OTHER THEMES

Educational (In)Efficiency from the Perspective of Disaggregated Public Expenditures

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ABSTRACT – Educational (In)Efficiency from the Perspective of Disaggregated Public Expenditures. To verify the efficiency of Brazilian municipalities in the application of public resources disaggregated in the quality of public education, from 2009 to 2013, the Stochastic Frontier Analysis method was used, according to Battese and Coelli (1995). The results showed that social aspects (health and infrastructure expenditures) were not drivers of efficiency, despite the greater allocation of resources by the most efficient. Of the disaggregated public educational expenditures, the infrastructure, outsourced services by legal entities and *other* expenses were positive. In addition, the most efficient municipalities were those with the fewest students in the classroom and, especially, with 90% of the students enrolled in the age-consistent grade.
Keywords: **Education Quality. Efficiency. Disaggregated Public Expenditures. Stochastic Frontier.**

RESUMO – (In)Eficiência Educacional sob a Perspectiva dos Gastos Públicos Desagregados. Para verificar a eficiência dos municípios brasileiros na aplicação dos recursos públicos desagregados na qualidade da educação pública, de 2009 a 2013, utilizou-se o método de Análise de Fronteira Estocástica, conforme Battese e Coelli (1995). Os resultados apontaram que aspectos sociais (gastos com saúde e infraestrutura) não foram propulsores da eficiência, apesar da maior destinação de recursos por parte dos mais eficientes. Dos gastos públicos educacionais desagregados, foram positivos os com infraestrutura, serviços terceirizados por pessoas jurídicas e com *outras* despesas. Ainda, os municípios mais eficientes foram os com menos alunos em sala de aula e, principalmente, com 90% dos alunos matriculados na série coerente à idade.
Palavras-chave: **Qualidade da Educação. Eficiência. Gastos Públicos Desagregados. Fronteira Estocástica.**

Introduction

The destination and allocation of public resources are guided by the needs detected by the Public Administration and reported by society. However, it must be questioned whether the resources applied are achieving the desired effects (effective) and/or generating the maximum possible results (efficient) in all economic and social dimensions.

Education is a "[...] significant sector in terms of public and private expenditures and is of key policy relevance due to its presumed links to human capital, growth and innovation" (Grosskopf; Hayes; Taylor, 2014b, p. 20). However, Coleman et al. (1966) identified that high levels of educational investment did not generate proportional growth in students' performance. Thus, public policies for promotion, improvement and efficiency in education became necessary.

Educational efficiency can be the relation between class size and school performance, time dedicated by the teacher per student; school size and educational costs; among others, and should consider a *mix* of consumables in this process. It may also be associated with the quality of teaching (Delgado; Machado, 2008) and the "[...] observed results of education [...] produced at the lowest level of resources" (Johnes; Portela; Thanassoulis, 2017, p. 331). Furthermore, Zoghbi et al. (2011) emphasized the importance of educational efficiency as this would lead to development and economic growth. However, for Savian and Bezerra (2013, p. 45) those "[...] with the best economic performance are not necessarily the most efficient".

From an international perspective, Chakraborty (2009) and Grosskopf, Hayes, and Taylor (2014a) analyzed school districts in the United States to verify educational efficiency. They found significant inefficiency, which might be caused by the size of the schools (given their benefits and difficulties posed by their size) and underutilization of employees in the educational process. Moreover, socioeconomic factors had more weight than school consumables.

In the Brazilian context, Faria, Jannuzzi e Silva (2008) and Dalchiavon e Melo (2016) focused on the ratio between public spending on education and culture; health and sanitation; and work, with indicators of living conditions and development. They identified positive and negative municipalities and highlighted that one municipality can spend a lot, erroneously, while another can use few resources, but efficiently, obtaining better results.

Also, Schuster and Zonatto (2017) identified the efficiency in the allocation of aggregate resources in education of the ten largest Brazilian municipalities. They indicated a low level of efficiency and that the most efficient spent less, were small-sized and with low economic activity. Trigo (2010) analyzed the efficiency of Brazilian schools and the influence of environmental variables (characterize the student's location) on inefficiency. The more students working concurrently with their studies, the greater the school inefficiency. In addition, teaching staff attributes, school infrastructure and administrative dependence,

the proportion of white students, and the educational level of mothers impacted school performance.

Emphasizing the municipalities of the Brazilian state of Ceará, Gramani (2017, p. 521) used aspects related to "[...] teachers, quality of education and socioeconomic factors that directly influence education (such as income, maternal education and access to sanitary sewage)" and school spending as a result of efficiency analysis. She concluded that the expenditure, the *per capita* income and the educational level of mothers boosted the quality of education.

The literature on this subject is extensive, however, the studies mentioned did not identify factors influencing education considering the efficiency of disaggregated educational expenditures. In this context, the objective is to verify the efficiency of Brazilian municipalities in the application of disaggregated public resources and social characteristics in the public education quality. In addition, it is intended to identify inter-regional differences as to such efficiency.

This work is relevant because it contributes to the theme of educational efficiency, since it allows understanding the *production* process of education, and points out the main important aspects in the efficient management of disaggregated public resources. It also contributes to the literature by identifying the Brazilian regions and states with different educational developments, thus allowing reflections for the adoption of actions to reduce the existing inequality between them.

This paper is divided into five sections. Section one is this introduction, aimed at contextualizing and presenting the theme; the second one goes deeper into the literature review that addresses the concepts of efficiency, with emphasis on Public Administration and educational processes; the third one contains the methodological procedures adopted to operationalize the study; the fourth one presents the results obtained, discussing the practice with the theoretical aspects; and the last one brings the general conclusions achieved throughout the work.

Efficiency in Public Administration

Given the scarcity of resources, organizations must seek the optimum allocation of these to achieve the defined objectives, also valuing quality. The use of resources depends on factors such as the technology used and the production process itself (Ferreira; Gomes, 2012). Thus, achieving efficiency in the production of goods and services can contribute to the growth and development of these organizations.

