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School competition and performance indicators: evidence from the creation of federal education institutions in Brazil

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ABSTRACT

The expansion of the Federal Institute of Education is characterized as an exogenous source of competition in Brazil. This research studies the effect of the Federal Institutes' creation on the performance of the other public schools in the benefited municipalities. The methodological approach is the Propensity Score Matching combined with the generalized difference in differences method. The results show a significant and negative impact on the pass rate of students who remain in the state public educational system and a positive impact in the fail rate. The policy of expansion of the Federal Institutes may lead to a cream skimming process.

1. Introduction

The federated entities (Federal Government, States, Federal District and Municipalities) and the private sphere constitute the group of institutions responsible for the education offer in Brazil. Municipalities are responsible for much of the provision of early childhood education and elementary education, while secondary education is a priority of the States and the Federal District. In addition to providing higher education, the Federal Government has gained strength in the field of vocational education (propaedeutic and vocational secondary education), and the private sector offers education in all levels, but requiring the citizen's own investment. In 2017, the proportion of enrollments in the first year of high school corresponding to the state was 85 %, the private sector 11 %, the federal government 2.3 % and in the municipalities the magnitude is almost null.

More specifically, the federal primary school system has expanded its offer for high school, and this is due to the expansion project developed since 2003, which built 500 new teaching units in Brazilian municipalities up to 2016 (MEC, 2019). This expansion had an institutional framework in its second phase, starting on December 29, 2008, where, with Law 11,892, the Federal Institutes of Education, Science and Technology were established, with the creation of units distributed throughout Brazil (Gouveia, 2016; Otranto, 2010).

Federal Institutes (IFs) are linked to the Ministry of Education, and aim at promoting basic, vocational and higher education (BRASIL, 2008). Among the purposes of the law is the emphasis on local, regional and national socioeconomic development. However, according to Faveri et al. (2018) and Tavares (2012), one of the trajectories of IFs in Brazil was their use as a regular high school, preparatory for access to higher education, especially for middle-income youth and in regions where preparatory education for college entrance exams was scarce.

Federal education also stands out in quality. The Brazilian System of Assessment for Basic Education (Saeb) makes it possible to evaluate the quality of education in Brazil and its result in 2017 indicates that the federal sphere of education has the highest indicator, when it surpassed the average grade of Brazilian private education, 247.24 and 241.62 points, respectively (INEP, 2018). In the case of IFs, unlike the rest of the public basic education system, higher performing students are expected to fill the vacancies. The reason is because the IFs have objective selection criteria (exam), therefore, the vacancies are supposed to be filled by the students with the highest grades.

The expansion policy of the Federal Institutes represents an increase

Abbreviations: AATT, Average of the Average Treatment Effect on the Treated; ATT, Average Treatment Effect on the Treated; BF, Bolsa Família; ENEN, National High School Exam; Fundeb, Fund for the Maintenance and Development of Basic Education; GDD, Generalized Differences in Differences; GPD, Gross Domestic Product; IDEB, Basic Education Development Index; IFs, Federal Institutes; INEP, National Institute for Educational Studies and Research Anísio Teixeira; IPEA, Institute of Applied Economic Research; LPA, Local Productive Arrangements; MEC, Ministry of Education; PSM, Propensity Score Matching; Saeb, Brazilian System of Assessment for Basic Education

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in the possibility of school choice at the high school level and is characterized as an exogenous variation of competitiveness for the other schools: private and state schools that offer this level of education. Based on the idea of free market efficiency, proposed by Friedman (1962), the increasing choice between schools leads to increased competition, which makes schools more efficient and productive. As a result, in light of other competitive markets, it boosts student performance in order to attract the most students or maintain enrollments (HOXBY, 2003; AKYOL, 2016).

In education, this process of increasing choice, which increases competitiveness and boosts performance, is more complex due to the restricted opportunity of school choice amid social heterogeneities (Hanushek and Rivkin, 2003). According to MacLeod and Urquiola (2012), unlike the market, school productivity reflects student arrangement, and this effect is difficult to separate. Urquiola (2016) argues that this is mainly because the best schools keep the best students and school stratification increases.

The introduction of a source of school competition has different results in the literature and, as MacLeod and Urquiola (2012) point out, the results are more modest and mixed than expected. The positives are that the competition ends up pushing for better results as a whole and contributes to right use in the school inputs (Belfield and Levin, 2002; Garcia-Diaz et al., 2016; Greene and Kang, 2004). However, Akyol (2016); Bukowski and Kobus (2018); Dills (2005) and Epple and Romano (1998) conclude that the introduction of a new school expands the family decision to enroll the child, which may lead to the withdrawal of the best students (cream skimming effect), increase school inequalities and decrease school quality (Gajardo and Grau, 2019). According to Hastings et al. (2006), school preferences are heterogeneous in terms of families' socioeconomic status, as those students with a better background are more likely to enter higher quality schools.

The aim of this study is to identify the impact of the creation of IFs on the performance of other state public schools in municipalities benefited by the expansion policy. To this end, we analyze the performance of state high schools of the municipalities where an IF was created starting in 2010, when the second phase of expansion began to have units in operation, through the doubly robust econometric approach of Propensity Score Matching (PSM) integrated combined with the Generalized Differences in Differences (GDD) method. The proxies used to measure performance are: Pass, Fail, and Dropout rates, which represent school performance indicators[1] .

