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Does more investment improve education performance? An analysis for municipalities in Rio Grande do Sul

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Abstract
This study aims to evaluate the relationship between education spending and educational indices at the municipal level in the state of Rio Grande do Sul, from 2005 to 2015. In this perspective, it seeks to analyze the relationship of expenditure with specific metrics of educational infrastructure and educational quality in the municipality. To this end, a panel of municipal data on education expenditures, the FIRJAN Index of Municipal Development (IFDM - Education), and the Socioeconomic Development Index (IDESE), among other control variables, was constructed. From the estimated results, it was possible to identify a statistically positive relationship between the proportion of education spending and better educational indices, measured through the IFDM-Education index. Additionally, it is observed that spending is positively related to educational infrastructure and does not present a statistically significant relationship with the quality of education in the municipality, measured through IDESE indicators.
Keywords: Education Investment. School performance. Municipalities of Rio Grande do Sul. IFDM – Education. IDESE – Education.

Mais investimento melhora o desempenho da educação? Uma análise para os municípios gaúchos

Resumo
O presente estudo tem por objetivo avaliar a relação entre os gastos alocados em educação e índices educacionais em nível municipal no estado do Rio Grande do Sul, no período de 2005 a 2015. Nessa perspectiva, busca-se analisar a relação do gasto com métricas específicas de infraestrutura da educação e de qualidade educacional no município. Para tanto foi construído um painel de dados municipais de gastos direcionados à Educação, do Índice FIRJAN de Desenvolvimento Municipal (IFDM - Educação) e do Índice de Desenvolvimento Socioeconômico (IDESE), dentre outras variáveis de controle. A partir dos resultados estimados foi possível identificar uma relação estatisticamente positiva entre a proporção de

gastos em educação e melhores índices educacionais, medido através do índice IFDM-Educação. Além disso, se verifica que o gasto está positivamente relacionado com a infraestrutura educacional e não apresenta relação estatisticamente significativa com a qualidade da educação no município, medidos através de indicadores do IDESE.
Palavras-chave: Investimento em educação. Desempenho Escolar. Municípios do Rio Grande do Sul. IFDM- Educação. IDESE - Educação.

¿Más inversión mejora el desempeño educativo? Un análisis para las ciudades de Rio Grande do Sul

Resumen
El presente estudio tiene como objetivo evaluar la relación entre los gastos asignados a la educación y los índices educativos a nivel municipal en el estado de Rio Grande do Sul, en el período de 2005 a 2015. Además, analiza la relación del gasto con métricas específicas de infraestructura educativa y calidad educativa en el municipio. Para ello, se construyó un panel de datos municipales sobre gastos en educación, el Índice FIRJAN de Desarrollo Municipal (IFDM - Educación) y el Índice de Desarrollo Socioeconómico (IDESE), entre otras variables de control. A partir de los resultados estimados, fue posible identificar una relación estadísticamente positiva entre la proporción de gastos en educación y mejores índices educativos, medidos a través del índice IFDM-Educación. Además, se observa que el gasto está positivamente relacionado con la infraestructura educativa y no presenta una relación estadísticamente significativa con la calidad de la educación en el municipio, medidos a través de indicadores del IDESE.
Palabras clave: Inversión en educación. El rendimiento escolar. Municipios de Rio Grande do Sul. IFDM-Educación. IDESE - Educación.

1 Introduction

Education, being a right for all and a duty of the State, holds essential importance in human development, workforce qualification, quality of life, reduction of social inequalities, and consequently, in the socio-economic development of a country. However, the situation of Brazilian education, according to the 2015 report from the Programme for International Student Assessment (PISA), is concerning, considering that the country ranked 63rd in science, 59th in reading, and 66th in mathematics out of the 70 participating countries. Furthermore, the cumulative expenditure per student aged 6 to 15 years in Brazil is equivalent to 42% of the average expenditure per student in OECD countries. This proportion was 32% in 2012, indicating a considerable increase; however, countries such as Uruguay, Mexico, and Colombia, despite having a lower average cost per student, achieved better results in 2015 compared to Brazil.

According to Barros and Mendonça (1997), the educational level of a country's population is the result of decades of investment in education. As reported by the Partnership for Educational Revitalization in the Americas (PREAL, 2006), although education expenditures have significantly increased in Latin America, several problems still persist: students' performance in tests remains low; students from poorer regions and classes receive lower quality education; and efforts to improve teacher quality and incentivize better teaching have not yielded results. In other words, the increase in school attendance time and the number of enrolled students are positive changes but are not sufficient.

Curi and Menezes-Filho (2006) emphasize that greater resources directed towards education improve school quality, meaning there is a close relationship between invested resources in education and improvement in school infrastructure. Additionally, Curi and Menezes-Filho (2009) also highlight that access to preschool increases the probability of completing high school and higher education, justifying the need for investment in infrastructure and especially in the expansion of preschool places. However, this relationship is questioned by other authors, such as Hanushek (2003), who states that resources employed in schools are not closely related to student performance. Nonetheless, this does not mean that resources directed towards education do not influence quality; they must be associated with other actions, such as greater involvement of parents or guardians in the educational process and school management.

