**Quality of Education and Public Resource Allocation in Brazil**

**Ricardo S. Freguglia[[1]](#footnote-2), Mônica A. Haddad[[2]](#footnote-3), and Cláudia Gomes[[3]](#footnote-4)**

***Abstract:*** The main objective of this paper is to examine whether Brazil’s scarce public resources were being allocated in a coordinated manner during the period 2003-2009. The overall research question it attempts to answer is as follows: what are the relationships between quality of education, educational spending, and *BF* cash transfer? *Prova Brasil*, a national test administered by the Brazilian Ministry of Education, is used as a proxy for measuring quality of education. Higher average scores in *Prova Brasil* indicate better quality of education. *Fundef* data is used to measure public spending on education. A fixed effects approach is used, including variables at the school and municipal levels. Results indicated that the hypothesis about higher *BF* allocation coinciding with lower *Prova Brasil* average scores is validated just to the early elementary math education (Mathematics 4th grade) and to the Portuguese 8th grade education. This may be due to the fact that municipalities’ skills to implement *BF* vary vastly, indicating that there is not a consistent municipal behavior with regards to *BF*. When considering *Fundef* resources, the hypothesis about higher *Prova Brasil* scores should be receiving higher government spending on elementary education was supported. In both situations, the magnitudes of the coefficients were very small, indicating that the returns to education that are expected from public spending are not yet very relevant for the Brazilian case. In general, these results may be related to difference in municipal performances in administering public spending.

**KEYWORDS**: Conditional cash transfer, basic education, public investment, fixed effects, human capital, Brazil.

**JEL Code**: I25, I28

***Resumo:*** O objetivo central desse artigo é examinar se os escassos recursos públicos estão sendo alocados de maneira coordenada no Brasil no período de 2003 a 2009. A pergunta principal que o artigo busca responder é: qual a relação entre qualidade da educação, gastos educacionais e transferência de recursos do Bolsa Família? A proficiência dos alunos na *Prova Brasil*, do Ministério da Educação, é usada como Proxy para medir a qualidade da educação. Notas mais elevadas na *Prova Brasil* indicam melhor qualidade da educação. Dados do *Fundef* são usados para medir o gasto público em educação. A abordagem de efeitos fixos é adotada, incluindo variáveis ao nível da escola e dos municípios. Os resultados indicam que a hipótese de que maiores gastos no Bolsa Família coincide com menores notas médias no exame da *Prova Brasil* é validada apenas para a primeira etapa da fundamental em matemática (4a ano) e para o 8o ano em Português. Isso pode ser devido a grande variabilidade na habilidade dos municípios em implementarem o *BF,* indicando que não existe uma conduta municipal padronizada relativa ao BF. Ao considerar os recursos do *Fundef,* a hipótese de que notas mais elevadas da *Prova Brasil* deveriam estar recebendo maiores gastos governamentais sobre a educação básica é sustentada. Em ambos os casos, as magnitudes dos coeficientes estimados é muito pequena, indicando que os retornos a educação que são esperados em decorrência dos gastos governamentais não são muito relevantes para o caso brasileiro. Em linhas gerais, sugere-se que tais resultados podem estar associados as diferenças de desempenho dos municípios na gestão dos recursos públicos.

**PALAVRAS-CHAVE**: Bolsa Família, Educação Fundamental, Investimentos Públicos, Efeitos Fixos, Capital Humano, Brasil.

**Área ANPEC**: Economia Social e Demografia Econômica

1. **INTRODUCTION**

Brazil has been in the headlines of international media because of its high economic growth rate and its investments in social development. In the context of the global economy, despite the current economic crises, Brazil is growing at a faster rate than most other countries. This growth is attracting many investors and new businesses to its territory. Additionally, under President Lula’s leadership (2002-2010), social investments were a priority, allowing many Brazilians who were living in poverty to have a better quality of life. According to the World Bank (2012), the poverty rate in Brazil rose to 36 percent in 2003, but has sharply declined since then to 27 percent in 2006 and 21 percent in 2009.  The population earning less than Purchasing Power Parity of $1.25 per day followed a similar pattern, rising to 11.2 percent in 2003 and falling to 6 percent in 2008, before a very slight rise to 6.1 percent in 2009.

Most of the social investments initiated during President Lula’s tenure had the ultimate goal of forming human capital. These investments happened through a conditional cash transfer program named Bolsa Família (*BF*). Under President Dilma Roussef’s administration (2011-2014), the Brazilian government continues to allocate public resources for the *BF* program. The program is based on direct cash transfer to poor families who agree to keep their children in school. The program also provides recipient families with basic health care. According to *Ministério do Desenvolvimento Social* (2012) *BF* benefited 8.7 million families in 2005, at a cost of R$5.7 billion; more than 21 percent of the federal budget was allocated for all social programs that year. In 2010, approximately 12.8 million families benefited at a cost of R$1.2 billion. Because of *BF* requirements, this increasing number of beneficiaries leads to increasing enrollment in public schools. Within this context, quality of education is an important part of the Brazilian economic growth process. In other words, children who receive a high quality education will be more likely to join the qualified work force that a growing country like Brazil is in need of.

When comparing economic growth, quality of education, and educational spending in a few Latin American countries, some interesting findings arise. Table 1 displays this comparison from 2006 to 2009, in which economic growth is described using GDP annual percentage growth, quality of education is described using the UNESCO index EDI[[4]](#footnote-5) (‘education for all’ EFA development index), and educational spending is described using the annual percentage of GDP that is allocated to education. Brazil was the only country that did not have an increasing trend in EDI from 2006 to 2008. In addition, Brazil had the lowest EDIs when compared to its three neighbors. When focusing on GDP, the effect of the 2008 world economic crises is visible: all countries had a decrease in their GDPs from 2008-2009. In fact, the GDPs of Brazil and Chile decreased between 2008 and 2009. Concerning educational spending, Brazil had the highest GDP percent allocated to education in 2006 and 2007, and spending continued to increase in 2008 and 2009.

From the economic growth perspective, the idea that growth goes hand in hand with investments in human capital in widely accepted. For instance, Baldacci et al (2008) demonstrated that “both education and health spending have a positive and significant impact on education and health capital, and thus support higher growth” (p.1317). Table 1 shows that this was happening in Brazil from 2006 to 2008; i.e. public spending on education steadily increased. However, given this, one might expect Brazil to have higher EDI values and an increasing trend in EDI. This discrepancy may be due to the need for a time lag for the index to capture the changes that the investment should promote. This may also be due to the high enrollment rates that are taking place in public schools because of *BF*.