Thus, this article contributes to the discussion about the effects of increased school competition on school performance. Although much discussed in developed countries and in Chile, in Brazil there are few empirical studies, and when the subject is discussed it deals with private schools as the main source of increased choice of school. The impact of the creation of IFs is measured on the development of regions (municipalities), but there are no known studies that analyze them as a source of increased choice of school and, consequently, of competition. These results corroborate the design of educational policies aimed at increasing school choice, such as school voucher policies in Brazil.

The paper is divided into six sections, including this introduction. The second section presents a literature review of the effects of competition on schools, which provides support for the econometric modeling framework, which is presented below. The fourth section discusses the main research findings. A robustness analysis is presented in the fifth section. Finally, the concluding considerations are presented.

2. School competition

The availability of more schools increases the possibility of school choice and consequently generates competitive pressure from the market, which leads schools to seek better results (Becker, 1995; HOXBY, 2003). International literature on school choice indicates that it depends on factors such as: income, quality of school, safe, parental education and distance from the student's home to the educational institution (Burgess and Briggs, 2010; Chumacero et al., 2011; Dustan and Ngo, 2018; Hastings et al., 2006; HASTINGS and WEINSTEIN, 2007; Humble and Dixon, 2017; Koning and Van der Wiel, 2013; Mancebón-Torrubia and Ximénez-de-Embún, 2014; Nunes et al., 2015; Vega-Bayo and Mariel, 2015). In Brazil, Opice (2014), analyzing the choice of school in the state of São Paulo, found that the school quality is an important factor for the effect of student migration, being the best students who move.

Hoxby (2003) sought to understand three issues that increasing the possibility of school choice can generate: the impact on student performance, the productivity of public schools and the withdrawal of the best students. From the studies conducted in the United States and their different designs, the author noted that the competition had a positive effect on student and school performance, with no effect on the withdrawal of the best students, as policies provided underperforming students with a choice of school. Schools seek better results in order to keep their students, otherwise the most productive schools overlap with lower productivity schools. However, school competitiveness can lead to positive or negative outcomes in schools, the direction of impact depends on the design of public policies that raise competition

Recently, from an exogenous law for the creation of community schools in Poland, Bukowski and Kobus (2018) analyzed the impact of increased competition on urban public schools. The result is a negative and significant effect as easy access makes parents keep their children in community schools and public schools lose students. By losing these students, the amount of money received from the government decreases in public entities, because the resource is linked to the number of students in the school. Since the fixed cost is constant, the available resources become relatively smaller, making it difficult to maintain its performance.

MacLeod and Urquiola (2012) conducted a literature review to identify the effect of competition on school performance. Unlike what the free market educational approach proposes, improved results, school tests showed modest and mixed evidence. In this sense, Cremata and Raymond (2014) have studied the effect of Washington charter schools on improving other schools in the vicinity, and assume that the mixed results found in the literature do not take into account the quality of the schools. The greatest impact on performance is seen when the newly created school has the highest quality.

Belfield and Levin (2002) did a literature review in the United States to see how competition can improve educational quality. By revisiting studies that address academic outcomes (school tests) and other measures such as quality, access to higher education, and teacher pay and efficiency, the authors attributed positive albeit modest results to the effect of competition. Greene and Kang (2004) point out that competition between public and private schools in New York was positive for high school students, with an emphasis on continuing education and reducing dropout rates, which may reflect improved unobservable characteristics, ie not directly focused on student performance (on the demand side) and on efficiency and reduced costs (on the supply side).

The behavior of public schools and their performance with increasing competition is widely discussed from the perspective of school voucher policies. Epple and Romano (1998) developed a theoretical and computational model to understand the relationship of competition between public and private schools from the policy of school vouchers and the trigger on the peer effects. The voucher policy generates a

[1] The Brazilian System of Assessment for Basic Education (Saeb) is used on a recurring basis in works that seek to analyze the early grades (the test is applied to fifth graders) and the final grades (ninth graders) of elementary school. However, the application of this test and the socioeconomic questionnaire was only used in high school in 2017 (only year with available indicator, since Prova Brasil is applied every two years), making the analysis impossible and justifying the use of school performance rates.

movement of students from public to private schools. Students with lower incomes and skills remain in the public sector and are worse off as low-income and more skilled students migrate to the private sector, where their performance gains are higher. Similarly, according to Akyol (2016), a voucher policy tends to transfer the best students, a move called cream skimming. Dills (2005) states that students who remain in these schools suffer a loss of peer group quality, which aggravates the stratification of the educational system.

However, according to Walsh (2009), the peer effects do not show great magnitude. The author argues that schools already have homogeneous students: families with better financial capacity already send their children to higher quality schools. Those students characterized as having high academic performance represent a very small portion of the total students. The idea of magnitude is also present in the study by Epple and Romano (1998), as the voucher policy had little impact on low-income and underperforming students. However, the authors found that increased competitiveness characterized a positive change in ineffective public schools, which mitigates the negative peer effects.

In addition to this view, Dustan and Ngo (2018) used Mexico's expanding public transportation to see if school preferences change with ease of access to the best schools. The result was a change in the school choice of the best performing students with the most qualified parents, while the preferences of the underperforming students with parents with lower education levels did not change. In Spain, the benefit of public subsidies for attending private schools was also seen among higher-income and higher-skilled households (Mancebón-Torrubia and Ximénez-de-Embún, 2014). Moenjak and Worswick (2003) analyzed the choice of the normal and vocational secondary school in Thailand and found that individuals from families with higher socioeconomic status are more likely to enter a technical school in high school.

