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Article

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Evaluating the impact of a change in the ICMS tax law in the state of Ceará in municipal education and health indicators

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Abstract

In 2007 the Brazilian state of Ceará changed its law of ICMS to share resources via outcome indicators in health, education and environment. This paper evaluates and discusses the impact of this change. For this, we use the municipalities of Bahia as a control group to estimate treatment effects using differences in differences models. The results indicate a positive impact on students' proficiency in standardized tests of Portuguese and mathematics.

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JEL classification: H75; K32

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Resumo

Em 2007 o Ceará modificou sua Lei do ICMS rateando a quota-parte municipal via indicadores de resultado em saúde, educação e meio ambiente. Este artigo avalia e discute o impacto desta mudança. Para tanto, utiliza os Municípios Bahia como grupo de controle para estimar efeitos de tratamento através de modelos de diferenças em diferenças. Os resultados apontam impactos positivos na proficiência dos alunos das redes municipais em exames padronizados de português e matemática.

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Palavras-chave: Avaliação de impacto; ICMS; Desenho de mecanismo

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1. Introduction

The Brazilian Federal Constitution of 1988 allowed the states to define criteria for transferring part of proceeds from the ICMS¹ tax to the municipalities. In the constitutional text, it was determined that 75% of proceeds from the tax would be appropriated by state government, and the remainder would be divided among the municipalities.

Of those 25% destined to the municipalities, at least 18.75% are shared according to the municipality's contribution to the added fiscal value, while the rest, i.e., 6.25% (or 25% of the share), can be distributed according to other criteria defined by state legislation.²

This created a legal support for the states to implement incentive mechanisms to certain municipal actions. In that sense, the state of Paraná was the first to use such support, when in 1991 it created the “Ecological ICMS”. This was a mechanism that aimed to protect the natural springs in the region, in the following manner: if the municipality increased its traditional economic activities, such as the number of industries, it also has to increase its green areas, so that it would not lose its share in tax revenue. Over the years, other states have also designed mechanisms with other specific interests.³

In the Northeast region, in 2011, with the exception of the states of Pernambuco, Piauí and Ceará, the distribution criterion of the 25% of quota share provided by state legislation involved simply territorial dimension, population and an egalitarian aspect. In the states of Maranhão and Rio Grande do Norte, for example, apportionment is at 5% proportional to territorial size, 10% proportional to the population and 15% to the egalitarian aspect. In the state of Bahia, 7.5% is proportional to the territory, 10% to population and 7.5% egalitarianism. In Sergipe, the 25% are evenly distributed.

As for the state of Pernambuco, since the year 2000, municipalities that have implemented treatment systems for municipal waste and maintained environmental conservation units tend to increase their share in tax revenue. The state's law aims to encourage mayors to adopt actions which lead to the maintenance of biological diversity and environmental quality.⁴

In the state of Piauí, until 2009, the apportionment of the 25% occurred by giving equal weight to all aspects, proportionate to population size and territory. But by the end of 2009, the law was changed to design quota shares in the following manner: 10% proportional to territory; 10% proportional to population; and 5% through environmental criteria, as featured in the state of Pernambuco.

As for the state of Ceará, it has a peculiar history concerning the context in the Northeast region. First, because it had already tried to use legal support to improve education, but it did not base itself on “result indicators”. Furthermore, reviewing the ICMS law became a component of results based management (RBM⁵), which the state has adopted since 2004.

The attempt by the state to use the apportionment of the ICMS tax to improve education indicators began in 1996, under the following criteria: (i) 5% provided by the relationship between the size of the municipality's population and the state's population; (ii) 12.5% provided by the relationship between the sum of expenditure incurred by the municipality on the maintenance and development of education and the municipal revenue from taxes and constitutional federal and state transfers; and (iii) 7.5% equally distributed among all municipalities. In other words, instead of using a result-based indicator (such as school evasion, grades in standardized tests and age-grade distortion), which would reflect the quality of expenditure, the criteria was concerned only with “spending”. In that context, the evolution of education indicators was less than expected through the 2000s.⁶

In 2007, guided by the RBM logic, the state of Ceará changed the law, apportioning the 25% of tax revenue through health, education and environment result indicators. As such, this work evaluates the impact of this change, aiming to

¹ ICMS stands for *Imposto sobre Circulação de Mercadorias e Serviços*, a tax on circulation of goods and services on interstate and intercity transportation and communications.

² For more information, see [Riani \(2000\)](#) or [Brunozi et al. \(2008\)](#).

³ Shortly after the Paraná tax, the state of Minas Gerais adopted criteria that made its law known as the “Robin Hood Law”, as it encouraged social investment.

⁴ For details, see [Silva et al. \(2010\)](#).

⁵ RBM is thoroughly discussed in [Kusek and Rist \(2004\)](#).

