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ANALYSIS OF THE CAUSES FOR THE GROWING EXPENDITURE ON ELEMENTARY EDUCATION IN BRAZIL FROM 2009 TO 2017

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ABSTRACT

Even though automation has been increasing and the number of students has been decreasing, spending on teachers has increased over time in Brazil. This occurs because these public servants have job stability and they are relatively well paid. This article verifies to what extent teachers' salaries are paid over their productivity, and what salary advantages they received by law to explain the expenditure per student in municipal public elementary education in Brazil. The remuneration above productivity in some professional categories has been analysed by the Public Choice Theory (PCT). An econometric model is used to verify the adequacy of the theoretical argument to the concrete case, especially if the salaries of municipal public elementary education are explained by the Baumol effect or the Nose effect. Applying an adaptation of the models of Baumol (1967) and Nose (2017), it is concluded that both effects contributed to the growth of municipal elementary school teachers' salaries above productivity, however the Nose effect was superior to the Baumol effect. This indicates that statutory salary advantages are the main component of salary increases. Understanding this issue is relevant for budget and educational public policy makers as it can guide allocative decisions.

Keywords: Spending on education, Efficiency, Wages, Productivity.

JEL classification: I28, H72

SUMMARY

1. INTRODUCTION

In 2009, elementary education accounted for 25% of Brazilian municipal budgets, according to data from the Brazilian Finance Department/National Treasury Secretariat (*Finanças do Brasil/Secretaria do Tesouro Nacional* - FINBRA/STN). This figure rose to 31% in 2017, at the expense of reductions in other areas that imposed budgetary restrictions on these entities.

In 2017, education was the biggest expense for Brazilian municipalities, accounting for 30.52% of total expenditures, or R$147 billion, according to FINBRA/STN/ME. This increase in spending was not limited by competition for resources with other budget items, nor was it related to productivity, since there constitutional biding is used to allocate a minimum proportion of revenue from taxes and transfers to education. This is reflected in the Elementary School subfunction, which saw expenditures increase from R$37 billion in 2007 to R$92 billion in 2017 in a sample of 4,959 municipalities. Personnel expenses were the main driver of this expenditure as the legally mandated minimum wage increased from R$800.00 in 2007 to R$2,298.80 in 2017.

From 2009 to 2017, despite increased spending on public elementary education by municipal governments, the quality of education did not improve, as evidenced by the Program for International Student Assessment (PISA) data, which revealed that Brazil's education indices have decreased during this time. In 2006, Brazil ranked 52nd worldwide in Science, 48th in Reading, and 53rd in Math; in 2018, it ranked 67th in Science, 58th in Reading, and 71st in Math.

Wagner's Law (i.e., the law of increased state's expenditure) states that as economies grow, public expenditure increases more than proportionally. This has been evidenced by Akitoby et al. (2006) and Higgs (1991) in their respective studies. Similarly, Brazilian municipalities with larger populations tend to have higher per capita spending. Depending on the specific public choice school, the increase in educational spending, particularly in wages, can be attributed to the influence of education-linked pressure groups that advocate for greater funding to improve the quality of teaching.

Baumol (1967) revisited Wagner's Law, suggesting that the rise in costs was due to the disparity in wages between labour-intensive sectors (such as education) and capital-intensive sectors (such as industry), with the former increasing at a higher rate than the latter. Thus, wage growth in non-capital-intensive sectors that exceeds labour productivity would lead to increased costs in the economy, resulting in deficits. According to the author, wages that exceed

productivity can only be sustained because of the need to retain workers in order to meet an inelastic demand.

In Brazil, the demand for services is relatively inelastic because of the obligatory nature of elementary education stipulated by Law 11.114/2005, which defines a minimum spending requirement as a proportion of taxes and transfers as well as the mandated minimum wage for teachers. Thus, despite the increase in teachers' salaries, declining productivity, and other current and capital expenses in an environment of budgetary scarcity, there is still a demand for the service. It is worth noting that supply is also inelastic since school construction and the hiring of teachers takes at least two years.

