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The Dynamics Of Public High School Student Performance In Ceará: A Study Of The Case Of Sobral In Brazil

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Abstract:
Background*: The consolidation of studies on education for the economic development of a nation in recent years has aroused growing concern among public authorities regarding the provision of quality education, especially considering the investments and policies adopted in public budgets. Thus, this article evaluates the impact of educational policies implemented between 2009 and 2019 on the quality of secondary education in the municipality of Sobral state of Ceará in Brazil.*
Materials and Methods*: The synthetic control method was used, which allows estimating the performance of a treated unit in the absence of treatment.*
Results*: The results demonstrated that after the maturation of the educational policy in elementary education in Sobral, there was an effective improvement in the quality of Secondary Education, obtaining more significant results in the areas of mathematics and its technologies and natural sciences*
Conclusion: *Sobral's educational policies positively impacted high school students, particularly in exact and natural sciences. These practices, requiring no significant investment, could serve as a model for other municipalities. Despite Sobral's economic status, its students achieved high ENEM performance rates, indicating the long-term benefits of these early policies.*
Keyword: *Educational politics; Synthetic Control; Investment in education; Enem.*

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I. Introduction

The academic economics literature discusses the construction of policies to promote education. In this context, there is evidence that the higher the spending on education, the positive the returns on student performance, although research shows that increases in spending cannot always be justified by better quality in education (Monteiro, 2015; Galvão, 2016; Menezes-Filho *et al. (*2009). Oliveira (2013), on the other hand, states that implementation, justification, ongoing policies, control, and monitoring are correlated with quality in education.

In Brazil, there are several mechanisms for calculating the proficiency of public and private school students, as well as an international assessment indicator, which are scores on standardized exams obtained by students at the end of a certain stage of the education system.

The Program for International Student Assessment (PISA) is a comparative study test that is administered every three years by the Organization for Economic Cooperation and Development (OECD) to 15-year-old students. The exam lasts two hours and consists of answering questions in the fields of science, literature, and mathematics, as well as collaborative problem-solving.

The results of these assessments allow each country to evaluate knowledge and skills in comparison to those of other countries, which is fundamental for analyzing the policies applied elsewhere and formulating them with a view to improving the quality and equity of education. A study carried out by Sassaki *et al.* (2018) analyzes the results of the test taken in 2015, and the results show a sharp reduction in performance throughout the test, where one of the main reasons is mainly due to the lack of skill and knowledge to solve the test (divided into two periods) that spend a lot of time answering the initial questions and are unable to complete all the questions, being related to the cognitive abilities of Brazilian students.

The last edition of the PISA test in Brazil was held in 2018, and the results were made available the following year. In this test, Brazil has had stagnant average results since 2009, lower than the OECD countries.

The Brazil test consists of a census evaluation of public schools nationwide, which aims to assess the quality of teaching and can detect inequalities within and between schools. If there are distortions, the authorities define actions and direct resources to correct and improve teaching. For logistical and cost reasons, this test does not cover all schools and students, and participation is not compulsory. Held every two years (odd-numbered years) since 2005, it consists of standardized tests in (Portuguese language - reading, and mathematics), and is taken by students in the 5th and 9th grades of elementary school in schools nationwide with 20 or more students in the grades tested.

A study by Alves and Ferrão (2019) analyzed a decade of evolution in the performance of the Prove Brazil from 2007 to 2017. In general, they found that the results show a continuous improvement in both indicators. The authors show that in 2017, in the 5th grade, students reached 57% of the adequate level in reading and 45% in mathematics, while in the 9th grade, the percentages were 35% and 16%, respectively. A decade ago, these values differed significantly: in 2007, in the 5th grade, 25% reached the level in reading and 21% in mathematics, and in the 9th grade, the values were 16% and 9%, respectively.

The Basic Education Evaluation System (SAEB) is a set of external evaluations that allow the National Institute for Studies and Research (INEP) to produce a diagnostic report on basic education and the factors that can interfere with student performance. In this way, the SAEB provides input for drawing up, controlling, and improving educational policies. The SAEB has two purposes: the first is to obtain results on the quality of teaching over time, and also to identify the factors that contribute to these results; the second purpose is to monitor the progress made by the programs and policies implemented through the targets set (Rodrigues, 2006).

In 2018, the MEC decided to unify the Prove Brazil and Prove SAEB and renamed them the SAEB exams, as well as changing the application calendar. The National High School Exam (ENEM) was instituted in 1998 to assess students who had completed Brazilian basic education or high school. As the exam improved, it came to be used as a gateway to higher education in Brazil.

The Basic Education Development Index (IDEB), created by INEP in 2007, was formulated to measure the quality of learning at the national level and to set targets for improving Brazilian education. The IDEB is calculated using two components: the pass rate and the average performance in the INEP exams, with the pass rate being obtained through annual censuses.

In general, when analyzing Brazilian educational indicators for public schools, the results are well below average compared to other countries in terms of international educational indicators, given the high spending on education. There are, however, municipalities in poor states that have been standing out, such as the municipality of Sobral in Ceará, located 138 km from the capital (Fortaleza), with an estimated population in 2021 of 212,437 inhabitants and an average income of 2.1 minimum wages for formal workers (IBGE, 2022).

According to the study carried out by Oliveira (2013), just over ten years ago, Sobral showed regular results and became a benchmark in the Prove Brazil, a national standardized test. Sobral also began to show the best results in the IDEB for the initial years of elementary school without significant increases in spending per pupil.

In Brazil, there is a public indicator measured every two years that analyzes and compares how each municipality, state, federal district and the entire country is supporting the educational success of Brazilians. It is developed by looking at the relationship between existing inputs in education: teacher education, number of teaching hours per day, experience of principals, and the rate of attendance in early childhood education; and educational results: IDEB and net enrollment rate in secondary education, as well as the variable that measures parental education. This indicator is known as the Brazilian Education Opportunities Index (IOEB).

