research results.

Regarding the cities' infrastructure and basic sanitation, Group 1 has higher water network coverage for the houses (76% versus 60% of Group 2), higher garbage collection (81% versus 54% of Group 2), sewage piping (68% versus 41% of Group 2), brick houses (96% versus 93% of Group 2) and electricity coverage (97% versus 90% of Group 2). These values indicate a higher basic sanitation and infrastructure coverage for the cities in Group 1, when comparing to Group 2.

Regarding the beneficiaries of Conditional Cash Transfer we notice a higher average for Group 2 with, approximately, 10% of the population versus 6% in Group 1. The other analyzed variables indicated a higher proportion of poor population in Group 2.

Due to the opposing characteristics observed in the groups, it was expected that because of the higher averages attained for infrastructure coverage and the lower ones for poverty, Group 1 would show a higher HDI average. Therefore, we found an average of the index of 0.76 versus Group 2 which presented an average index of 0.67.

About the splitting of Group B, according to the pseudo-F criteria, we should choose the solution comprised by 5 clusters, with the highest value of 276.84 for a pseudo-F, due to them being more distinct. However, when analyzing the amount of cities in each group, we noticed that one of them was formed by only 2 cities. These were the cities of São Paulo and Rio de Janeiro. Knowing the characteristics of these cities as the biggest cities and the most important financial centers, it was expected that these cities would be grouped separately, for a better distinction among the groups. We opted, then, for considering these two as outliers in the study and taking them out of the analyses due to their distinct characteristics when comparing to other cities.

With the exclusion of the two cities a new cluster analysis was performed and, as we can see in Table 2, the highest Calinski Harabaz pseudo-F value of 314.02 was shown to be the best division with two groups.

Group B was partitioned into Groups 3 and 4 after the Cluster analysis. Analyzing the descriptive statistics of the variables which integrate the groups, we may notice that Group 3 has a higher average for the infrastructure variables such as water piping coverage (90% versus 78%), garbage collection (94% versus 80%), sewage (83% versus 69%), brick housing (96% versus 95%) and electric energy (99% versus 57%). The quartile analysis also shows that most cities in Group 3 have higher values observed for the variables of infrastructure and sanitation.

As for the private coverage, Group 3 has the cities with higher private coverage average (19% versus 13%) as the observation shows. Apart from having a higher private health coverage than Group 4, this group has a lower number of people dependent on Conditional Cash Transfer program (4% versus 7%).

Regarding size, Group 3 hasw a higher average population and a higher range than Group 4. Group 3 has an average 98,929 inhabitants versus 23,369 inhabitants of Group 4. Analyzing the quartiles, 75% of the cities in Group 3 have less than 95 thousand inhabitants, while this value is less than 20 thousand inhabitants for Group 4.

Table 2 Descriptive Analysis – Group B split in Groups 3 and 4*

Gr	Var	N	Avg	Min	Max	25%	Median	75%
G3	WATER	306	89.86	0.87	100.00	84.52	95.42	98.91
	GARBAGE	306	93.60	45.30	100.00	91.04	97.04	99.54
	SEWAGE	306	82.52	0.17	100.00	75.09	90.87	98.16
	BRICK	306	96.29	57.34	100.00	96.97	99.27	99.74
	ELECTRICITY	306	98.53	86.16	100.00	98.21	99.14	99.58
	PRIVATE	306	187.97	100.10	568.51	140.81	180.49	227.24
	TRANFER	306	3.53	0.76	7.27	2.71	3.52	4.35
	POPULATION	306	98.92	1.05	2.41	13.20	34.12	94.23
	HDI	306	0.80	0.73	0.92	0.78	0.80	0.82
G4	WATER	176	77.61	0.51	100.00	66.90	81.57	93.00
	GARBAGE	176	79.61	25.43	100.00	71.43	82.17	92.22
	SEWAGE	176	68.76	0.00	99.97	55.19	75.85	89.36
	BRICK	176	95.04	23.81	100.00	95.02	98.93	99.70
	ELECTRICITY	176	97.61	73.33	100.00	97.04	98.72	99.41
	PRIVATE	176	120.72	100.08	396.38	121.31	136.10	172.33
	TRANFER	176	6.75	2.95	13.76	5.45	6.47	7.67
	POPULATION (in 1,000)	176	23.37	1.39	356.53	5.22	9.55	19.33
	HDI	176	0.74	0.57	0.80	0.73	0.75	0.76