The efficiency can be technical or allocative. The product-oriented technique is the "[...] difference between the amount actually produced with a certain amount of consumables and the amount feasible to be produced, given the technology available." From the perspective of consumables, it is the "[...] difference between the amount of consumables actually used to produce a given product level and the minimum feasible amount of consumables needed to produce that same product

level using the available production technology" (Mattos; Terra, 2015, p. 214). Allocative efficiency is related to the possibility of the organization producing "[...] the same level as the others of a given set of activities at the lowest possible cost" (Ferreira; Gomes, 2012, p. 40). That is, it is to use the consumables in an optimal way, minimizing production costs.

Each organization, even with similar conditions, has different efficiencies due to the different approaches to problem solving and policy-making. According to Fagerberg, Srholec and Verspagen (2009, p. 11), this difference exists because of the technological congruence and social capacity of each federative entity. Technological congruence would be the "[...] degree to which the characteristics of the leading country and the following country are congruent in areas such as market size, factor supply." Social capacities are characteristics that municipalities must develop in order to recover in front of others. Education is one of the main pillars for this advance, linked to the solidification of the financial and commercial systems (Fagerberg et al., 2009).

In Public Administration, there are management models: patrimonial, bureaucratic, and managerial. The first model dates back to the imperial era, where the king exercised his sovereign will, without separation between public goods (society) and private goods (king) (Aguiar, 2000), tied to clientelist attitudes. The bureaucratic model is based on the distinction between government and governor goods and on the systematization of processes for independent execution of the government and meritocracy, guaranteeing fair and equal insertion in public service.

In addition, the managerial model is based on the scarcity of public resources, and efficient action is needed to generate quality goods and services for society, using as few consumables as possible. This government style "[...] focuses on the flexibility of procedures and greater control of results" (Seabra, 2001, p. 25). There is greater autonomy granted to public administrators, linked to the greater need to achieve results, making information on institutional performance more transparent (Pacheco, 2010).

However, efficiency is a constitutional principle, since "[...] the direct and indirect public administration of any of the Powers of the Union, the States, the Federal District and the Municipalities will obey the principles of legality, impersonality, morality, publicity and efficiency [...]" (Brasil, 1988, art.37). Moreover, the Fiscal Responsibility Law reinforces the "[...] dissemination of practices that result in greater efficiency in the allocation and execution of public expenditure, in revenue collection, in the control of indebtedness and in the transparency of fiscal management" (Brasil, 2000, art.67, II).

It is perceived that the prerequisites for achieving efficiency are present in legislation and in public management models, using mechanisms to achieve the best results with the fewest possible resources.

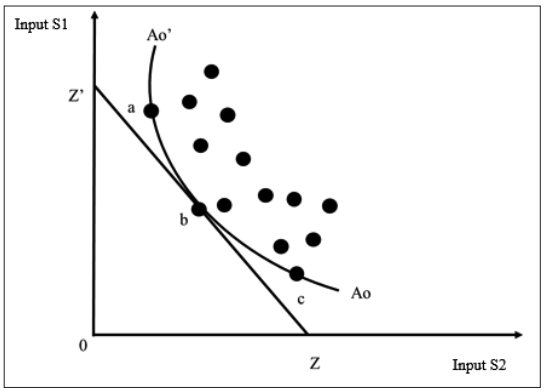
Educational Efficiency

Education is at the heart of development (Todaro; Smith, 2012) and therefore has relevance in economic studies. Linked to the demand for qualified workers to compose the job market (Morais, 2009), and under the aegis of the Human Capital Theory, in which the best remunerations are received by those with higher education levels (Andrade, 2010; Cabral; Silva, 2016), the offer and obtaining of quality education are constantly necessary.

In this light, Marginson (1991, p. 201) states that education needs to "[...] expand and improve the quality of services, as shown by the rapid growth in high school enrollment, training and higher education and the incessant demands to broaden and deepen the range of functions performed." Also, the study field focused on educational efficiency emerged, as there were no increasing and positive returns from students, even though there were increasing financial expenditures (Levin; Jamison; Radner, 1976).

Thus, the economics of education has developed approaches and models to understand the factors associated with student performance. In this sense, the efficiency in the allocation of educational resources has emerged, composed of an educational production function. Levin, Jamison and Radner (1976) illustrate efficiency in education (Figure 1). The educational production frontier is represented by the isoquant AoAo' and individual observations (schools/municipalities), resulting from the various combinations of consumables S1 and S2. Points a, b and c are technically efficient. Therefore, being Z'Z the relative price (budget constraint line), only b is technically efficient. Points a and c are no longer efficient, as they need greater financial contributions to achieve the Ao' result.

Figure 1 – Educational Production Frontier

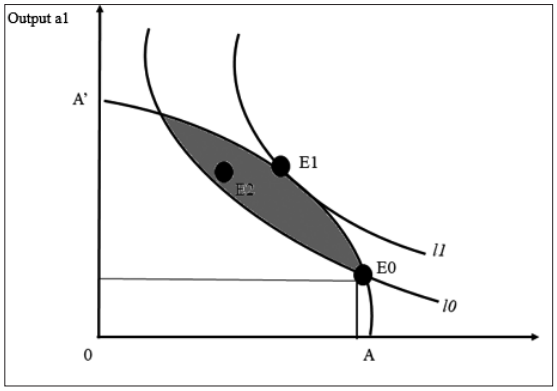


Source: Adapted from Levin, Jamison and Radner (1976).

The authors also considered social welfare, being important to evaluate not only the technical perspective of resource allocation but also the fulfillment of the needs of the society benefited (or not) by the execution of activities related to the analyzed investment. In Figure 2, the frontier considers the efficiency points of education (E0, E1, and E2), given the combination of consumables that generate the products with the functions of satisfying society as to the results provided by educational policies (*l0* and *l1*). Thus,

> [...] given the possibilities of production and the preferences of the community, the highest level of well-being is represented by E1 [...]. Clearly, E0 gives the community less satisfaction than E1, but more importantly, any choice of outputs within the shaded part of the diagram (e.g., E2) will produce a level of well-being greater than E0. That is, [...] it may be better to produce inefficiently what is highly desirable for the community than to produce perfectly efficiently what is of low value (Levin et al., 1976, p. 155).

Figure 2 – Efficiency and Social Satisfaction



Source: Adapted from Levin, Jamison and Radner (1976).