**Table 1: Comparing Economic Growth, Quality of Education, and Educational Spending, 2006-2009.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Year | **Chile** | **Argentina** | **Colombia** | **Brazil** |
| **EFA Development Index (EDI)** | 2006 | -- | 0.956 | 0.905 | 0.901 |
| 2007 | 0.966 | 0.971 | 0.920 | 0.883 |
| 2008 | 0.968 | 0.972 | 0.929 | 0.887 |
| Change | ↑ | ↑ | ↑ | ↓ |
| **Annual % change in GDP** | 2006 | 5.69 | 8.47 | 6.70 | 3.96 |
| 2007 | 5.16 | 8.65 | 6.90 | 6.09 |
| 2008 | 3.29 | 6.76 | 3.55 | 5.17 |
| 2009 | -1.04 | 0.85 | 1.65 | -0.33 |
| Change | ↓ | ↓ | ↓ | ↓ |
| **Public spending on education in % of GDP** | 2006 | 3.2 | 4.5 | 3.9 | 5.0 |
| 2007 | 3.4 | 4.9 | 4.1 | 5.1 |
| 2008 | 4.0 | 5.4 | 3.9 | 5.4 |
| 2009 | 4.5 | 6.0 | 4.7 | 5.7 |
| Change | ↑ | ↑ | ↑ | ↑ |

*Source: UNESCO and World Bank*

As noted above, two increasing trends of public investments are taking place in Brazil, in social development and in education. Coordination in the allocation of these public resources would contribute to the formation of human capital. Table 2 depicts specific total annual amounts of public resources that were allocated to education and social development between 2003 and 2007, corresponding to the period of the data below. The former is illustrated by data on *Fundo de Desenvolvimento do Ensino Fundamental e da Valorização do Magistério* (Fundef), described in more detail below, and the latter is illustrated by data on *BF.* The selected years correspond to the period of study of this paper. All percent changes were positive. *BF* change from 2003 to 2005 was extremely large (790%) because this period captures the switch in the federal budget allocation towards social development. These numbers indicate that public spending in Brazil shifted towards social development; a very wise strategy for a growing economy known for its high social inequality. These figures further emphasize the need to better understand the relationship between quality of education, and public resource allocation to education and social development in Brazil, to assure that the allocation of public resources is indeed contributing to the growth process.

**Table 2: Public Resources Allocation – Fundef and BF.**



*Note: FUNDEF data was available until2006.*

*Source: Tesouro Nacional and Ministério do Desenvolvimento Social*.

The main objective of this paper is to examine whether Brazil’s scarce public resources were being allocated in a coordinated manner during the period 2003-2009. The overall research question it attempts to answer is as follows: what are the relationships between quality of education, educational spending, and *BF* cash transfer? *Prova Brasil*, a national test administered by the Brazilian Ministry of Education, is used as a proxy for measuring quality of education. Higher average scores in *Prova Brasil* indicate better quality of education. *Fundef* data is used to measure public spending on education. The research question was answered using regressions that treated *Prova Brasil* scores as the dependent variable and *BF* and *Fundef* spending (along with numerous controls) as the independent variables. The results of the regression also allowed us to address the paper’s two research hypotheses: 1) municipalities with higher level of *BF* allocation also had lower scores in *Prova Brasil*; and 2) municipalities characterized by higher *Prova Brasil* scores also received higher government spending on elementary education. The first hypothesis is based on the fact that *BF* is increasing enrollment in public schools, but the public school system may not be able to provide resources needed to meet the needs of more students. The second hypothesis is based on the idea that higher government spending on education should result in better education performance.

The paper is organized as follows. Section 2 presents a literature review, and section 3 describes the variables used in this paper and the methodology. Section 4 presents the estimation results. The final section contains concluding remarks, including policy recommendations, limitations of the study, and ideas for future research.

1. **LITERATURE REVIEW**

This review focuses on three main topics. First, *BF* started being implemented in Brazil in the early 2000’s and there is extensive published literature about this program, exploring a variety of topics. Second, given that Brazil is investing a large portion of its GDP in education, that the ultimate goal of *BF* is to form human capital, and that Brazilian economic growth is attracting many investors and new businesses, it is important to understand the relationship between education and economic growth. Third, examining work related to educational spending in Brazil contributes to a better understanding of our regressions results.

1. *Bolsa Família*

The first step for a municipality to receive *BF* funding is to establish an agreement with the federal government. The municipality then becomes responsible for registering families interested in becoming *BF* beneficiaries. This registration process happens through an electronic system, named *Cadastro Único*, which provides the federal, state, and municipal governments with access to the information. Funding allocation to *BF* beneficiaries varies according to the family poverty level, the number of children in the family, or the presence of a pregnant or nursing woman in the family. Once the agreement is established, each municipality is responsible for managing and distributing *BF* funds in its territory. Fried (2012) showed “strong evidence that *BF* is distributed in a programmatic manner” (p. 1049) indicating that its distribution process is not dependent on political criteria such as clientelism and political interference in how transfers are distributed.

Overall, most of the studies indicate that the program is allowing many Brazilians who were living in poverty to have a better quality of life. Studies that analyzed the relationship between *BF* and equality show that poverty and inequality were decreasing in Brazilian municipalities because of *BF* (Soares *et al.*, 2006; Tavares *et al.*, 2009; Landin, 2009; Soares *et al.*, 2010; Vale *et al.*, 2010; Machado *et al.*, 2011). Other studies that focus on *BF* and educational issues indicate increased enrollment and attendance, and decrease in dropouts (Bourguignon *et al.*, 2003; Haddad, 2008; Kassouf and Glewwe, 2008; Romero and Hermeto, 2009; Vale *et al*, 2010, Machado *et al*, 2011). Specifically focusing on student proficiency, two studies found a negative relationship as a result of increased BF spending (Liso, 2010; Camargo, 2011). Moreover, studies on child labor have found decreasing trends (Ferro and Kassouf, 2005; Pedrozo, 2007), but also no change, and limited effects (Cardoso and Souza, 2004; Machado et al, 2011). Finally, research on health issues had mixed findings (Paes-Sousa *et al*., 2011; Andrade *et al*., 2012). Several of these studies are described further below.

Concerning education, Haddad (2008) showed the importance of *BF* in increasing enrollment in public schools, and confirmed that public resources allocated to *BF* were contributing to greater social equality. Similarly, Glewwe and Kassouf (2008) estimated that the program will raise school enrollment among children in eligible families by 13 percent, will lower dropout rates by 1 percent, and will raise grade promotion rates by 2.3 percent in the long run. With regards to student performance, Liso (2010) showed a negative relationship between 8th grader proficiency and the program, pointing out that diminished quality of education in public schools, related to increasing enrollment, was a consequence of *BF*. In the same direction, Camargo’s (2011) results showed a negative relationship between proficiency and *BF*. But the author indicated that the schools included in his study already had lower performance, prior to *BF*’s creation.

In addition to increasing school enrollment, ideally *BF* should also diminish child labor and income inequality. Indeed, results of a study by Pedrozo (2007) indicated that including families in conditional cash transfer programs led to the reduction of such labor. Conversely, in a study of PNAD (*Pesquisa Nacional por Mostra de Domicílio*) data from 2004-2006, Machado *et al.*(2011) found that *BF* had only limited effects on curbing child labor, but did slightly boost school attendance.  However, they did see improvements in income inequality, showing that beneficiaries were less likely to work in the informal economy and earned more by the end of the two-year period studied.

With regards to *BF* health service provision, on one hand, Paes-Sousa *et al.* (2011) found that children in families that benefit from *BF* were 26 percent more likely to be of normal height for their age, indicating that they have greater access to adequate food. On the other hand, even though *BF* beneficiaries have access to child immunization services, Andrade *et al*. (2012) found that the program had little effect on child immunization rates among beneficiary families, despite a higher rate of immunization among children under 6 months of age.

In summary, despite the fact that *BF* has been the topic of various studies, there has been no systematic study that yet relates the coordination of public resources allocation in social development and education, and quality of education.