IOEB 2021 was calculated based on data from IBGE 2010, the 2019 School Census, and Saeb 2019. In the IOEB 2021 *ranking*, Ceará represents second place in the country with an average of 5.5, behind only the state of São Paulo, whose average is 5.7. An important analysis of the data from this index shows that of the 20 municipalities with the highest scores, 18 of them are in Ceará territory: Sobral, Cruz, Milhã, Ararendá, Itatira, Jijoca de Jericoacoara, Pires Ferreira, Martinópole, Quixeramobim, Catunda, Uruoca, Mucambo, Deputado Irapuan Pinheiro, Barroquinha, Ipaporanga, Meruoca, Cariré and Forquilha. Sobral has seen its IOEB averages rise. In 2015, the average was 6.1; in 2017 the average rose by just 0.1; i 2019, Sobral's average rose to 6.6; and in 2021, the last year of the survey, the average rose to 6.7.

According to Rocha, Menezes-Filho and Komatsu (2018), the educational policies adopted in Sobral showed significant results in the initial grades of elementary school. However, the results pointed to persistent problems in the final years of the same level of education. Thus, there is a lack of studies that can assess whether, more than a decade after the adoption of these educational policies, the positive effects appear in secondary education, notably in the performance of students on the ENEM.

In this context, the general objective of this work is to evaluate the impact of educational policies adopted between 2009 and 2019 on the quality of secondary education in the municipality of Sobral, in the state of

Ceará. Specifically, the synthetic control method is applied to compare the performance of secondary school students in Sobral with other similar municipalities in the state of Ceará. In addition, the possible differences in the performance ofhigh school students on the ENEM between Sobral, the municipality treated, and the control group are highlighted.

In addition to this introduction, this article has four sections. The second section is dedicated to the theoretical foundations of the research. Section three presents the methodological procedure adopted in the study. Sections four and five deal with the article's results and final considerations, respectively.

II. Theoretical Framework

Educational Production Function

One of the pioneers in the study of education was sociologist James Coleman, who conducted a study of American schools that received students of different races, promoted by the US *Office of Education* in the 1960s. The study sought to analyze social interventions as a way of reducing racial inequalities in student learning. However, the results obtained were contrary to what was expected, leading to the conclusion that differences in school resources were not as relevant in explaining inequality as the socioeconomic factors of the students. This finding paved the way for other authors to prove this important discovery in thefield of education (Vernier *et al.*, 2013).

Academic literature generally uses statistical techniques, commonly some form of regression analysis, to isolate the effects of different *inputs* and estimate the magnitude and/or significance of any relationships. Production functions are conceptual constructs used by economists in the analysis of companies' resource allocation decisions, aimed at maximizing profits. These production functions establish a relationship between educational *inputs* and educational *outputs.* However, the discrepancy between the conceptual model and the estimatedempirical models implies that the interpretation of empirical results often requires a series of implicit assumptions (Hanushek, 1987).

For Luz (2006), the educational production function examines the productivity relationship between inputs and the final product, in this case the inputs that affect school performance and student proficiency, respectively. In the literature on the determinants of school performance, researchers use this analogy to understand the technology of combining school and family inputs so that the educational result is maximized (Todd; Wolpin, 2003). Theproduction function is given by equation (1).

$$Y = f(A, F, E) + \varepsilon \quad (1)$$

Where Y represents the student's school performance, which is a function of three distinct groups of factors associated with school performance: A: individual characteristics of the student; F: family characteristics; and E, school characteristics.

The complete determination of the production function is made difficult by the absence of complete information on the inputs that students have had over the years. Depending on the research, only results from the current year are extracted, and there is a lack of data determiningtheir past conditions. Todd and Wopin (2003) present two specifications to overcome the lack of retroactive information. These are the contemporary models and value-added.

The contemporary model follows in principle the equation presented above, except forthe addition of the factors referring to past inputs in the error term, as shown in equation (2).

$$Y_{ijs} = y_s (E_{ijs}, F_{ijs}) + \varepsilon_{js} \quad (2)$$

Where: Y_{ijs} represents the income of pupil *i*, from household *j*, from grade *s*, F_{ijs} are the inputsfrom the same pupil's family; E_{ijs} are the educational inputs and ε_{js} is the term that designates the residual error that includes all the omitted variables - past inputs and mental capacity to acquire knowledge.

This model considers that the effect on the student's cognitive ability does not change over time, so the estimated parameters absorb a kind of accumulated effect of the inputs on the student's performance. In this model, the following hypotheses are imposed: i) only contemporary inputs play a role in determining contemporary performance; ii) the effects of inputs do not change over time, so current inputs measure all their historical participation in student learning and iii) contemporary inputs are not correlated with unobserved cognitive ability, i.e. with the error term.

More comprehensively, Machado *et al.* (2008) describe the educational production function by personal and socioeconomic aspects and school inputs, expressed in equation (3).

$$Y = F(cBa, cBf, cBe, cBm, \varepsilon) \quad (3)$$

Where: Y is student performance, *cBa* is a vector made up of student (characteristics - color, gender, and age), *cBf* is the vector of family characteristics, *cBe is the vector* of schoolcharacteristics, *cBm* is a vector of characteristics of the student's municipality, and ε is the random error term.

Sobral's education

According to Rocha, Menezes-Filho and Komatsu (2018), access to education ispractically universal. However, the quality of basic education is still precarious in the public network. Meanwhile, social inequalities persist, as those who can afford it enroll their children in better-quality private schools, while the public education offered to the less privileged generally continues to be of poor quality. However, there are cases in which internal educational management policies have resulted in significant effects, showing that it is possible, through the reorganization of the education system, to establish examples of educational excellence thatcan serve as a model for other localities through the implementation of a set of educational policies.

During the challenges faced by quality education, teaching management, continuous student learning, high investments without significant returns, the literature shows that cases in which an intensive, constant policy without political issues makes a difference in our society. The city of Sobral shows that a regulated education policy, from management to teaching, demonstrates positive results in terms of student performance. More recent studies such as Cruz and Loureiro (2020), Becker (2020), Rocha, Menezes-Filho and Komatsu (2018), as well as previous studies by Oliveira (2013) and Freitas (2011), have shown the success of the policies adopted by this city in Ceará.

Achieving significant results in education clearly depends on having clear and well-defined objectives on which to base policies and achieve results. In the case of Sobral, at the end of the 20th century, the starting point for work around education was identifiedand it was realized that substantial investments in resources were only the first step. Improvingthe quality of education would only happen if there was a focus on learning. Sobral therefore sets the goal of ensuring that all students complete elementary school at the appropriate age andwith an adequate level of learning (Cruz; Loureiro, 2020). Works such as those by Cruz and Loureiro (2020), Becker (2020), and Rocha, Menezes-Filho and Komatsu (2018) address the mechanisms adopted by the city's educational management, highlighting three main aspects: change in pedagogical practice, implementation of accountability mechanisms by the agents involved, and decentralization of the educational system. These three measures are also based on international experiences.