In a general perspective, most of the literature does not confirm a positive relationship between the amount of resources spent on education and school performance. Studies point to the existence of several variables that influence the quality of education, such as the socio-economic characteristics of students and the allocation of resources within school management (Hanushek and Kimko, 2000; Hanushek & Luque, 2003; Amaral and Menezes-Filho, 2008; Silva and Oliveira, 2012; Domiciano and Almeida, 2015; Monteiro, 2015; Panassol and Florissi, 2018). However, Fabrino (2011), relating public spending on education and school performance in Brazilian basic education from 1995 to 2009, achieved different results. The research covered educational institutions from federal, state, and municipal networks for basic education, included in the INEP school census, and the author found a positive correlation between education spending and school performance.

Given the above, this study aims to contribute to the literature by innovating with a panel data format for the case of municipalities in Rio Grande do Sul, evaluating the relationship between allocated education expenditures and three different educational indicators at the municipal level from 2005 to 2015. The first indicator is the Firjan Index of Municipal Development (IFDM) in Education, an aggregate metric based on information about education coverage and quality in the municipality, especially for early childhood education and elementary education. The other two indicators allow understanding the mechanisms through which education spending can affect educational performance by analyzing specific metrics for infrastructure and teaching quality. For infrastructure, the sub-block Early Childhood Education from the Socioeconomic Development Index (IDESE) Education Block, which is composed of the enrollment rate in preschool, was used. Regarding quality, the sub-block Elementary Education from IDESE Education, derived from scores in the Basic Education Assessment System (SAEB), was used.

The results indicate that a higher proportion of education spending is positively correlated with better educational indices in the municipality. The effects mainly result from issues related to infrastructure and availability of places, with no evidence of improvements in education quality. These findings align with studies indicating that schools or education networks, whether public or private, that invest more financial resources in education do not systematically perform better than those with more limited resources.

The article is structured into four more sections, besides this introduction. The second section presents relevant studies on the analyzed topic. The third section

discusses the adopted methodology and the description of the data used. The fourth section analyzes the obtained results, and finally, the fifth and last section presents the final considerations.

2 Education Spending and Educational Performance

2.1 International Studies

According to Sen (2000), education is a mechanism of social transformation and inclusion, essential for promoting the economic and human development of countries (DREZE; SEN, 2003). In this sense, Harbison (1973) when addressing the importance of investment in education indicates that human beings are the active agents who accumulate capital, exploit natural resources, build social, economic, and political organizations, and drive national development forward. Clearly, a country that is not capable of developing the skills and knowledge of its people and effectively utilizing them in the national economy will be unable to develop anything.

Gannicott and Thorsby (1992), in a study for the island economies of the South Pacific, found that although there is considerable variation between countries, the factors that most influence the quality of schools in the region are isolated. These factors are: the quality of teachers; the availability of learning materials; initial instruction in the mother tongue; the quality of educational management; and curricular reform. The authors also emphasize that strategies to improve quality will fail unless they recognize important complementarities among the factors that determine quality.

Hong-Sang and Thorbecke (2001), when evaluating the impact of education spending on human capital, economic growth, and poverty in Tanzania and Zambia, based on a computable general equilibrium model, suggest that an increase in education spending can generate economic growth. However, to maximize the benefits of education spending, a sufficiently high level of physical investment is necessary, as well as measures to improve the alignment between the pattern of educational production and the effective demand structure for labor. An important result of the simulation experiments is that a well-targeted pattern of education spending can be effective in reducing poverty.

Hanushek and Kimko (2000), when evaluating the relationship between workforce quality and economic growth, identified a strong relationship between workforce quality, expressed by performance in international mathematics and science tests, and better economic performance. However, the authors find that direct spending in schools is not related to differences in student performance.

Furthermore, Hanushek and Luque (2003), when analyzing the efficiency and equity of schools around the world, identify that attention to the quality of human capital in different countries naturally leads to concerns about how school policies relate to student performance. The results of the analyses of educational production functions within a range of developed and developing countries show general problems with the efficiency of resource use allocated to education. Moreover, improvements in the educational process do not seem to be dictated by variations related to the country's income level or the level of resources in schools, nor are they determined by school policies involving compensatory resource allocation. The

conventional view that school resources are relatively more important in poor countries is also not supported.

In an attempt to identify the relationship between investment in education and employment generation, Grimaccia and Lima (2013), studying this relationship for European Union countries, identified, from a panel of countries, a causal relationship between public education expenditure and employment rates. The results showed that in countries where education investments were higher than the average of the last 10 years, there was an increase in the employment rate.

Murname and Ganimian (2014), after studying a group of 33 poor and developing countries, indicate four lessons derived from 115 rigorous evaluations of the impact of educational initiatives. First, reducing the costs of attending school and providing alternatives to traditional public schools increase student attendance. Second, providing information about school quality generally improves student motivation and encourages parental involvement, but parental contribution capacity only improves when focused on tasks they can easily learn to perform. Third, more resources do not improve student learning unless they change children's daily experiences at school. Finally, well-designed teacher incentives increase effort and improve student performance, but poorly qualified teachers need specific guidance to minimally achieve an acceptable level of instruction.