*b) Education and Economic Growth*

In many countries educational spending has proven to be effective means of accumulating human capital. Likewise, various approaches have demonstrated how education may affect economic growth. First, some scholars (see Lucas, 1988; Mankiw, Romer, and Weil, 1992; Texeira and Fortura, 2004; Oketch, 2006; Fleisher, 2011) empirically showed that education fostered human capital, which increased labor productivity, and as a consequence, moved economic growth to a higher level. Second, various studies (see Nelson and Phelps, 1966; Lucas, 1988; Aghion and Howitt, 1998; Ranis and Ramirez, 2000; Wolff, 2000; Lin 2003; Benhabib and Spiegel, 2005; Park, 2008) indicated that education boosted both innovation capacity and new knowledge about technology, products, and processes leading to growth. Third, the fact that education can facilitate spillovers of knowledge and promote skill-based technical changes (Fleisher, 2011) is well documented (see Acemoglu 1996 and 1998; Ciccone and Peri, 2006).

Investments in education are related to differences in levels of development between countries and regions. These global differences are illustrated by the work of Hanushek and Wossmann (2007). By comparing education in different countries, they found that educational deficits were larger in developing countries, where programs focused only on school enrollment and attendance, and not on quality of education. They showed that in order to decrease the economic deficit between countries, changes in the structure of educational institutions in developing countries should take place. Barro (2001) also contributed to this discussion, indicating that program measures that focused on quality of education (evaluated by tests of cognitive abilities) were more important for economic growth than measures such as enrollment and attendance. Along these lines, Baldacci et al (2008) found that public spending on health and education was positively and significantly related to human capital (measured using the sum of the gross primary and secondary enrollment rates), resulting in economic growth.

There are, however, some studies that contradict the ones presented above. Teles and Andrade (2008) demonstrated that there was no consensus in empirical studies that focused on the relationship between government spending on education and economic growth. Additionally, Blankenau and Simpson(2004) showed that even when public expenditure promotes human capital, economic growth may not increase. In summary, the findings reviewed above stress the need to better understand how the process of human capital formation is evolving in Brazil.

1. *Educational Spending in Brazil*

The system that finances education in Brazil is very complex; various funds work together, a large combination of taxes are used to accumulate resources, and resource allocation is based on many criteria. Therefore, for the purpose of this paper, a narrowed approach is presented focusing only on *Fundef*. Recall that *Fundef* spending is the variable used in this paper to capture public investment in education. The 1988 Brazilian Constitution created *Fundef*, which lasted from 1997 to 2006.In Brazil, the K-12 system (*educação básica*) is divided into two levels. The elementary school (*ensino fundamental*) corresponds to grades 1 to 9 and the high school (*ensino médio*) corresponds to grades 10 to 12. *Fundef* resources were targeted only to elementary schools. *Fundef* was replaced by the *Fundo de Manutenção e Desenvolvimento da Educação Básica e de Valorização dos Profissionais da Educação* (Fundeb). *Fundeb* was created in 2007 and is expected to end in 2020, and its resources are being target to both, elementary school and high school.

*Fundef* allocation process was based on automatic transfers to municipalities and states, according to enrollment in elementary school. When *Fundef* was active, 60 percent of all education resources in the country had to be allocated to maintain and develop elementary school. These resources were gathered in state funds, and then, allocated to municipalities and state according to enrollment in elementary school. This fund had a combination of resources from municipalities and states, including a variety of taxes. In addition, the federal government would also contribute to the fund, assuring that a minimum per student was reached. In other words, the federal government was committed to complement the resources in order to assure a minimum value per student. This system allowed poor municipalities to have a minimum to spend on students. On the other hand, rich municipalities, in addition to *Fundef*, also had other resources to spend on students.[[5]](#footnote-6)

A few studies prior to this one also examined *Fundef*. Davies (2006) developed ​​an overview of the Brazilian education financial system and found that *Fundef* did not bring new resources to the system and did not improve teachers’ salary. Instead, the fund only redistributed a portion of the taxes between the state government and municipalities, allowing some municipalities to receive more funding and others to receive less. According to Davies (2006), the tax inequality that exists between the different levels of governments in Brazil inhibited the formation of a national system of education spending with good standards and quality.

Using *Fundef* data, Mello and Hoppe (2005) studied the evolution of public expenditure on education in Brazil during 1991-2002. When comparing Brazil to Organization for Economic Co-operation and Development (OECD) countries, they found that Brazil invested a higher share of its budget in public education programs. Despite the high spending on education, Brazilian students performed poorly, indicating a problem in the quality of investments. Indeed, these international comparisons showed that some countries with lower public spending, achieved better outcomes than Brazil. The authors pointed out that these discrepancies could reflect a lack of efficiency (Mello and Hoppe, 2005).

Gordon and Vegas (2005) found that increased spending from *Fundef* was associated with smaller class sizes and small gains in enrollment.  Conversely, they found no evidence that it has improved school performance for most students, except perhaps for low-achieving and non-white students. In a study using 1998 *Fundef* data, Menezes-Filho and Pazello (2007) found that, overall, increases in teacher salaries due to *Fundef* did little to improve performance in public schools.  However, these raises did attract better new teachers to some schools, and students of these teachers did have improved proficiency.

In summary, there are mixed results with regards to public spending in education in Brazil, making the overall research question – what are the relationships between quality of education, educational spending, and *BF* cash transfer? – an important one to be examined. The two research hypotheses – 1) municipalities with higher level of *BF* allocation also had lower scores in *Prova Brasil*; and 2) municipalities characterized by higher *Prova Brasil* scores also received higher government spending on elementary education – specifically target this need.

1. **DATA AND MODELS**
2. *Data*

The data used in this study came from various sources. Table 3 describes all the variables used in the models. Some variables were collected at the school level and others at the municipal level. The dependent variables – average *Prova Brasil* scores – were obtained from the *Insitituto Nacional de Estudos e Pesquisas Educacionais Anisio Texeira* (INEP). *Prova Brasil* started in 2005 and is administered by the Ministry of Education every two years. In 2005, the test was administered in schools located in urban areas that had a minimum of 20 students per grade. In 2007 and 2009 it was administered in schools located in urban and rural areas that had a minimum of 30 students per grade.

The objective of *Prova Brasil* is to assess student proficiency in math and Portuguese for grades 4 and 8. The two hypotheses posed above were tested in four regressions using average scores for the four tests as dependent variables. It was expected that the four dependent variables would have the same relationships to the independent variables of interest, regardless of the test age and subject matter differences.

There were two independent variables of interest: 1) the amount of cash allocated through *BF* (in Brazilian currency) in a municipality divided by the number of poor people in that municipality (*BF\_poor*); and 2) the amount of public spending on elementary education in a municipality divided by the number of students enrolled in elementary schools in that municipality (*Fundef*). The *BF* data was gathered through the Ministry of Social Development, and the number of poor to create the *BF* ratio came from *Instituto Brasileiro de Geografia e Estatística* (IBGE) 2000 Census. IBGE defines poor people as the proportion of individuals with per capita income below R$75.50, corresponding to half of the minimum wage in August of 2000 (Atlas do Desenvolvimento Humano no Brasil). Data on education spending was obtained from the Department of the Treasury.

A variety of control variables were also included in the models. These were classified as student, school, teacher, or municipality related, and identified from literature that examines student proficiency (Menezes-Filho, 2007; Barros and Mendonça, 1998; Hanushek, 2006; Kilkenny and Haddad, 2008). Characteristics of students who took *Prova Brasil* were obtained from INEP. The School Census (Censo Escolar) developed by the Ministry of Education was used to get data for the characteristics of schools and teachers in each municipality. Municipal characteristics came from the following sources: GDP per capita came from IBGE; and income and health indices were calculated by the Federation of Industries of the State of Rio de Janeiro. The income index included variables of average wage, generation and supply of formal employment; and the health index included number of pre-natal and infant deaths.