Variables: WATER – proportion of houses with water piping ($x10^2$); GARBAGE – proportion of cities with garbage collection ($x10^2$); SEWAGE – proportion of houses with sewage piping ($x10^2$); BRICK – proportion of houses made of bricks ($x10^2$); ELECTRICITY – proportion of houses which have electricity ($x10^2$); PRIVATE – proportion of population covered by private healthcare assistance ($x10^3$); TRANSFER – proportion of population benefited by the "Conditional Cash Transfer" program ($x10^2$); POPULATION – population living in the city ($x10^{-3}$); HDI – Human Development index; Gr – group.

Tests results: highest pseudo-F of Calinski and Harabaz: 314.02; p-value<0.01 for univariate normality asymmetry and kurtosis test and bivariate and multivariate normality of Doornik-Hansen; p-value<0.01 for differences between the groups G3 and G4 by the Kruskal-Wallis non-parametric test.

Source: research results.

It was possible to see that, for the analyzed dimensions, groups 1, 2, 3 and 4 were formed with cities of different sizes, but similar by other dimensions. Despite this fact, Group 2, with the lowest private coverage has the cities with the lowest population and, by analyzing the quartiles, 75% of these have less than 12 thousand inhabitants. This group also showed the smallest averages for the other variables, indicating the presence of the smallest cities and also the poorest of the sample.

Group 1 and Group 4 have similar characteristics, except for the private coverage percentage. While Group 1 has 75% of the cities with less than 23 thousand inhabitants, Group 4 has 75% of the cities with less than 20 thousand inhabitants. As to development, they are close in HDI indexes, Group 1 having an HDI index average of 0.76 and Group 4 has 0.74.

Group 3 showed itself to be opposed to Group 2, presenting the highest averages for variables analyzed. This group may be considered as the one formed by the biggest cities in the sample and, at the same time, being in average the most developed.

In general, the 4 groups presented the best possible distinction for the four proposed dimensions which could have influence over the expenditure efficiency in primary care. The formation of these groups will enable to perform the analysis of technical efficiency to identify better benchmark cities.

Placing the groups in an imaginary line which measures the dimensions stated for ranking the cities, we may say that Groups 2 and 3 are at the extremities of this imaginary line, while Groups 1 and 4 are in intermediate positions. The list of efficient cities by groups are available in the appendix of this study after the references.

Technical efficiency analysis

The descriptive statistics of technical efficiency in allocating primary care resources for Group 1 are set out in Table 3 through the four years. We may notice that the average efficiency of resource allocation was, respectively and approximately, 58%, 59%, 65% and 62% from 2007 to 2010. Analyzing the quartiles of the technical efficiency scores we can observe that in all years 75% of the cities had efficiency scores lower to 75% approximately. As to the inferior quartile, 80% of the cities have indexes higher than 44%. Relatively, we may say that these results are far from 100% efficiency.

Analyzing these results we may infer that most of the analyzed cities could increase the service offer for the population in primary care, for being below the limit of efficient cities. This score and efficiency dispersion was expected due to the autonomy in expenditures of the city governments in primary care as discussions of Fleury and Baris (2001), Brasil (2008) and La Forgia and Couttolenc (2009). If each city allocates its resources without relative comparison parameters, it is expected that the results will be so spread. Therefore, this study proposes to bring these differences into evidence, in order to motivate the decision maker for controlling the resource allocation in these cities.