Del Boca, Monfardini, and See (2018), using data from the OECD PISA, Eurostat, and World Bank WDI, found that children's cognitive outcomes at the aggregate country level are related to macroeconomic conditions, specifically education spending and early education experience. Moreover, the authors emphasize that both government spending on education and early childhood care assistance are associated with better future school performance. The authors also identified that different childcare characteristics, such as duration and quality, are relevant to good student performance. In summary, the results imply that policies encouraging the expansion of childcare should also consider quality issues in early years education.

Thus, at the international level, there is still a dominance of studies that do not directly find a relationship between education investments and school performance. However, some authors, when analyzing in a more aggregate manner and with a time lag, end up finding a relationship between investment in education and teaching quality, which further reinforces the importance of studying the theme, especially for poor and developing countries experiencing severe fiscal constraints. The following section portrays some of the main works related to the topic for Brazil.

2.2 National Studies

Menezes-Filho and Pazello (2007) identified the relationship between teachers' salary gains and academic performance, finding that teachers' salaries are determined by state or municipal legislation and are not related to academic performance. Initially, they identified that salaries are not related to the proficiency of students in public schools; however, in the private sector, a correlation was found. Furthermore, the authors evaluated the effect of the 1998 education reform on education funding in Brazil (FUNDEF) on the performance of students in public schools. This reform established a floor for the percentage of expenditures on

teachers' salaries depending on the size of each system. The evidence suggests that FUNDEF increased the relative salaries of public school teachers and that the effect was positive on the proficiency of students in these schools. Additionally, the results suggest that this effect may also be associated with an improvement in the attractiveness of new talents to fill public school teaching positions.

Amaral and Menezes-Filho (2008) examined the relationship between education expenditures and students' academic performance in elementary schools in Brazilian municipalities in 2005, finding that, after controlling for various observable characteristics of schools and municipalities, the effect of expenditures on performance was very small and statistically insignificant in most specifications. Furthermore, through quantile regressions, they found that the significance of the effect of expenditures on performance occurs only for municipalities with higher scores in the fourth grade.

In the search for evidence on the relationship between these resource allocations and academic performance, Silva and Oliveira (2012) analyzed how physical and human resources, as well as municipal expenditures, influence the IDEB results of municipal schools in Bahia in 2009 for the final year of elementary education. The authors observed that for every 1% increase in per-student spending, the IDEB result increased by about 0.5%, indicating a relationship between municipal educational expenditures and academic performance. Regarding infrastructure, the difference between schools with excellent infrastructure and those with poor or very poor infrastructure was, on average, 0.21 points. However, the presence of a library and computer lab in schools did not contribute to IDEB results. Although not highly significant, having teachers with higher education degrees contributed to better IDEB results. Nevertheless, salaries were not significant in explaining school performance. The authors concluded that the improvement in academic performance is not solely associated with the amount of resources spent on education, but rather with how these resources are allocated, particularly in teacher training and school infrastructure improvement.

More recently, Domiciano and Almeida (2015) investigated the implications of public expenditures in municipalities in Paraíba on meeting IDEB targets in 2011. The study included 174 of the 223 municipalities in Paraíba, using the ratio between the municipality's actual IDEB in period t and the IDEB projection calculated by INEP as an indicator of public management efficiency. A municipality was considered efficient in educational management when it met the target established by INEP for the given year. Regarding expenditures, Domiciano and Almeida (2015) found that public education spending did not have a close relationship with effectiveness in meeting IDEB targets in 2011, nor with the level of public management efficiency. Additionally, they found that cities with higher per-student costs did not show better academic performance. Thus, the quality of education does not depend solely on the amount allocated to the sector but also on how resources are managed by public entities.

Monteiro (2015) analyzed the relationship between public education spending and educational performance, as well as the effects associated with municipalities that received oil royalties and their impact on education spending and student performance. The results indicated that increases in municipal education expenditures were associated with increases in the schooling of the young population, but there were no indications that Brazilian municipalities that invested

the most in the sector improved the quality of education. Furthermore, evaluating the impact of increased expenditures in the sector on the educational performance of oil-producing municipalities benefiting from increased royalty revenues showed a 14% higher increase in education expenditures than neighboring coastal municipalities, but there were no effects on student learning.

Caetano, Ávila, and Tavares (2017) examined the relationship between government transfers, own tax revenues, and the education index of municipalities in the state of Minas Gerais (2009 to 2013), considering the changes provided to Brazilian municipalities since the promulgation of the 1988 Federal Constitution. The hypothesis was that greater financial resources would positively impact the quality of municipal education. The study variables were tested through variance analysis, correlation tests, and multiple linear regression. Among the results, the lack of association between the degree of financial autonomy and investments in education stands out, as well as evidence that the amount of tax revenues and the additional percentage of investment in education do not impact the education quality index.

