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Public Expenditures and Productivity in Medium and High-Complexity Health Services in the Brazilian States

Abstract

Objective: Verify to what extent the volume of public expenditures in health has influence the efficiency and productivity gains of medium and high-complexity services in the Brazilian States.

Method: Based on Data Envelopment Analysis (DEA) and Malmquist's Productivity Index, a theoretical-empirical study was developed with a quantitative approach, using the Brazilian states that disclosed information in Datasus between 2008 and 2015 as analysis units.

Results: The main findings evidenced that the states with the mean highest resource volume could not be considered the most efficient, indicating that there may exist a negative relationship between the growth of public expenditures and the efficiency in the services offered. In addition, in the states that increased their spending in health between 2009 and 2015, the productivity was not directly proportional to the resource volume used.

Contributions: The research offers empirical elements that evidence the need to seek better outcomes for the health system, in the context of medium and high-complexity care, based on the efficiency and productivity gains offered, in principle without liberating new resources for the sector.

Key words: Public Expenditures. Public Health. Efficiency. Productivity.

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1. Introduction

The Brazilian health system, established in the Federal Constitution of 1988 (Brazil, 1988), sought roots in the principles of equality and universality to allow anyone, regardless of contribution, to have access to health. From that moment on, the public health services underwent a process of decentralization to favor comprehensive care and health care for those who needed it (Brazil, 1990), resulting in one of the most important conquests in the social field, at a time when Brazil sought its redemocratization (Marques & Mendes, 2012).

In order to guarantee greater access, the Unified Health System (SUS) was structured in blocks of financing according to the specificities of its actions and services agreed upon (Brazil, 2007). The block of financing of the medium and high complexity procedures consumes most of the resources (Junior & Mendes, 2015) because it is inserted in an area that demands the use of cutting-edge technology and professionals with higher qualification. In recent years, however, access to this type of service has been pointed out as one of the obstacles to the integrality of SUS (Spedo, Pinto & Tanaka, 2010), as it has prioritized only basic care and directed the other services to the private initiative (Santos & Gerschman, 2004; Spedo *et al.*, 2010).

Law No. 8.080 / 1990 (Brazil, 1990) assigns, as a priority, the operationalization of these services to the federal states, which require a higher percentage of expenditures in more specialized actions, with a high operational cost and a high technological standard (Junior & Mendes, 2015). It has been observed, however, that states have to face some challenges in order to make the execution of these services feasible. Piola and Vianna (2002), Santos (2007), Koerich, Drago, Andrade, and Erdmann (2016) showed that these challenges may be related to the low amount of resources applied in the sector.

On the other hand, studies have pointed out that the problem in the health sector is not only related to the volume of expenditures (Gupta, Davoodi & Tiongson, 2001; Makuta & O'Hare, 2015; Novignon, Olakojo & Nonvignon, 2012), being a necessary condition, but not enough to improve the quality of services (Giuffrida, 1999). The amount of resources applied can be an important factor in determining quality, but it is not a guarantee that the services offered will positively impact the health indicators (Gupta *et al.*, 2001). Therefore, the efficiency in the use of these resources has been pointed out as one of the aspects that also needs to be considered in order to achieve the desired health improvements (Giuffrida, 1999; Makuta & O'Hare, 2015).

Considering the constitutional responsibilities defined for the Brazilian states in the execution of medium and high-complexity services, it is necessary to verify the level of efficiency of public health expenditures in these entities and to what extent resources are sufficient to meet the demands of the population. Thus, to allow the efficient management of public resources to increase the productivity of the goods and services offered to the population, without the need to increase the amount of resources allocated, the following research problem is proposed: **To what extent does the increase in public expenditures influence the increase of efficiency and productivity of health services of medium and high complexity in the Brazilian states?**

This study aimed to verify the extent to which the volume of public expenditures has influenced the increase of efficiency and productivity of medium and high-complexity health services offered by the Brazilian states. It is justified in view of the need to empirically observe whether the proposed improvement to the health system, especially in terms of medium and high complexity, rests on the need to raise public expenditures (Koerich *et al.*, 2016; Piola & Vianna, 2002; Santos, 2007), or if the efficiency in the execution of these services, accompanied by increased productivity, are essential elements to add improvements to the system (Gupta *et al.*, 2001; Makuta & O'Hare, 2015; Novignon *et al.*, 2012).

Therefore, this study presented empirical evidence that indicates the possibility of finding improvements for the health system without, in principle, allocating new resources to the SUS. Although many argue that increasing revenues would be the most viable solution for public health in the Brazilian states, this study shows that, first, it is necessary to improve the public spending of resources already available, increasing productivity through management efficiency, and not necessarily through the increase of revenues.

At the same time, the study motivates a reflection on the importance of using accounting information from the public sector, together with socioeconomic variables, to determine the ability of the government to act upon the society's health demands. And, with this information, to present to the public manager the priorities that need to be observed when setting public policies that effectively optimize the public expenditures, aiming to reduce the health problems in Brazil.