Table 3 - Technical efficiency and productivity changing for Group 1

	Efficiency							Malmquist			
Year	Obs	Avg	Min	Max	25%	Median	75%	Avg	25%	Median	75%
2007	360	57.68	18.95	100.00	44.59	54.84	66.06	-	-	-	-
2008	360	59.34	20.03	100.00	44.98	56.33	70.16	0,99	0,90	0,99*	1,06
2009	360	65.11	19.70	100.00	52.95	64.20	75.53	0,99	0,90	0,98*	1,05
2010	360	62.39	22.68	100.00	48.74	58.37	73.56	1,01	0,90	1,00	1,07

Obs – Observations; Min – Minimum; Max – Maximum; Avg – average

Observations: p-value<0.05 for univariate normality asymmetry and kurtosis test and bivariate and multivariate normality of Doornik-Hansen; * significant at 5% by the nonparametric Wilcoxon test for the theoretical value of the median equal to 1.

Source: research results.

About the differences in efficiency through the years was not possible to verify significant changes in productivity (Malmquist) in the range 2009-2010. For the other years, it can be inferred that the cities had Malmquist indexes different from 1 (one). From Table 2 it can be seen that more than half of the cities in Group 1 showed a lost in productivity in the ranges of 2007-2008 and 2008-2009. In the interval 2009-2010 there were no significant changes. According to the average there was a loss of 1% in productivity in the range from 2007 to 2008 and the same amount for 2008-2009.

Group 2, formed by 255 cities, forms Group A of cities with lower coverage of private health insurance. The technical efficiency scores and scale of this group are presented in Table 4.

For the respective analyzed years, the average technical efficiency scores were, approximately, 58%, 48%, 56% and 60%. We may see by the scores' descriptive statistics a considerable range for efficiency which has a minimum of 20% for year 2007; approximately 16% for year 2008; 28% for year 2009; 29% for year 2010. Similar ranges were observed when analyzing Group 1, reinforcing the hypothesis that the analyzed cities are different in primary care expenditure efficiency. The efficiency of the cities are low when we analyze that 75% of the sample have efficiency scores below 73% between the four years analyzed. If we analyze only year 2008, this value falls to 60%.

Looking at Table 4 we could see that most cities in Group 2 showed lost in productivity in the range 2007-2008 and 2009-2010. On average there was a gain in productivity by 1% from 2007 to 2008 and an average reduction of 2% in 2009-2010. Even with the average increase in the interval 2007-2008, most municipalities have reduced productivity as seen in quartiles.

Table 4 Technical efficiency and productivity changing for Group 2

	Efficiency							Malmquist			
Year	Obs	Avg	Min	Max	25%	Median	75%	Avg	25%	Median	75%
2007	255	58.05	19.51	100	43.59	54.34	68.62	-	-	-	-
2008	255	48.07	15.77	100	31.49	42.51	60.24	1,01	0,90	0,98*	1,06
2009	255	55.93	18.67	100	41.14	51.20	65.58	1,00	0,89	1,00	1,09
2010	255	59.70	28.34	100	43.37	54.95	72.32	0,98	0,85	0,97*	1,08

Obs – Observations; Min – Minimum; Max – Maximum; Avg – Average

Observations: p-value<0.05 for univariate normality asymmetry and kurtosis test and bivariate and multivariate normality of Doornik-Hansen; * significant at 5% by the nonparametric Wilcoxon test for the theoretical value of the median equal to 1.

Source: research results.

Group 3, formed by 306 cities, has its efficiency scores presented in Table 5. As we can observe, the technical efficiency scores were, approximately, 61%, 54%, 60% and 60% for the years analyzed. Regarding range, this group shows cities with lower efficiency scores, namely 15% for 2007 and 14% for 2008.