In this context, it is important to consider adequate consumables and products for efficiency analysis, covering variables that represent as closely as possible the reality of Brazilian education. In addition, efficiency must take into account the needs of the population, since social well-being is important.

In literature, the main drivers of quality education are: the relationship between student and teacher (Urwick; Junaidu, 1991; Recuero; Olaberria, 2018); class and schools sizes (Penkova; Valkov, 2015; Flores, 2017); financial expenditures (Wheat, 2010; Zoghbi et al, 2011; Schuster; Zonatto, 2017); infrastructure of municipalities, states or countries (Carvalho; Waltenberg, 2015); human development (Todaro; Smith, 2012); socioeconomic aspects (Penkova; Valkov, 2015); adequate nutrition of students (Ramos; Santos; Reis, 2013; Cunha, 2014); and family *background* (Silva; Hasenbalg, 2001; Morais, 2009).

Methodological Procedures

This study is descriptive and quantitative. The sample included 4,642 Brazilian municipalities in 2009; 4,635 in 2011; and 4,608 in 2013 (unbalanced panel). The period analyzed is justified by the general quality indicator of municipal basic education (indicador de qualidade geral da educação básica municipal — IQGEM) used being available only for the years mentioned (Bernardo; Almeida; Nascimento, 2020). The use of formal indicators, such as the Basic Education Development Index (Índice de Desenvolvimento da Educação Básica — IDEB), contemplates student performance and disregards external aspects that influence school results. Therefore, it is relevant to use indexes built based on dimensions that impact learning, because it allows a more comprehensive evaluation of educational quality. Given the heterogeneity among Brazilian regions, states and municipalities, having the latter as units of analysis have contributed to understanding the efficiency in the allocation of public resources in education, at a disaggregated level.

Data were collected from the following platforms: Information System on Public Budgets in Education (Sistema de Informações sobre Orçamentos Públicos em Educação — SIOPE), Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística — IBGE), Institute of Applied Economic Research (Instituto de Pesquisa Econômica Aplicada — IPEA), Department of Informatics of the Unified Health System (Departamento de Informática do Sistema Único de Saúde — DATASUS) and National Treasury Secretariat (Secretaria do Tesouro Nacional — STN), among others.

Variables and Statistical Treatment

The Stochastic Frontier method was used, which, besides estimating the efficiency indexes, makes it possible to identify the contribution of each variable to the educational system and considers the existence of two random components. The first is related to technical inefficiency and the second represents traditional random errors. The Stochastic Frontier based on the production function started to include the existence of the composite error term: one with normal distribution, and another with normal unilateral distribution (Aigner; Lovell; Schmidt, 1977).

Faced with the need to consider the variations of the analysis units (i) over time (t), Pitt and Lee (1981) and Schmidt and Sickles (1984) developed a model for panel data. Additionally, Battese and Coelli (1995) built an approach, where "[...] the effects of technical inefficiency are independently distributed (but not identically)" (Pires, 2004, p. 39).

According to Battese and Coelli (1995, p. 326), the general formulation of the stochastic frontier for panel data is:

$$y_{it}=\exp(x_{it}\beta+v_{it}-u_{it}) \quad (1)$$

where y_{it} represents product values for i-th unit of analysis in the t-th period of time; x_{it} is a consumables matrix of the production process for i-th unit of analysis in the t-th period of time; B and δ are vectors of parameters to estimate; v_{it} is a random term "[...] distributed identically and independently $N(0, \sigma_v^2)$, in addition to being distributed independently of u_{it}"; u_{it} are "[...] non-negative random variables associated with the technical inefficiency of production, which are assumed to be independently distributed in such a way that they are obtained by truncation (at zero) of the normal distribution with mean, z_{it}, and variance σ^2" (Battese; Coelli, 1995, p. 326); z_{it} is a vector of variables explaining the technical inefficiency of units production over time.

The Stochastic Frontier parameters are estimated by maximum likelihood, which considers "[...] as estimates the values of the parameters that make the maximum value of the likelihood function. This is equivalent to finding the value for the parameter that makes the log-likelihood function negative minimal" (Batista, 2009, p. 9).

Therefore, technical inefficiency (Battese; Coelli, 1995) is:

$$u_{it}=\delta z_{it}+w_{it} \quad (2)$$

in which u_{it} represents effects of technical inefficiency, assumed independently and identically distributed; z_{it} is a vector of explanatory variables of efficiency; δ is a set of parameters of each z_{it}; and w_{it} is "[...] a random variable with truncated normal distribution with zero mean and variance σ^2_u. To prove $u_{it} \geq 0$ it is necessary to truncate w_{it} so that $w_{it} \geq -\delta z_{it}$" (Bento, 2014, p. 45).

So, the technical efficiency (TE_{it}) (of the analysis units is:

$$TE_{it}=\exp(-u_{it})=\exp(-z_{it}\delta-w_{it}) \quad (3)$$

Thus, the model's variables are in Chart 1, showing those of the product to consumables ratio (1) and those of inefficiency (2).

Chart 1 – Variables

Variable	Meaning	Consumable/ Product
IQGEM	General Quality Index of Municipal Education	Product
Personnel	Amount spent, in ln, divided by the enrollments	Consumables *X*
Material		
Capital Expenses		
Other expenses		
Outsourced services		

Qualified Workforce (WK)	Proportion of workers with higher education over total formal workers	*Z* variables that explain (in)efficiency
Health	Municipal public expenditure (in R$/inhabitant)	
Infrastructure		
State *Dummies*	*Dummy* that assumes value 1 when municipality *i* belongs to the state; and zero otherwise	
Sized *dummies*	*Dummies* for municipal size: small size I up to 20,000 inhabitants; small size II from 20,001 to 50,000; medium size between 50,001 and 100,000; and large size over 100.001	

Source: Own elaboration.

Descriptive Statistics

Table 1 shows the descriptive statistics of the variables, dividing them into: financial (disaggregated expenditures on education-R$/enrollment), social (health and municipal infrastructure expenditures-R$/inhabitant), educational (IQGEM and proportion of formal workers with higher education), regional and sized (*dummies* to consider unobservable characteristics).