**Table 3: Description of all Variables**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Years** | **Unit of analysis** | **Variable** | | | **Years** | | **Unit of analysis** |
| **Dependent variables** |  |
| Prova Brasil Math average score - 4th grade (Math\_4) | 2005, 2007, 2009 | School | **School-related control variables** | | | | | |
| Prova Brasil Portuguese average score - 4th grade (Port\_4) | 2005, 2007, 2009 | School | Proportion of public schools in a municipality that had a computer lab (Sch\_comp) | | | 2003, 2005, 2007 | Municipality | | |
| Prova Brasil Math average score - 8th grade (Math\_8) | 2005, 2007, 2009 | School | Proportion of public schools in a municipality that had a library (Sch\_lib) | | | 2003, 2005, 2007 | Municipality | | |
| Prova Brasil Portuguese average score - 8th grade (Port\_8) | 2005, 2007, 2009 | School | Total number of students divided by number of classes in elementary schools (Stud\_class) | | | 2003, 2005, 2007 | Municipality | | |
| **Independent variables of interest** |  |  | **Teacher-related control variables** | | | | | |
| Amount invested in BolsaFamília - in Brazilian currency - divided by number of poor people (BF\_poor) | 2003,2005, 2007 (BF amount) & 2000 (number of poor) | Municipality | Proportion of teachers working in public schools with undergraduate degree (Teach\_edu) | | | 2003, 2005, 2007 | Municipality | | |
| Fundef spending divided by number of enrollment in elementary education (Fundef) | 2003, 2005, 2006 | Municipality | **Municipality-related control variables** | | | | | |
| **Student-related control variables** |  |  | GDP per capita (GDP) | | | 2003, 2005, 2007 | Municipality | | |
| Proportion of students who took Prova Brasil who lived in a place with internet access (Stud\_int) | 2005, 2007, 2009 | School | Health index (HEALTH\_Index) | | | 2000, 2005, 2007 | Municipality | | |
| Proportion of students who took Prova Brasil and worked (Stud\_wor) | 2005, 2007, 2009 | School | Income index (INCOME\_Index) | | | 2000, 2005, 2007 | Municipality | | |
| Proportion of mothers -of students who took Prova Brasil - who attended 4th grade or higher (Mother\_edu) | 2005, 2007, 2009 | School |  |  |  | | | | |
|  |  |

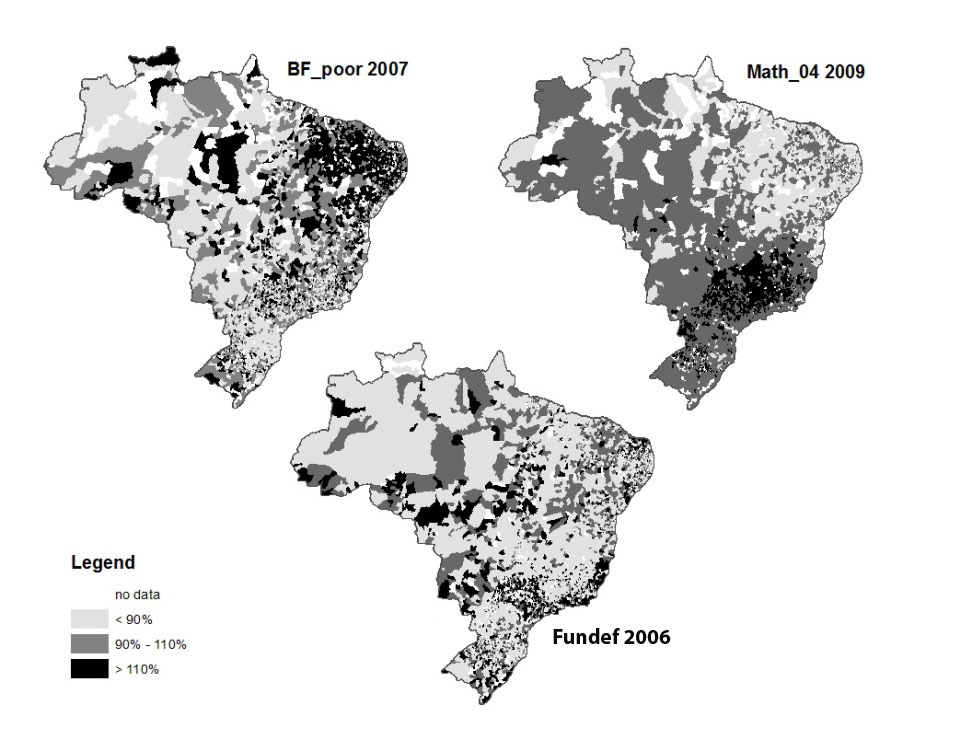
The number of observations of the variables displayed on Table 3 varied within a source, and also from source to source. For instance, the number of schools that participate in *Prova Brasil* Math\_4 in 2005 was 26,232, and in 2009 the number was 27,850. 5,564 municipalities were BF participants in 2007, and Fundefwas present in 5,286 municipalities in 2006.In addition to that, all six different sources had missing values, varying from variable to variable, and also from year to year. After merging these different data, every school included in the econometric analysis appears in every year with no missing values. In other words, the used data composes a balanced panel. As a consequence, the number of observations decreased as table 5 below indicates.

The correlation matrix of the variables is displayed on Table 4. We used the fourth grade on math to the sample from 2005-2009 to illustrate the mean behavior in this period. In general, the other variables present their expected signal. The interest variables – BF\_poor and Fundef – present a positive correlation with the math grades. However, this behavior is not consistent when considering other grades. For instance, *BF\_poor* presents a negative correlation with the proficiency of students of the fourth grade.[[6]](#footnote-7) These descriptive results deserves some additional exploration and motivate our investigation on additional factors which may contribute to the causal explanation between quality of education and public resource allocation in Brazil.



The dependent variables and the independent variables of interest deserve some exploration. Figure 1 displays*Math\_4* for 2009, *BF\_poor* for 2007 and *Fundef* for 2006. A common scale based on sample averages was created in order to compare these three variables: low values were defined as those less than 90 percent of the sample average, and high values were defined as those greater than 110 percent of the sample average. The spatial distributions of *Math\_4* and *BF\_poor* presented some patterns of clustering. On one hand, there was a spatial concentration of higher values of *BF\_poor* in the Northeast region, and of lower scores in *Math\_4* in the same region. On the other hand, the Southeast region was characterized by lower values of *BF\_poor* and higher values of*Math\_4*. Given that the Northeast is the poorest region in Brazil, and the Southeast is the richest region, the distribution of *BF\_poor* values in these regions is not surprising. Furthermore, the coincidence of high *BF* spending and low *Prova Brasil* scores may be due to increasing enrollment in public schools because of *BF* and inadequate resources to meet the needs of more students. The spatial distribution of *Fundef* displayed an apparently random distribution in 2006, with no visual indication of clustering.

**Figure 1: Spatial Distribution of Dependent and Independent Variables of Interest**



*Source: INEP, Tesouro Nacional and Ministério do Desenvolvimento Social.*

Descriptive statistics, estimated using schools, for the dependent and independent variables of interest are presented in Table 4[[7]](#footnote-8). The total number of schools for 4th grade regressions is 8,833, and the total number of schools for the 8th grade regressions is 7,546.In general, the average score for 8th graders is higher than 4th graders for both, math and Portuguese. There is a consistent increase on the average of public resource allocation for social development and education. The maximum values for *Fundef* differ a lot from 4th grade to 8th grade. An outlier school, located in São Vicente – RN – municipality with very high average education spending was included in the 8th grade regressions, but not in the 4th grade ones.