The educational sector has experienced a decline in productivity, as evidenced by the decrease in the student-teacher ratio from 24.1 in 2009 to 20.26 in 2017. This is largely attributed to the aging population and the lack of technological advancement in the educational sector. Conversely, industrial productivity has been bolstered by the gradual replacement of labour with machinery. Therefore, one of the ways to reverse this trend is to introduce technical progress that can reduce the number of teachers and, consequently, mitigate the Baumol effect (1967). This can increase teacher productivity and help contain wage increases that exceed the marginal productivity of labour. With enhanced productivity, it would be possible to free up resources for investments in other essential state functions, thereby fostering long-term economic growth.

Based on this line of reasoning, Nose (2017) concluded that institutional elements and the Baumol effect could explain the growth in per capita spending on elementary education. However, the costs arising from salary increases granted to teachers by legal requirements constituted the main element for the increase in per capita spending in developed and developing countries. To reach this conclusion, Nose (2017) broke down expenditures on elementary education and one of its items: the expenditure/students ratio. Then, they employed econometric techniques to analyse the Baumol effect and salary advantages, which are components of this relationship.

Two aspects can characterize the originality of this work. The first is the hypothesis that teachers are paid above productivity, which is confirmed, opposing common sense. In particular, the texts produced by teachers' syndicates demand constant wage increases with the argument of a wage gap. The second element that contributes to the study's uniqueness is the measurement and the differentiation of salary gains guaranteed by law and those arising from the need to retain education professionals.

In Brazil, research on the efficacy of public elementary education is relatively recent and limited. Monteiro (2015) was one of the first to investigate the issue and concluded that there is no evidence that municipalities that invested the most in the sector improved the quality of education. However, studies based on data from the Elementary Education Development Index/Ministry of Education (*Índice de Desenvolvimento da Educação Básica/Ministério da Educação* - IDEB/MEC) suggest that Brazilian education has improved, even though PISA results indicate decreased.

This study aims to contribute to the field of public finance by applying Baumol's (1967) original model to analyse the efficiency of spending on public elementary education in municipalities. This is done by considering the grade obtained in the Evaluation System of Elementary Education (*Sistema de Avaliação da Educação Básica* - SAEB) as a product. This contrasts with Nose's (2017) opinion that it is difficult to measure the product of education taking the amount of labour in the sector as a proxy. This study focuses on determining whether an increase in this expense improves the quality of teaching.

Thus, our aim is to quantify the wage surplus that is not accounted for by the marginal productivity of elementary school teachers. To do this, we will analyse three factors: (a) the proportion of the school-age population compared to the working-age population; (b) educational coverage, or school enrolment; and (c) spending per student on education as a percentage of GDP per worker.

The methodology of this research is of quantitative and descriptive nature, as it is based in panel data, much alike to Nose (2017)'s work. The extracted data refer to the municipal GDP, the school-age population, the economically active population and the total population per municipality, which consisted of 24,795 observations. Thus, this study tested the model using panel data for k Brazilian municipalities in t years. It aims to measure the share of municipal public elementary school teachers' salaries by the Baumol effect and the Nose effect.

To this end, the study is structured as follows: following this introduction, the institutional context and stylized facts about elementary education are discussed; then, the theoretical model based on Baumol and Nose is presented, with the aim of explaining expenditure per student.

The cost of elementary education is an important factor in the formulation of public policies and budget allocation decisions. To ensure that the needs of the education sector are met while still managing other expenses, it is essential to understand the drivers of the rising cost of public education, as explored by Wolff, Baumol, and Saini (2014) in the countries of the Organization for Economic Co-operation and Development (OECD).

Among the limitations of this study, the limited number of years analyzed stands out. Socioeconomic contexts can show significant changes in decades. The influence of economic growth on the wages of all categories of workers in the longer term is well known. It should be noted that political variables can also affect wage variations and that these can suffer significant changes in decades. In this sense, it is recommended that these aspects be addressed in future studies.

2. INSTITUTIONAL FRAMEWORK AND STYLIZED FACTS ABOUT ELEMENTARY EDUCATION

This section demonstrates that elementary education was accorded such importance in legislation that it was enabled to realize gains beyond the productivity of the sector and to receive greater budgetary allocations than other essential budget functions.