Panassol and Florissi (2018) sought to determine whether increased spending on elementary education by municipalities in the state of Rio Grande do Sul results in improved education quality. A sample of 198 municipalities was used, referring to the 2015 IDEB results, along with control variables related to students, schools, municipal management, and teachers. Six models were estimated using OLS based on the production function of Hanushek and Luque (2003), considering different variables in each model. The authors observed that, depending on the explanatory variables used, expenditures might or might not be positively related to academic performance. Specifically for municipalities in Rio Grande do Sul, a 1% increase in the average amount invested in elementary education increased the IDEB by about 0.009003%, concluding that there is no significant economic relevance concerning the relationship between expenditures and educational performance.

Fabrino's (2011) study aimed to understand the relationship between public education spending and the results of academic performance in Brazilian basic education from 1995 to 2009. The research covered federal, state, and municipal basic education institutions, as covered by INEP's school census, and used the econometric technique of Vector Autoregression (VAR). To measure academic performance, the author created a synthetic indicator called the Basic Education Results Index (IREB), based on three dimensions: quality, universality, and equity of basic education. The analyses concluded that there is a causal effect between budget expenditure and academic performance when considering a three-year temporal lag for the relationship.

In a national study, Vasconcelos et al. (2021) highlighted the relationship between school infrastructure and public investments in education with academic performance. For this purpose, the authors constructed a school infrastructure index and applied quantile regression models based on information regarding education expenditures, the Basic Education Development Index (IDEB), and school data from the Basic Education Censuses of 2007 and 2017. The main results showed that the implementation of infrastructure by the municipality influences the quality of education. However, municipalities lacking administrative mechanisms for education management reduce their ability to efficiently apply resources allocated to the sector.

It can be observed that most of the literature and research conducted do not confirm a robust positive relationship between academic performance and the amount of resources allocated to education in Brazil. Studies point to the existence of various variables that influence education quality, such as students' socioeconomic characteristics and resource management at the school level. However, studies using a three-year lag and different levels of estimates evidenced a positive relationship between education expenditures and academic performance. Nevertheless, these results are a minority in the national literature and need to be corroborated through other indicators and different analysis techniques.

Thus, the present work aims to contribute to the literature by innovating in the temporal period, educational indices, and methodological technique, attempting to explore the relationship between education expenditures in municipalities in Rio Grande do Sul and educational performance at the municipal level. To this end, three educational indices focusing on early childhood education and elementary education are used, which is unprecedented to our knowledge. Therefore, the next section highlights the methodology and data sources used.

3 Data and Empirical Strategy

3.1 Source and nature of the data

The FIRJAN Municipal Development Index (IFDM) is an indicator created in 2008 by the Federation of Industries of the State of Rio de Janeiro (FIRJAN) through the FIRJAN System, with the purpose of annually monitoring the socioeconomic development of the 5,565 Brazilian municipalities in the first decade of this century. This index equally weighs three areas: Employment & income, Education, and Health, consolidating into a single number the level of local socioeconomic development, calculated by the simple average of the results obtained in each of these three areas.

The IFDM – Education is composed of six indicators, aiming to understand the provision of early childhood education and, especially, the quality of education provided in elementary schools, both public and private. The six indicators are weighted as follows: enrollment in early childhood education (20%), elementary school dropout rate (15%), age-grade distortion in elementary school (10%), teachers with higher education in elementary school (15%), average daily class hours in elementary school (15%), and the Basic Education Development Index (IDEB) results in elementary school (25%). Only the first indicator relates to early childhood education; the others refer to elementary education. Regarding early childhood education, the assessment is based on the percentage of enrollments in daycare centers and preschools relative to the total number of children aged 0 to 5 years.

The Socioeconomic Development Index (IDESE), published by the Department of Economics and Statistics (DEE) of the Government of Rio Grande do Sul, is a composite indicator designed to measure the level of development of the state's municipalities. Its objective is to evaluate and monitor the evolution of socioeconomic indicators of municipalities in Rio Grande do Sul concerning education, income, and health, considering both quantitative and qualitative aspects of the development process, as well as providing information for public policy

formation. This indicator comprises 12 indicators, divided into three blocks: Income, Health, and Education.

In 2013, IDESE was revised, and the Education Block was defined from four sub-blocks according to age groups: (1.1) population aged four to five years (preschool) – preschool enrollment rate; (1.2) population aged six to 14 years (elementary school) – scores in the Prova Brasil exam for the 5th grade of elementary school and the 9th grade of elementary school; (1.3) population aged 15 to 17 years (high school) – high school enrollment rate; and (1.4) population aged 18 years or older (adult schooling) – percentage of the adult population with at least a complete elementary education. The final index of the Education Block is the arithmetic mean of the indices of these sub-blocks. However, when evaluated separately, it is important to note that only the IDESE Elementary Education takes into account student scores in national exams, as indicated by Kang et al. (2014). Moreover, the period adopted was chosen to represent a homogeneous number in the analyzed series and without significant changes in the IDESE calculation.

Table 01 presents the variables used in the study for the 496[1] municipalities of Rio Grande do Sul.