Regarding changes in teaching practice, the necessary prerequisites for student learning are established, with an emphasis on literacy. This is accompanied by an evaluation and monitoring system, through which the results obtained guide the necessary pedagogical interventions.

The second practice adopts the teaching mechanism of accountability, known in the literature as the accountability of agents in the educational process (Rocha; Menezes- Filho; Komatsu, 2018), which acts in the form of bonuses for teachers and staff when they achieve or reach an established or predetermined goal. As discussed by Becker (2020) in his study of the analysis of the regional distribution of the IDEB, in a time cut between 2007 and 2017, he reports on award policies for Grade 10 Schools, divided into two awards, the first of which began in 2009 for public schools that achieved the best results in school performance indices: literacy (IDE-Alfa), 5th grade (IDE-5) and 9th grade (IDE-9). The second award focuses on learning and is aimed at the 50 best high schools in the Ceará state network that perform well in the Permanent System for the Evaluation of Basic Education in Ceará (SPAECE) and in theindicators for the schools initially mentioned.

Regarding the decentralization of the education system, emphasis is placed on the local management of schools, based on the belief that local agents have greater knowledge of the specific needs and problems of the region. In Brazil, the municipalization process began with the incentives established in the 1988 Constitution, through the Fund for the Maintenance and Development of Primary Education and the Valorization of the Teaching Profession (FUNDEF)and the Guidelines and Bases Law (LDB), both enacted in 1996, in the context of primary education. Razo, Fernandes and Soares (2005) look at the impact of municipalization on primary education, estimated by means of propensity scores using data from the School Census from 1996 to 2002. The results indicate that, for the state in which there was no lack of data in relation to average school delay and the percentage of pupils with a delay of more than two years, municipalization had a negative impact, contributing to a deterioration in the quality of primary education.

In addition to these mechanisms, Sobral's educational success stems from a set of actions that have mutually reinforced the aim of ensuring that around 100% of students in the municipal schools complete basic education on time and with adequate learning. Cruz and Loureiro (2020) state that Sobral needed to set a public and political agenda focused on education, establishing clear and intermediate policies through a policy focused on learning, be it literacy for all students up to the second grade.

Rocha, Menezes-Filho and Komatsu (2018) address another important instrument in terms of political issues, as do Cruz and Loureiro (2020) in their work. Named nucleation, it constituted a process of reducing the number of municipal schools, a decrease of around 60%, which were mainly located in rural areas and with their small physical and administrative structure of multigroup classrooms and great variation in the number of enrollments, at first the main difficulty was summarized in the acceptance of the students' locomotion to the main schools that moved from the residence to their new educational destination.

Effects of education policies

Educational policy, or a set of them, refers to the decisions taken by the public authorities, i.e. the state, to take measures to improve education. Rocha, Menezes-Filho and

Komatsu (2018) presents positive results in primary education for the municipality of Sobral. To measure results, the municipal public school system set up an evaluation system that was independent of state and federal evaluations in 2001. With each test, the education department can manage the performance of all classes and individually develop and analyze theperformance of teachers and principals.

In view of the above, literacy levels show upward results in terms of their management. In 2003,regular students in the 1st grade began to stand out ([a]), and they would later be highlighted when they took the Brazil test in 2007, when Sobral's IDEB began to stand out (Rocha; Menezes-Filho; Komatsu, 2018). In Sobral, in 2013, 97% of the children in the second grade showed an adequate level of reading, as well as having expressive results in the IDEB; teachingcan be compared to education in a developed country, and another relevant factor is that the results were achieved without a sharp increase in spending on education (Cruz; Loureiro, 2020;Amaral; Menezes-Filho, 2009; Bezerra *et al.*, 2018).

The results of Rocha, Menezes-Filho and Komatsu (2018) show that between 2005 and2011, students in Sobral obtained a performance of 40 points more in the Brazil Portuguese language test, an increase of 28% compared to the beginning of the period. As for the math test,the students' performance was 70 points higher than the initial level, which is almost 50% higher the results. In this way, the policies adopted with the results of these authors show that there have been no significant improvements for students in the 9th year of elementary school,but there is still a gap in studies on the case, both in the final years and in secondary school.

To the extent that educational policies are constant, as in the municipality of Sobral, the results accumulate to later grades, and, subsequently, the student enters high school. In primary school, student performance is measured by the SPAECE test as well as the Brazil test. When it comes to high school, the National High School Examination (ENEM) is used to analyze the effects of the mechanisms on subsequent years of education based on performance in this assessment.

III. Methodology

The empirical strategy adopted to measure the effects of public education policies in thecity of Sobral is the synthetic control group method. The period covers the beginning of educational policies in the municipality of Sobral, from the initial phase to their possible effectson high school students. In this way, the characteristics of the initial phase are analyzed and then what changes in primary education the continued policies have planned for the target audience of this work. Thus, this study analyzes the period from 2009 to 2019 for themunicipality of Sobral.

Database and variables

This study takes an empirical approach, using specific economic data from the city of Sobral, located in the state of Ceará. The analysis is based on ENEM microdata, provided by INEP. In order to constitute the control group, the municipalities with the 10 highest municipal gross domestic product (GDP) in the state of Ceará were chosen, excluding the capital, Fortaleza. These municipalities are: Caucaia (1st), Juazeiro do Norte (2nd), Maracanaú (3rd), Sobral (4th), Crato (5th), Itapipoca (6th), Maranguape (7th), Iguatu (8th), Quixadá (9th) and Canindé (10th), according to data from the Brazilian Institute of Geography and Statistics (IBGE).

The choice of predictor variables such as population and GDP per capita is based on the literature on synthetic control and the existence of data. The first is a set of inhabitants of a given place, and the second, in simple terms, is the sum of GDP divided by the population of theregion measured, so these data are available from the IBGE census, and their values are measured in reais (R$) and deflated by the National Broad Consumer Price Index (IPCA) indicator.

Expenditure on education per capita is also included in the econometric model and was taken from SICONFI - the Brazilian Public Sector Accounting and Fiscal Information System. Its values are calculated in Reais (R$) and deflated by the Broad National Consumer Price Index(IPCA).