According to item VI of Article 30 of CF/1988, the responsibility for elementary education lies with the municipalities. This responsibility is supported by the constitutional biding of 25% of revenue resulting from taxes and transfers, which ensures the financing of this level of education in municipalities (Constitution of the Federative Republic of Brazil). However, as Sanches (2004) points out, bindings are contrary to the budgetary principle of non-allocation of revenues and cannot be contingent upon financial execution. The Fiscal Responsibility Law (*Lei de Responsabilidade Fiscal* - LRF) also requires that funds bound in one fiscal year remain in a different fiscal year (Complementary Law No. 101, 2000). This legislation protects spending on elementary education, to the detriment of other budget expenditures. Schick (1998) described this situation as the 'tragedy of the commons', in which service to one sector occurs to the disfavour of others.

Elementary education has received more resources than other sectors, yet this has not translated into better teaching outcomes. According to FINBRA/STN, Brazilian municipalities allocated 25% of their budget to this level of education in 2009, and 31% in 2017. However, the PISA evaluation showed a decline in Brazilian education during this period. Thus, the increased spending on primary education did not necessarily result in an improvement in the quality of education.

It is noteworthy that 60% of the Fund for the Maintenance and Development of Elementary Education (*Fundo de Manutenção e Desenvolvimento da Educação Básica* - FUNDEB) is allocated to remunerating teachers, leaving only 40% for other current and capital expenditures. It is observed that the resources which could be most beneficial for modernization

and the enhancement of labour productivity are being used for other purposes. Consequently, the allocation of resources is not being completed with the aim of cost reduction.

In addition, socioeconomic changes caused a reduction in the number of enrolments and an increase in the population over 60 years of age, from 10% in 2009 to 13% in 2017, resulting in a shift in budget priorities that cannot be met because of budget allocations. Binding revenues to elementary education led to an increase in public spending. Additionally, the expectation of a guaranteed revenue stream tends to increase demand for expenses that justify the binding provided by legislation.

In this scenario, budget allocation (binding) encourages a phenomenon known as 'inversion of priorities', where agencies with dedicated revenue streams tend to prioritize expenses of lower importance instead of aligning them with the government's overall priorities. Binding resources to elementary education represents a clear violation of the principle of budgetary unity, which, from a macroeconomic perspective, amplifies the pro-cyclical nature of public spending and makes budget cuts more challenging to implement.

It is essential to recognize that the binding of revenues can have disproportionate consequences. If revenue is not forthcoming, the corresponding expenditures, even if they are of lesser priority in the government's overall spending, are not necessarily reduced. This will place a strain on the limited resources available, which make up a small portion of primary revenue. Additionally, the allocation of a significant portion of the budget towards elementary education—approximately 30%—has led to increased budget rigidity at the municipal level. As a result, the government's ability to prioritize needs based on current circumstances is hindered by inefficiencies in budget formulation and implementation.

In addition to the obligatory percentage of tax revenue and state and municipal transfers that must be spent on education, there are several federal programs that provide financial assistance to municipalities. These include the National School Feeding Program (*Programa Nacional de Alimentação Escolar* - PNAE), which provides food and nutrition education to students in all stages of public elementary education, and the Money Directly to the School Program (*Programa Dinheiro Direto na Escola* - PDDE), which aims at contributing to the maintenance and improvement of physical and pedagogical infrastructure; *Formação pela Escola* (FPE) or 'School-based Training', a program that aims at enhancing the training of individuals involved in the implementation of education-related financial actions; the *Plano de Ações Articuladas* (PAR) or 'Coordinated Action Plan', a tool provided to federal entities for the diagnostic and planning of educational policies, which is designed to structure and manage strategically defined goals, thereby contributing to the development of a national education

system; the *Programa Nacional do Livro e do Material Didático* (PNLD), or 'National Program for Books and Teaching Materials', which encompasses a series of actions aimed at distributing educational, pedagogical and literary works, as well as other materials to support educational practices, to students and teachers of public elementary education schools across the country; the *Programa Nacional de Tecnologia Educacional* (ProInfo) or 'National Program of Educational Technology', which promotes the use of technology as an aid for pedagogical enrichment in public primary and secondary education; the *Programa Nacional de Apoio ao Transporte do Escolar* (PNATE) or 'National Program for Support of Student Transportation', which facilitates the automatic transfer of financial resources to cover expenses related to the transportation of students who reside in rural areas to public elementary schools; and lastly, the *Programa Banda Larga nas Escolas* (PBLE) or 'Broadband in Schools Program', which is aimed at connecting all urban public schools to high-speed and high-quality Internet to enhance public education in the country.