Table 1 – Descriptive Statistics

Variables	2009		2011		2013	
	Average	SD	Average	SD	Average	SD
IQGEM	0.610	0.17	0.614	0.16	0.604	0.17
Fixed salaries and benefits	785.57	310.37	973.84	375.06	1,159.43	433.56
Employer's Obligations	120.55	87.80	151.18	108.92	177.11	122.41
Other current expenses	540.72	294.13	655.31	352.65	669.73	363.09
Consumption Material	223.72	167.41	286.22	201.50	293.38	211.36
Natural Person's Services	69.01	97.00	67.03	100.81	39.46	74.36
Juridical Person's Services	194.70	180.89	240.85	221.89	259.11	231.90
Capital Expenses	119.96	185.00	209.93	255.43	184.00	240.73
Health Expenditures	335.90	151.61	446.63	598.50	533.74	249.96
Infrastructure Expenditures	45.98	81.77	71.60	103.81	61.78	98.28
Qualified WF	0.12	0.09	0.13	0.09	0.15	0.10

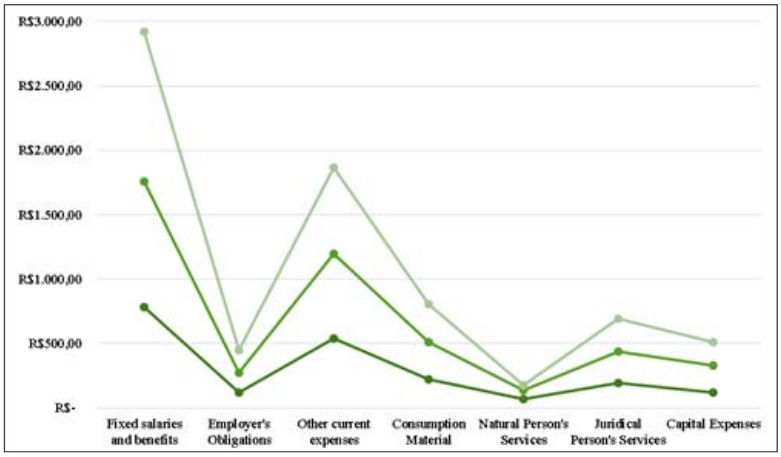
Note: monetary variables deflated by the 2009 Broad Consumer Price Index (Índice de Preços ao Consumidor Amplo). Legend: SD-standard deviation.
Source: Research Data.

Figure 3 shows the disaggregated amounts invested in education by enrollment, in Brazil. Most of them focus on the remuneration of the personnel directly involved (school staff) and indirectly involved (administrative staff) in the maintenance and development of education.

In 2009, the average was R$785.57 and in 2013, R$1,159.43. An increase in these expenditures was perceived, possibly due to the expansion of enrollments, which requires the creation of new educational institutions and an increase in the personnel.

The remuneration paid to education servers increased 48% between 2009 and 2011. When creating new schools and/or reducing class sizes, it is necessary to expand the school staff to meet local demands. This increase can be partially explained by the growing number of students with physical and/or cognitive needs, who need auxiliary teachers, and it is the special student's right to have assistance in developing school activities (Brasil, 1996).

Figure 3 – Disaggregated Educational Expenditures (R$/enrollment)



Source: Research Data.

Also, the educational expenditure item *Other current expenses* was also growing (27.75%) between 2009 and 2013. This accounting item includes components necessary to promote education, such as "[...] consumable material, free distribution material, tickets and transportation expenses, outsourced services, rental of labor, leasing, food aid" (Senado Federal, 2018).

The Public Administration needs outsourced workers to guarantee the rights and comply with the obligations inherent to it, having incurred in a 47.86% reduction in expenses with these workers, as individuals, and a 33.39% increase in services provided by legal entities. The institution of Complementary Law no. 128/2008 may have encouraged the creation of companies as Individual Micro-entrepreneur (Microempreendedor Individual — MEI), obtaining lower taxation, influencing the increase of companies serving the Public Administration.

As for socioeconomic information, the average *per capita* spending on health and infrastructure was R$335.90 and R$45.98, respectively, in 2009. In 2013, these amounts were R$533.74 (health) and R$61.78 (infrastructure). There was an average increase of 34.36% in the infra-

structure dimension and 58.90% in health expenses, corroborating Vieira (2018, p. 11), who stated that "[...] SUS expenditures with medications in the three spheres of government increased, in real terms, from R$14.3 billion in 2010 to almost R$20 billion in 2015 (growth of 40%)".

As for the proportion of formal workers with higher education, there was an increase of three percentage points, indicating the search for professionalization and educational formation. The goal is to achieve higher levels of schooling and consequently high positions and salaries, consistent with the training (Ide; Rotta Junior, 2013; Cabral; Silva, 2016).

Stochastic Frontier

The coefficients estimated by the stochastic frontier and the estimation tests, showing the effects of disaggregated educational expenditures (consumables) on IQGEM (product), are in Table 2. According to Wald's statistics, the model is statistically significant with 99% confidence.

Table 2 – Efficiency by Stochastic Frontier

	Variables	Estimates
Consumables X	(ln)Fixed salaries and benefits	0.0017 (0.0028)ns
	(ln)Employer's obligations	-0.0013 (0.0008)ns
	(ln)Other current expenses	0.0723 (0.0043)***
	(ln)Consumption Material	-0.0026 (0.0023)ns
	(ln)Natural Person's Services	-0.0102 (0.0006)***
	(ln)Juridical Person's Services	0.0049 (0.0018)***
	(ln)Capital Expenses	0.0076 (0.0007)***
	Constant	0.2373 (0.0184)***
	Wald	1,573.97
	Prob>chi²	0.0000
	LL	8,918.25

Note: in brackets are the standard errors of the coefficients. *, **, *** and ns mean, respectively, 90%, 95%, 99% confidence and no significance.
Source: research data.

On disaggregated educational expenditures and their relationship to IQGEM, expenses with personnel remuneration, employer obligations and consumption materials were not statistically significant. Since the taxes collected with payrolls are not exclusively for educational funding, it is plausible that this item does not interfere with its quality.