Table 5 Technical efficiency and productivity changing for Group 3

	Efficiency							Productivity changing			
Year	Obs	Avg	Min	Max	25%	Median	75%	Avg	25%	Median	75%
2007	306	61.64	15.41	100	46.80	58.67	74.11	-	-	-	-
2008	306	54.14	13.87	100	38.60	48.86	65.48	1,04	0,89	0,99	1,10
2009	306	59.53	24.22	100	42.92	54.46	74.76	1,01	0,89	0,98*	1,05
2010	306	60.06	19.64	100	43.96	56.73	72.38	0,99	0,86	0,97*	1,05

Obs – Observations; Min – Minimum; Max – Maximum; Avg – Average

Observations: p-value<0.05 for univariate normality asymmetry and kurtosis test and bivariate and multivariate normality of Doornik-Hansen; * significant at 5% by the nonparametric Wilcoxon test for the theoretical value of the median equal to 1.

Source: research results.

As can be seen in Table 5, there was a lost in the productivity for most cities. In Group 3, from the first to the second year (2007-2008) no significant change in productivity was found. In the rest of the intervals analyzed, it was observed that most cities lost expenditure productivity in primary care, although the averaged gain of 1% from 2008 to 2009.

We can observe through the descriptive statistics that 50% of the cities have efficiency scores below 60% over all the years analyzed. Thus, we expect a higher percentage increase in the outputs generated by these cities so that they may improve technical efficiency.

In Table 6 we have available the efficiency scores for Group 4, formed by 176 cities. The average efficiency found was of 65%, 70%, 67% and 50%, respectively, for the years analyzed. Technical efficiency for the year 2010 was inferior to the other years, contrary to the averages of years 2007 to 2009. By analyzing the quartiles, for the year of 2010 it is possible to infer on the presence of cities with low scores for the year of 2010. Again Table 6 shows that most cities lost expenditure productivity. In other years there was no significant change in the median productivity.

Table 6 Technical efficiency and productivity changing for Group 4

	Efficiency							Productivity changing			
Year	Obs	Avg	Min	Max	25%	Median	75%	Avg	25%	Median	75%
2007	176	65.42	30.52	100.00	51.95	62.48	76.59	-	-	-	-
2008	176	69.76	31.84	100.00	54.89	68.26	82.02	1,02	0,94	0,99	1,03
2009	176	67.33	15.63	100.00	53.36	64.31	79.73	1,03	0,96	1,01	1,05
2010	176	49.58	10.34	100.00	29.14	42.67	62.78	1,01	0,86	0,98*	1,05

Obs – Observations; Min – Minimum; Max – Maximum; Avg - Average

Observations: p-value<0.05 for univariate normality asymmetry and kurtosis test and bivariate and multivariate normality of Doornik-Hansen; * significant at 5% by the nonparametric Wilcoxon test for the theoretical value of the median equal to 1.

Source: research results.

Analyzing the quartiles, we notice that 75% of the cities have efficiency indexes above 50%, except for year 2010. In the same direction, except for the year of 2010, 75% of the analyzed cities have efficiency scores below 75%.

Overall, it can be inferred that most of the cities analyzed showed lost in productivity in primary care expenditure over the years analyzed. This result can be inferred by analyzing median of Malmquist Index of Ray and Desly (1997). It may be possible that the reduction of this productivity is related to stabilization of Primary Care National Policy since the early years there may be greater effort by governments to promote policy and this effort would be reduced over the year. This is a hypothesis not tested in this study and it is not possible to tell if this is the cause of most lost in productivity.

The analysis posted here meet the performance studies, such as Behn (2003) and Greiling (2006) who claim that the performance measures that diverge from the expected can create opportunity for learning and that these measures may suggest topics for research.

Conclusions

This study was developed aiming at being utilized by the city managers and researchers as an instrument for supporting the decision making, so that the inefficient cities can look for their benchmarks (100% efficient cities) of the best public resource allocation practices seeking to increase the primary care services offer for the population. We have attached the list of efficient cities in the appendix of this study that could offer more services in primary care with the same level of resource allocation.