2. Literature Review

The literature on public health expenditures has sought to understand the relationship between the amount of resources employed and how it affects the quality of services and the specific health indicators. Filmer & Pritchett (1999) evaluated the impact of public expenditures and economic, educational and cultural factors in determining the mortality rate of children under five years old in developing countries. They noted a gap between the apparent potential of expenditures to improve health conditions and the current health performance in those countries, suggesting that the amount of resources is not the most important factor in improving the quality of a country's health.

Gupta, Verhoeven, and Tiongson (2003) estimated the impact of health spending on poor countries. They showed that these countries have a significantly lower health status than developed countries. They concluded that health in the poorest regions is more heavily affected by public expenditure than in rich countries. The results show new evidence that public expenditures are more important for the poor, so that increasing the level of health spending by one percent would reduce child mortality by two or more deaths in those countries. Nevertheless, the results indicate that the increase in public spending alone is not enough to improve the health status.

Bokhari, Gai, and Gottret (2007) corroborated this evidence by studying the impact of government expenditures on health outcomes using as a measure of quality the under-five mortality rate and the maternal mortality rate. Using an instrumental variable technique, they estimated the average elasticity of the mortality rate for children under five years of age in relation to public health expenditure reaching -33%. As for maternal mortality, the mean elasticity was around - 50%.

These pieces of evidence have suggested, empirically, that there is no direct relationship between the quantity of resources and the quality of health. Little has been discussed about this relationship though, according to Beauvais and Wells (2006), who reviewed the literature produced in the period from 1980 to 2005 and sought to distinguish which aspects of health financing affect different dimensions of quality. They identified, in this period, 16 empirical studies analyzing how the finances of health organizations affect quality. The authors observed limited research, investigating whether the behavior of additional factors modifies the relationship between finance and quality.

In order to find the determinants of the impact of public spending on health in developing countries, Makuta and Hare (2015) analyzed the quality of governance in health conditions in 43 sub-Saharan African countries. The results confirmed the hypothesis that public health expenditure has no statistically significant impact on the improvement in health outcomes. But by inserting the governance variable into the model, the impact of the health expenditures improved the results by about 17 to 19 percentage points. These results, according to the authors, can be attributed to the increase in efficiency due to the presence of a better governance index.

As can be seen, there is evidence that increased public expenditures may not result in improvements in the health system. This opens the possibility to investigate whether the amount of resources alone is a determinant factor to increase productivity in public health services, or whether the efficient management of these resources would be one of the preponderant factors to ensure better quality in health outcomes.

2.1 Efficiency of Public Expenditures and Productivity in Health

Health quality, according to Donabedian (1988), can be classified under aspects of structure, process, and outcomes. As a structure, quality denotes the attributes by which medical care takes place, that is, they are material, human, and organizational resources. As a process, it indicates what is actually done to ensure medical care. They are the patient's activities in the search for improvements in his health conditions and the professionals' actions in the implementation of a treatment. The outcomes, then, correspond to the effects of health actions on the life of patients or the population.

Based on these aspects, the quality of health can be evaluated through the attributes of efficacy, effectiveness, efficiency, optimization, acceptability, legitimacy and equity (Donabedian, 2003). A structural quality assessment was chosen for this study though, based only on the efficiency attribute applied to the context of public spending on medium and high-complexity health in the Brazilian states.

Efficiency is the ability to reduce service costs without decreasing the improvement of health conditions (Donabedian, 2003). Thus, efficiency is increased for a given level of costs when the health conditions of the population gain increasing improvements. In that sense, efficiency can be observed by verifying the level of goods and services produced and offered to the population (Donabedian, 2003), that is, by observing whether the resources are organized and managed to minimize the service costs, as well as if the staff, supplies and equipment are paid at values representing their best alternative cost (Aday, Begley, Lairson & Slater, 2004).

Two fundamental approaches are generally used to measure the efficiency of a production unit and can be based on parametric methods or non-parametric models (Seiford & Thrall, 1990). Those that use parametric methods are the most common, although they have the disadvantage of using a previously known functional relationship for the production technology and the assumption of normality for the distribution of inefficiency terms (Seiford & Thrall, 1990).

Non-parametric methods are usually elaborated through Data Envelopment Analysis (DEA): a tool developed by Charnes, Cooper, and Rhodes (1981, 1978) that was constructed based on Farrell's productive efficiency (1957) and expanded to measure the efficiency of a Decision Making Unit (DMU) based on multiple inputs and multiple products, not requiring a functional relationship between the variables and the efficiency of a DMU. It can also be measured relative to all others with the simple restriction that DMUs are at or below the efficiency frontier (Seiford & Thrall, 1990).

Farrell (1957) pointed out that the efficiency of a production unit is composed of two components: technical efficiency, which demonstrates the ability of a DMU to obtain the maximum output from a set of inputs; and allocation efficiency, which reflects the ability of a firm to use the inputs in an optimized proportion, given their respective prices and production technology. According to Farrell (1957), production technology is the set of inputs that has the capacity to generate a product). These two measures are combined to determine the overall economic efficiency of a decision-making unit (Coelli, Rao, O'Donnel & Battese, 2005).