1. *Model Specification*

The main goal of the econometric approach presented below is to capture the relationship between quality of education, government spending on education, and *BF* allocation in Brazil during the period 2003-2009. The dependent variables were average test scores on *Prova Brasil*, which are used as a proxy for quality of education[[8]](#footnote-9). Hanushek and Wößmann (2007) recommend that quality of education be measured by standardized test scores rather than years of education to account for vast differences in educational quality between countries, or even individual schools.  In a survey of several studies, they found that higher performance on tests translated to increased earnings, especially in the developing world.  They also suggest that higher cognitive skills, as measured by standardized testing, are also linked to lower repetition rates, meaning that higher test scores could lead to higher educational attainment.  While test scores cannot be solely attributed to school performance, as factors like family background and living conditions have an impact, these scores have significant implications for the economic performance of the students, and of the countries that provided their education.

Student proficiency has been used as a proxy for quality of education in various studies (Barro, 2001; Kilkenny and Haddad, 2008; Parankader *et al.*, 2008; Liso, 2010). In particular, Prova Brasil was used as a dependent variable by Parankader et al. (2008) and Liso (2010). Barro (2001) found that standardized test scores were positively correlated with economic growth, especially in science.  An increase in science scores by one standard deviation would result in a 1 percent rise in annual economic growth, whereas a rise in educational attainment by one standard deviation would yield only a 0.2 percent gain in annual growth.  This echoes the work of Hanushek and Wößmann (2007) which suggests that the quality of education is more important than the quantity of education in determining a nation's economic growth.

A panel data approach for Brazilian schools was used for the years 2005, 2007 and 2009. A span of two years was applied between the dependent and independent variables as an attempt to capture any time lags required for financial resources to start working. Specifically, the dependent variable 2005 *Prova Brasil* had as its independent variables *BF\_poor* and *Fundef* for 2003. The 2007*Prova Brasil* had both independent variables from 2005, and the 2009 *Prova Brasil* had *BF\_poor* for 2007 and *Fundef* for 2006 (last year of this fund’s existence). Based on literature examining student proficiency (Menezes-Filho, 2007; Barros e Mendonça, 1998; Hanushek, 2006), a variety of control variables were also included in the equation, as given above in Table 3.

The panel data approach also allows for inclusion of unobserved municipal and school characteristics that could influence *Prova Brasil* average scores. Examples of these characteristics could be public policies that motivate reading, community engagement in early childhood education, the presence of NGOs that have a strong capacity to be engaged in educational debates, school management, and other social factors that may influence school performance in some way. When estimating a pooled ordinary least squares (POLS) without taking into account such unobserved characteristics, the estimated coefficients could be biased. Therefore, this paper applies the methodological technique of fixed effect panel data which includes unobserved specific characteristics of municipalities and schools that are fixed across time.

**Table 4: Descriptive Statistics of Dependent and Independent Variables of Interest**

****

This approach can be used to obtain consistent estimators in the presence of omitted variables. The adopted identification hypothesis is that E*(Uit|Xit) = 0*, that is, there are no unobserved characteristics fixed across time from municipalities which are correlated to any independent variable. For instance, important unobserved factors such as school management may be correlated with *Fundef*, i.e. spending in elementary education. Assuming that school management is fixed over time (according to our dataset from 2005 to 2009, this assumption is reasonable to be considered because this is a short period for this type of changes), it is possible to control for these managerial characteristics, and estimated results will be unbiased. These estimates are obtained following the functional form expressed by equation (1).

(1)

Where:

*Yit* is the natural log of the students' average score in *Prova Brasil* (math 4th grade, Portuguese 4th grade, math 8th grade, Portuguese 8th grade);

*β0* is the constant of the model;

*BF\_poorit-2*, is the natural log of the ratio, amount of cash allocated through *BF* divided by the number of poor people, representing one explanatory variable of interest;



*Fundefit-2*, is the natural log of the ration, amount spent on elementary education divided by total enrollment in elementary education, representing another explanatory variable of interest;



*Studentit* is the vector of control variables with characteristics of the students who took *Prova Brasil*;

*Schoolit* is the vector of control variables with characteristics of public schools by municipalities;

*Teacherit* is the vector of control variables with characteristics of public school teachers by municipalities;

*Municipalityit* is the vector of control variables with socio-economic characteristics of municipalities;

*Ci* corresponds to the specific (fixed) effects of each municipality;

*Uit* is the error term.

The estimations were made using the statistical software Stata 11. Due to the longitudinal feature of the used data base, the panel data approach was considered in this study. The use of fixed effects for the regressions was recognized based on both the Breush and Pagan (1980) and Hausman (1978) tests. The Breush Pagan test indicated that the null hypothesis of non existence of specific effects should be rejected. Instead, there were indeed unobserved fixed effects in the dataset. Likewise, the Hausman test showed that the fixed effects were better specifications than the random effects for the dataset used in this study (see Table 5).

1. **ESTIMATION RESULTS**

The results for the regressions presented in this section had variables at school and municipal levels, as displayed in Table 3. The variable *Fundef* was used to measure public spending on education at the municipal level. The regression that examined the relationship between quality of education, government spending on education, and *BF* program allocation were estimated using two models of estimation: ordinary least squares for panel data (POLS), random effects, and a fixed effects model. As stated above, the fixed effect model was the best specification for the dataset examined in this study. Therefore, only the fixed effects results are presented in Table5. Other estimated coefficients are presented in the appendix.

From Table 5, one can observe a positive significant relationship (*p*-value < 0.01) between *BF\_poor* and *Math\_4*and *Port\_8,* showing that this explanatory variable positively affected the average math scores for4th grade and Portuguese scores for 8th grade. For instance, 1 percent increase in *BF* allocation per poor would increase in 0.014 percent the score in math 4th grade and in 0.002 percent the score of Portuguese 8th grade. Negative significant relationships (*p*-value < 0.01) existed between *BF\_poor* and *Math\_8* and *Port\_4*. For example, 1 percent increase in *BF* allocation per poor would decrease in 0.003 percent the score in Portuguese 4th grade and in 0.003 percent the score of math 8th grade. The very small magnitude of the coefficients may indicate that the increasing enrollment in public schools caused by *BF* is not affecting average scores in a relevant manner.