Budget allocations also reflect the significance assigned to a particular sector. Policymakers are usually opposed to the creation of such bindings as they decrease the government's budget management flexibility and hinder the government's ability to prioritize based on current needs and circumstances, as highlighted by Giacomoni (2011).

Establishing a minimum wage for education professionals prompts other public servants to also demand salary increases. This competition for salary parity ultimately disconnects productivity from compensation, thereby exacerbating inefficiency within the public sector. The creation of a minimum wage for teachers illustrates the current state of the profession, which is further highlighted by the lack of success of other professional groups in seeking similar treatment. This phenomenon can be explained by the theory of public choice, which posits that the increasing role of the state stems from the interests of certain segments of society as represented by pressure groups.

With regards to the Baumol effect, there is a general agreement among economists that productivity is a key factor for growth. Unlike other industries, the productivity in elementary education measured by the student–teacher ratio has decreased. In 2009, this ratio was 24.1; by 2017 it had dropped to 20.26. This is largely attributed to the aging population and the limited adoption of technological advancements within the education sector. Conversely, in the manufacturing industry, the substitution of labour with machinery has been a significant factor in raising productivity.

One strategy to counteract this trend is to implement technological advancements, which would lead to a reduction in the number of teachers and the Baumol effect (1967). This

implementation can enhance teacher productivity and contain the granting of salary increases beyond marginal labour productivity. Furthermore, it allows for the release of resources for investment in other vital functions of the state, promoting long-term economic growth.

The rising allocation of resources is a result of popular pressure on the National Congress, resulting in laws that support the expansion of spending on elementary education. As McLeay, Ordelheide, and Young (2004) explain, the alignment of interests in the National Congress is due to political incentives for those who benefit from the laws. This contributed to the approval of FUNDEB, for example, with the argument that public spending on this level of education can reduce regional disparities and income concentration.

It's important to note, however, that some objectives are not being achieved. The poor quality of municipal elementary education is linked to problems with management capacity, which involves public policies. Therefore, the assessment of education heavily depends on the comparison of costs and outcomes, as there is no way to determine the optimal or best solution without relative terms.

While investments in elementary education may play a role in reducing regional disparities, its high cost diverts resources from other crucial investments in infrastructure, such as transportation, communication, and energy, which also contribute to alleviate regional and per capita income concentration.

3. MODEL

In this section, our goal is to pinpoint the root causes of inefficiency, specifically the payment of salaries above productivity. To achieve this, a model is presented that aims at determining whether the salaries of public municipal elementary education are more accurately explained by the Baumol effect or the Nose effect.

3.1 Teacher Salary Growth Model

As per the Nose model (2017), the expenditure on public municipal elementary education as a proportion of the municipal GDP ($\frac{GAF}{PIB}$), can be broken down into three components: (a) the proportion of the school-age population among the economically active population ($\frac{PIE}{PEA}$); (b) the proportion of students among the economically active population, referred to as educational coverage ($\frac{NE}{PEA}$); and (c) the expenditure per student on education as a

proportion of GDP per economically active population, represented by $(\frac{\frac{GAF}{NE}}{\frac{PIB}{PEA}})$, as outlined in equation (1).

(1) (1) $\frac{GAF}{PIB} = \frac{PIE}{PEA}\ \frac{NE}{PEA}\ \frac{\frac{GAF}{NE}}{\frac{PIB}{PEA}}$

Where:

GAF = expenditure on public municipal elementary education;

GDP = Gross Domestic Product of municipalities;

PIE = school-age population;

PEA = economically active population;

NE = number of students measured by school enrolment.

The expenditure on public municipal elementary education, as a proportion of $\frac{GAF}{PIB}$, encompasses the total of the salary bill (*SB*), along with other recurrent and capital expenses (RCE), divided by the number of students. It's worth noting that RCE is derived from the salary of teachers (*W*) multiplied by the number of teachers (*NT*). This expenditure can be represented as W multiplied by the teacher-student ratio (θ), in addition to DCC, divided by the number of students, as outlined in equations (2), (3), and (4).