A DMU is considered to be 100% efficient if and only if the performance of other DMUs does not indicate that some of its inputs or outputs can be improved without the need to reduce some of its inputs or products (Cooper, Seiford & Zhu, 2011). Thus, efficiency does not require knowledge of the prices of inputs or products, concentrating only on the different inputs and outputs. Thus, to determine the efficiency of the states in offering medium and high complexity health products and services, it is not necessary to obtain the prices of the inputs used, only data related to the expenses and services offered.

It should be noted, however, that the performance of a DMU might change over time. Therefore, measuring these changes may be relevant to understand how entities have changed over time and how they have been impacted by technological change, or to see if improvements in DMU results can be attributed to their own initiatives, which drove them to improve their performance in relation to the existing technology (Bogetoft & Otto, 2011). The main methodology to verify the efficiency dynamics over time, according to Begotoff and Otto (2011), is the Malmquist Index, because it does not use prices to aggregate the different inputs and products.

The Malmquist Index (Malmquist Productivity Index), developed by Caves, Christensen and Diewert (1982), based on Malmquist (1953), is constructed by measuring the radial distance of the output and input vectors observed between two periods, relative to the change in the technology of the DMU. As the distance can be oriented according to the inputs and outputs, this index can measure the productivity by looking at the outputs based on the maximum level of products that were produced using a certain vector of inputs and a given production technology related to the level of observed products. When directed at the inputs, the productivity index is related to the level of inputs needed to produce a vector of outputs relative to a reference production technology.

Empirically, several studies have used these indicators to evaluate productivity in health services. Färe, Grosskopf, Lindgren, and Poullier (1997) compared productivity growth in the health sector for a sample of member countries of the Organization for Economic Cooperation and Development, based on the Malmquist productivity index. According to them, it is more advantageous to use this indicator, as one can work with multiple inputs and multiple products without the need to know the prices of the inputs and outputs used. This makes the method viable to work with the productivity of health systems.

Giuffrida (1999) used this index to analyze the UK health system. The author evaluated the change in productivity by decomposing the indicator into three parts: index of change in pure technical efficiency change, change of efficiency of scale and technological change; and concluded that the increase in productivity can be attributed to the improvement in pure technical efficiency and in the positive change in scale efficiency. Nevertheless, technological change was not significant. Allin, Grignon, and Want (2016) observed high levels of inefficiency in the Canadian health system. They perceived the possibility, based on the available resources, of presenting improvements in the outcomes by about 18 and 35%, reducing the rates of mortality by treatable causes. In addition, they found that the inefficiencies were related to three aspects: management factors (such as hospitalizations), public health factors (such as obesity and smoking) and environmental factors, such as mean income of the population.

Souza and Barros (2013), when evaluating the efficiency in the allocation of public resources destined to hospital care in the Brazilian states in 2009 and 2010, used as input variables hospital care expenses and as outputs the number of beds, the number of professionals in the health area and the number of health facilities. They concluded that only six states were considered efficient in 2009 and seven of them were 100% efficient in 2010, that is, most states failed to maximize the outcomes of the services offered to the population.

Also using the efficiency and productivity measures, other studies aimed to disclose the aspects of quality in healthcare: Ferrari (2006), Löthgre and Tambour (1999), Lyroudi, Glaveli, Koulakiotis, and Angelidis (2006), Sola and Prior (2001), and others. This shows that the literature has put great emphasis on measuring productivity in health services. This study broadens this discussion by making use of public sector accounting information in Brazil to measure the efficiency and productivity of the medium and high-complexity health system and to relate them to the increase in public spending on health in the Brazilian states.

3. Method

To answer the research problem, a theoretical-empirical study was carried out, using quantitative methods to analyze the extent to which the increase in the level of public expenditures influences the efficiency and productivity of the medium and high-complexity health services. Thus, the states of the Federation and the Federal District, whose public health information was available in the Department of Information Technology of the Brazilian Unified Health System (Datasus), were adopted as the unit of analysis.

The analysis considered the data from 2008 to 2015, during which data in Datasus were classified according to the Agreement process of Guidelines, Objectives, Targets, and Indicators for 2013-2015 (Brazil, 2013) and organized by a historical series from 2008 to 2015. Therefore, it was decided to use this period to maintain the uniformity of data and the definitions of the indicators available in the Datasus system.

In the first phase of the study, an analysis was developed of the efficiency of the Brazilian states in relation to the public health expenditures in the medium and high-complexity care category. For this purpose, DEA was used, which, according to Lobo and Lins (2016) and Hollingsworth (2003), is the method most frequently chosen to discuss health efficiency. The model of Banker, Charnes, and Cooper (1984) was adopted, with a focus on outputs, as public health services are not expected to reduce resources, but to maximize the goods and services offered to the population based on a set of inputs already available (Marinho & Façanha, 2001).