In Brazil, there is scarce literature on the influence of increased school competitiveness on school performance. Marques (2013) sought to verify the impact of the disclosure of the average grade of students in Enem (National High School Exam) on the performance of other schools. The author used a spatial approach, which considers a matrix of spatial distances between teaching units, and students' socioeconomic variables. The result found converged to a positive impact of increased competitiveness on the performance of other public schools. In the private sector, the disclosure of grades had no impact, which may be justified because schools in this sector already have high grades when compared to those in the public sector.

In seeking to understand the spatialities in the competitive process generated by the private schools of Salvador-BA, Moreira et al. (2016) point out that the resource allocation system in Brazil, by itself, does not contribute to the increase in the competitiveness of public schools, since resources are limited and their allocation is not based on productivity. The results indicated that the quality of neighboring schools has implications for the investments of other private schools. In this sense, according to Estevan (2009), the quality of the public school in Brazil is a relevant factor for parents to enroll their children in it.

In summary, there is no consensus in the literature on the impact of creating new schools on the performance of others. Specifically, the authors do not disagree that a higher quality level of the new school is an important determinant of the cream skimming effect and may generate more competition, while broadening the choice of school. This also meets the determinants of school choice, which mainly depends on the quality, distance and costs linked to the enrollment decision. In the case of this study, the creation of Federal Institutes generates another option for the choice, since they are known for their quality and gratuity. Moreover, it is an exogenous variation for the other schools, which minimizes the identification problems, very common in the empirical evidence. The next section explains the methodological strategy to meet the objective of the paper.

3. Methodological approach

Given the proposed context, the analysis is centered on identifying whether the school competition generated by the IFs - specifically for the period when the units were inaugurated, that is, from 2010 onwards - brought about changes in the performance of other students of the state school system. The methodological approach is designed based on the characteristics of the municipalities, which makes them eligible to have the policy implemented, based on the study of Faveri et al. (2018).

The criteria for the municipality to have a Federal Institute, according to the Ministry of Education (Brasil, 2011), are divided into three dimensions: social, geographical and development. The social aspect includes those municipalities with a high percentage of extreme poverty, more populous and with low per capita income. The geographical dimension determines priority for municipalities with more than 50,000 inhabitants or those belonging to microregions that are not covered. In the development sphere, municipalities with identified local productive arrangements (LPAs) and large-scale investments around them are required (Tavares, 2012).

Based on these characteristics, the first methodological strategy to be adopted is the Propensity Score Matching (PSM). The time frame of the analysis covers the period from 2007 to 2016, which has municipalities with IFs in operation starting in 2010. As there is no specific year for institutes to operate, the work presents different years of treatment among the benefited municipalities. Thus, the design characterizes the Generalized Differences in Differences (GDD) method, the second empirical strategy combined with PSM. Both models are formally presented in the next section.

3.1. Empirical strategy

The basis of the propensity score matching is to look for the most similar comparison pair, conditional on the probability of getting an IF given a set of observable characteristics and remove the problem of selection bias (Abadie and Imbens, 2002; Imbens and Wooldridge, 2009; Khandker et al., 2010; Rosenbaum and Rubin, 1983; Rubin and Thomas, 1996). This probability of getting an IF from observable characteristics can be defined according to Eq. 1.

$$P(X) = Pr[T = 1|X] \tag{1}$$

Since this probability represents all information contained in the observable characteristic vector (X), and the selection hypothesis in the observable is valid, the treatment can be conditioned to the propensity score (Eq. 2).

$$Y_i(0) \perp T_i | X_i = Y_i(0) \perp T_i | p(X_i) \tag{2}$$

Each municipality in the treatment group should have a pair that can reproduce what their outcome would be in the absence of an IF. The pair must belong to the common support and can be chosen from the designation by: nearest neighbor, caliper and radius, range stratification and matching, kernel matrix or local linear. The choice of pair can be done with or without replacement. In order to test that the comparison includes municipalities with the same observable characteristics, the means comparison test is performed. From the definition of the control group, it is possible to identify whether the installation of IFs modifies the performance of the other state schools of the beneficiary municipalities.

Therefore, in addition to the criteria for receiving the program, which makes it possible to perform the PSM, the study has characteristics of the period before the creation and after it, which allows the use of a differences in differences (DD) model. The DD consists of the calculation of a double difference of the means in the result variables. The first is the difference in the mean result over time (before and after the program) for the treated and control subjects and the second is the difference in the calculation between the groups (Angrist and Pischke, 2008). This result of subtractions is the impact of the program (Eq. 3).

$$\beta_{dd} = \{E[Y|T=1, t=1] - E[Y|T=1, t=0]\} - \{E[Y|T=0, t=1] - E[Y|T=0, t=0]\} \quad (3)$$

Where T assumes values equal to the unit when it represents the participation of the municipality in the program and zero when otherwise. t identifies whether the period is before (zero) or after (one) the program. β_{dd} is the mean effect of treatment on the treated (ATT), the structural function is represented by Eq. 4.

$$Y_{it} = X'_{it}\alpha + \rho t + \gamma T_i + \beta D_{t,T_i} + \varepsilon_{it} \quad (4)$$

Where Y_{it} is the result variable in the municipalities $i = 1,\ldots, n$ in the period $t = 2007, \ldots, 2016$. X'_{it} is a vector of control variables. t and T_i assume value one for any year after treatment and if the municipality belongs to the treaty group respectively. The interaction of these two terms is the coefficient of interest, β, which indicates the causal effect of the program.

Angrist and Pischke (2008) state that the differences in differences method allows time constant control and treatment groups to be compared, so time-varying differences cannot be eliminated. Thus, it is necessary to assume the assumption of Equality Trends or Parallel Trends. In the absence of treatment, the results of the two groups move together in time, that is, the time trend is assumed to be equal when there is no treatment.