One of this study's main contributions was the proposal of the analytic model of performance in primary care expenditures. This model take in account the main variables described by literature. Furthermore, this study took into consideration a longitudinal analysis which is not taken into consideration in most studies which use efficiency indexes in Brazil.

Analyzing the most similar possible cities, in four different groups, the efficiency scores evidenced the disparities in resource allocation in the southeastern region because of the differences in the efficiency scores, a fact which could be justified by their autonomy in allocating their resources and the absence of relative comparison procedures between them for these expenditures. The 1988 Federal Constitution gave attributions to municipalities and states besides the federal government by the decentralization process in the public management. This study proposes a model to solve this problem of a lack of relative comparisons. According this study there is space for increase the primary care service offer.

As a proposal for a performance analysis, this model should be applied continuously, so that it may be justified as a performance study. This study is the initial proposal of a model so that the measuring is not restricted only the period of this study. The building of reference units or benchmarks may be an instrument to direct the decision-making of city managers, as well as other higher public management levels.

It was important to incorporate all possible cities from southeast region to create a practical frontier. We indicate not exclude or look for outlier in these frontiers assuming that all cities are under the same conditions to manage his resources because of the decentralization of primary care resource allocation. That is why we did not apply the super-efficiency of Banker and Chang (2006) for identifying outliers in the production frontier. Maybe exceptional efficient cities should be taken into account to know why that could be so different in offering more services with some level of investments. By the way the inefficient cities should try to reach these exceptional efficient cities and not those with the same productivity level. That was one of the reasons to apply a non parametric metric to analyze the expenditure efficiency.

Therefore, this study follows Greiling (2006) in the supposition that performance measures which diverge from what was expected may create an opportunity for learning. But the measures themselves tend more to suggest themes for investigation than to directly transmit main operational lessons. So do this study. In order to improve performance, public managers need to understand how they can influence people's behavior inside their cities which produce their results, and how they can influence the citizens' behavior, which is converted into results from these outputs.

We questioned whether there were changes in productivity from 2007 to 2010 and we found that there was no gain in productivity in any of the four groups obtained. For most cities there were no statistically significant changes in productivity or when it was found, these were caused by lost in productivity. The analysis of the cause of productive lost is not in this study but there are a main hypothesis about that: the rise in the difference between the efficient cities and inefficient cities. In this case, we could analyze in future studies if this difference was caused by the improvement of efficient cities or worse of inefficient cities.

Since the importance cited in this study, the need to increase efficiency at the expense of the budget increase for the sector, it is important to try to seek the causes of reduced productivity and work so that resources can be allocated more productively.

Besides analyses of productivity lost, future studies could analyze and compare the validity among different models that could incorporate other variables as number of physicians, number of nurses and epidemiological and mortality variables (as childhood mortality, frequency of diabetes and arterial hypertension). The purpose of studies like that are beyond this study purpose and could incorporate statistical analysis as structural equation modeling and path analysis to test which model could be more appropriate to rank the efficiency of cities.

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Submissão: 05/06/2012
Aprovação: 14/04/2014