The variables used in the DEA model were selected to encompass the most relevant aspects highlighted in the literature and which can be used to evaluate the provision of health services in the medium and high complexity modality. The number of inputs and outputs was also checked in order not to exceed the basic DEA assumptions that condition the number of variables to the number of DMUs: Hollingsworth and Peacock (2008) recommend that the amount of DMU should not be less than three times the number of input and output variables. In this way, the model was developed with two input variables and two output variables, as shown in Table 1:

Table 1
Description of input and output variables for the DEA model

Variável	Descrição	Fundamentação
Total Expense (TE)*	Input variable corresponding to the sum of Hospital and Outpatient Expenses funded by the Fund of Strategic Actions and Compensations (FAEC) and the expenses funded by the MAC – Medium and High Complexity Hospital and Outpatient.	(Evans, Tandon, Murray & Lauer, 2000; Marinho, 2003)
Number of Establishments (NE)	Input variable corresponding to the Number of hospital and outpatient Establishments of medium and high-complexity under the responsibility of the States and maintained by the FAEC and MAC.	(Queiroz, Silva, Figueiredo & Vale, 2013; Ribeiro, 2008)
Hospital Procedures (HP)	Outpatient variable corresponding to the number of hospital procedures in the SUS, by place of hospitalization, approved per year of care per Unit of the Federation.	(Marinho, 2003; Souza, Scatena & Kehrig, 2016).
Outpatient Procedures (OP)	Outpatient variable corresponding to the number of outpatient procedures in the SUS, by place of hospitalization, approved per year of care per Unit of the Federation.	(Marinho, 2003)

Obs.: * The Total Expense amounts were deflated using the General Price Index – Internal Availability, a method developed by the Getúlio Vargas Foundation (FGV).

Source: Elaborated by the authors (2016).

After analyzing the efficiency of the Brazilian states in terms of public expenditure on medium and high-complexity procedures, the next step was to assess the behavior of these expenditures over the period, noting if there was a growth in the volume of resources applied and if this impacted the increase in the productivity of the goods and services offered.

Initially, the percentage difference between the resources expended in 2008 and 2015 was calculated. Thus, one can identify the states that increased the amount of resources in that period and, then, a comparative analysis was developed, using a test of means between the most efficient states and those that had the highest percentage increase in resources. Hence, it can be inferred if the average growth of resources was accompanied by a significant increase in the efficiency of the expenditures in medium and high-complexity services.

In the second stage of the study, the productivity of the States was calculated in relation to public expenditures in the health services through the Malmquist Productivity index. According to Färe, Grosskopf, Norris, and Zhang (1994), this indicator, developed by Caves, Christensen and Diewert (1982), based on Malmquist (1953), is used to make comparisons in several situations, being constructed through the distance function of inputs and output, where input-based approaches require that DMUs maximize revenues and output-based approaches serve to minimize costs.

Fare *et al.* (1994) specified an output-oriented model for the Malmquist Index of Productivity Change, considering the productivity at point related to the production at point adopting the following equation:

$$M_0^{t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)} \right]^{\frac{1}{2}} \quad [1]$$

This index corresponds to a geometric mean between two outputs, so that the values obtained that are higher than 1 (one) will be considered a positive increase in the productivity of the DMUs. Thus, in the approach adopted in this study, the respective productivity index was determined for each state, considering that there was an increase in the production of goods and services when the Malmquist index, calculated by equation [1], was higher than 1. Thus, indicators were obtained for several aspects of productivity, according to Coelli *et al.* (2005):

Variation in Technical Efficiency: this is the change in the technical efficiency index of each state in the period based on the inputs used, considering constant returns of scale;

Technological Variation: corresponds to the change in the production frontier, permitting the identification of the increase in productivity because of the improvement in the production technology used by each entity of the state;

Variation in the Pure Technical Efficiency: corresponds to the variation in the productivity of the states based on the technical efficiency calculated based on variable returns of scales, that is, it is the increase of the services offered based on the inputs used;

Variation in Scale Efficiency: represents the change of efficiency based on the production scale, making it possible to identify if a state entity operates at its optimal level of production relative to other entities;

Total Productivity of Production Factors: the Malmquist index, which defines the total productivity of a DMU, combining the measurement of technical efficiency with the efficiency of scale.

After defining the productivity indices for each state, the percentage change in productivity and health expenditures was determined. For this purpose, the Horizontal Analysis technique was used, which, according to Martins, Diniz, and Miranda (2012), is an important tool to analyze the evolution of the accounts in the financial statements over time. In this work, we used the value of public expenditures on medium and high-complexity care and the respective variation over time in each state of the Federation, based on the year 2008. Finally, a comparative study was developed between the variables, testing whether the means were considered equal and statistically significant. Thus, the goal was to identify if an average increase in the level of resources would tend to be statistically equal to an average increase in the productivity of the services performed.

4. Results

Analyzing public health expenditures in the period 2008 to 2015, we observed disparities in the mean value the states applied in the sub-function medium and high-complexity care. During this period, there was a state that spent only R$ 53 million, as can be seen in Table 2, while others used more than 9 billion. These values may reflect regional differences in Brazil (Albuquerque, Viana, Lima, Ferreira, Fusaro & Iozzi, 2017), showing that, in some locations, there is a greater concentration of health facilities with a higher degree of specialization to attend to the more complex services, demanding a higher percentage of resources.