Table 01 – Analyzed Variables

Variable	Period	Source
Total GDP	2005-2015	DEE Data
Population	2005-2015	DEE Data
Formal Employment	2005-2015	RAIS
Criminality – Theft	2005-2015	DEE Data
Number of Graduates in Primary Education	2005, 2007-2014	DEE Data
Expenditure, in R$, Maintenance and Development of Education	2005-2015	TCE/RS
Net Revenue from Taxes and Transfers (Adjusted)	2005-2015	TCE/RS
Expenditure, as % of net tax revenues, on Maintenance and Development of Education	2005-2015	TCE/RS
IFDM - Education	2005-2015	S. FIRJAN
IDESE Primary Education	2007-2015	DEE Data
IDESE Preschool	2007-2015	DEE Data

Source: own elaboration.

Among the variables highlighted in Table 01, the importance of the percentage of tax revenue applied to the maintenance and development of education stands out. This is the explanatory variable of interest used as a proxy to assess the relationship between education spending and the performance of education-related indices at the municipal level in Rio Grande do Sul. The following section outlines the empirical strategy adopted.

[1] Currently, the State of Rio Grande do Sul has 497 municipalities. In 2013, Pinto Bandeira, previously a district of the municipality of Bento Gonçalves, was elevated to the status of a municipality. However, due to the timeframe of the analysis, it was not possible to include it due to the lack of data.

3.2 Empirical Strategy

In the present analysis, different specifications for panel data were utilized. This database characteristic combines time series and cross-sectional data, meaning it includes data from multiple units measured over time. Among the advantages of its use are greater degrees of freedom in estimations, the observation of dynamic relationships among individuals, and controlling for the impact of omitted variables (CAMERON; TRIVEDI, 2005; BALTAGI, 2008; HSIAO, 2014).

Considering a dataset with i = 1,2,...,N units and t = 1,2,...,T time periods, the general model can be seen as:

$$Y_{it} = \propto_i + X_{it}\beta + \varepsilon_{it} \quad (1)$$

Where $\propto_i$ represents specific effects or characteristics of units that do not vary over time, and ε_{it} is the error term.

This model is generally treated in three distinct ways. First, without controlling for heterogeneous effects or impacts that may affect units uniformly over a given period, in which case the specification is associated with a pooled model. Second, with controls for homogeneous effects that interfere with the analyzed units over a given period, which corresponds to a specification controlling for random effects. Finally, the fixed effects model controls individual municipality characteristics that are related to explanatory variables and, if left untreated, would bias the estimators. Additionally, a fourth specification is possible, known as dynamic panel, which allows identifying temporal relationships between lagged dependent and independent variables that are important for the analyses generated in this study.

The estimation of dynamic panel data using the Generalized Method of Moments (GMM) is associated with the works of Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). The use of dynamic models for panel data is justified by the fact that many data series are related to each other and to their past values. In this regard, models that consider lagged dependent variables as explanatory variables, in the case of GMM System estimations, unlike static panel estimations (Fixed Effects or Random Effects), can provide more efficient estimators. GMM estimation in these cases allows for the persistence of the dependent variable over time to be taken into account.

The representative equation of the dynamic model for the growth rate (y) can be expressed as:

$$y_{it} = \delta y_{i,t-1} + X'_{it}\beta + u_{it} \text{ , com i = 1,...,N e t=1,...,T} \quad (2)$$

where δ is a scalar, X'_{it} is the value of explanatory variables 1 x k, which can be strictly exogenous, endogenous, or predetermined; β is the coefficient vector k x 1, and it is assumed that the error term u_{it} follows the following error component model:

$$u_{it} = \mu_i + v_{it} \quad (3)$$

where $\mu_i \sim$ IID(0, σ_μ^2) and $v_{it} \sim$IID(0, σ_V^2).

The component μ_i represents individual fixed effects (specific to each city) that are time-invariant, while v_{it} represents shocks specific to each city that vary over time. The v_{it} terms are heteroskedastic and correlated over time among individuals, but not between individuals.

It is assumed that:

$$E(\mu_i) = E(v_{it}) = E(\mu_i . v_{it}) = 0$$

$$E(v_{it} . v_{js}) = 0 \text{ for each i, j, t, s with i} \neq \text{j} \quad (4)$$

The Generalized Method of Moments (GMM) estimator by Arellano and Bond (1991) instruments the explanatory variables in differences ($\Delta x'_{it}$) that are not strictly exogenous with their lagged levels available at the level. However, in this first-difference GMM estimator, lags can be weak instruments for variables that are not strictly exogenous if these lags can be characterized as a random walk. To overcome this problem, the System GMM described by Arellano and Bover (1995) and Blundell and Bond (1998) is used. This model allows the use of lagged first differences of variables as instruments and proves suitable for models with temporal persistence in relationships between variables[2].

3.3 Structural Model

Panel data models were estimated[3] based on equation (5):

$$EDUC_{it} = \beta_0 + \beta_1\, logpropeduc_{it} + \beta_2\, logGDPperc_{it} + \beta_3 logempformperc_{it} + \beta_4 logcrime_{it} + \beta_5 logestabprim_{it} + \varepsilon_{it} \quad (5)$$

Where:

- $EDUC_{it}$ – represents the IFDM-Education indices or IDESEs of municipalities i in period t;
- $logpropeduc_{it}$ - log of the proportion of education spending weighted by the total net revenue of municipalities i in period t;
- $logGDPperc_{it}$ - log of the per capita GDP of municipality i in period t;
- $logempformalperc_{it}$- log of formal employment per capita of municipality i in period t;
- $logcrime_{it}$ - log of per capita crime (theft category) of municipality i in period t;
- $logestabprim_{it}$ - log of primary education establishments of municipality i in period t;
- ε_{it} - component of the random error term of municipality i in period t.