However, *consumption materials* are basic consumable to promote education, but when analyzing Brazilian municipalities, it is common that some of them have difficulty in supplying essential items such as chalk, paper sheets, among others. Thus, this variable, for having derisory values, on average, did not interfere in the quality of education. This may be due to the large number of municipalities with low investment, not allowing the exact identification of the effect on IQGEM.

The lack of significance of the expenditures with the remuneration of professionals, in turn, could be due to the cumulative effect of the educational impacts, that is, the investments of the current period may bring benefits in the evaluation rates in later periods (Schuster; Zonatto, 2017). Furthermore, it is believed that the possible direct effects provided by teachers are low, considering the municipalities, the periods, and the model adopted. Also, it is possible that the salaries paid to other servers are omitting part of the benefits provided by teachers, because the auxiliary teams do not have direct daily contact in class with students.

Additionally, given the lack of training of managers, represented by the dependence of public management on accounting *software* that prepares municipal accounts (Sediyama; Aquino; Lopes, 2017), items of great weight to leverage municipal education may have been improperly accounted, which would explain the absence of statistical significance of the other financial variables, as well as occurred with the expenses with employer obligations, which could be important to increase educational efficiency (but did not have this effect in this study).

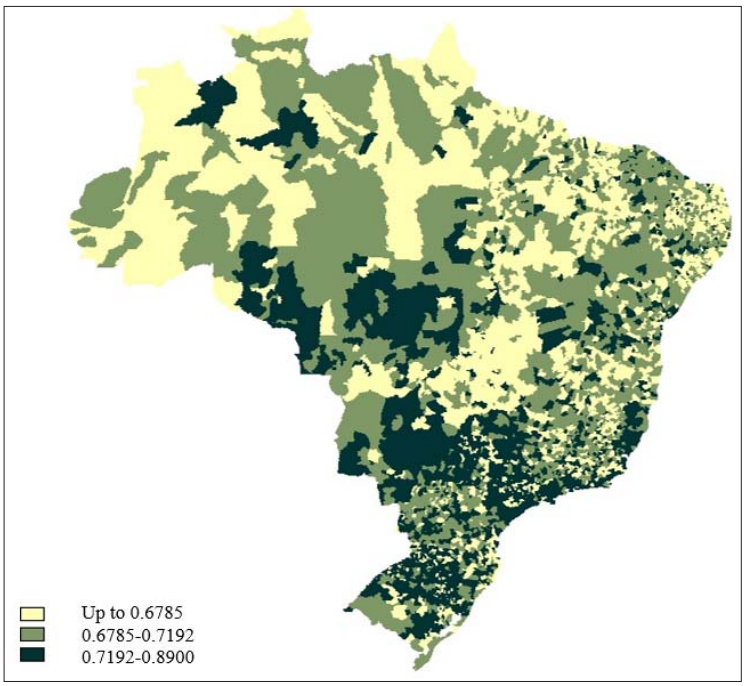
The other expenses were important in the educational production process with 99% confidence. In *Capital Expenses*, for example, are the construction works, maintenance in buildings, reforms, and expansions. The positive effect is justifiable, as it is necessary appropriate place for students to absorb the taught content (Penkova; Valkov, 2015). The *Other* expenses have also boosted educational quality, since this includes several items (aid, consumption materials, food). Therefore, investment in components that provide a suitable environment for teaching and learning can increase school performance (Sousa Junior, 2009).

Corroborating this, the expenses with legal entity outsourcing were positive in the IQGEM. According to Penkova and Valkov (2015) and Masi (2018), these components tend to boost educational quality, as they are supplies for the promotion and development of education. However, expenditures with outsourcing of individuals were negative. The absence or deficiency in the inspections of contracts signed between legal entities and/or individuals and the Public Administration (Almeida, 2009) can be the reason for this result, because, in the absence of inspection, the contracted services may not be effectively rendered or, even, rendered with lower quality than agreed upon. As a consequence, there may be interference with the performance of students, who depend on school consumables.

After the estimation of the stochastic frontier function, the efficiency scores were estimated for each municipality in each time period,

and the average score is illustrated in the map (Figure 4). The average efficiencies were 69.64% (2009), 71.80% (2011) and 72.70% (2013). It is possible to notice a growth in investment in education and improvements in its quality. In 2009, 2011 and 2013, 55.73%, 52.00% and 51.26% of the municipalities, respectively, scored below the average. And 44.27%, 48.00%, and 48.74% of the municipalities had efficiencies above the averages for the years analyzed.

Figure 4 – Average Educational Efficiency of the Municipalities between 2009 and 2013



Source: Research Data.

In general, South and Southeast were the most efficient regions, besides Ceará state, which has recorded, since 2007, advances and improvements in education. It is the result of public policies developed by the state and its municipalities, such as Sobral, whose IDEB "[...] was 4.0, in 2005 (early years), in 2013, reached the score of 7.8, considerably exceeding the goal set by the government [...] Sobral's experience was recommended to the whole country as an example of success and good educational practices" (Gramani, 2017, p. 510).

Inter-Relational Aspects of Efficiency

To illustrate social and educational characteristics of the municipalities with similar efficiency, Tables 3 (ten most efficient municipalities of each year) and 4 (ten most inefficient) were constructed. The first point brought up is the location, with the most efficient ones being in the South and Southeast regions of Brazil, except for São Francisco do Condé (BA), and the least efficient ones in the northern and northeastern states, mostly.

In the most efficient ones, the Age-Grade Distortion Rates (Taxas Distorção Idade-Série — TDI) were lower, ranging from 5.95% to 41.50%, while in the inefficient ones it was between 21.50% and 64.80%. Thus, in the least efficient ones, the TDI was 3.6 times higher than in the most efficient ones, signaling the significant importance of intra-school characteristics for the good progress of educational quality.

Moreover, the approval rates for the most inefficient students had the minimum (60.70%), very close to what is established in Brazil for students to advance through the grades/modalities (60%), and the maximum of 91.70%, in addition to a dropout rate between 1.70% and 25.80%. However, in the most efficient municipalities there are high pass rates (72.60%-100%) and low dropout rates (0%-10.70%). Also, in those most efficient ones there is an average of 14 to 25 students/class, reinforcing the importance of smaller classes, so that teachers can adapt didactic-pedagogical methodologies to meet the specificities of the students (Pintoco, 2017).