Appendix - Cities on the frontier

Table 1 – Group 1

Year	City (State)	Year	City (State)	Year	City (State)
2010	Arapuá(MG)	2007	Itaboraí(RJ)	2009	Flórida Paulista (SP)
2007	Campo Belo(MG)	2008	Itaboraí(RJ)	2010	Flórida Paulista (SP)
2008	Campo Belo(MG)	2009	Itaboraí(RJ)	2007	Guarujá (SP)
2009	Campo Belo(MG)	2010	Itaboraí(RJ)	2008	Indiaporã (SP)
2007	Campo do Meio(MG)	2008	Itaguaí(RJ)	2007	Itu (SP)
2010	Campos Altos(MG)	2010	Itaguaí(RJ)	2010	Itu (SP)
2007	Faria Lemos(MG)	2008	Magé(RJ)	2009	Mesópolis (SP)
2010	Heliodora(MG)	2009	Nilópolis(RJ)	2009	Mineiros do Tietê (SP)
2010	Inconfidentes(MG)	2007	Nova Iguaçu(RJ)	2010	Monte Castelo (SP)
2010	Itueta(MG)	2008	Nova Iguaçu(RJ)	2007	Ourinhos (SP)
2008	Lima Duart(MG)	2009	Nova Iguaçu(RJ)	2009	Ourinhos (SP)
2008	Maravilhas(MG)	2010	Nova Iguaçu(RJ)	2008	Paulicéia (SP)
2009	Maravilhas(MG)	2007	São Fidélis(RJ)	2009	Piacatu (SP)
2010	Maravilhas(MG)	2008	São Fidélis(RJ)	2010	Piacatu (SP)
2009	Nova Era(MG)	2009	São Fidélis(RJ)	2007	Planalto (SP)
2008	Passos(MG)	2010	São Fidélis(RJ)	2009	Planalto (SP)
2009	Poço Fundo(MG)	2007	Araçatuba(SP)	2010	Pontalinda (SP)
2007	Pratápolis(MG)	2008	Araçatuba(SP)	2007	Ribeirão do Sul (SP)
2010	Pratápolis(MG)	2009	Araçatuba(SP)	2008	Ribeirão do Sul (SP)
2007	Ribeirão das Neves(MG)	2010	Araçatuba(SP)	2008	Salto Grande (SP)
2008	Ribeirão das Neves(MG)	2009	Arandu(SP)	2010	Salto Grande (SP)
2009	Ribeirão das Neves(MG)	2010	Arandu(SP)	2007	Santa Cruz do Rio Pardo(SP)
2009	Santa Luzia(MG)	2008	Assis(SP)	2008	Santa Cruz do Rio Pardo(SP)
2007	Santana do Paraíso(MG)	2009	Assis(SP)	2007	Santana de Parnaíba (SP)
2008	São Gonçalo do Sapucaí(MG)*	2007	Buritama(SP)	2010	Santana de Parnaíba (SP)
2008	São Pedro da União(MG)	2008	Buritama(SP)	2007	São Lourenço da Serra (SP)
2009	Teófilo Otoni(MG)	2010	Cajati (SP)	2008	São Lourenço da Serra (SP)
2010	Teófilo Otoni(MG)	2009	Canas (SP)	2010	Tabatinga (SP)
2009	União de Minas(MG)	2010	Canas (SP)	2010	Taquarituba (SP)
2010	União de Minas(MG)	2007	Castilho (SP)	2008	Urupês (SP)
2007	Marataízes(ES)	2008	Castilho (SP)		
2008	Marataízes(ES)	2009	Castilho (SP)		
2010	Marataízes(ES)	2010	Castilho (SP)		
2007	Belford Roxo(RJ))	2007	Cravinhos (SP)		
2008	Belford Roxo(RJ)	2007	Embu-Guaçu (SP)		
2009	Belford Roxo(RJ)	2010	Emilianópolis (SP)		
2010	Belford Roxo(RJ)	2009	Cachoeiras de Macacu(RJ)		

*Weakly efficients cities

Fonte: resultado da pesquisa.