Finally, we used the Municipal Human Development Index (MHDI), considered a methodological adjustment to the Human Development Index (HDI), which evaluates Brazilian municipalities in the same dimensions as the index of origin. Its insertion is due to the work having a micro-spatial approach working with the municipal spheres to build the synthetic Sobral, for interpretation purposes, the closer the indicator is to 1, the greater the human development of that municipality. The variables in the model are population, GDP per capita in (R$), spending on education per capita in (R$) and the MHDI. In addition, the choice of per capita variables was based on Abadie, Diamond and Hainmueller (2010).

Synthetic Control

The empirical model follows the model presented by Ellery Jr, Nascimento Jr and Nachsida (2018), which allows conclusions to be drawn about how a treated unit would perform in the absence of treatment, thus referred to in the literature as synthetic control. Initially, this model applied in the field of social sciences shows some pitfalls due to the establishment of causality. However, the difference-in-differences method is used to exclude common effects when using temporal data from the units by means of the difference between the units overtime.

The model adopted consists of considering $j = 1,2,...,i + 1$ units over periods $t = 1,2,...,T$, *in which* the first unit has been subjected to an intervention, while the other units will be used to form the synthetic control group. The aim is to compare the values of the variable of interest for unit i *in* period t, if that unit had not undergone the intervention, with the values if the unit had undergone the modifications.

To create the synthetic control group, this synthetic unit must be able to reproduce the treated unit not only in the variable of interest, but also in a set of relevant variables. To do this, define the vector U_i as a vector of dimension r×1 containing the relevant variables observed for each unit. In addition, we define the vector $K = (K1, ..., KT0)$, where $T0$ is the period before the intervention, as the weights of a linear combination of the relevant variables before the intervention for the various units. These combinations can be used to control for characteristics whose effects vary over time.

When constructing the synthetic control unit, it is necessary to create a $(j×1)$ vector of weights $W = (w2, ..., wj = 1)$ with $wj \geq 0\ j$, where each element of the vector represents the weight of an observed control unit. We propose choosing the vector of weights W^*, such that the synthetic control unit obtained best approximates the unit that underwent the intervention with respect to U_i and $M \leq T_0$ linear combinations for the variable of interest before the intervention. This gives equation (4).

$$\tilde{\alpha}_{1t} = Y_{1t} - \sum_{j=2}^{j+1} W_j^* Y_{jt} \qquad (4)$$

Thus, equation (4) is the estimator of $_{1t}$ in the periods after the intervention.

When implementing the synthetic control estimator, it is necessary to define a distance between the synthetic control unit and the treated unit, simply by adding the characteristics of the treated unit to the matrix, according to equation (5).

$$X_1 = (U'_1, \bar{Y}_1^{K\,1}, ..., \bar{Y})_1^{K\,M}{}_{kx1} \qquad (5)$$

and the values of the same variables for the control units are given by expression (6).

$$X_1 = (U'_j, \bar{Y}_J^{K\,1}, ..., \bar{Y})_j^{K\,M}{}_{kx} \qquad (6)$$

The vector of weights is calculated to minimize the expression given in (7).

$$||X_1 - X_0\ W||_V = \sqrt{(X1 - X_0W)'V(X1 - X_0W)} \qquad (7)$$

Where $V_{k\times k}$ is symmetric positive semi-definite. The authors Abadie, Diamond and Hainmueller (2011) suggest choosing $V_{k\times k}$, according to equation (8).

$$argmin_{V \in V}\ (Z_1 - Z_0\ W^*(V))'\ (Z_1 - Z_0\ W^*(V)) \qquad (8)$$

which summarizes the set of all defined positive diagonal matrices.

IV. Results

Several works in the academic literature present the synthetic control method as the main strategy for analyzing the intervention of a given economic policy. Amon-há, De Arruda and Bezerra (2017) used the method to check whether economies with stricter patent laws influenced Brazil's innovation process in 1996. Studies such as Eller Jr, Nascimento Jr and Sachsida (2018) addressed the study of the synthetic control method in the evaluation of the Investment Substitution Program (PSI). More recent studies, such as Leite and Lúcio Carvalho (2021), which analyzes the educational performance of the state of Ceará from 2007 to 2014 with qualitative and quantitative indicators for secondary education. Maia and Marinho (2021) studied the effects of the Pacifying Police Units (UPP) program on the homicide rate in the municipality of Rio de Janeiro from 1999 to 2016. In the same direction, therefore, this study uses this method to assess the impact of educational policies implemented between 2009 and 2019 on the quality of secondary education in the municipality of Sobral-CE

In forming the synthetic Sobral, it was found that it is a weighted average of three municipalities out of the ten selected: Caucaia (0.136), Maracanaú (0.441) and Crato (0.413), as shown in Table 1. Thus, synthetic Sobral is made up of these three municipalities, which are characteristically close to the results for the city of Sobral.

Table 1 - Composition of the Synthetic unit

Municipality	Weight
Caucaia	0,136
Juazeiro do Norte	0,000
Maracanaú	0,441
Crato	0,443
Itapipoca	0,000
Maranguape	0,000
Iguatu	0,000
Quixadá	0,000
Canindé	0,000

Source: Prepared by the authors (2023).

Table 2 shows the descriptive statistics of the variables that make up the ten municipalities used to form the Synthetic Control of this study, consisting of GDP *per capita,* education expenditure per capita and finally MHDI, with the results presented as means, standard deviation, minimum and maximum for each variable.

Table 2 - Descriptive statistics of the variables that make up the ten municipalities for forming the Synthetic Control

Variable	Average	Std, Dev	Min	Max
Population	164953,7	84091,84	74473	363982
GDP *per capita*	13363,11	7755,668	3886,12	45685,69
G. Educ. *per capita*	540,5976	159,7541	265,28	1072,88
MHDI	0,660	0,052	0,448	0,714

Source: Prepared by the authors (2023).

Thus, the first variable is the population, which, in its general characteristics, is defined by understanding the information on the size and structure of the group according to the IBGE.The average for all ten cities is approximately 164,954 inhabitants, with the smallest city having74,473 inhabitants (Canindé) and the largest having 363,982 inhabitants (Caucaia).