The most efficient municipalities are mostly small-sized, with 18 of them having no more than 10,000 inhabitants. Of these, the one with the largest numbers of enrollments has just over 800 students. However, those municipalities with lower scores were diversified, having small size I (14), small size II (11), medium size (3), and large size (2) municipalities. Therefore, population size was not a determinant of efficiency in those with difficulties in efficient management.

Considering this, the discrepancies in the amounts invested are reflected, since in the most efficient municipalities the average *per capita* spent on health ranged from R$382.17 to R$3,466.69. On the other hand, in the less efficient ones, located mostly in the North and Northeast regions of Brazil, the minimum value was R$154.03 and the maximum R$665.07, which may reflect the difficulties of these regions in offering essential public services to the population, such as access to quality health care.

Table 3 – Most Efficient Municipalities

Ranking	Municipality	Year	EFF	IQ-GEM	ENR	POP	TDI	SPC	APR	DR	HE	IE
1st	BOA VISTA DO CADEADO-RS	2009	0,87	0,75	446	2525	18,45	16,87	79,70	0,30	699,14	7,16
2nd	SANTA SALETE-SP		0,87	0,97	285	1446	8,40	16,80	99,20	0,00	873,47	366,09
3rd	SEBASTIANOPOLIS DO SUL-SP		0,86	0,94	606	3109	8,90	21,33	97,55	0,00	781,44	196,21
4th	NOVA CASTILHO-SP		0,86	0,85	257	1122	14,20	19,00	87,80	0,00	1187,34	175,03
5th	UBATUBA-SP		0,85	0,79	21142	81096	14,30	25,10	88,15	1,45	382,17	14,55
6th	BOA VISTA DO INCRA-RS		0,85	0,77	502	2583	20,65	14,23	84,30	0,75	642,36	0,01
7th	TRIUNFO-RS		0,84	0,63	7098	25374	32,10	21,17	80,60	10,70	469,42	165,75
8th	PORTO REAL-RJ		0,84	0,67	3795	16253	29,35	21,10	80,10	0,75	1487,84	117,78
9th	ITAIPULANDIA-PR		0,84	0,68	2237	9349	31,50	24,17	80,85	3,65	795,91	45,21
10th	PRESIDENTE KENNEDY-ES		0,84	0,55	2659	10903	34,45	19,77	72,60	5,30	1021,28	93,66
1st	PRESIDENTE KENNEDY-ES	2011	0,93	0,61	3005	10373	30,45	19,17	80,45	7,95	1760,00	126,52
2nd	NOVA CASTILHO-SP		0,89	0,87	256	1136	9,90	15,93	93,05	2,45	1643,27	982,18
3rd	PORTO REAL-RJ		0,89	0,65	3788	16938	29,90	21,77	80,35	4,50	2412,95	962,69
4th	SEBASTIANOPOLIS DO SUL-SP		0,88	0,92	557	3069	8,20	19,50	97,90	0,80	992,40	115,78
5th	SERRA DA SAUDADE-MG		0,86	0,69	163	811	13,1	10,90	100	0	1821,73	785,78
6th	SANTA SALETE-SP		0,86	0,79	301	1453	6,75	15,47	97,95	0,60	1093,60	13,66
7th	CUBATAO-SP		0,86	0,71	30762	119520	24,35	26,60	84,30	3,50	1309,92	15,49
8th	MERIDIANO-SP		0,85	0,87	804	3842	8,10	19,93	89,05	5,55	689,20	606,91
9th	SAO FRANCISCO DO CONDE-BA		0,85	0,47	9670	33713	41,50	25,07	77,15	9,80	428,54	461,54
10th	ANHEMBI-SP		0,85	0,80	1494	5739	13,25	21,83	92,30	0,30	714,73	272,27
1st	PRESIDENTE KENNEDY-ES	2013	0,91	0,51	2770	11130	32,95	18,73	75,50	9,95	0,00	0,00
2nd	SAO GONCALO DO RIO ABAIXO-MG		0,89	0,70	2459	10384	24,65	22,73	86,80	6,85	2594,15	143,24
3rd	SEBASTIANOPOLIS DO SUL-SP		0,87	0,87	616	3252	9,45	21,77	96,35	2,20	1148,30	127,72
4th	PORTO REAL-RJ		0,87	0,63	3937	17663	27,45	22,57	84,80	3,80	3466,69	221,21
5th	BOA VISTA DO CADEADO-RS		0.87	0.80	431	2520	19.35	17.17	95.65	0.85	0.00	0.00
6th	BALBINOS-SP		0.87	0.83	250	4433	5.95	14.07	99.05	0.95	707.47	73.54
7th	CUBATÃO-SP		0.86	0.68	30703	125178	22.15	24.43	82.15	3.25	1408.74	0.00
8th	MARAPOAMA-SP		0.86	0.90	536	2818	13.30	16.20	94.05	2.20	841.66	0.00
9th	DIRCE REIS-SP		0.86	0.87	301	1760	7.65	16.63	92.80	0.00	1260.56	308.53
10th	BURITIZAL-SP		0.86	0.60	806	4279	36.45	19.07	85.45	5.60	1004.42	213.37

Legend: EFF – Efficiency; IQGEM – General Quality Index of Municipal Education; ENR – Number of Enrollments; POP – Population; TDI – Age-Grade Distortion Rate; SPC – Students Per Class; APR – Approval Rate; DR – Dropout Rate; HE – Health Expenditures; IE – Infrastructure Expenditures.
Source: research data.