Table 2

Descriptive statistics of variables in 2008-2015

Variable	Mean	Standard Deviation	Minimum	Maximum
Total Expense*	1.187.677	1.666.779	9.096.352	53.093
Number of Establishments	1.086	1.351	6.094	68
Hospital Procedures	426.843	492.235	2.507.111	24.703
Outpatient Procedures	44.008.825	65.374.565	404.188.787	2.461.161
State Population	7.252.559	8.503.830	44.396.484	412.783

Obs.: * Amounts in thousand reais.

Source: organized by the authors based on Datasus (2016) data.

The number of hospital and outpatient establishments also showed disparities, so that the state with fewer public centers for medium and high-complexity care has only 68 units. On the other hand, there are states with about six thousand hospitals and outpatient clinics. Therefore, in the collected data, it is observed that it is a heterogeneous sample with particularities inherent to each entity. Considering that the method used to measure efficiency was based on DEA with variable returns of scale (which reconciles different levels of production scale), however, this disparity did not influence the results of the research.

The per capita values of these variables, according to Table 3, depict public expenditures considering the demographic effects in the states. According to Varela, Martins, and Fávero (2012), a lower population density can cause a rise in the costs of providing health services because it requires greater effort to reach even the population farthest away. Thus, this evaluation pointed out that the average Total Expenditure per capita varies from 69.25 *reais* to 219.34 *reais*, indicating that there are states, proportionally to the number of inhabitants, with a lower amount of expenditures on medium and high-complexity services.

Table 3

Descriptive statistics of variables in per capita amounts for the period 2008-2015

Variable	Mean	Standard Deviation	Minimum	Maximum	Median
Total Per Capita Expense	149,86	30,71	69,25	219,34	146,24
Number of Establishments*	0,22	0,28	0,01	1,57	0,15
Hospital procedures*	5,99	0,86	3,94	7,82	6,01
Outpatient procedures	5,77	1,50	3,45	9,68	5,33

Obs.: * Amounts per 1000 inhabitants.

Source: organized by the authors based on Datasus (2016) data.

Another variable that reinforces some of the weaknesses of the medium- and high complexity health system in the Brazilian states was the Number of Establishments, which reached 0.01 per thousand inhabitants (data referring to the State of Rio de Janeiro, followed by Paraíba with a minimum value of 0.02). Thus, in the previous eight years, on average, in these states, 1 (one) health establishment of medium and high-complexity is available for every 100 thousand inhabitants, data that corroborate the findings of Souza and Barros (2013), who listed Rio de Janeiro between the states with the greatest dispersion between the number of inhabitants and the number of health facilities in 2009. There are signs that there are more patients in medium and high-complexity establishments demanding health services.

The other variables followed the trend towards inequality between the states, with highly discrepant maximum and minimum values. It was also recorded that the average number of hospital procedures was lower than the median, and the standard deviation was lower than one unit. Thus, there are indications that, amidst inequalities in the amount of resources, states are obliged to carry out, proportionally, the same amount of services. Thus, there may be state entities whose health systems are overloaded, having to meet a demand greater than their capacity and, therefore, they need to be more efficient in the use of resources.

4.1 Efficiency of the States in Medium and High-Complexity Health Services

After characterizing the variables, the Brazilian states' efficiency in offering medium and high-complexity health services is discussed. Efficiency measures corresponding to each year were obtained, according to Figure 1. On average, there was an increase in efficiency during the period, with 2013 being the year with the highest efficiency index in public expenditures.

In 2008 and 2009, the states of Rondônia, Amazonas, Roraima, Pará, Amapá, Ceará, Bahia, and São Paulo were on the border of efficiency, with a 100% score. As from 2010, Rio de Janeiro became part of this group and, in the years 2013 and 2014, Paraíba and Goiás also presented themselves technically efficient. Based on these results, it is observed that most of the efficient states are located in the North, confirming the findings of Souza and Barros (2013).