**Table 5. Results of natural log of average *Prova Brasil* scores estimated by fixed-effect panel data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Fixed Effects** | | | |
| **Dependent Variables** | Math\_4 | Port\_4 | Math\_8 | Port\_8 |
| **Independent variables of interest** | | | | |
| BF\_poor | 0.012\*\*\* | -0.003\*\*\* | -0.003\*\*\* | 0.003\*\*\* |
|  | (0.001) | (0.001) | (0.000) | (0.000) |
| Fundef | 0.037\*\*\* | 0.016\*\*\* | -0.001 | 0.015\*\*\* |
|  | (0.003) | (0.003) | (0.002) | (0.002) |
| **Student-related control variables** | | | | |
| Stud\_int | 0.088\*\*\* | 0.050\*\*\* | 0.048\*\*\* | 0.076\*\*\* |
|  | (0.008) | (0.008) | (0.005) | (0.005) |
| Stud\_wor | -0.164\*\*\* | -0.192\*\*\* | -0.069\*\*\* | -0.147\*\*\* |
|  | (0.007) | (0.007) | (0.004) | (0.005) |
| Mother\_edu | 0.059\*\*\* | 0.070\*\*\* | 0.071\*\*\* | 0.082\*\*\* |
|  | (0.005) | (0.005) | (0.004) | (0.005) |
| **School-related control variables** | | | | |
| Sch\_comp | 0.019\*\*\* | 0.020\*\*\* | -0.001 | 0.014\*\*\* |
|  | (0.001) | (0.001) | (0.001) | (0.001) |
| Sch\_lib | 0.006\*\*\* | 0.009\*\*\* | -0.001 | 0.006\*\*\* |
|  | (0.002) | (0.002) | (0.001) | (0.001) |
| Stu\_class | -0.001\*\*\* | -0.001\*\*\* | -0.000\*\*\* | -0.000\*\*\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) |
| **Teacher-related control variables** | | | | |
| Teach\_edu | 0.030\*\*\* | 0.035\*\*\* | -0.003 | 0.017\*\*\* |
|  | (0.003) | (0.003) | (0.003) | (0.003) |
| **Municipality-related control variables** | | | | |
| GDP | 0.000\*\*\* | 0.000\*\*\* | -0.000\*\*\* | 0.000 |
|  | (0.000) | (0.000) | (0.000) | (0.000) |
| Health\_Index | 0.109\*\*\* | 0.085\*\*\* | 0.013\*\* | 0.078\*\*\* |
|  | (0.009) | (0.008) | (0.006) | (0.007) |
| Income\_Index | 0.012\*\* | -0.011\*\* | 0.005 | -0.001 |
|  | (0.005) | (0.005) | (0.004) | (0.004) |
| Constant | 4.751\*\*\* | 4.931\*\*\* | 5.409\*\*\* | 5.174\*\*\* |
|  | (0.018) | (0.017) | (0.011) | (0.013) |
| Observations | 26,499 | 26,499 | 22,638 | 22,638 |
| R-square within | 0.392 | 0.152 | 0.053 | 0.311 |
| R-square between | 0.389 | 0.448 | 0.421 | 0.455 |
| R-square overall | 0.39 | 0.366 | 0.325 | 0.406 |
| Breusch-Pagan *χ²*(01) | 2693.90 | 3062.67 | 4561.54 | 3077.44 |
| Hausman *χ²*(11) | 1494.39 | 2120.67 | 1524.69 | 633.82 |
| Number of schools | 8,833 | 8,833 | 7,546 | 7,546 |
| Constants were significant (p<0.01) in all estimations. | | | | |
| Standard errors in parentheses | | | | |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 | | | | |

Based on these findings, the hypothesis about higher *BF* allocation coinciding with lower *Prova Brasil* average scores is validated just to the early elementary math education (Mathematics 4th grade) and to the Portuguese 8th grade education. This may be due to the fact that municipalities’ skills to implement *BF* vary vastly, indicating that there is not a consistent municipal behavior with regards to *BF*. As Faria (2002) noted, social programs like the *Bolsa Escola*(precursor of *BF*) that require coordination between government agencies are not being effectively managed by these disparate groups. Differences in competence and interpretation between agencies can yield inconsistent results in the implementation of these programs. In the same direction, Rocha (1998) suggested that administrative and coordination problems were “the most obvious operational shortcoming” in Brazil's social programming. Municipalities face unequal levels of funding and managerial experience, meaning that they cannot implement these programs equally. There are abundant examples in the literature of differences in municipal performance at all levels. For example, Janvry et al. (2010), analyzed how municipal electoral factors affected performance of *Bolsa Escola* in reducing school dropout rates of poor children. They observed that municipalities “governed by a first-term mayor had an estimated 36 percent higher program performance compared to municipalities governed by a second-term mayor” (p. 3), indicating that political factors can have striking effects on municipal performance.

When considering *Fundef[[9]](#footnote-10)*, there was a positive significant relationship with *Math\_4*, *Port\_4*, and *Port\_8*(*p*-value < 0.01), i.e., for these three tests there was a coincidence of higher scores and higher spending in education. This shows that investments in education are having some positive effects on student proficiency. For instance, a 1 percent increase in *Fundef* allocation would increase score in math 4th grade by 0.028 percent and in Portuguese 4th grade and 8th grade by 0.011 percent. Based on these findings, the hypothesis about higher *Prova Brasil* scores should be receiving higher government spending on elementary education was supported. Again, the magnitudes of the coefficients were very small, indicating that the returns to education that are expected from public spending are not yet very relevant for the Brazilian case.

In general, these results may be related to difference in municipal performances in administering public spending. There is abundant literature documenting differences in the characteristics and performance of Brazilian municipalities. Much of this research focuses on the effects of good governance and other political factors. Motta and Moreira (2009) analyzed how municipal political factors and spending were related to improvements in social welfare. They found that “the size of the spending needed to attain a certain level of quality is associated with some characteristics of municipalities, scale, municipal fragmentation and patronage of an elected governor” (p. 369). In a study of corruption and electoral accountability, Ferraz and Finan (2009) found that municipal performance varied with electoral incentives and other related factors. Notably, misuse of funds was more pronounced in municipalities where the mayors have no reelection incentives, the populace is less privy to information, and where corrupt politicians are less likely to be punished. Timmons and Garfias (2012) studied the effects of corruption on property tax collection, a measure of municipal performance. They found a clear relationship between corruption and tax revenue, where revealed corruption diminished municipal tax revenue and increased the likelihood of “participatory budgeting”. All of these examples provide evidence for the importance of endogenous factors in defining how well a municipality provides for its residents.

In Brazil, according to Barros and Mendonça (1997), an improvement in the educational system can be obtained through the rise of resource allocated to education and/or through the rise of efficiency that they are used. As spend in education is large in Brazil, the inefficiency can be related to the way that these resources are allocated. In the present study, we assume that municipal performance in administering public spending are controlled as a fixed effect. As the obtained results show that the hypothesis about higher *BF* allocation coinciding with lower *Prova Brasil* average scores is validated just to the early elementary math education (Mathematics 4th grade) and to the Portuguese 8th grade education, municipalities’ skills to implement *BF* vary vastly, indicating that there is not a consistent municipal behavior with regards to *BF*.

Other secondary results can also be highlighted. When focusing on the student-related control variables, *Stud\_int* presented a positive significant relationship with all tests (*p*-value <0.01).These findings suggest that the higher the economic status of students, the higher their scores. With regards to *Stud\_wor*, negative significant (*p*-value <0.01) relationships with all tests were observed. As expected from the literature, students who work outside the home have a lower proficiency in school. Knowing that one of the reasons *BF* was created was to eliminate child labor, a study tracking individual students, instead of schools and municipalities, would be beneficial to clarify this finding. *Mother\_edu* had a positive significant (*p*-value < 0.01) relationship with all tests, suggesting that the higher the level of the mother’s education, the higher the probability of children doing better in school. These finding are in accordance with empirical literature showing that mothers’ education is one of the most important variables to explain student proficiencies. For instance, for the 4th grade math regression, an increase of 1% in *Mother\_edu*, corresponded to an increase of 6% in the average test scores.