[2] Details regarding the methodology can be found in Blundell and Bond (1998).
[3] To perform the estimations, STATA 15 software was used.

The specified equation (5) was estimated in four distinct ways: one considering residuals without any specific controlled component (POOL). Subsequently, a model was estimated considering the existence of a random component that affects cross-sectionally the groups of municipalities analyzed (Random Effects), and finally, the model with control over unobserved heterogeneity of municipalities (Fixed Effects).

In addition to the three described methods, specifications were also estimated where lagged dependent variables were used to control the problem of residual autocorrelation.

$$y_{it} = \delta y_{i,t-1} + X'_{it}\beta + u_{it} \text{ , com i = 1,...,N e t=1,...,T} \quad (6)$$

Where, y_{it} indicates the dependent variables used, namely IFDM/IDESE of municipalities i in period t, and the matrix of covariates is represented by matrix X'_{it}.

4 The Relationship between Education Spending and Educational Indicators

The results are discussed in three distinct parts. The first part highlights the analyses on the relationship between education spending and IFDM-Education. Following that, the values of the relationships between education spending and IDESEs for preschool and elementary education are portrayed. Regarding the effect of spending on IFDM, as depicted in Table 02, four estimates were conducted, considering pooled models, models with random effects control (RE), fixed effects control (FE), and finally, panel dynamic serial autocorrelation control. The first model is estimated based on aggregated panel data, which did not show statistical significance between education spending and IFDM. However, statistically robust results were found based on the model correcting serial autocorrelation, as indicated by the autocorrelation tests Ar(1) and Ar(2) in Table 02, which demonstrate the neutrality of the issue after lagging the dependent variable for one period. Additionally, the Sargan test confirms the robustness of the estimates by indicating exogeneity in the instruments used. Thus, the relationship between the variables was significantly verified in the other three specifications, with the dynamic panel showing the relevant effect, as portrayed in Table 02 below.

Table 02 – Analysis for the IFDM Index – Education

	(Pooled)	(RE)	(FE)	(GMM System)
VARIABLES	IFDM	IFDM	IFDM	IFDM
$Firjan_{t-1}$ Index	-	-	-	0.81449***
				(0.042092)
Logpropeduc	0.00133	0.0203**	0.0220**	-0.29212
	(0.00924)	(0.00970)	(0.00986)	(0.255848)
$logpropeduc_{t-1}$	-	-	-	0.762***
				(0.2940649)
Logcrime	-0.0231***	-0.00673***	-0.00343	-0.0111*
	(0.00168)	(0.00221)	(0.00240)	(0.00637)
logGDPperc	0.0296***	0.0149***	0.00893	-
	(0.00231)	(0.00462)	(0.00547)	
$logGDPperc_{t-1}$	-	-	-	0.0464***
				(0.00976)
Logempformperc	0.0153***	0.00908**	-0.00281	-
	(0.00200)	(0.00408)	(0.00596)	
Logestabprim	-0.0131***	-0.0104***	-0.00737*	-
	(0.00153)	(0.00326)	(0.00409)	
	(0.0625)	(0.162)	(0.262)	
Constant	0.401***	0.647***	0.701***	-
	(0.0219)	(0.0353)	(0.103)	
Observations	5,200	5,200	5,200	4,738
R^2	0.603	-	0.763	-
Municipalities		491	491	491
Trend	yes	yes	yes	yes
Hausman Test			159.41	
			(0.0000)	
Wooldridge Test			573.197	
			(0.0000)	
Ar(1)				-8.26
				(0.000)
Ar(2)				-1.13
				(0.259)
Sargan Test				23.44
				(0.267)
Groups				493
Number of instruments				36

Source: Research results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Other controls were also used in the estimates, such as the proportion of the population by gender and age groups.

Based on the results in Table 02, a 1% variation in the proportion of education spending leads to a 0.762% increase in IFDM-Education, with a lagged period. The coefficients' magnitudes, although less than proportional, reveal a convergence between the values in the variations of municipal spending and IFDM-Education for municipalities in RS. This synchronicity in investment percentages in schools and IFDM-Education aligns with findings by Silva and Oliveira (2012) and is consistent with Fabrino (2011) and Vasconcelos et al. (2021). In addition to spending proportion, other covariates also showed statistical relevance to IFDM-Education, such as the lagged

indicator by one period (0.814%), per capita crime (-0.01%), and per capita GDP (0.04%). The first reflects the dynamic effect of IFDM, while the latter two indicate socioeconomic importance on municipal educational indicators.