Table 4 – Less Efficient Municipalities

Ranking	Municipality	Year	EFF	IQ-GEM	ENR	POP	TDI	SPC	APR	DR	HE	IE
1st	MIRANDIBA-PE	2009	0,54	0,59	4238	13810	38,05	26,37	90,55	2,15	269,77	52,57
2nd	ITAPORANGA-PB		0,55	0,46	6274	23224	30,75	22,97	78,35	13,10	222,96	47,36
3rd	OIAPOQUE-AP		0,55	0,44	7443	20962	53,30	22,50	77,00	12,25	171,32	46,42
4th	UIRAUNA-PB		0,56	0,47	3726	14963	35,65	19,80	78,60	14,30	190,60	42,59
5th	LIMOEIRO-PE		0,56	0,63	16450	57243	33,85	24,13	84,70	4,75	210,08	48,98
6th	LENCOIS-BA		0,56	0,43	3021	10112	47,60	19,87	69,30	10,80	245,26	0,00
7th	CRUZEIRO DO SUL-AC		0,57	0,61	28359	77004	29,80	25,37	81,70	8,65	154,03	17,76
8th	AURORA DO PARA-PA		0,57	0,16	7521	22315	64,80	22,73	60,70	25,80	0,00	41,15
9th	PARELHAS-RN		0,57	0,53	5423	20676	33,85	25,77	78,50	12,25	283,60	0,00
10th	SANTANA DO SAO FRANCISCO-SE		0,57	0,34	2389	6861	44,30	26,33	70,55	14,05	366,76	13,98
1st	SAO CRISTOVÃO-SE	2011	0,47	0,38	19024	79956	44,70	25,13	71,25	10,10	167,48	7,02
2nd	PARELHAS-RN		0,55	0,47	5487	20434	36,70	24,87	76,95	13,95	318,36	0,00
3rd	VITORIA DO JARI-AP		0,56	0,41	4494	12725	46,85	22,70	72,50	10,60	332,23	166,85
4th	GLORIA DE DOURA-DOS-MS		0,57	0,65	2126	9919	27,30	20,03	82,10	6,35	430,27	283,10
5th	BARBACENA-MG		0,58	0,79	28298	127218	21,50	24,03	87,80	1,70	665,07	8,18
6th	SANTA MARIA DAS BARREIRAS-PA		0,58	0,43	4480	17686	56,55	17,77	87,85	6,30	196,62	1,29
7th	OIAPOQUE-AP		0,59	0,45	7354	21095	51,80	20,90	77,50	10,85	216,76	85,41
8th	PROPRIA-SE		0,59	0,48	8585	28533	33,35	24,63	78,60	10,60	309,08	0,00
9th	SATUBA-AL		0,59	0,43	4115	14815	36,60	26,70	74,55	9,70	274,34	0,00
10th	BELEM-AL		0,59	0,40	1625	4446	49,50	20,53	74,65	9,30	545,53	5,78
1st	AMAPA-AP	2013	0,58	0,34	2873	8483	42,90	21,37	76,85	13,50	311,60	0,00
2nd	CURRAIS NOVOS-RN		0,58	0,62	10573	44528	24,60	23,93	85,20	5,05	305,18	3,79
3rd	ESPUMOSO-RS		0,59	0,74	3140	15770	21,80	17,07	81,80	4,70	379,99	12,00
4th	SANTANA-AP		0,59	0,57	31374	108897	26,20	23,87	84,25	6,20	218,13	9,26
5th	PEDRINHAS-SE		0,60	0,45	2610	9298	37,25	25,67	84,45	1,90	303,41	0,00
6th	PATU-RN		0,60	0,38	2879	12561	41,00	22,43	79,60	11,65	454,09	12,41
7th	NOVA CRUZ-RN		0,60	0,26	10468	37079	39,00	26,70	75,25	14,65	199,37	23,10
8th	XAPURI-AC		0,61	0,56	4694	17021	34,35	21,03	85,50	4,50	273,09	55,15
9th	TAIOBEIRAS-MG		0,61	0,71	8239	32698	22,40	25,47	91,70	3,00	575,21	95,22
10th	QUIJINGUE-BA		0,61	0,42	7777	28996	40,95	25,33	83,95	4,80	316,21	92,68

Legend: EFF – Efficiency; IQGEM – General Quality Index of Municipal Education; ENR – Number of Enrollments; POP – Population; TDI – Age-Grade Distortion Rate; SPC – Students Per Class; APR – Approval Rate; DR – Dropout Rate; HE – Health Expenditures; IE – Infrastructure Expenditures.
Source: research data.

In infrastructure, such behavior was similar. Of the 30 least efficient municipalities, 18 invested below R$25.00 per capita, with one municipality with 17,686 inhabitants investing only R$1.29 per capita; while only two invested above R$150.00. Regarding the most efficient ones, the smallest investment was R$0.01, going up to a maximum of R$982.18, in a municipality with only 1,136 inhabitants.

In short, it can be seen that the North and Northeast regions have deficiencies that interfere with the achievement of greater efficiencies, resulting from regional, economic, and institutional factors. Among the exceptions are Vitória do Xingu (PA) and São Francisco do Conde (BA), with 84% and 85% efficiency in the allocation of public resources, respectively. These municipalities are constantly seeking improvements in education, especially due to the growth in IDEB scores over the years. The smaller municipalities in terms of population, and with higher investments in health and infrastructure, have managed to stand out in providing educational development.

Determinants of Educational Inefficiency

Table 5 presents the results obtained with the estimation of the inefficiency function (2), with the contribution (or not) of social and economic variables, and regionalization aspects in the inefficiency of the educational production process (determinants of inefficiency-Z). Positive coefficients indicate increased *in*efficiency, while negative coefficients indicate decreased inefficiency (increased technical efficiency) (Battese; Coelli, 1995).

As for the error terms of the Battese and Coelli (1995) function, inefficiency was noted regarding the use of expenditures to generate quality education, around 12.75% (Sigma_u). The perceived random errors in the municipalities were only 8.35% (Sigma_v). That is, during the allocation of public educational expenditures, there was an inefficiency of 12.75%, a result that could generate greater positive effects if the resources were well managed, reinforcing the difficulties of public administrators in managing resources to obtain educational quality with efficiency (Grosskopf et al., 2014b; Schuster; Zonatto, 2017).