(2) $\frac{GAF}{PIB} = \frac{FS+(DCC)}{NE}$

(3) $\frac{GAF}{PIB} = \frac{W*NP+DCC}{NE}$

(4) $\frac{GAF}{PIB} = W\theta + \frac{DCC}{NE}$

From this perspective, two assumptions of the Baumol model (1967) are adopted: the salary of teachers (W_1), which is driven by the salary advantage (α_t); and the salary level of workers in the industry (W_2), which is determined by the productivity of this sector (r_2); and the constant GDP growth rate, as presented in equations (5) and (6).

(5) $W_{1t} = \frac{(1+\alpha_t)be^{r_2 t}}{be^{r_2 t}}$

(6) $W_{2t} = be^{e^{r_2 t}}$

The ratio $W_{1t}/W_{2t} = 1+ \alpha_t$ represents the salary gap between the two sectors. It is important to note that, when the productivity of these professionals is lower than that of industrial workers, their salary increase is under the influence of the Baumol effect. It is observed that α_t,, established by institutional factors such as laws that establish a minimum salary or expenditure on education, leads to salary increases. In the Baumol model (1967), α = 0, meaning that the salary increase of teachers is explained by the difference in productivity between the two sectors. Nose (2017) adds the possibility of salary advantages (α ≠ 0) to this effect.

Furthermore, assuming that the economy has only two sectors, one non-progressive (education) and one progressive (industry) with outputs Y_1 and Y_2 respectively, as in the original models of Baumol (1967) and Nose (2017), the assumption of constant GDP growth can be incorporated by using a Cobb–Douglas production functi on, without the capital factor, where the growth rate of output is constant. Given that the total workforce of the economy (L_t) is composed of the workforce of the educational sector (L_{1tm}) and the workforce employed in the industrial sector (L_{2t}), we have:

(7) $Y_{1t} = aL_{1t}e^{r_1 t}$

(7) Y_1t = aL_1t e^(r_1 t)

(8) Y_2t = bL_2t e^(r_2 t)

Where:

Y_t = Municipal GDP;

Y_{1t} = output of public municipal elementary education;

L_{1t} = number of workers in municipal elementary education;

L_{2t} = number of workers in industry;

‘a’ and ‘b’ are constants; and

r = productivity, with $r_1 < r_2$.

In contrast to Baumol (1967) and Nose (2017), who used the number of workers in the sector as a proxy for Y1t, this study recognizes that Y_{1t} can be measured by the performance on the SAEB (Brazilian System of Elementary Education Evaluation). It is therefore assumed that

the scores achieved by schools can be considered as outputs. Therefore, the labour force employed in the sectors can be expressed as follows:

$$(9)\ L_{1t} = \frac{L_t}{1+\frac{a}{b}Ke^{(r_2-r_1)t}}$$

$$(10)\ L_{2t} = \frac{\frac{a}{b}Ke^{(r_2-r_1)t}L_t}{1+\frac{a}{b}Ke^{(r_2-r_1)t}}$$

Taking into account the unit cost of the elementary education sector ($\frac{C_{1t}}{Y_{1t}}$), which is the cost divided by the output of the sector, and the cost of the sector (C_{1t}) is defined as W_{1t} as per equation (5), and the output (Y_{1t}) is defined as per equation (7), we have:

$$(11)\ \frac{C_{1t}}{Y_{1t}} = \frac{W_{1t}L_{1t}}{Y_{1t}} = \frac{(1+\alpha_t)be^{r_2t}}{ae^{r_2t}}$$

The cost per student (C_{1t}/NE_t) can be broken down into two components, price effect and income effect. The price effect is represented by the first two terms of equation (12), namely, the Baumol effect (1967), which is defined as the difference in productivity growth between sectors, and the Nose effect (2017), which is defined as the increase in wage advantage. The third term represents the income effect.

$$(12)\ \Delta log\frac{C_{1t}}{NE_t} = (r_2 - r_1) + \frac{\Delta\alpha_t}{1+\alpha_t} + log\left(\frac{Y_t}{NE_t}\right)$$

The greater the value of the expression ($r_2 - r_1$), the stronger the technological progress in the industry compared to the educational sector. As a result, the cost per student increases because of the Baumol effect. The greater the expression ($\frac{\Delta\alpha_t}{1+\alpha_t}$), the higher the cost per student resulting from legally established wage increases.