GDP per capita *is* the second variable and is an indicator that measures the degree of economic development of an economy. The average of the ten cities that make up the panel data is R$13,363.11, which is close to the state's average GDP per capita, which reached R$18,168.35 in 2020, according to data from IPECE (2022). In turn, the standard deviation is R$7,775.67, the lowest GDP per capita is R$3,883.12 and the highest is R$45,685.69.

The third variable is spending on education per capita, i.e., the average spending ofeach municipality per pupil. The average for the ten cities is approximately R$540.60 per pupil, with a standard deviation of approximately R$160.00 and minimum spending of R$265.28, rising to R$1072.88 per pupil per year.

Finally, the MHDI is part of an MHDI methodological adjustment for analyzing a municipality. The average of the municipalities composing the panel data is approximately 0.661, so the closer it is to 1, the more it indicates that the municipality has positive results in terms of income, health, and education. Its standard deviation is approximately 0.052, and the minimum and maximum results are 0.448, and 0.714, respectively.

Table 3 shows the descriptive statistics for the variables of the three cities that make upthe synthetic control, consisting of GDP *per capita,* education expenditure per capita, and finally, MHDI, with the results presented as means, standard deviation, minimum, and maximumfor each variable.

Table 3 - Descriptive statistics of the variables of the three municipalities that make up the Synthetic Control

Variable	Average	Std, Dev	Min	Max
Population	229635,7	92009,93	116759	363982
GDP *per capita*	18365,83	11075,71	6883,5	45685,7
G. Educ. *per capita*	556,04	164,8	270,9	960,3
MHDI	0,682	0,038	0,555	0,713

Source: Prepared by the authors (2023).

For the population variable, the average between the three cities that make up the synthetic control group is approximately 229,636 inhabitants per city, where the lowest numberof inhabitants is 116,759 and the maximum number of inhabitants in each city is 363,982.

In terms of income, the three towns have an average of R$18,365.83, which is higher than the GDP per capita of almost 90% of the towns in the state of Ceará, equivalent to 165 towns, but lower than the state's GDP per capita of R$ 18,168.35, according to data from SEPLAG. Spending on education per pupil amounts to R$ 556.04, the minimum spendingis R$ 556.04 and the maximum is R$ 960.30. Compared to the data from the ten municipalities in the data panel, the three municipalities have lower figures when compared to the maximum spending per pupil.

For the three municipalities, the MHDI has an average of 0.682 and a minimum of 0.555 and a maximum of 0.713. Thus, the first is higher, and the second and third are likethe aggregate of cities that make up the data panel for the synthetic control.

Table 4 shows the descriptive statistics of the variables for the municipality of Sobral, comprising GDP per capita, spending on education per capita and, finally, the MHDI, with the results presented as means, standard deviation, minimum, and maximum for each variable.

Table 4 - Descriptive statistics of the variables for the municipality of Sobral

Variable	Average	Std, Dev	Min	Max
Population	197040,8	7509,467	182431	206644
GDP *per capita*	17973,93	3854,77	11561,21	23033,6
G. Educ. *per capita*	606,30	152,46	335,17	841,76
MHDI	0,697	0,533	0,537	0,714

Source: Prepared by the authors (2023).

The first variable in the descriptive statistics for Sobral is the population, which had an average of approximately 197,040 inhabitants between 2009 and 2019, with a minimum of 182,431 inhabitants and a maximum of 206,644 inhabitants. In relation to the ten municipalities and the three that belong to the synthetic Sobral, Sobral has an average above the first and belowthe second.

The second variable, GDP per capita, *has* an average of R$ 17,973.93, a standard deviation of R$ 3,854.77, the lowest value of R$ 11,561.21, and a maximum of R$ 23,033.60. Compared to the average of the ten municipalities and the synthetic Sobral, Sobral has a higherGDP per capita than the former and lower income than the latter. Spending on education in themunicipality of Sobral has an average of R$ 606.30, a minimum of R$ 335.17 and a maximum of R$ 841.76. Looking at Tables 18 and 19, Sobral has a higher average, although when analyzing the maximum amount spent per pupil, it has the lowest compared to the tenmunicipalities, thus obtaining maximum values of R$ 1072.88 and synthetic Sobral of R$ 960.30.

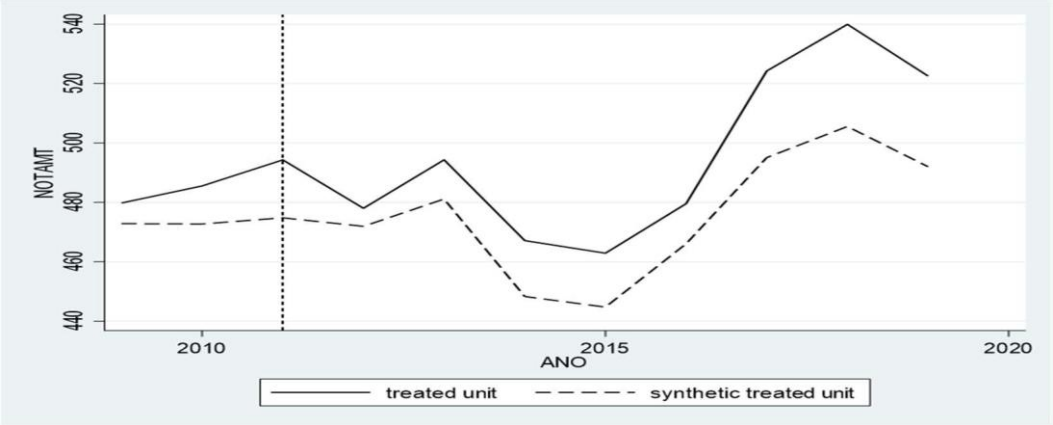
Sobral's MHDI has an average of 0.697, and a minimum and maximum of 0.537, and 0.714, respectively. Compared to the ten municipalities and the synthetic Sobral, the municipality of Sobral has a higher index, but the values are approximate for all three situations.

Synthetic Control Results

The data shows that the city of Sobral had significant results, which, in turn, contributedto the future of high school students. However, there would be a period of maturation for the students, from the elementary school stage, benefiting from the policies adopted until they reached later education. This period of treatment was considered from 2012 onwards. Considering the time that had passed since the start of the policy and the time it took for the first classes to reach the 3rd year of secondary school.