Table 2 – Group 2

Year	City (State)	Year	City (State)	Year	City (State)
2009	Chapada Gaúcha (MG)	2007	São João Evangelista (MG)	2007	São José do Goiabal (MG)
2010	Coroaci (MG)	2010	São João Evangelista (MG)	2008	São José do Jacuri (MG)
2007	Engenheiro Caldas (MG)	2009	Orizânia (MG)	2010	São Sebastião do Anta (MG)
2008	Engenheiro Caldas (MG)	2009	Passa-Vinte (MG)	2009	Bonito de Minas (MG)
2010	Estrela Dalva (MG)	2010	Pedra Azul (MG)	2010	Bonito de Minas (MG)
2009	Felício dos Santos (MG)	2007	Pedras de Maria da Cruz (MG)	2010	Ubaporanga (MG)
2010	Felício dos Santos (MG)	2009	Pedras de Maria da Cruz (MG)	2007	Várzea da Palma (MG)
2009	Glaucilândia (MG)	2010	Pedras de Maria da Cruz (MG)	2009	Várzea da Palma (MG)
2010	Glaucilândia (MG)	2008	Pescador (MG)	2008	Brasília de Minas (MG)
2007	Itabirinha (MG)	2009	Pescador (MG)	2009	Brasília de Minas (MG)
2008	Itanhomi (MG)	2008	Pintópolis (MG)	2009	Conceição da Barra (MG)
2007	Araçuaí (MG)	2010	Porteirinha (MG)	2010	Braúnas (MG)
2009	Jordânia (MG)	2009	Poté (MG)	2008	Santa Leopoldina (ES)
2010	Jordânia (MG)	2010	Poté (MG)	2010	Sooretama (ES)
2007	José Raydan (MG)	2009	Pres. Kubitschek (MG)	2009	São Franc. de Itabapoana (RJ)
2008	José Raydan (MG)	2010	Pres. Kubitschek (MG)	2010	São Franc. de Itabapoana (RJ)
2007	Lassance (MG)	2008	São Dom. das Dores (MG)	2009	Cajuri (MG)
2008	Minas Novas (MG)	2010	São Dom. das Dores (MG)	2010	Cajuri (MG)
2009	Minas Novas (MG)	2008	São Francisco (MG)	2010	Bom Sucesso de Itararé (SP)
2010	Miradouro (MG)	2009	São Francisco (MG)		
2009	Arinos (MG)	2010	São Francisco (MG)		
2007	Nanuque (MG)	2009	São Geraldo do Baixio (MG)		
2008	Nanuque (MG)	2010	São Geraldo do Baixio (MG)		
2010	Nanuque (MG)	2010	São Gonç. Rio Preto (MG)		

Fonte: resultados da pesquisa.

Table 3 – Group 3

Year	City (State)	Year	City (State)	Year	City (State)
2009	Água Comprida (MG)	2007	Birigui(SP)	2007	Itanhaém(SP)
2007	Araújos (MG)*	2008	Birigui(SP)	2008	Itanhaém(SP)
2007	Belo Horizonte (MG)	2009	Birigui(SP)	2009	Itanhaém(SP)
2008	Belo Horizonte (MG)	2010	Birigui(SP)	2010	Itanhaém(SP)
2009	Belo Horizonte (MG)	2010	Buritizal(SP)	2009	Jaboticabal(SP)
2010	Belo Horizonte (MG)	2010	Cajobi(SP)	2007	Jambeiro(SP)

2007	Betim (MG)	2009	Cesário Lange(SP)	2008	Jandira(SP)
2008	Betim (MG)	2010	Cesário Lange(SP)	2009	Jandira(SP)
2009	Fortaleza de Minas (MG)	2008	Diadema(SP)	2010	Jandira(SP)
2007	Guaxupé (MG)	2009	Diadema(SP)	2010	Lençóis Paulista(SP)
2008	Guaxupé (MG)	2010	Diadema(SP)	2007	Lins(SP)
2008	Ipatinga (MG)	2007	Embu(SP)	2009	Lins(SP)
2010	Nova Lima (MG)	2008	Embu(SP)	2010	Lins(SP)
2010	Patos de Minas (MG)	2009	Embu(SP)	2007	Mauá(SP)
2008	Tiradentes (MG)	2010	Embu(SP)	2008	Mauá(SP)
2010	Tiradentes (MG)	2010	Guareí(SP)	2008	Meridiano(SP)
2008	Uberlândia (MG)	2007	Guariba(SP)	2007	Mogi das Cruzes(SP)
2009	Uberlândia (MG)	2009	Guariba(SP)	2008	Mogi das Cruzes(SP)
2008	Serra (ES)	2007	Guarulhos(SP)	2007	Mogi Guaçu(SP)
2007	Venda Nova do Imigrante(ES)	2008	Guarulhos(SP)	2008	Mogi Guaçu(SP)
2010	Venda Nova do Imigrante(ES)	2009	Guarulhos(SP)	2009	Mogi Guaçu(SP)
2007	Alfredo Marcondes(SP)	2010	Guarulhos(SP)	2007	Osasco(SP)
2008	Alfredo Marcondes(SP)	2009	Iperó(SP)	2008	Osasco(SP)
2009	Alfredo Marcondes(SP)	2007	Iracemápolis(SP)	2009	Osasco(SP)
2010	Alfredo Marcondes(SP)	2009	Iracemápolis(SP)	2010	Osasco(SP)
2007	Barretos(SP)	2007	Batatais(SP)		
2010	Nova Castilho(SP)	2009	Bilac(SP)		
*Weakly efficient cities					