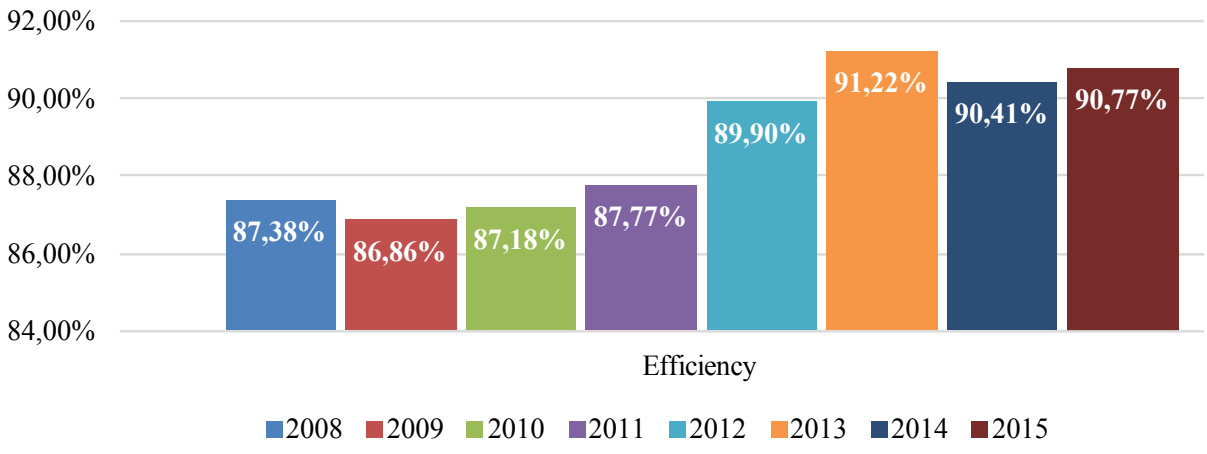

Figure 1. Mean Efficiency of the States in 2008 – 2015

In order to observe if the increase in the public health expenditures in the sub-function medium and high-complexities is somehow related with the efficiency in the use of these resources, the test of means between these variables was executed. Therefore, a group was created with the most efficient states, that is, the states whose efficiency scores were greater than or equal to the median efficiency values (89.7%, non-tabulated data) and another with the inefficient states (with scores lower than 89.7%). Then, the average per capita expenditures in each of these groups were compared. The Kolmogorov-Smirnov test for Independent Samples, presented in Table 4, showed that, at a significance level of 5%, there are indications that the average efficiency of the states that have spent most differs from the efficiency of those who have spent fewer resources.

Table 4

Kolmogorov-Smirnov test for efficiency and health expenditures in the Brazilian states

Groups	Test Statistics	P-value
States considered inefficienta	0,028	0,919
States considered efficienctb	-0,381	0,000
Combined (Kolmogorov-Smirnov)	0,381	0,000

Obs: (a) corresponds to the States with below-median (E < 89.7%) efficiency (E); (b) corresponds to the States with above-median efficiency (E > 89.7%);

Source: elaborated by the authors based on the research data (2016).

In the first line of Table 4, we test the hypothesis that the group of states defined as inefficient does not contain a lower value for health expenditures than the group considered efficient. With a 2.8% difference between the frequency and p-value distributions of 0.919, there are strong indications that lead to the non-rejection of the null hypothesis. Therefore, there is evidence to conjecture that inefficient states were not necessarily those that spent less.

Corroborating these observations, the second line of Table 4 verifies the hypothesis that expenditures are greater for the group of efficient states. The results suggest that the set of states considered to be efficient did not carry out higher amounts of per capita spending. The smaller difference between the two variables (-0.381) and the p-value of the distribution (0.000), at the level of 5%, motivate the need to reject the null hypothesis that there is equality between the means of these variables. Therefore, it should be assumed that the distributions are statistically different, indicating that it cannot be concluded that the efficient states are those that spend the highest amount of resources.

The descriptive statistics of per capita expenditures and the efficiency ratios for the two groups (Efficient and Non-Efficient) support these results, according to Figure 2. It can be verified that, among the inefficient states, the average per capita expenditure on health, in the category of medium and high-complexity care, was higher than in the group of Efficient States. Nevertheless, the states that used 12% less public resources managed to be 20% more efficient.

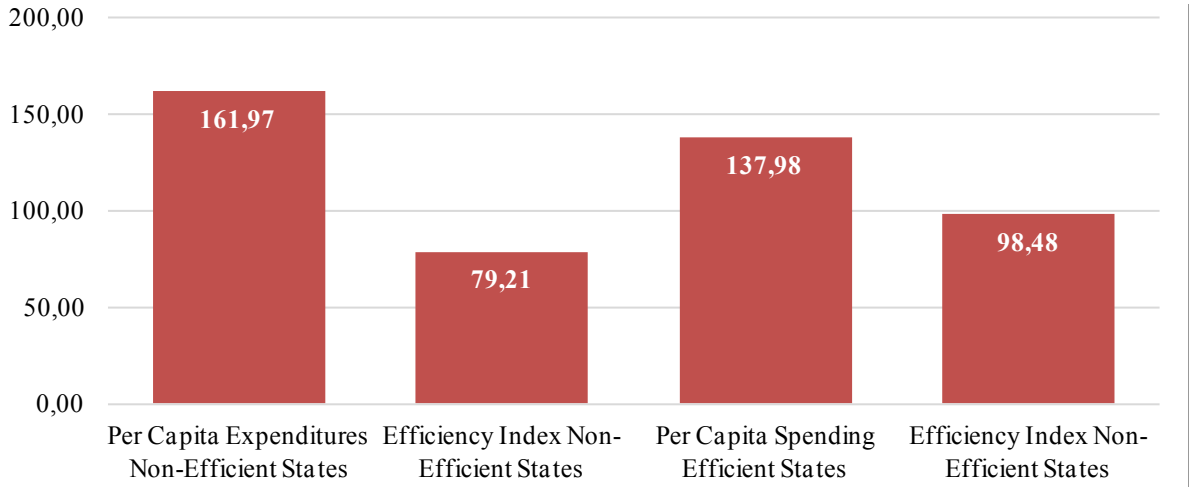

Figure 2. Efficiency and Public Expenditures of Efficient and Non-Efficient Groups

Based on these results, it can be inferred that higher efficiency is not necessarily related to a higher amount of available resources, which corroborates the results proposed by Filmer and Pritchett (1999), Gupta *et al.* (2003), Bokhari *et al.* (2007) and Makuta and O'hare (2015). At the same time, these results point out that the states with the highest amount of resources in per capita terms may figure among those with the lowest efficiency. This suggests that outpatient and hospital services could be expanded at the medium and high-complexity level in those states without allocating any new resources to the sector.