Figure 1 shows the evolution of the students' average grades in mathematics and its technologies. The results show that the city of Sobral outperformed the control group, as demonstrated by the graph showing the treated group outperforming the control group throughout the intervention period. This leads us to conclude that the intervention had a positive impact on the performance of high school students. It is important to note that, before 2012, the average performance of Sobral's students was already higher than the synthetic group, albeit with fluctuations over the years that reduced the difference in average performance. However, as the policies matured, the gap between Sobral and the treated group widened.

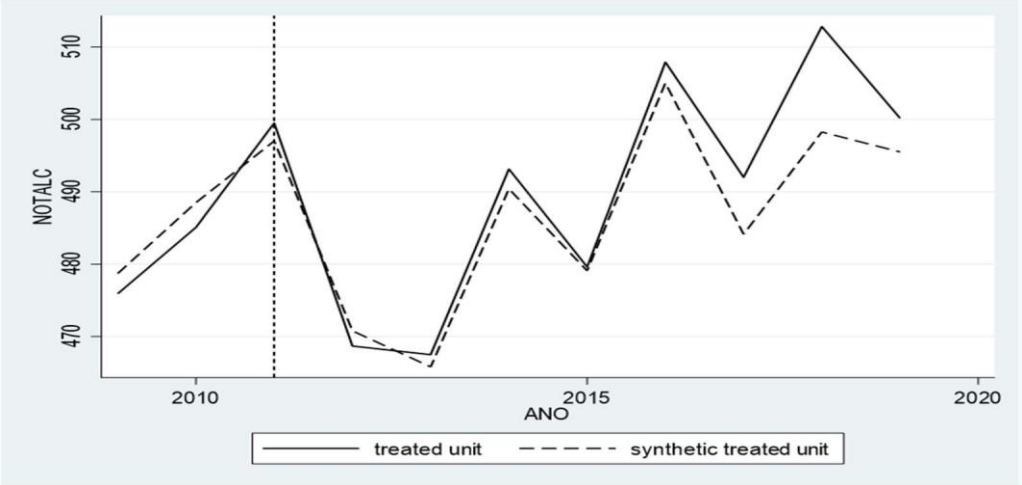
Figure 1 - Average performance of Sobral and the synthetic Sobral in mathematicsand its technologies in ENEM from 2008 to 2019



Source: Prepared by the author (2023)

Figure 2 shows the average performance for the languages and codes area. There is a difference in behavior between this area and mathematics and its technologies. During the initial years of treatment, the averages for both Sobral and the synthetic control are similar. In this way, the policy introduced in elementary school had a positive effect on secondary school,albeit late, only in the years after 2015 did the performance of Sobral students show significantresults over the synthetic control. At apex or peak points, both observations coincide in the periods before 2015, such as 2012, the base year for the synthetic control and between 2013 and 2014, then 2015, we have the period of 2016 with another peak inperformance and then the difference between Sobral and the synthetic control increases.

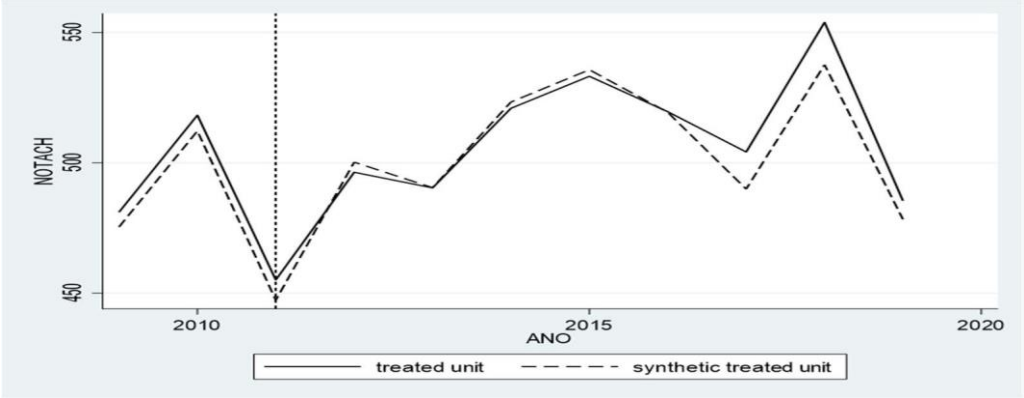
Figure 2 - Average performance of Sobral and synthetic Sobral around languages and codes in ENEM from 2008 to 2019



Source: Prepared by the author (2023).

Figure 3 shows a similar pattern for the area of humanities and its technologies to thatof languages, where the average performance of Sobral and the Sobral synthetic group are comparable from the start of the survey until approximately the final years. However, the surveydata shows that, in the final period of the survey (2018-2019), there is a clear reduction in the average performance curve in both observations. One possible explanation for this could be the negative impact on the labor market that began during the second Dilma government, which may have discouraged young people from maintaining their efforts in their studies due to the poor job prospects signaled by performance in the labor market, especially for the youngest. During this period, there was a significant restriction and increase in FIES (Student Financing Program) financing rates (Guimarães, 2018; Queiroz, 2018; Santos, Chaves; Paixão, 2021), which culminated in a period of high default (Almeida Júnior, 2018; Guimarães, 2018).

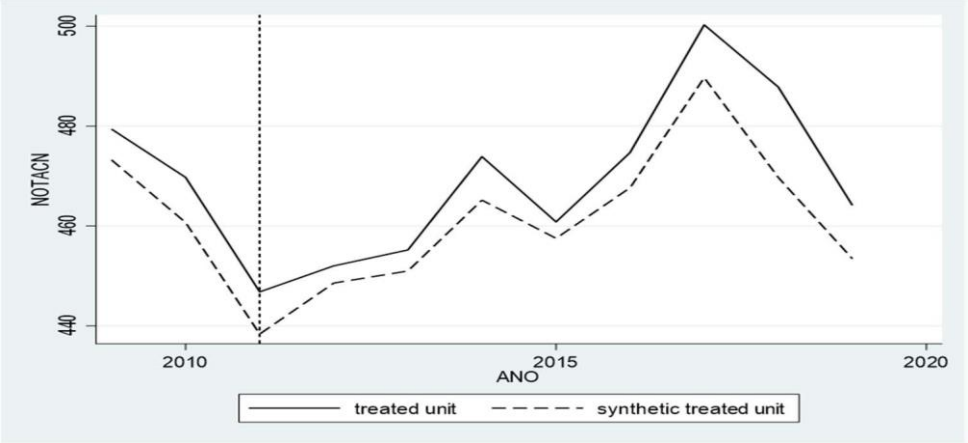
Figure 3 - Average performance of Sobral and synthetic Sobral in humansciences in ENEM from 2008 to 2019



Source: Prepared by the author (2023)

Figure 4 shows similar results to the gap between Sobral's performance and the syntheticunit as in figure 1 and the behavior of the curve as in figures 2 and 3. Both figures show sharp curves until 2018 and a drop in student performance the following year. As shown in the previous research data, the year 2019 is represented by a period of higher enrollment in the high school level exam, possibly more enrollment, resulting in lower exam scores.