For school-related control variables, *Sch\_comp* had a positive relationship (*p*-value < 0.01) with *Math\_4*, *Port\_4,* and *Port\_8*. *Math\_8* was negative and not significant. These results are in agreement with Menezes-Filho’s (2007) findings. He stated that digital inclusion in schools is still a nun clear independent variable in education literature of education. Menezes-Filho’s (2007) results showed that the presence of computers had little impact on students’ proficiency and the sign varied: they were occasionally positive, and sometimes negative. When observing the relationship of *Sch\_lib*, it had a positive (*p*-value <0.01) relationship with*Math\_4*, *Port\_4,* and *Port\_8*. These results indicate that school resources, such as the existence of libraries, were important for improving scores. Considering teacher-related control variables, *Stu\_class* showed a negative (*p*-value < 0.01) relationship with all tests. These findings suggest that, in the Brazilian context, smaller classroom size would help to improve students’ test scores. *Teach\_edu* had a positive and significant relationship with *Math\_4*, *Port\_4*, and *Port\_8* (*p*-value < 0.01). The higher the educational level of teachers, the better the students’ performance on tests.

With regards to the municipality-related control variables, *GDP* showed a positive relationship with *Math\_4* (*p*-value < 0.01) and *Port\_8* (*p*-value < 0.10). The *Health\_Index* had a positive relationship (*p*-value < 0.01) with all tests. To interpret, the healthier the children are in a municipality, the better they do in school. *Income\_Index* had a positive significant (*p*-value <0.01) relationship only with *Math\_4*.This means that students in municipalities with a higher the economic status, did better on the tests.

1. **CONCLUSION**

The main objective of this paper is to examine whether Brazil’s scarce public resources were being allocated in a coordinated manner during the period 2003-2009. The overall research question it attempts to answer is as follows: what are the relationships between quality of education, educational spending, and *BF* cash transfer? *Prova Brasil*, a national test administered by the Brazilian Ministry of Education, is used as a proxy for measuring quality of education. Higher average scores in *Prova Brasil* indicate better quality of education. *Fundef* data is used to measure public spending on education. The research question was answered using regressions that treated *Prova Brasil* scores as the dependent variable and *BF* and *Fundef* spending (along with numerous controls) as the independent variables. The results of the regression also allowed us to address the paper’s two research hypotheses: 1) municipalities with higher level of *BF* allocation also had lower scores in *Prova Brasil*; and 2) municipalities characterized by higher *Prova Brasil* scores also received higher government spending on elementary education. The first hypothesis is based on the fact that *BF* is increasing enrollment in public schools, but the public school system may not be able to provide resources needed to meet the needs of more students. The second hypothesis is based on the idea that higher government spending on education should result in better education performance.

Results indicated that the hypothesis about higher *BF* allocation coinciding with lower *Prova Brasil* average scores is validated just to the early elementary math education (Mathematics 4th grade) and to the Portuguese 8th grade education. The very small magnitude of the coefficients may indicate that the increasing enrollment in public schools caused by *BF* is not affecting average scores in a relevant manner. For instance, 1 percent increase in *BF* allocation per poor would increase in 0.014 percent the score in math 4th grade and in 0.002 percent the score of Portuguese 8th grade. Negative significant relationships (*p*-value < 0.01) existed between *BF\_poor* and *Math\_8* and *Port\_4*. For example, 1 percent increase in *BF* allocation per poor would decrease in 0.003 percent the score in Portuguese 4th grade and in 0.003 percent the score of math 8th grade. This may be due to the fact that municipalities’ skills to implement *BF* vary vastly, indicating that there is not a consistent municipal behavior with regards to *BF*.

When considering *Fundef*, the hypothesis about higher *Prova Brasil* scores should be receiving higher government spending on elementary education was supported. The investments in education are having some positive effects on student proficiency. For instance, a 1 percent increase in *Fundef* allocation would increase score in math 4th grade by 0.028 percent and in Portuguese 4th grade and 8th grade by 0.011 percent. Based on these findings, the hypothesis about higher *Prova Brasil* scores should be receiving higher government spending on elementary education was supported. Again, the magnitudes of the coefficients were very small, indicating that the returns to education that are expected from public spending are not yet very relevant for the Brazilian case. Again, the magnitudes of the coefficients were very small, indicating that the returns to education that are expected from public spending are not yet very relevant for the Brazilian case.

In general, these results may be related to difference in municipal performances in administering public spending. Some of the potential limitations of this study follow.  First, fixed effects approach may not account for endogeneity between BF allocation and/or public spending in education and unobserved variables. Second, understanding the positive relationship between test scores and child labor is difficult at the level of analysis utilized here. Future research should focus on using individual students as the unit of analysis instead of schools and shed some light on this issue. Unfortunately, current limitations on data availability precluded such an analysis.