This study applied the model using panel data for *k* Brazilian municipalities over t years. Specifically, data on public municipal spending on elementary education, as defined by the subfunction of elementary education, was obtained from FINBRA/STN for 4.959 Brazilian municipalities. Data from SAEB was obtained every two years from the MEC website, and data from the years 2009, 2011, 2013, 2015, and 2017 were used in this study. Information on student enrolment and teacher numbers was also sourced from the MEC website. Data on

municipal GDP, school-aged population, economically active population, and total population per municipality was obtained from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* - IBGE) website, resulting in a total of 24,795 observations. The econometric package used in this study was Studio R.

An adjustment was made to the previous equation to account for the unique characteristics of Brazil. A dummy variable (D) was added to differentiate municipalities with higher scale costs, specifically those with a population of less than 50,000 or more than 500,000. This was done to mitigate endogeneity by reducing the possibility that the results are explained by omitted variables, as outlined in equation (13).

$$(13)\ \Delta log\frac{C_{1kt}}{NE_{kt}} = \beta_0 + \beta_1 \mathrm{D} + \beta_2(r_{2t} - r_{1t}) + \beta_3\frac{\Delta\alpha_{kt}}{1+\alpha_{kt}} + \beta_4 \Delta log\left(\frac{Y_{kt}}{NE_{kt}}\right) + \varepsilon$$

To determine whether the increase in teacher salaries is primarily caused by the Baumol effect or the Nose effect, the following hypotheses were tested:

• Hypothesis 1: β2 > β3, indicating that the Baumol effect is the primary contributor to teacher salary increases, surpassing the contribution of the Nose effect;

• Hypothesis 2: β3 > β2, indicating that the Nose effect is the primary contributor to teacher salary increases, surpassing the contribution of the Baumol effect.

4. RESULTS

Table 1 presents a statistical summary of the main variables that were first used in the analysis.

Table 1 – Statistical Summary

	D	$(r_{2t} - r_{1t})$	$\frac{\Delta\alpha_{kt}}{1+\alpha_{kt}}$	$\log\left(\frac{Y_{kt}}{N\,E_{kt}}\right)$
Mean	0.0995	3.99222	0.0581	-8.027944
Median	0	2.29617	0.003	-8.061487
Maximum	1	11.3898	93392	-3.838931
Minimum	0	-1.3177	-1.7	-11.4334
Standard Deviation	0.2993	4.2405	0.3583	0.752218
Distortion	2.676	0.62951	3.2203	0.376028
Kurtosis	81.612	2.27039	38.442	4.088.826
Jarque-Bera	57113	2187.6	1E+06	1809.136
Probability	0	0	0	0

Sum	2467	98987	1441.6	199052.9
Sum of Standard Deviations	2221.5	452925	3182.7	14029.23
Observations	24795	24795	24795	24795

Source: Prepared by the Author.

The table above provides a statistical summary of the key variables used in the analysis. It can be observed that, on average, spending per student increased by 4.6%, with the highest growth rate at 9.4% and the lowest at −2.1%. The Baumol effect had a 3.3% impact on the period analysed, with a maximum value of 11% and a minimum of -−1.3%. The Nose effect had an average growth of 0.5% for the period, with a maximum of 9.3%. However, it also had a negative impact of reducing spending per student by 1.6%. Finally, the income effect had an average growth rate of −0.8%. This is likely due to an increase in the percentage of students attending private schools compared to the total number of municipal primary school enrolments during the analysed period.

Prior to estimating the model, the assumptions outlined in the previous section were examined. The first assumption, which concerns constant product growth, was supported by the stationarity nature of the growth rate of the product. The second assumption, which relates to the common growth of wages in progressive and non-progressive sectors, was evaluated using panel data regression. There was no evidence to reject the assumption of a relationship between changes in wages in these sectors.