Figure 4 - Average performance of Sobral and synthetic Sobral in naturalsciences in ENEM from 2008 to 2019



Source: Prepared by the author (2023)

The average treatment effect on those treated (ATT) in Table 5 is calculated as the difference between the observed result and the estimated counterfactual result (Pessoa, 2020). In the area of mathematics and its technologies, the highest average value of this difference isobserved, indicating that the policies implemented in Sobral had a significant impact on high school students in this area. In second place is the area of natural sciences, with values close to those of mathematics. The human sciences area has a lower average value compared to the previous areas, while the languages and codes area has the lowest average values, indicating relatively lower impacts in this area.

It is worth noting that Sobral's economy ranks, 2627th in the national per capita incomeranking and 9th in the state, according to IBGE data. In view of its excellent performance in both primary and secondary education, Sobral achieves excellent results in educational indicators (Oliveira, 2013), without necessarily presenting such significant economic indicators.

Table 5 - Average effect of treatment on treated units

	ATT
Mathematics and its Technologies (MT)	14,03646
Languages and Codes (LC)	3,140485
Human Sciences (CH)	6,54092
Nature Sciences (CN)	7,963725

Source: Prepared by the author (2023).

Gap

This section presents the results of the *gap*, which shows the difference in each area ofthe national high school exam for Sobral and the synthetic Sobral. The graphs shown in Figure 5 refer to the effect of the treatment (educational policies implemented in Sobral) on the synthetic Sobral after correcting for bias. This gives a more accurate view of the treatmenteffect.

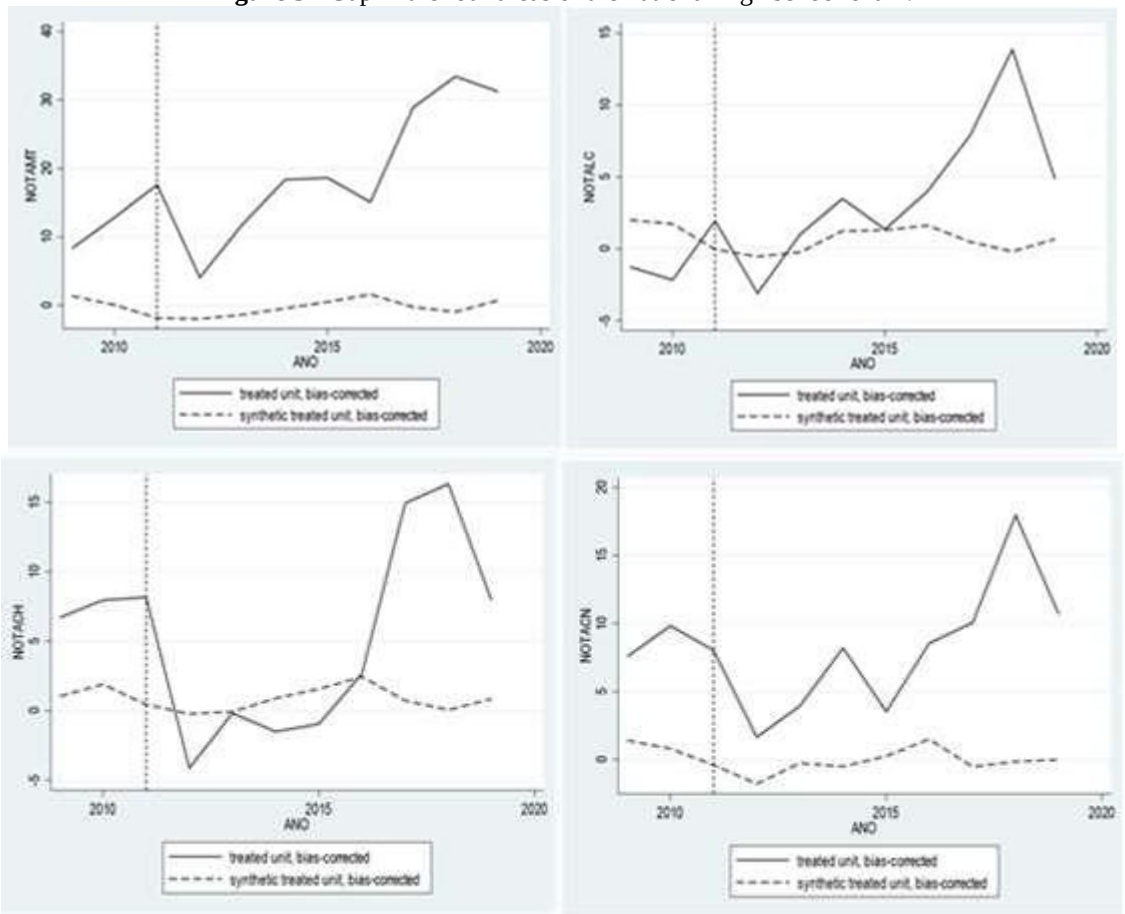
In this analysis, when Sobral's performance curve is above that of the treated group, it indicates that the educational policy adopted in elementary school had a positive effect on student performance in secondary school. On the other hand, when Sobral's performance curveis below that of the treated group, it suggests that the policy adopted did not have a significanteffect on student performance in secondary school. This comparison between the curves makes it possible to assess the impact of the educational policy over the years and its influence on theresults obtained by the students.

For the area of Mathematics and its Technologies, from the initial years of the research, the policy adopted in the elementary schools of Sobral shows a positive effect on the performance of students when they enter high school and take the test that measures their performance. Its most prominent period is between 2015 and 2019.