These findings may indicate some fragility in medium and high-complexity public health care. Given the essential importance of these services, a higher level of efficiency was expected in their execution, as the sector has more qualified human resources and technologically more sophisticated equipment. The results have pointed in another direction though, showing signs of inefficiency in the SUS between 2008 and 2015, even in those entities that received a larger volume of resources.

4.3 State Productivity in Medium and High-Complexity Health Services

After analyzing the efficiency in relation to the public expenditures on medium and high-complexity health services, the change of productivity of the states in the period 2008-2015 is discussed. Table 5 shows the mean values for the period 2008 to 2015.

Table 5
Malmquist Productivity Index for the Brazilian states in 2008-2015

Year	Variation in Technical Efficiency	Technological Variation	Pure Efficiency	Scale Efficiency	Total Productivity
2009	0,979	0,939	0,994	0,985	0,919
2010	1,002	1,106	1,003	0,999	1,108
2011	1,014	1,022	1,007	1,007	1,036
2012	1,010	1,067	1,026	0,984	1,077
2013	0,999	1,020	1,016	0,983	1,019
2014	0,977	1,049	0,990	0,987	1,025
2015	1,018	1,084	1,005	1,013	1,103

Source: research data.

Based on the Malmquist index, five measures of productivity were obtained: Variation in Technical Efficiency, Technological Variation, Change in Pure Technical Efficiency, Change in Scale Efficiency and Variation in Total Productivity of the Factors. It is observed that there were no results in 2008, as the Malmquist Productivity Index uses the first year of the series as a basis to calculate the indicators. For the following years, there was an increase in the Technical Efficiency variation, from 0.979 to 1.018. This result implies that Brazilian states increased productivity by 1.8% in the services offered because of the increased efficiency in the execution of public expenditures.

For the technological variation, the most significant increase was 10.6% in 2010 and the other years, except in 2009, showed a growing variation. This can be interpreted considering that there were improvements in the production technology, that is, in the inputs used by hospitals and clinics that provide medium and high-complexity services. On the other hand, the efficiency of scale did not show significant modifications, with a drop between 2012 and 2014 and a small increase in 2011 and 2015. Thus, it was verified that the states are working below their productive capacity, with the possibility of expanding services only by the increase in the production scale.

Finally, total productivity increased by around 10% in the years 2010 and 2015, while this result was less significant in the other periods, ranging between 1.9% and 3.6%; in 2012, total productivity increased by 7.7% in relation to 2008. This shows that the states, despite increasing productivity, did not continue with this performance over the periods, evidencing possible weaknesses in the management of the health resources.

After using the horizontal analysis technique for public health expenditures in the medium and high-complexity services and for the total state productivity, two different moments of the series were chosen to compare the behavior of these variables. 2010 was chosen as the starting year because the base year of the horizontal productivity analysis was 2009. And, to close off the analysis, the year 2015 was chosen. Figure 3 shows the variation of total expenditure and productivity in relation to the baseline year of the horizontal analysis.

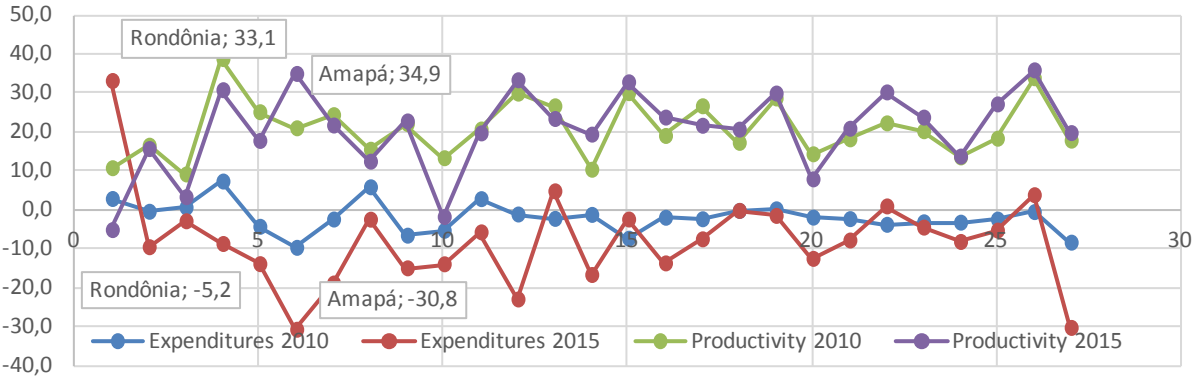

Figure 3. Relation between Expenditures and Total Productivity between 2009 and 2015

This analysis revealed how the variation in Health Expenditures occurred and the variation in Total Productivity indices for each state. To exemplify how this behavior took place, we chose the data referring to the State of Amapá, which showed the lowest change in expenditures in 2015 compared to the base year 2009 of the horizontal analysis. For this state, it was verified that, in 2010, expenditures dropped by 9.7% in relation to the baseline (2009), but productivity grew by 20.9%. In 2015, despite a 30.8% reduction in spending, this state increased its productivity by 34.8%. This points to the existence of a non-proportional relationship between public spending and productivity, so that, with the reduction of resources, the states have to meet their demands by seeking management alternatives to meet the needs of the population.