However, the average treatment effect on the treated (ATT) is inappropriate when there are multiple time periods and multiple treatment initiation points. There must be an ATT for each period of time the unit can receive treatment and for each possible treatment path known as the generalized difference in differences method (Strezhnev, 2017). For the calculation of ATTs, the assumptions of non-reverse causality and consistency are assumed. Moreover, the assumption of parallel trends is analogous to that of the two-period DD, assumed for the entire time period.

With the generalized assumption of parallel trends, it becomes possible to add pretreatment periods. And in the posttreatment period, an average of the average treatment effect on the treated (AATT) is used. With a nonparametric estimator this equals two time periods. The two-way fixed effects model generates the same results as a nonparametric estimator. As pointed out by Angrist e Pischke (2008), the generalization of the saturated model (Eq. 4) allows the analysis for the adoption of a policy in different time periods and individuals. For the generalization dummies for each municipality and each year are included in the model (Eq. 5).

Using the DD method combined with PSM solves the problem of the need for identification of the posttreatment period in the control group. This is a major difficulty in a design with multiple periods of time and treatment. The strategy used was the PSM without replacement, which facilitates the identification of the ideal pair and provides for the inclusion of the posttreatment period identical to the treated municipality. Together, the two methods also require weaker hypotheses, ie, with the hypotheses of selection in the observables (conditional on the vector of characteristics that influence the municipality getting the Federal Institute) it is assumed that there are no unobservable characteristics that contribute to receiving the treatment and to the result. The unobservable time invariant characteristics are controlled by DD.

The next section explains the model design used in this study.

3.2. Empirical model

According to Belfield and Levin (2002), there are challenges in researching school competitiveness, including methodological ones, such as simultaneity and omitted-variable bias. Dee (1998) used a set of socioeconomic variables to approach the problem of omitted variables, such as parental education, the percentage of children who cannot speak the local language, the proportion of people vulnerable to poverty, the percentage of students in private schools, the percentage of non-white children, the percentage of families with high school, the percentage of families with higher education, the average household income and the size of the city. For the simultaneity or endogeneity problem, the author used a two-stage estimation.

For Hoxby (2003), the establishment of pretreatment trends is an important method to correct the selection bias problem. In this respect, with the selection criteria for getting an IF and the propensity score matching method, the hypothesis of endogeneity can be overcome. The IF expansion policy can be considered an exogenous variation in the competitive pressure on the other schools of each contemplated municipality. The expansion law was instituted in 2008, but the operation of the facilities occurred gradually starting in 2010. Eq. 5 represents the structural form of the model to be estimated.

$$Y_{it} = X'_{it}\alpha + EF_i + EF_t + \beta D_{t,T_i} + \varepsilon_{it} \quad (5)$$

Where Y_{it} represents the rate of passing, failing and dropping out of high school in each municipality for each year of analysis. X'_{it} the set of control variables for each municipality i in year t, based on Dee (1998), which are: per capita income, percentage of people with higher education, percentage of people with high school, percentage of children vulnerable to poverty, percentage of population aged zero to 18 years, Saeb grade from state schools for the second stage of primary education, percentage of people receiving Bolsa Família[2], proportion of private schools and a dummy variable with value one for municipalities with less than 50,000 inhabitants, and zero otherwise. EF_i and EF_t indicate fixed effects for the municipalities and for the year, respectively. β is the parameter of interest that reflects the long-term causal effect of the expansion policy of the Federal Institutes of Education. According to Angrist and Pischke (2008), in order to understand what happens to effects over time, whether they grow or disappear, an alternate specification (Eq. 6) can be used.

$$Y_{it} = X'_{it}\alpha + EF_i + EF_t + \sum_{\tau=0}^{m} \beta_{+\tau} D_{t+\tau,T_i} + \varepsilon_{it} \quad (6)$$

Where m periods - leads - ($\beta_0, \beta_{+1}, \ldots, \beta_m$) is the period of treatment and posttreatment, and includes the year of intervention, one year, two years and three or more years after the IF opened in the municipality. As the study also has data for three years before the intervention, it becomes possible to test for Granger causality. According to Angrist and Pischke (2008), it is a way of testing whether the cause occurs before the consequence, ie whether the IFs are causing the result of interest Y_{it}. Therefore, the parameter of interest in the period prior to adoption should not be significant in Eq. 7.

$$Y_{it} = X'_{it}\alpha + EF_i + EF_t + \beta D_{t,T_i} + \sum_{\tau=1}^{q} \beta_{-\tau} D_{t-\tau,T_i} + \varepsilon_{it} \quad (7)$$

Where q periods - lags - ($\beta_{-1}, \ldots, \beta_{-q}$) is the anticipated effect of the federal network expansion policy. For robustness checking, it is also possible to include specific time trends for the municipalities. This allows treatment and control municipalities to follow different trends to a limited extent. The idea of including the time trend is that treatment effects should not change (Eq. 8).

$$Y_{it} = X'_{it}\alpha + EF_i + EF_t + \beta D_{t,T_i} + \gamma_{0i} + \gamma_{1it} + \varepsilon_{it} \quad (8)$$

Where γ_{0i} is the specific intercept of municipalities and γ_{1it} is a municipality-specific trend coefficient multiplied by a time trend variable, t. Another way to assess robustness is through a placebo test, which uses a fake treatment group. In this case, one year prior to the policy implementation. The impact on the differences in differences model for this group must be null.