In the selection of the panel data model, which offers improved accuracy in data fitting, the F test and Hausman test (1978) were employed. The F test compared fixed and grouped effects models. The null hypothesis of the test posits that there is no difference in intercepts. Upon accepting the null hypothesis, the grouped model was selected, which posits that the intercept and angular coefficients remain constant over time and space, and that errors are homoscedastic, as shown in Table 2. This choice may have been influenced by the inclusion of a dummy variable in the regression, which differentiates municipalities based on size, highlighting distinct characteristics among them.

Table 2 – F test comparing fixed and grouped effects models

Redundant Fixed Effects Tests

Equation: EQ01

Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	0.0867	-495,819,832	1
Cross-section Chi-square	531.6895	4958	1

Source: Prepared by the author.

In the next step, the panel data models with random and grouped effects were compared using the Hausman test (1978). The outcome, with a p-value below 5%, revealed that the random effects model was the most appropriate, as demonstrated in Table 3. This model has the benefit of assuming that unobserved factors remain constant over time. By doing so, the unique characteristics of each municipality can be captured in the estimation, eliminating the factors that impact the explained variables, thus reducing the endogeneity resulting from omitted variables.

Table 3 – Hausman test comparing random and grouped effects models

Correlated Random Effects - Hausman Test

Equation: EQ01

Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	120.18794	4	0

** WARNING: estimated cross-section random effects variance is zero.

Source: Prepared by the author.

The estimated model, as defined by equation (13), is also presented. The ordinary least squares method was employed for this purpose. According to hypothesis 1 ($\beta_2 > \beta_3$), the primary explanation for spending per student would be the Baumol effect, with the salary advantage (Nose effect) being an additional explanatory factor.

In terms of the control variable, it is important to highlight the population size of the municipality. In Brazil, over 80% of municipalities have less than 10,000 inhabitants. These municipalities lack financial autonomy, and their spending structure is costly to serve a small number of inhabitants. Additionally, municipalities with more than 500,000 inhabitants experience diseconomies of scale, as expenses grow proportionally more than revenues, as predicted by the Wagner's Law.

The estimation of the model is presented in Table 4:

Table 4 – Model Estimation

Variables	Coefficient	Standard Deviation	Statistical Value	Probability
$\Delta log \frac{Y_{1kt}}{NE_{kt}}$				
β_0	4.87268	0.112068	43.47958	0.00
D	0.247483	0.035184	7.033987	0.00
$(r_{2t} - r_{1t})$	0.209797	0.002351	89.23768	0.00
$\frac{\Delta\alpha_{kt}}{1+\alpha_{kt}}$	0.405397	0.027957	14.500062	0.00
$\Delta log \frac{Y_{1kt}}{NE_{kt}}$	0.138425	0.0138425	9.91744	0.00
R-Squared: 0.292306				
Included Time Periods: 5				
Adjusted Sample: 2009 2017				
Included Time Periods: 5				
Included Cross-Sections: 4959				
Total Observations in a Balanced Panel: 24795				

Source: Prepared by the author.

It can be observed that the coefficient of 0.21 for the Baumol effect $(r_2 - r_1)$ rejects the hypothesis that the Baumol effect is the primary driver of teacher salary increases, as it is less than the Nose effect. The primary driver of the increase in teacher salaries was the Nose effect $(\frac{\Delta\alpha_t}{1+\alpha_t})$, with a coefficient of 0.46.

The result of the ADF test indicated the absence of a unit root for all the variables tested, as shown in Table 5:

Table 5 – Panel Unit Root Test Summary

ADF – Fisher Qui-quadrado

H0: Unit root			**Significance level**
Variables	Statistic	Probability	Model
$\Delta log \frac{C_{1kt}}{NE_{kt}}$	21613.8	0	Intercept
	-236.12	0	Trend and intercept
$(r_{2t} - r_{1t})$	39696.3	0	Intercept
	30187.9	0	Trend and intercept
$\frac{\Delta\alpha_{kt}}{1+\alpha_{kt}}$	39696.3	0	Intercept
	30187.9	0	Trend and intercept

$\Delta log \frac{Y_{1kt}}{NE_{kt}}$	24748.3	0	Intercept
	20080.4	0	Trend and intercept

Source: Prepared by the author.