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**APPENDIX**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table A.1: Descriptive statistics of independent variables (cont.)** | | | | | | | | |  | |  |  |
| **Variable** | **4th grade** | | | | **8th grade** | | |
| **Mean** | **Standard deviation** | **Min** | **Max** | **Mean** | **Standard deviation** | **Min** | | | **Max** | | |
| BF\_poor | 6.30 | 1.32 | -1.16 | 8.09 | 6.31 | 1.32 | -2.10 | | | 8.38 | | |
| Fundef\_d | 6.23 | 0.49 | -4.19 | 9.12 | 6.28 | 0.52 | -4.19 | | | 11.08 | | |
| Stud\_int | 0.13 | 0.13 | 0.00 | 0.86 | 0.17 | 0.16 | 0.00 | | | 0.91 | | |
| Stud\_wor | 0.15 | 0.08 | 0.00 | 0.76 | 0.19 | 0.10 | 0.00 | | | 1.00 | | |
| Mother\_edu | 0.81 | 0.12 | 0.00 | 1.00 | 0.82 | 0.12 | 0.00 | | | 1.00 | | |
| Sch\_comp | 0.33 | 0.47 | 0.00 | 1.00 | 0.60 | 0.49 | 0.00 | | | 1.00 | | |
| Sch\_lib | 0.34 | 0.47 | 0.00 | 1.00 | 0.45 | 0.50 | 0.00 | | | 1.00 | | |
| Stu\_class | 30.45 | 6.80 | 1.00 | 114.00 | 34.04 | 7.36 | 1.00 | | | 112.33 | | |
| Teach\_edu | 0.59 | 0.34 | 0.00 | 1.00 | 0.79 | 0.27 | 0.00 | | | 1.00 | | |
| GDP | 10428.13 | 11964.46 | 1124.07 | 389828.80 | 11905.57 | 12321.93 | 1124.07 | | | 389828.80 | | |
| Health\_Index | 0.69 | 0.12 | 0.03 | 0.96 | 0.71 | 0.13 | 0.03 | | | 0.99 | | |
| Income\_Index | 0.51 | 0.22 | 0.00 | 0.99 | 0.54 | 0.23 | 0.00 | | | 0.99 | | |
| Note: The number of observations to the pooled data (2005, 2007 and 2009) to the 4th grade is 26,499 and to the 8th grade is 22,638. | | | | |  |  |  | | |  | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table A.2. Results of natural log of average *Prova Brasil* scores estimated by Polled OLS** | | | | |
| **Dependent Variables** | (1) | (2) | (3) | (4) |
| Math\_4 | Port\_4 | Math\_8 | Port\_8 |
|  |  |  |  |  |
| lnBF\_poor | 0.018\*\*\* | -0.000 | -0.003\*\*\* | 0.005\*\*\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) |
| lnFundef\_d | -0.001 | -0.005\*\*\* | 0.002\*\*\* | 0.003\*\*\* |
|  | (0.001) | (0.001) | (0.001) | (0.001) |
| Stud\_int | 0.242\*\*\* | 0.245\*\*\* | 0.179\*\*\* | 0.171\*\*\* |
|  | (0.006) | (0.006) | (0.004) | (0.004) |
| Stud\_wor | -0.300\*\*\* | -0.348\*\*\* | -0.049\*\*\* | -0.121\*\*\* |
|  | (0.008) | (0.008) | (0.005) | (0.005) |
| Mother\_edu | 0.093\*\*\* | 0.129\*\*\* | 0.104\*\*\* | 0.110\*\*\* |
|  | (0.005) | (0.005) | (0.004) | (0.005) |
| Sch\_comp | 0.001 | -0.001 | -0.006\*\*\* | 0.004\*\*\* |
|  | (0.001) | (0.001) | (0.001) | (0.001) |
| Sch\_lib | 0.008\*\*\* | 0.012\*\*\* | 0.012\*\*\* | 0.011\*\*\* |
|  | (0.001) | (0.001) | (0.001) | (0.001) |
| aluno\_turma\_4 | -0.001\*\*\* | -0.001\*\*\* |  |  |
|  | (0.000) | (0.000) |  |  |
| Teach\_edu | 0.013\*\*\* | 0.008\*\*\* | 0.014\*\*\* | 0.016\*\*\* |
|  | (0.002) | (0.002) | (0.002) | (0.002) |
| GDP | -0.000\*\*\* | -0.000\*\*\* | -0.000\*\*\* | -0.000\*\*\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) |
| Health\_Index | 0.074\*\*\* | 0.063\*\*\* | 0.040\*\*\* | 0.065\*\*\* |
|  | (0.007) | (0.007) | (0.005) | (0.005) |
| Income\_Index | -0.021\*\*\* | -0.015\*\*\* | -0.035\*\*\* | -0.019\*\*\* |
|  | (0.003) | (0.003) | (0.003) | (0.003) |
| LAT | -0.003\*\*\* | -0.003\*\*\* | -0.001\*\*\* | -0.000\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) |
| LON | -0.001\*\*\* | -0.001\*\*\* | -0.001\*\*\* | -0.001\*\*\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) |
| aluno\_turma\_8 |  |  | -0.001\*\*\* | -0.001\*\*\* |
|  |  |  | (0.000) | (0.000) |
| Constant | 4.908\*\*\* | 4.960\*\*\* | 5.293\*\*\* | 5.167\*\*\* |
|  | (0.010) | (0.010) | (0.007) | (0.007) |
|  |  |  |  |  |
| Observations | 26,499 | 26,499 | 22,638 | 22,638 |
| R-squared | 0.502 | 0.482 | 0.410 | 0.457 |
| Robust standard errors in parentheses | | | | |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table A.3. Results of natural log of average*Prova Brasil* scores estimated by random effects panel data** | | | | | |
| **Variables** | (1) | (2) | (3) | (4) | (5) |
| Math\_4 | Port\_4 | Math\_8 | Math\_8 | Port\_8 |
|  |  |  |  |  |  |
| lnBF\_poor | 0.014\*\*\* | -0.004\*\*\* | -0.005\*\*\* | -0.005\*\*\* | 0.004\*\*\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| lnFundef\_d | 0.008\*\*\* | 0.001 | 0.004\*\*\* | 0.004\*\*\* | 0.006\*\*\* |
|  | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Stud\_int | 0.256\*\*\* | 0.242\*\*\* | 0.149\*\*\* | 0.149\*\*\* | 0.147\*\*\* |
|  | (0.006) | (0.006) | (0.003) | (0.003) | (0.004) |
| Stud\_wor | -0.260\*\*\* | -0.296\*\*\* | -0.053\*\*\* | -0.053\*\*\* | -0.133\*\*\* |
|  | (0.006) | (0.006) | (0.004) | (0.004) | (0.004) |
| Mother\_edu | 0.087\*\*\* | 0.114\*\*\* | 0.103\*\*\* | 0.103\*\*\* | 0.116\*\*\* |
|  | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| Sch\_comp | 0.010\*\*\* | 0.010\*\*\* | -0.002\*\* | -0.002\*\* | 0.009\*\*\* |
|  | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Sch\_lib | 0.003\*\*\* | 0.006\*\*\* | 0.000 | 0.000 | 0.008\*\*\* |
|  | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| aluno\_turma\_4 | -0.001\*\*\* | -0.001\*\*\* |  |  |  |
|  | (0.000) | (0.000) |  |  |  |
| Teach\_edu | 0.017\*\*\* | 0.016\*\*\* | 0.009\*\*\* | 0.009\*\*\* | 0.016\*\*\* |
|  | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| GDP | 0.000 | 0.000 | -0.000\* | -0.000\* | -0.000\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Health\_Index | 0.125\*\*\* | 0.115\*\*\* | 0.055\*\*\* | 0.055\*\*\* | 0.066\*\*\* |
|  | (0.006) | (0.006) | (0.005) | (0.005) | (0.005) |
| Income\_Index | -0.006\* | -0.006\* | -0.009\*\*\* | -0.009\*\*\* | -0.010\*\*\* |
|  | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| aluno\_turma\_8 |  |  | -0.000\*\*\* | -0.000\*\*\* | -0.000\*\*\* |
|  |  |  | (0.000) | (0.000) | (0.000) |
| Constant | 4.920\*\*\* | 4.988\*\*\* | 5.332\*\*\* | 5.332\*\*\* | 5.210\*\*\* |
|  | (0.010) | (0.010) | (0.007) | (0.007) | (0.007) |
|  |  |  |  |  |  |
| Observations | 26,499 | 26,499 | 22,638 | 22,638 | 22,638 |
| Number of ESCOLA\_CODIGO | 8,833 | 8,833 | 7,546 | 7,546 | 7,546 |
| Standard errors in parentheses | | | | | |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 | | | | | |

1. Assistant Professor, Federal University of Juiz de Fora, Department of Economics. [↑](#footnote-ref-2)
2. Associate Professor, Iowa State University, Department of Community and Regional Planning. [↑](#footnote-ref-3)
3. Master in Economics, Federal University of Juiz de Fora, Department of Economics. [↑](#footnote-ref-4)
4. The United Nations Educational, Scientific and Cultural Organization (UNESCO) index is a composite index, which includes four variables in its calculation: universal primary education, measured by the primary adjusted net enrolment ratio; adult literacy, measured by the literacy rate for those aged 15 and above; gender parity and equality, measured by the gender-specific EFA index, an average of the gender parity indexes of the primary and secondary gross enrollment ratios and the adult literacy rate; and quality of education, measured by the survival rate to grade 5. No EFA was available for 2009. [↑](#footnote-ref-5)
5. [↑](#footnote-ref-6)
6. The correlation matrix to Math\_8, Port\_4, and Port\_8 are available with the authors by request. [↑](#footnote-ref-7)
7. The full descriptive statistics, including all the independent variables considered in the regression, are presented in the appendix. [↑](#footnote-ref-8)
8. Natural logarithms were applied to the dependent variables and the independent variables of interest to allow for the measurement of elasticity. By doing that, it was possible to capture how a change of one percent in the independent variable would affect the dependent variable. [↑](#footnote-ref-9)
9. The dichotomy between poor and rich municipalities led us to explore another variable to measure public spending on education, FINBRA (*Finanças do Brasil, Secretaria Tesouro Nacional*) instead of the variable *Fundef*. Differently from *Fundef*, FINBRA data are reported by each municipality annually, including the educational share of their municipal budget. In other words, FINBRA data indicates the intention of spending in education and they represent a more disaggregated approach (school and municipality levels) with an education public spending variable that is actually measured. The estimation results for both specifications were consistently very similar, and they are available with the authors by request. [↑](#footnote-ref-10)