Eq. 5 is also calculated for the pass, fail, and dropout rates of private schools in the affected municipalities. Besides contributing to the understanding of the impact of creating a Federal Institute, this specification designs a robustness test, considering that the effect found can be different between the Private and Public spheres and, thus, proving that

[2] Brazilian Federal Government Income Transfer Program.

Table 1
Difference of means test for the variables used between treatment and control municipalities (2010).

Variables	Before the Matching				After the Matching			
	Treatm.	Cntrl.	Diff.	S. E.	Treatm.	Cntrl.	Diff.	S. E.
Natural Logarithm of Total Population	10.97	9.22	−1.74***	0.05	10.93	10.88	−0.04	0.07
Human Development Index (HDI)	0.69	0.65	−0.03***	0.00	0.69	0.69	0.00	0.00
Income Concentration Index – GINI	0.51	0.49	−0.02***	0.00	0.51	0.51	−0.00	0.00
Percentage of population in extreme poverty	8.94 %	11.67 %	2.73***	0.70	9.03%	8.32 %	−0.70	0.80
Percentage of women in total population	0.49 %	0.51 %	0.01***	0.00	0.49 %	0.49 %	0.00	0.00
School attendance rate of 4 and 5 year olds	77.79 %	78.35 %	0.56	0.92	77.88%	77.12 %	−0.76	1.16
Pass Rate	74.04 %	79.78 %	5.74***	0.57	74.12 %	74.34 %	0.21	0.72
Fail Rate	12.12 %	8.89 %	−3.22***	0.39	12.05%	12.66 %	0.61	0.54
Dropout Rate	13.82 %	11.31 %	−2.51***	0.44	13.81%	12.98 %	−0.83	0.56
Number of Observations	301	4910			296	296		

Notes: 1. The null hypothesis of the difference of means test is H_0: *Difference* = 0, *** represents that with 99 % confidence the means between the groups are different. 2. Treatm. = treated municipalities. Cntrl. = untreated municipalities. Diff. = difference of means. S. E. = Standard Error.

the impact presented is not random.

As the responsibility of public high school is primarily the responsibility of states and each may adopt different educational policies, a specification with fixed effects by state was also used.

3.3. Source and database

The Federal Institutes analyzed in this study, as previously explained, started to operate in 2010. Data on the units of the Federal Network, address data and year of operation were collected in the portal of the Ministry of Education (MEC, 2016). However, it should be noted that the municipalities that already had a federal technical school, and with the policy were called IFs, were excluded from the analysis, leaving 301 municipalities that got IFs in the sample (Appendix A). The variables used to calculate the probability of getting the IF were extracted from the Atlas of Human Development in Brazil, which matches the Demographic Census data. Table 1 shows the mean differences in the treated and control groups before and after the matching.

The control group, before the matching, has a different mean than the treatment group, because the null hypothesis of equality of means was rejected. After the matching the means of the two groups are very close and the null hypothesis of equal means was not rejected for either variable. This generates an adjustment of observable characteristics between treated and control municipalities. The number of observations between the treatment group before and after the matching decreased in five municipalities, which were not within common support.

The variables of interest (dependent): pass, fail and dropout rates are extracted from the Educational Indicators database of the National Institute for Educational Studies and Research Anísio Teixeira (INEP) and refer to the average rate of state high schools in the municipality of interest. These flow indicators are a proxy for measuring performance because, in the case of high school, the index of development of basic education (IDEB) was calculated only in 2017, when it adopted the Saeb grade for this education level. The IDEB grade is consists of the average of the school performance in the exams applied by INEP and the pass rate (which indicates the school performance).

In order to do the matching, the criteria for getting the IF must be respected. The main characteristics for a municipality to get a Federal Institute Campus is to have more than 50,000 inhabitants or to have a high percentage of people in extreme poverty. Using data from the Atlas of Human Development in Brazil, these criteria were extracted for the municipalities covered by the program and are presented in Fig. 1.

In general, the municipalities with the smallest number of inhabitants have more people in extreme poverty. One of the two main criteria is met when choosing the treated municipality. Thus, the standard protocol is followed, and minimizes the possibility of sample endogeneity. In addition to the variables used in the PSM, in the generalized differences in differences model there is a set of control variables, which have influence on student performance. Table 2 presents a descriptive summary of these variables.

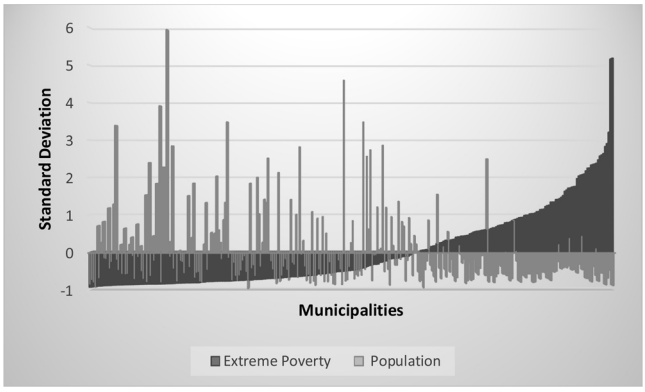

Fig. 1. Municipal population and proportion of people in extreme poverty, standardized for 2010, of municipalities that have had IFs in operation starting that year in Brazil.

The Saeb grade of the second stage of elementary school (6th to 9th grade) of state schools and the proportion of private schools in the municipality are found in Inep's statistical database. The Saeb is held every two years, so the grade in the year it takes place corresponds to the data for the next two years. For example, the 2007 grade was used for 2008 and 2009, when the information is already available to the school community.