The results of F test show a significance level of 5%, reaching 1%. Thus, the coefficients of the model are different from zero (0). In other words, the null hypothesis that all coefficients estimated by the regression are simultaneously equal to 0 can be rejected.

5. FINAL CONSIDERATIONS

This study examined the factors that drive the growth of per-student expenditure in public municipal elementary education in Brazil from 2009 to 2017. It was found that hypothesis 1, which stated that the payment above the productivity of the industry is the main factor contributing to the growth of elementary school teachers' salaries in municipalities, was not supported.

The findings of this study suggest that both the Baumol (1967) effect and the Nose (2017) effect play a role in driving the growth of elementary school teachers' salaries in municipalities above productivity. However, it was found that the Nose effect was more pronounced than the Baumol effect. This implies that the salary increases for teachers in this level of education were the primary factor contributing to the overcompensation of their salaries.

Among the limitations of this study, the limited number of years analyzed stands out. Socioeconomic contexts can show significant changes in decades. The influence of economic growth on the wages of all categories of workers in the longer term is well known. It should be noted that political variables can also affect wage variations and that these can suffer significant changes in decades. In this sense, it is recommended that these aspects be addressed in future studies.

BIBLIOGRAPHICAL REFERENCES

Akitoby, B., Clements, B., Gupta, S., & Inchauste, G. (2006). Public spending, voracity, and Wagner's law in developing countries. *European Journal of Political Economy*, 22(4), 908–924. https://doi.org/10.1016/j.ejpoleco.2005.12.001

Baumol, W. J. (1967). Macroeconomics of unbalanced growth: Anatomy of an urban crisis. *The American Economic Review*, 57(3), 415–426.

Constitution of the Federative Republic of Brazil of 1988. (1988). Available at: https://www.planalto.gov.br/ccivil_03/constituicao/ConstituicaoCompilado.htm

Giacomoni, J. (2011). *Receitas vinculadas, despesas obrigatórias e rigidez orçamentária: Orçamentos Públicos e Direito Financeiro*. São Paulo: Revista dos Tribunais.

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of The Econometric Society*, 46(6), 1251–1271.

Higgs, R. (1991). Eighteen problematic propositions in the analysis of the growth of government. *The Review of Austrian Economics*, 5(1), 3-40.

Complementary Law no. 101, of May 4, 2000. (2000). Establishes public finance norms focused on responsibility in fiscal management and makes other provisions. Available at: https://www.planalto.gov.br/ccivil_03/leis/lcp/lcp101.htm

Law no. 11,114, of May 16, 2005. (2005). Amends art. 6, 30, 32 and 87 of Law nº 9.394, of December 20, 1996, with the aim of making it compulsory to start elementary school at the age of six. Available at: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2005/lei/l11114.htm#:~:text=LEI%20N%C2%BA%2011.114%2C%20DE%2016%20DE%20MAIO%20DE%202005.&text=Altera%20os%20arts.,aos%20seis%20anos%20de%20idade.

McLeay, S., Ordelheide, D., & Young, S. (2004). Constituent lobbying and its impact on the development of financial reporting regulations: evidence from Germany. *The Economics and Politics of Accounting: International Perspectives on Research, Trends, Policy, and Practice*, 285–316. https://doi.org/10.1016/S0361-3682(99)00028-8

Monteiro, J. (2015). Gasto Público em Educação e Desempenho Escolar. *Revista Brasileira de Economia*, 69(4), 467–488. https://doi.org/10.5935/0034-7140.20150022

Nose, M. (2017). Estimation of drivers of public education expenditure: Baumol's effect revisited. *International Tax and Public Finance*, 24(3), 512–535. https://doi.org/10.1007/s10797-016-9410-7 .

Sanches, O. M. (2004). *Dicionário de Orçamento, Planejamento e Áreas Afins*. Brasília: OMS.

Schick, A. (1998). *A Contemporary Approach to Public Expenditure Management*. Washington: World Bank Institute.

Wolff, E. N., Baumol, W. J., & Saini, A. N. (2014). A comparative analysis of education costs and outcomes: The United States vs. other OECD countries. *Economics of Education Review*, 39, 1–21. Google Scholar] [CrossRef]