To further investigate the relationship between education spending proportion and school indicators in RS municipalities, an analysis of IDESE-Preschool was conducted. Therefore, four estimates were made, considering pooled models, models with random effects control, fixed effects control, and finally, panel dynamic serial autocorrelation control. The first three estimated models did not show statistical significance between education spending and IDESE-Preschool. However, statistically robust results were found based on the model correcting serial autocorrelation, as indicated by the autocorrelation tests Ar(1) and Ar(2) in Table 03, which demonstrate the neutrality of the issue after lagging the dependent variable. The Sargan test further confirms the robustness of the estimates due to the exogeneity of the instruments used.

Thus, the relationship between the variables was significantly verified in the fourth model. Evaluating the results, it was found that a 1% variation in the education spending proportion generates a 0.08% effect on IDESE-Preschool after three temporal lags. This reinforces the fact that improvements in previous periods tend to perpetuate into subsequent periods. These results align with those found by Fabrino (2011), especially regarding the temporal lag period. However, the magnitudes of the values found are lower than the relationship found in the estimate for IFDM, but they maintain the convergence of positive relationships between expanded education spending and increased indicators reflecting school infrastructure, as highlighted by Fabrino (2011), Silva and Oliveira (2012), and Vasconcelos et al. (2021). Additionally, similar to the IFDM case, the dynamic effect of indicators can be observed, where lagged periods of IDESE-Preschool influence the current indicator, as indicated by the parameters Ideset-3 (0.1341949), Ideset-2 (0.0710561), and Ideset-1 (0.8801322). These values indicate that a 1% variation in previous IDESEs leads to approximately 0.13%, 0.07%, and 0.88% variation in the current indicator, reflecting the dynamic effect of the index. Violence indicators with up to two temporal lags reveal that a 1% change in crime reduces IDESE-Preschool by 0.02% and 0.01%, respectively, further highlighting the socioeconomic importance of the municipality on educational indicators, as shown in Table 03 below.

Table 03 – Analysis for the IDESE Preschool

	(Pooled)	(RE)	(FE)	(GMM System)
VARIABLES	Idese Preschool	Idese Preschool	Idese Preschool	Idese Preschool
$Idese_{t-3}$	-	-	-	0.1341949***
				(0.0236468)
$Idese_{t-2}$	-	-	-	0.0710561***
				(0.0658117)
$Idese_{t-1}$	-	-	-	0.8801322***
				(0.0814882)
Logpropeduc	-0.0120	-0.00725	-0.00576	-
	(0.0107)	(0.00965)	(0.00989)	
$logpropeduc_{t-3}$				0.0830445**
				(0.0414246)
Logcrime	-0.00858***	0.00260	0.00421*	-
	(0.00181)	(0.00239)	(0.00250)	
$logcrime_{t-1}$				-0.0245369***
				(0.0073573)
$logcrime_{t-2}$				-0.0159322***
				(0.003886)
logGDPperc	0.0359***	0.0185***	0.00732	-
	(0.00235)	(0.00470)	(0.00552)	
$logGDPperc_{t-1}$				0.0199467
				(0.0128265)
Logempformperc	0.00855***	0.0127***	0.00728	-
	(0.00195)	(0.00450)	(0.00644)	
Logestabprim	-0.00838***	-0.00308	0.00280	-
	(0.00191)	(0.00359)	(0.00466)	
Constant	0.455***	0.617***	0.858***	-
	(0.0260)	(0.0407)	(0.121)	
Observations	4.431	4.431	4.431	2976
R^2	0.490	-	0.569	
Municipalities	-	493	493	
Trend	yes	yes	yes	yes
Hausman Test			97.77	
			(0,0000)	
Wooldridge Test			325.961	
			(0,0000)	
Ar(1)				- 7.01
				(0.000)
Ar(2)				0.85
				(0.396)
Sargan Test				74.46
				(0.305)
Groups				496
Number of instruments				92

Source: Research results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Other controls were also used in the estimates, such as the proportion of the population by gender and age groups.

Lastly, regarding IDESE Primary Education, Table 04, although the aggregated panel showed statistical significance, it appeared with an opposite direction and lacked statistical robustness. Similarly, the other models, with variable effect control, fixed effect, and dynamic, did not show statistically significant results for the analyzed relationship, thus it is not possible to find a robust causal relationship between expansion of education spending and school performance measured by IDESE-Elementary Education for the evaluated period. This result aligns with those generated by Gannicot and Thorsby (1992), Curi and Menezes Filho (2006), Amaral and Menezes Filho (2008), Monteiro (2015), and Panassol and Florissi (2018), reflecting the fact that merely expanding spending is not sufficient to increase elementary school students' performance.

Moreover, albeit less robustly, it is found that Crime shows its presence in impacting IDESE-Elementary Education, reflecting once again the importance of socioeconomic conditions on students' performance, evidence that aligns with national and international literature, as highlighted by Lau et al. (1996); Brady (2006); Figlio (2007); Giambiagi (2008); Andrade et al. (2012); Castelar, Monteiro, and Lavor (2012); Cittadin and França (2016); Abramovay et al. (2016); Lombardi Filho and Oliveira (2017); Santos et al. (2018); and Silva de Aguiar (2022).