The percentage of children and youth in the population, educational indicators (percentage of people with high school and higher education) and vulnerability to poverty are census variables, their availability is restricted to the years 2000 and 2010. Data distribution followed two criteria: the years until 2010 assumed the values disclosed by the 2000 Demographic Census; from 2010 onwards, the data refer to the 2010 Demographic Census.

The population living in the municipality was extracted from the Datasus database (TABNET) of the Ministry of Health, specifically from the municipal population estimate. In this case, if the municipality has less than 50,000 inhabitants, it assumes value one, and zero if otherwise. The Gross Domestic Product (GDP) and the number of families benefited by the Bolsa Família (BF) program were extracted from the database of the Institute of Applied Economic Research (IPEA), weighted by total population and total families in the municipality, respectively. Proper understanding of the ratios of performance indicators and the impact of the IF expansion program is discussed in the next section.

Table 2
Statistical summary for the 592 Brazilian municipalities in the sample (control and treatment group).

Variables	Mean	Minimum	Maximum
Saeb Grade from state schools for the second stage of primary education	4.61 (0.53)*	2.82	7.44
Percentage of population aged 0–17 years**	35.60 % (0.06)	20.73 %	56.26 %
Percentage of people aged 25 and over who have finished high school	25.35 % (10.78)	2.38 %	60.61 %
Percentage of people aged 25 and over who have finished undergraduate school	6.52 % (4.49)	0	31.19%
Percentage of children vulnerable to poverty	56.78 % (22.60)	7.21 %	98.4 %
Percentage of cities with less than 50,000 inhabitants	46.57 % (0.49)	0	1
Municipality GDP per capita**	R$ 24,355.40 (24,144.90)	R$ 381.01	R$ 380,828.60
Proportion of private schools	27.86 % (18.79)	0	83%
Percentage of families receiving Bolsa Familia	29.79 % (19.45)	2%	88.17 %

Notes: * Standard deviation. **Variable in Natural Logarithm.

Table 3
The impact of the establishment of Federal Institutes (IFs) on the performance of other state public schools of the municipalities (Eq. 5).

Variables	Pass			Fail			Dropout		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
β	−1.73***	−1.18***	−1.44***	1.41***	1.17***	1.26***	0.31	0.01	0.18
	(0.31)	(0.35)	(0.30)	(0.27)	(0.28)	(0.27)	(0.24)	(0.24)	(0.24)
Private school		−2.07***	1.85		1.68***	−0.57		0.38	−128
		(0.66)	(1.29)		(0.54)	(1.19)		(0.49)	(1.08)
Saeb grade		1.97***	2.82***		−032	−1.23***		−1.64***	−1.59***
		(0.27)	(0.37)		(0.21)	(0.29)		(0.18)	(0.28)
Log population aged 0–17 years		−5.09***	21.27***		1.51	11.61**		3.57***	−32.88***
		(1.35)	(6.68)		(1.17)	(5.28)		(0.99)	(4.90)
% of population with high school degree		−0.10***	0.19***		0.11***	−0.18***		−0.00	−001
		(0.02)	(0.05)		(0.01)	(0.04)		(0.01)	(0.04)
% of population with higher education degree		0.11***	−0.83***		−0.06*	0.14*		−004	0.68***
		(0.04)	(0.08)		(0.03)	(0.07)		(0.03)	(0.06)
% of Vulnerable Children		0.02	−0.00		−0.00	−0.05***		−0.03***	0.06***
		(0.01)	(0.02)		(0.01)	(0.02)		(0.01)	(0.01)
Municipality with less than 50,000 inhabitants		1.81***	0.49		−1.08***	0.20		−0.73***	−070
		(0.23)	(1.00)		(0.18)	(1.08)		(0.16)	(0.61)
Log GDP per capita		−0.64***	0.48		0.43***	0.78		0.20*	−1.26***
		(0.14)	(0.57)		(0.12)	(0.58)		(0.11)	(0.45)
Percentage of families with BF		1147***	−0.94*		−3.61***	354**		−7.85***	−0.59
		(1.59)	(1.69)		(1.15)	(1.61)		(1.24)	(1.47)
Constant	72.77***	56.74***	80.14***	11.94***	12.89***	31.96***	15.27***	29.98***	−12.11**
	(0.28)	(2.39)	(7.54)	(0.25)	(1.93)	(6.02)	(0.24)	(1.73)	(5.56)
Fixed Effect Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect Municipality	Yes		Yes	Yes		Yes	Yes		Yes
Fixed Effect State		Yes			Yes			Yes	
R^2	69.04	46.38	70.08	55.53	33.39	55.94	64.45	51.44	65.97

Notes: 1. *, ** and *** represent confidence of 90 %, 95 % and 99 % respectively. 2. Considering robust standard errors. 3. In (C) the effect of belonging to a particular state is estimated and affects the total residual sum of squares.

4. Results and discussion

The first step in the analysis was doing the matching in order to compare municipalities with closest observable characteristics. The results are found in Appendices Fig. A.1 and Table A.2. The impact of the Federal Institute on Pass, Failure, and Dropout rates from the state public school system is presented in Table 3. For each dependent variable three specifications are estimated: (a) without control variables, only the program's impact; (b) with control variables and the fixed effects by state; and (c) with control variables.