When the same analysis was performed for the State of Rondônia, a disproportionate behavior was found between expenses and productivity. While the resources used by this state increased from 2.8% to 33.1% in relation to the base year (2009), the productivity index decreased from 10.7% in 2010 to 2.8% in 2015, once again indicating that there is no direct relationship between expenditure and productivity. Thus, there are signs that increasing public spending on health does not necessarily make the entity more productive and in better conditions to offer more services.

To expand the scope of this discussion, the Non-Parametric test of Means was carried out, verifying the hypothesis that the states with the highest average growth in per capita expenditures on medium and high-complexity health services have the same average growth in the Malmquist Total Productivity Index. Table 6 presents the Kolmogorov-Smirnov test results for this relationship.

Table 6
Kolmogorov-Smirnov test for productivity and health expenditures in the Brazilian states

Groups	Test Statistics	P-value
States that did not increase their expenditures between 2008 and 2015	0,167	0,654
States that increased their expenditures between 2008 and 2015	-0,148	0,718
Combined (Kolmogorov-Smirnov)	0,167	0,963

Source: elaborated by the authors

Considering that the statistical null hypothesis was defined as that there are no differences between the average growth of expenditures and the average growth in productivity, the Kolmogorov-Smirnov Non-Parametric test showed that there is a 16.7% probability that there is no equality between these averages. In addition, the p-value of 0.963 indicates the possibility that, at the 5% level, the null hypothesis is not rejected. Therefore, there is not enough statistical significance to confirm that an average increase in spending is accompanied by the average increase in the Productivity index. Therefore, once again, it is evident that, within the scope of the medium and high-complexity subfunction in the states of the Federation and under the limitations defined by the choices of variables used in the DEA model adopted in this study, it is not expected that increasing public spending will increase the productivity of the services offered. As a consequence, it is not expected that there will be a direct and proportional relationship in the increase in the number of services offered to the population.

5. Final Considerations

This study aimed to verify the extent to which greater public spending influences the increased efficiency and productivity of medium and high-complexity health services in the Brazilian states. The basic assumption to carry out this research was to consider that, to improve the SUS, it is not enough to increase the level of health spending, but the efficiency in the use of these resources is another aspect that needs to be considered. Thus, based on the Data Envelopment Analysis and the Malmquist Productivity Index, a theoretical-empirical study was developed with a quantitative approach, using as a unit of analysis the Brazilian states that provided information in the Datasus system between 2008 and 2015.

The main results pointed to inequality in health expenditures among the Brazilian states so that Total per capita Expenditure presented great variation. Even so, it can be observed that, in entities with the lowest relation between health expenditures per inhabitant, the performance was similar to the entities that had the highest expenditure per capita. This reveals a possible inefficiency in the use of public resources so that States with fewer resources had to make a management effort to maintain the level of outpatient and hospital care in the standards of the states that spent the most.

In addition, it was observed that, in the entities that spent more, the efficiency in the services offered, on average, remained below the efficiency frontier. This shows that there was no balance between the growth of expenses and the number of services offered. This became more evident when verifying whether the average expenditure and the average efficiency could be considered statistically equal. The tests indicated that there was no statistical significance to corroborate this hypothesis. This reveals the trend that the state with the highest health expenditure is not always the most efficient.

When the productivity was evaluated, the results resembled those of the efficiency study. In the states that increased spending between 2009 and 2015, the impact on productivity was not directly proportional to the resource used. Some of them even increased the Productivity index, but most of them revealed a reduction in this indicator. Finally, the hypothesis test revealed no equality between the per capita expenditure averages and the Total Productivity index.

Given these results, it is noticed that many challenges still need to be overcome in the SUS to ensure that states perform better in medium and high-complexity services. There are signs that the resources used are insufficient to change the health status of the population. In a period of fiscal crisis and reduction in public spending though, as has been happening in Brazil, it is expected that management measures be taken to improve the use of resources, making health services more efficient and less costly for the public sector. Therefore, it is hoped that improving public management in the states will increase productivity and expand the supply of health services, broadening access to the services and improving the quality of Brazilian public health.

Therefore, in this perspective, using available accounting information on the public sector, this study contributes to public health policy makers, showing the need to improve the SUS based on complementary measures that make the services more efficient and less costly for the contributing citizens. At the same time, this study offers methodological resources to public accounting researchers, which can be used in the assessment of public policies in different sectors to identify the productivity of the states in the use of public resources.

Although the results presented here can serve as the base for other efficiency and productivity analysis studies, the limitations found in the development process should be highlighted. The health sector was only addressed in the medium and high-complexity context at the state level, without considering the role the cities play. Therefore, in future studies, we suggest including the participation of municipal entities in the development of primary health care services

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