Fonte: resultado da pesquisa.

Table 4 – Group 4

Year	City (State)	Year	City (State)	Year	City (State)
2009	Araçaí (MG)	2007	Montes Claros (MG)	2007	Aparecida d'Oeste (SP)*
2010	Aracitaba (MG)	2008	Montes Claros (MG)	2008	Aparecida d'Oeste (SP)
2009	Bela Vista de Minas (MG)	2009	Montes Claros (MG)	2009	Aparecida d'Oeste (SP)
2008	Belo Oriente (MG)	2010	Montes Claros (MG)	2010	Aparecida d'Oeste (SP)
2010	Campo Florido (MG)	2010	Reduto (MG)	2009	Borborema (SP)
2007	Carmópolis de Minas (MG)	2007	Resplendor (MG)	2007	Itapevi (SP)
2010	Claraval (MG)	2007	Ritápolis (MG)	2009	Itapevi (SP)
2009	Conceição dos Ouros (MG)	2008	Ritápolis (MG)	2007	Itaquaquecetuba (SP)
2008	Conselheiro Pena (MG)	2010	Ritápolis (MG)	2008	Itaquaquecetuba (SP)
2009	Conselheiro Pena (MG)	2007	Santa Cruz de Minas (MG)	2009	Itaquaquecetuba (SP)
2008	Corinto (MG)	2009	Santa Cruz de Minas (MG)	2010	Itaquaquecetuba (SP)
2007	Delta (MG)	2010	Santa Cruz de Minas (MG)	2008	Narandiba (SP)

2007	Formiga (MG)	2010	São Sebastião da Bela Vista (MG)	2008	Nova Independência (SP)
2008	Formiga (MG)	2008	Sapucaí-Mirim (MG)	2010	Nova Independência (SP)
2009	Formiga (MG)	2010	Sapucaí-Mirim (MG)	2008	Paranapanema (SP)
2009	Gonçalves (MG)	2007	Cariacica (ES)	2007	Piedade (SP)
2007	Governador Valadares (MG)	2008	Cariacica (ES)	2008	Piedade (SP)
2007	Ibirité (MG)	2009	Cariacica (ES)	2009	Piedade (SP)*
2008	Ibirité (MG)	2007	Nova Venécia (ES)	2010	Piedade (SP)
2009	Ibirité (MG)	2008	Nova Venécia (ES)	2010	Piquerobi (SP)
2010	Ibirité (MG)	2009	Nova Venécia (ES)	2009	São Francisco (SP)
2008	Mateus Leme (MG)	2007	São Mateus(ES)	2007	Taiaçu (SP)
2007	Matipó (MG)	2007	Viana(ES)	2008	Taiaçu (SP)
2008	Matipó (MG)	2010	Viana(ES)	2010	Taiaçu (SP)
2009	Matipó (MG)	2008	Anhumas (SP)		
2010	Matipó (MG)	2008	Uchoa (SP)		
* Weakly efficient cities					

Fonte: resultado da pesquisa.