The effect of the creation of IFs on pass and fail rates was statistically significant, but for the dropout rate it had no impact. The increased competition generated by the greater choice, which the IFs represent in the municipalities make the other public school students worse off. The creation of the Federal Institute generates an increase in the fail rate and a reduction in the pass rate for any specification adopted. This is to say that the effect of competition has a negative impact on performance indicators and does not affect the movement indicator (dropout).

By analyzing the program design, as recommended by Hoxby (2003), it is possible to identify that IFs select the best students, because their selection is objective and they provide free and good education. Adoption of a quota policy[3] allocates half of the vacancies to students from public schools. Quotas allow lower income and lower quality students, when compared to private sector students, to enter the federal education system. However, it should be noted that the quotas still select the best students from the benefited group, the students with the highest performance in the selection test. Figure A.2 shows that more than 50 % of students entering IFs come from public (state and municipal) schools. And the withdrawal of the best performing peers has a negative effect on those who remain in the state public system.

Epple and Romano (1998) corroborate this result, while identifying

[3] "Under Law Law No. 12,711 of August 2012, the Federal Educational Institutions started to reserve at least 50% percent of their places for students of public schools. Of these, 50% should be reserved for students from families with an income of at least one and a half minimum wages per capita. In the case of entering high school, in order to apply for places reserved for students from public schools, the candidate must have completed elementary school in the public school system."

Table 4
Impact of the establishment of Federal Institutes (IFs) on the performance of other state public schools in the municipalities for the 2007-2009 placebo period (Eq. 5).

Variables	Pass			Fail			Dropout		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
β	−0.45	−0.46	−0.44	0.30	0.29	0.25	0.14	0.16	0.18
	(0.45)	(0.67)	(0.44)	(0.41)	(0.50)	(0.40)	(0.37)	(0.48)	(0.37)
Constant	72.77***	60.83***	24.93	11.94***	8.98***	17.35	15.44***	30.18***	57.70**
	(0.21)	(4.84)	(38.51)	(0.20)	(3.42)	(31.26)	(0.17)	(3.52)	(29.34)
Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Fixed Effect Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect Municipality	Yes		Yes	Yes		Yes	Yes		Yes
Fixed Effect State		Yes			Yes			Yes	
R^2	74.55	42.33	74.64	61.11	39.29	61.58	74.60	53.52	74.82

Note: 1. *, ** and *** represent confidence of 90 %, 95 % and 99 % respectively. Considering robust standard errors.

that it is the students with lower incomes and skills who remain in the public sector, and their situation tends to worsen. Peer effects - the influence of one student over another - and the process of withdrawing the best students (cream skimming) are also discussed in Akyol (2016) and Dills (2005). The quality of Federal Education Institutions is another determinant feature in school choice. Cremata and Raymond (2014) argue that the quality of the new choice is an important factor for increasing competitiveness.

The idea that schools already have homogeneous students and the withdrawal of some students does not reflect on others, as pointed out by Walsh (2009), cannot be visualized for the expansion policy of the Federal Institutes. This is because Federal Institutes are present in the range of public opportunities, without incurring direct costs (tuition), and they can get the best students from state public schools. However, income may be indirectly associated with the best grades in the selective tests, since students from private schools also compete for vacancies in the free competition system. According to Faveri et al. (2018) and Tavares (2012), IFs are filled with many students who wish to pursue a quality high school, not just for technical training purposes.

The issue of financial resources, pointed out by Bukowski e Kobus (2018), becomes relevant when resources are passed on to schools according to the number of students. In Brazil, one of the criteria for the resource distribution from the Fund for the Maintenance and Development of Basic Education (Fundeb) is based on the number of students (60 % of the resource is invested in teachers' salaries and the remainder distributed among the municipalities according to the number of students). According to Moreira et al. (2016), the low response to increased competitiveness in the Brazilian education system is due to limited resource availability and lack of distribution according to school productivity. Similarly, from the teacher's point of view, there are no incentives for student retention, as the salary presents no variation. In addition, when municipalities lose students and consequently receive less resources from Fundeb, the municipality itself, via the Municipal Participation Fund (FPM) and the State Participation Fund (FPE), may grant free investment in education.

The causal effect of the federal primary school expansion policy on the dropout rate was not statistically significant. This result may correspond to the effort to keep the student enrolled and attending classes, as the National Education Guidelines and Framework (LDB) Law aims to prevent and review school dropout. Schools should inform parents or guardians when a student is absent or, in more frequent cases of the student not attending school, the information should be passed on to the Guardianship Council.

Control variables are socioeconomic characteristics that imply student performance. When introduced to the model, they generate a minor variation in the β coefficient, which represents the policy impact, but their statistical significance remains valid. In terms of marginal variation (Appendix Table A.3), the introduction of an IF in the municipality can reduce the pass rate by about 0.63 to 0.88 percentage points (on a scale from 0 to 100). The fail rate increases by about 0.50 to 0.75 percentage points.

The average Saeb grade in the municipality refers to the students of elementary school and controls the characteristics intrinsic to the school's students, that is, it is a way to control the student background. The higher the Saeb grade in municipal state schools, the higher the pass rate and, conversely, the dropout and fail rates. The presence of private schools negatively affects the pass rate and positively affects the fail rate. This may reveal that the IF is just another form of competition that leaves students in the state public sphere worse off.

The causal effect of the program, measured by parameter β, represents the long-term effect, the variation in the years after the establishment of the IF is not visualized. With the estimation of Eq. 6, presented in Appendix Table A.4, it can be inferred that there is no effect of the establishment of Federal Institutes in the short term for municipalities' pass and fail rates. The performance rates of the first three years after the establishment of an IF still reflect pre-policy cohorts (period when the municipality had not yet received treatment). Performance with only post-policy cohorts will be observed three years after the establishment, time for the student to go through the first, second, and third year of high school, as indicators are an average of three years. This fact corroborates the long-term effect found.