Considering the indicators used in the research and their composition, when they consist of quantitative variables related to enrollment rates, dropout rates, for example, and not solely standardized test scores measuring student knowledge level, there is a positive relationship between education spending and education quality, as seen in the case of IFDM-Education and IDESE Preschool. However, when considering standardized test scores applied to students, such as in IDESE Elementary Education, there is no statistical robustness to assert a relationship between education spending and learning quality. Thus, based on the results found, there is evidence that municipal resources allocated to education influence indices that seek to verify the relationship with school infrastructure rather than student performance. As highlighted by Domiciano and Almeida (2015) for Paraíba, Caetano, Ávila, and Tavares (2017) for Minas Gerais, and Panassol and Florissi (2018) for RS, other important elements such as parents' education, teacher training, teacher remuneration, among others, can have a more incisive influence on the analyzed index.

Therefore, the results corroborate the literature that shows education spending at the municipal level in Rio Grande do Sul is associated with school infrastructure, thereby providing, for example, more school-age children with access to school, which in turn influences indices associated with early education, as seen both in IFDM-Education, which weighs early childhood education in its construction, and specifically in IDESE Preschool.

Table 04 – Analysis for IDESE Primary Education

	(Pooled)	(RE)	(FE)	(GMM System)
VARIABLES	Idese Primary Education	Idese Primary Education	Idese Primary Education	Idese Primary Education
Idese prim$_{-1}$	-	-	-	0.1550***
				(0.033)
logpropeduc	-0.0134*	0.00375	0.00666	0.0306
	(0.00802)	(0.00777)	(0.00786)	(0.3026)
logpropeduc$_{t-1}$				0.2504
				(0.3373)
logcrime	-0.0159***	-0.00395**	-0.00152	-0.0398***
	(0.00131)	(0.00180)	(0.00208)	(0.0044)
logGDPper	0.00782***	0.00556	0.00209	-
	(0.00197)	(0.00382)	(0.00479)	
logGDPper$_{t-1}$				0.1587
				(0.0114)
logempformper	0.00610***	0.00621**	-0.00204	-
	(0.00110)	(0.00266)	(0.00516)	
logestabprim	-0.00197	0.000666	0.00351	-
	(0.00130)	(0.00255)	(0.00365)	
Constant	0.588***	0.707***	0.694***	-
	(0.0180)	(0.0286)	(0.0527)	
Observations	4,431	4,431	4,431	3,968
R^2	0.468	-	0.581	
Municipalities		493	493	
Trend	yes	yes	yes	yes
Hausman Test			211.62	
			(0,0000)	
Wooldridge Test			163.088	
			(0,0000)	
Ar(1)				-7.94
				(0,0000)
Ar(2)				-14.80
				(0,0000)
Sargan Test				87.59
				(0,0000)
Groups				496
Number of instruments				26

Source: Research results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Other controls were also used in the estimates, such as the proportion of the population by gender and age groups.

However, in the case of primary education, the estimated models failed to demonstrate the relationship between the proportion of education spending and the indicator. This result is also observed in national and international literature, where improvements in school performance are not only associated with the amount of resources spent but also with their allocation, especially in teacher training and

school environment improvement, as well as elements such as parental involvement in school and internal violence, among others that are beyond the scope of this study and could be a focus of municipal management.

Education generates mechanisms for human development (SEN, 2000), and it is therefore fundamental to understand how it should be promoted. Thus, the proposed analyses, for the case of municipalities in Rio Grande do Sul, provide insights to rethink basic and primary education not only from the perspective that more expended resources generate positive impacts, particularly on teaching quality. Among the actions that municipal managers should consider to complement resources directed towards school infrastructure, defining career plans for teachers and education professionals, offering school management training courses to principals, promoting parental and family engagement in the process of building a participatory and secure school environment, as effectively evidenced in all analyses conducted.

5 Final Considerations

This study aimed to evaluate the relationship between allocated education expenditures and school performance at the municipal level in the state of Rio Grande do Sul from 2005 to 2015. For this purpose, a panel of municipal data on education expenditures and performance indices published by the Federation of Industries of the State of Rio de Janeiro (FIRJAN) and the Department of Economics and Statistics (DEE/RS) was constructed.

The results indicate that higher spending on education improves municipal educational indicators. Furthermore, the findings corroborate the literature suggesting that education spending at the municipal level in Rio Grande do Sul is associated with school infrastructure, which leads to, for example, greater access to school for school-aged children, thereby influencing indicators associated with early education. However, when analyzing the relationship with educational quality, in the case of primary education, it is observed that merely the proportion of education spending did not constitute a differential factor. Other factors highlighted by national and international studies, such as teacher quality, parental involvement in schools, internal violence, school management, among other elements beyond the scope of this study, may be more relevant in determining educational quality and should be the focus of municipal management.

Thus, this study aimed to contribute to the national literature on the relationship between municipal education spending and school performance, particularly for municipalities in Rio Grande do Sul. The results underscore the importance of education spending in expanding municipal educational coverage. However, it is important to emphasize that increased spending is not necessarily linked to improved educational quality, requiring municipalities to adopt other practices for this purpose and to monitor applied resources more effectively. Policies for monitoring and local assessments of public resource management and, especially, educational practices are essential to improve educational performance in municipalities and to guide efficient policies aimed at enhancing education quality.

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