Table 5 – Inefficiency Function Results

Variables	Estimates
(ln)Health Expenditures	1.7127 (0.0985)***
(ln)Health Expenditures(t-1)	0.0636 (0.0588)ns
(ln)Infrastructure Expenditures	0.0208 (0.0152)ns
Qualified WF	1.4366 (0.2552)***
AC	-0.1897 (0.7558)ns

AM	0.7792 (0.7159)ns
AP	0.4629 (0.7874)ns
RO	0.0428 (0.7246)ns
RR	-0.9916
CE	-1.2327 (0.7002)*
BA	0.9968 (0.7019)ns
MG	-7.8708
ES	-2.1647 (0.7172)***
SP	-9.5731
RJ	-2.2511 (0.7222)***
RS	-2.8581 (0.6888)***
PR	-4.4925 (0.6937)***
SC	-12.0618 (6.6382)*
PI	0.5385 (0.7055)ns
MT	-1.9341 (0.7089)***
MS	-0.7061 (0.7156)ns
GO	-3.1913 (0.8141)***
RN	0.6633 (0.7071)ns
PE	0.2986 (0.7030)ns
TO	-1.5448 (0.7085)**
SE	1.2460 (0.7095)*
AL	1.2033 (0.7120)*
MA	0.4320 (0.7048)ns
PA	1.6946 (0.7076)**
PB	0.3640 (0.7058)ns
Small Size I	0.0328 (0.1417)ns

Small Size II	0.3990 (0.1454)***
Medium Size	0.2016 (0.1645)ns
Constant Usigma	-13.9999 (0.8155)***
Constant Mu	0.0031 (0.0016)**
Constant Vsigma	-4.9658 (0.0191)***
E(Sigma_u)	0.1275**
Sigma_v	0.0835 (0.0008)***

Note: in brackets are the standard errors of the coefficients. *, **, *** and ns mean, respectively, 90%, 95%, 99% confidence and no significance. The control *dummies* were Federal District and Large Size.
Source: Research Data.

The state *dummies* associated with the municipalities in the states of Alagoas, Pará and Sergipe showed a positive signal, indicating an increase in educational *in*efficiency. However, there is negative contribution of the coefficients, indicating, in fact, reduction in inefficiency when the municipality belongs to one of the following states: Ceará, Espírito Santo, Goiás, Mato Grosso, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina or Tocantins. Those states capable of increasing efficiency are mostly in regions of higher socioeconomic development, such as the South and Southeast of Brazil. However, the state of Ceará, in one of the least developed regions, was able to boost efficiency due to educational policies implemented to improve student performance (Gramani, 2017).

As for the variables and their participation in the educational expenditures inefficiency, of the socioeconomic ones, only the lagging *per capita* health expenditures and the municipal infrastructure did not influence it. Access to electricity and sanitation contribute to school development (Chakraborty, 2009), however, in this study infrastructure spending was contrary. They do not cease to be important to society, they just have not been significant in the process of educational efficiency itself.

However, health expenditures and the proportion of formal workers with a qualified workforce have increased inefficiency. A society with higher schooling levels leads to greater transparency (Cruz et al., 2012) and possibly to social control. Thus, citizens are able to monitor whether the management of resources is being efficient, and therefore it was hoped that the proportion of skilled workers would increase educational efficiency.

According to Trigo (2010), educational inefficiency would be lower in schools where the mothers of the students obtained higher education. Since it was not possible to consider the schooling level of the mothers (Schonhaut et al., 2008), we used as *proxy* a variable to indicate

the schooling of the economically active population. However, it was not enough to influence the efficiency.

In the analysis on health, it is not known what proportion of the expenditures make up the total amount, that is, focused on prevention or treatment policies. It is understood that spending on prevention would contribute to efficient management in terms of a healthy population with good health conditions. On the other hand, if the expenditures are mostly for treating diseases, there is evidence of a less healthy population. According to Saldiva and Veras (2018, p. 56) "[...] the guarantee of health depends mainly on effective actions of prevention, promotion and access to information followed by access to quality health services, good food, adequate housing, sanitation, and safety."

Socioeconomic factors can have greater effects on educational efficiency than financial and school resources themselves (Chakraborty, 2009). The justification is based on the particular conditions for the student's development, since with adequate hygienic conditions, healthy food, and access to electricity, a favorable environment is created to improve cognitive absorption. Also, education cannot be considered in isolation, and there must be integration of the other dimensions (Gramani, 2017).

Another influence is due to the economic capacity of the municipalities, represented by the population size *dummies*, in which the small size II municipalities have succinctly increased inefficiency. Corroborating Diel et al. (2014) and Moraes, Polizel and Crozatti (2016), municipalities with more inhabitants should better manage public resources to be efficient in generating products and/or services for society.

Conclusions

Social aspects (expenditures on health and on skilled workers) were drivers of educational inefficiency, being important to improve the educational system, but not to increase efficiency. It is believed that health expenditures are mostly made up for disease treatment policies, indicating no leasing for disease prevention. As for the qualification of formal workers, higher levels of qualification of the population are able to contribute to efficient management, because better-educated citizens realize the importance of social control.

None of the analyzed municipalities reached 100% efficiency, given the average technical inefficiency of 12.75%. However, the most efficient ones had as a common characteristic greater allocation of financial resources to social aspects; classrooms with fewer students, providing more contact with teachers; and, mainly, having about 90% of students enrolled in the grade consistent with their age, that is, with a low percentage of gaps in the educational process. In contrast, those municipalities that have more difficulties in efficiently managing education resources are located in the North and Northeast regions of Brazil, with medium population sizes and low investments in health and infrastructure.

Due to the perceived interstate and interregional differences of efficiency, efficient management must be done without disregarding social welfare and local specificities, since the variation in efficiency follows the socioeconomic condition of the municipalities/states. Moreover, the fact that the most inefficient municipalities are in less developed regions reinforces the importance of policies to equalize the conditions of access to quality and efficient education.

Despite the result contrary to what was expected, it is important to reinforce the importance of the remuneration of the education professionals, salary valuation, and career plan. This is because it is considered that the educational policies promoted do not produce the desired effects in the same period of their implementation, being necessary to evaluate their effects and complexities in future times.

Of the limitations of this study, the main one was the absence of data for a longer period of time, and it was not possible to consider the year-to-year time-lag of the education financial variables. For future research, it is suggested to address more time periods and other aspects to characterize the school and municipal environment, whether in the student/school scope or institutional and management aspects.

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