In the area of Languages and Codes, there are divergent curves from the previous area, the initial years of the study show that the control group outperforms Sobral, although along the curve in the observation period there is a period of beneficial intervention for the area of Languages and Codes. As for the Humanities, the results after 2011 show zero effects on the policy, with only significant results in 2015 and the following years.

As for the natural sciences, their characteristics are like those of mathematics and its technologies. Throughout the study period, they showed positive results in the light of the policy adopted, with better results from 2015 onwards, just like the other areas presented.

Figure 5 - Gap in the four areas of the national high school exam.



Source: Prepared by the author (2023)

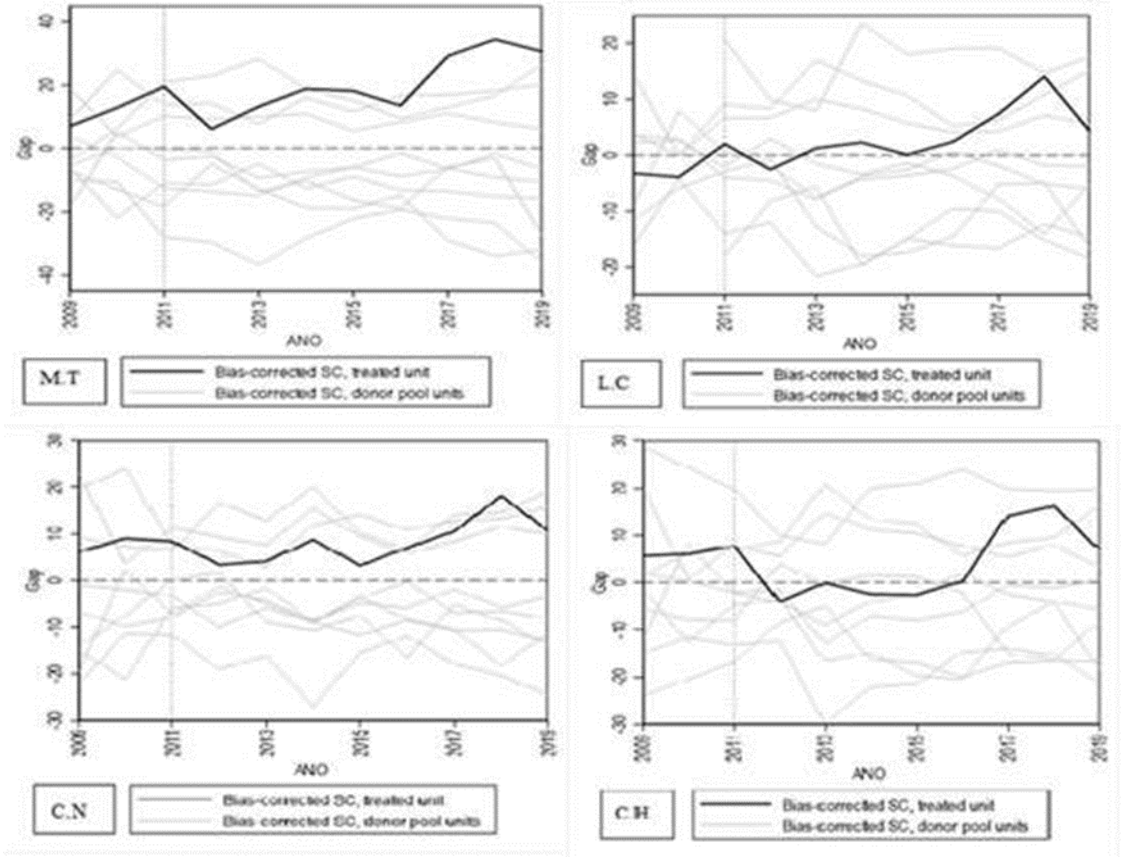
Placebo test

This section presents the results obtained for the placebo test. The test is applied to check that the results of the synthetic control are robust, i.e., to check that the results were not just a random event (Maia;

Marinho, 2021). This test was first recommended by Abadie and Gardeazabal (2003). According to Eller Jr, Nascimento Jr and Sachsida (2018), it is used to conclude the analysis of the results.

Figure 6 shows the placebo test for the four areas of the ENEM. The gray lines represent the gap associated with each of the cities in the control group, i.e., they show the difference in average student performance between each city in the control group and its respective syntheticversion. The darker overlapping line indicates the estimated gap for Sobral. As the graph shows,the estimated gap for Sobral between 2012 and 2019 is considerably unusual compared to the distribution of gaps for the cities in the control group. According to Figure 6, the synthetic method provides a good fit for the study.

Figure 6 - Placebo tests for the four areas of the national high school examination



Source: Prepared by the author (2023).

IV. Conclusion

Considering the context in which education is one of the main drivers of economic growth and continues to be a priority in public policy discussions, this study evaluated the impact of the policies implemented in primary education in the municipality of Sobral and their subsequent effects on secondary education during the period from 2009 to 2019. To this end, the synthetic control method was used, in this period, when the students benefiting from such policies would be taking the National High School Exam (ENEM), which was the main sourceof data for this research.

The results indicated that the educational policies adopted in Sobral had positive effectson high school students. In particular, the data revealed more significant impacts in the areas of exact sciences, such as mathematics and its technologies, and natural sciences, while the results were less expressive in the areas of languages and codes and human sciences.

Given the measures implemented in primary education in Sobral, detailed and specifiedin this research, and the positive results observed in both primary and secondary education, other municipalities could consider Sobral's educational practices and approaches as a model, with a view to achieving better results in their own educational indicators.

Thus, it is important to emphasize that improving the quality of teaching and achieving higher educational indicators do not necessarily require high investments, as evidenced by the case of Sobral, which, despite not being a wealthy municipality in national terms, achieved high performance rates by high school students on the ENEM, and thus the effects of the policies adopted in the initial years by the very continuous

nature of the educational process will bear fruit in the final years of the educational training process and quite possibly in the professionallives of the students who benefited.

For future studies, we suggest investigating the effects of educational policies in a post- pandemic context, a period in which educational indicators may fluctuate. In addition, other methodologies for analyzing their effects, investments, and implementation, based on the guidelines adopted by Sobral, are also recommended. As studies on education generate positiveimpacts on the economy, it is necessary to seek updates for improvements in the education system, and consequently in society and the economy.

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