The robustness tests are presented in the next section.

5. Robustness checks

In order to check whether the program effect found in the previous section is not random, that is, to determine whether the causal effect is not a coincidence, the model was applied to a placebo group. From 2007–2009, IFs were not operating in the municipalities, so 2009 was falsified as a treaty. Results are presented in Table 4.

As expected, the causal effect parameter, β, is not significant. When including a time trend, the negative impact on the pass rate is still maintained (Appendix Table A.5). In specifying lags for pre-policy years (Appendix Table A.6), the causal effect was not significant for two and three years before the intervention. This result corroborates the robustness of the found effect, however, it is not possible to rule out that students miss a year of high school to attend it in an IF. The indicator of age-grade distortion, calculated by Inep, shows that the institutes have a larger range of students with more than two years of school delay, when compared to the state public system. Another hypothesis is that, in order to prepare their children for the selection process of the institutes, parents may allocate their children to better quality schools in the year prior to the opening of the IF.

For private school performance rates (Table 5), IFs have no significant effect. Thus, as a whole, it is possible to verify that the causal effect found is robust.

The increase in school competitiveness generated by the choice for IFs had no significant impact on the private high school system. This result may be linked, according to Moreira et al. (2016), to the increased resources invested in private schools when there is competition,

Table 5
Estimated results from the specification of Eq. 5 for the Pass, Fail and Dropout rates for Private Schools of municipalities benefited by IFs.

Variables	Pass			Fail			Dropout		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
β	−0.07	−0.01	−0.03	0.05	0.09	0.01	0.01	−008	0.01
	(0.19)	(0.21)	(0.19)	(0.17)	(0.19)	(0.17)	(0.08)	(0.08)	(0.07)
Constant	94.36***	92.66***	99.16***	4.95***	6.12***	2.66	0.65***	1.21**	1.82
	(0.16)	(1.44)	(5.06)	(0.15)	(1.34)	(4.49)	(0.06)	(0.54)	(2.56)
Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Fixed Effect Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect Municipality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect State									
R^2	40.83	16.18	41.32	43.77	16.17	44.38	18.74	7.57	18.22

Notes: 1. *, ** and *** represent confidence of 90 %, 95 % and 99 % respectively. 2. Considering robust standard errors. 3. In (C) the effect of belonging to a particular state is estimated and affects the total residual sum of squares.

which represents action strategies to improve and maintain their student base, which is limited in the public sector. On the other hand, it is not possible to identify how IFs alter the family's school choice at the time of enrolling their children, as it may differ between the socioeconomic and demographic characteristics of the municipalities. Thus, within the range of family choices, IFs may not represent an alternative for those seeking a private school.

6. Conclusions

The increased competition approach in most economic studies is treated as beneficial to the efficiency and performance of the sectors. In the literature of economics of education there are questions about its results. This study seeks to take advantage of the exogenous change in the increased competition generated by the establishment of the Federal Institutes of Education, Science and Technology to verify its effects on the performance of other state public schools in high school.

The criteria for a municipality to get a federal vocational education network expansion policy made it possible to identify a comparison group similar to the group of municipalities treated in terms of observable characteristics. The combination of municipalities, through propensity score matching, did not reject that the attributes have equal means between the two groups. This leads to the weakening of the possibility of endogeneity and its coupling to the generalized differences in differences method allows the identification of the policy's causal effect.

The impact of the increased choice, which generates competition for students in the Brazilian municipalities that got the IFs, did not imply a positive performance of students who remain in the state public education system. The creation of the Institute leads to an increased fail rate and a lower pass rate. The policy has no significant impact for the dropout rate. This indicates that students who remain in the state education system are harmed by peer effects. This scenario also goes back to what the literature calls cream skimming, that is, the withdrawal of the best students makes the other state public schools worse off.

However, it is important to study the Brazilian case and its specificities, since the stratification of schools tends to increase when the options expand and, consequently, generates socioeconomic inequalities. This suggests that there must be caution in designing educational policies that promote increased school choice, such as school voucher policies. Thus, three central questions arise: How much can public schools improve and increase their efficiency with competition? Are there any costs for lowering the pass rate and increasing fail rates for state schools? What is the impact of peer effects on a long-term perspective for these students?

This work contributes to the literature on the subject, which is little discussed in Brazil. Moreover, it contributes to: the comparison of results from very close municipalities in observable characteristics, the analysis from a period of time before and after the implementation of the policy, the exact year that the IF started operating in the municipality (the other Brazilian studies use 2008 as the year of treatment) and the various robustness tests used. However, one of the limitations of the study is that the bidirectional model applied to policies with treatment and time variations have different weights in the parameter of interest, which may change the size of the coefficient.

Furthermore, the results indicate negative effects on students who remain in the state public school system, although in terms of coefficient, the impact is small. In this sense, the coefficient may be underestimated due to the displacement of students from untreated municipalities to treated ones, although the proportion of students from other municipalities is less common (data from the School Census show that more than half of the students from the federal school system live in the municipality itself). Another factor that may explain the low magnitude of the coefficient is the adoption of a state school improvement strategy, since as the effect is long term, it is not possible to know how these schools reacted to the establishment of IFs. On the other hand, the problem may not only be linked to the expansion of competition, but also because the Brazilian education system has difficulties and cannot react positively to these circumstances.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ijedudev.2020.102211.

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