⁶ For more information, see [Costa et al. \(2009\)](#).

answer the following question: is there a way to encourage municipalities to invest more wisely, in terms of improving certain indicators, using the ICMS tax quota share prerogative?

The answer is relevant in many contexts. It can, for example, be important when discussing the resurgence of the CPMF tax,⁷ since one way to avoid bringing back that tax to attenuate issues in health services would be to align the ICMS laws to increase efficiency in municipal expenditure. Another context is the preservation and expansion of natural springs. But all that would be conditioned to empirical evidence that the alignment of such incentives could increase efficiency in public expenditure.

To perform such an evaluation, a difference in difference model with propensity score matching is used, for a panel of relevant variables for the years 2007 (the year this legislation was discussed) and 2009 (the year the law came into effect).

This work consists of four more sections, aside from this introduction. In the following section, the law for the state of Ceará is described. The third section presents the evaluation strategy, and the analysis itself appears in section four. Lastly, the concluding remarks are presented.

2. The law in Ceará

The changing of the ICMS tax law in the state of Ceará was motivated by a sequence of events initiated in 2004. That year, the state treasury suffered a considerable shock to its revenue, hard to equate, for the economic conjecture was not favorable and there were no financing alternatives via state banks or privatizations. The dilemma presented was this: preserve social spending and delay payment of public debt service, or preserve the financing spending in detriment to social spending. To avoid making such a difficult choice, the state sought out the World Bank, which was favorable to a proposition which came to be known as Ceará Sector Wide Approach (SWAP) Project, which featured an implementation of results based management (RBM).⁸

Between 2005 and 2012, through that operation, the bank loaned resources not for structural or political works, but in exchange for advancements in result indicators that would directly impact the population's living standard. Thus, the disbursements were subject to the achievement of results of pre-established goals. In case the goal was not achieved, the state would not receive the bank's disbursement.

In 2007, guided by the RBM logic of the SWAP Project, government technicians worked in improving the use of shares of the ICMS quota to influence result indicators. From that work came Holanda et al. (2007), which presents a critique of Ceará's first attempt to use the 25% from ICMS revenue to improve education indicators – which was in place since 1996. In the document, the authors analyze the municipalities' fiscal dependence in relationship to that revenue, and make simulations of modifications to the law.⁹

To observe how important the quota share is to the municipal government, Table 1 presents statistics related to that resource in the current and tributary revenues for the municipalities of Ceará – for the years 2007 and 2009 (before and after the law change). Note that, first, in the years considered, the mean of revenue participation of the quota share in total current revenue is close to 10% (9.34% in 2007 and 9.63% in 2009). And there are municipalities where that revenue represents more than 30% of routine resource availability for mayors. In other words, it is a relevant resource for the municipalities.

The relevance of these resources can be gathered by comparing the percentage in revenue from the quota share vis-à-vis the tax revenue of the municipalities.¹⁰ On average, the resource transfers discussed are equivalent to around four times what the municipalities collect with their own tax authorities (341.25% in 2007 and 401.82% in 2009).

⁷ CPMF stands for *Contribuição Provisória sobre Movimentação ou Transmissão de Valores e de Créditos e Direitos de Natureza Financeira*, or Provisional Contribution on Movement or Transmission of Values, Credits and Entitlements of Financial Nature, an extinct tax in Brazil which was used to partly finance health services.

⁸ Details about the operation are featured in Holanda (2006).

⁹ A shortened presentation of the results found by those authors is presented in Holanda (2012).

¹⁰ The tax revenue's main components are the IPTU tax, the ITBI tax, the ISSQN tax, and various different municipal taxes. For further details, see chapter 10 of Giambiagi and Além (2011).

Table 1

Statistics of participation in ICMS revenue transfers in current and tax revenues for the municipalities in the state of Ceará – 2007 and 2009.

Statistic	% of current revenues		% of tax revenues	
	2007	2009	2007	2009
Mean	9.34	9.63	341.25	401.82
Standard deviation	4.33	4.95	221.85	462.49
Minimum	3.87	3.32	43.68	13.51
1st quartile	6.52	6.15	202.9	191.78
Median	8.30	8.28	286.07	294.41
3rd quartile	11.22	11.35	417.58	458.64
Maximum	32.11	32.54	1772.72	4439.55

Source: Made by the authors using data from STN (National Treasury).

During the year of 2007, state government launched a proposal to modify the law. After it was lengthily discussed in the legislative assembly, in December of that same year, the law was modified, coming into effect in January 2009, using the following criterion:

$$\begin{aligned} \text{Quota} = & 0.192[\text{5th grade scores}] + 0.048[\text{4th to 5th grade school pass rate}] + 0.48[\text{2nd grade literacy}] \\ & + 0.2[\text{TMI}] + 0.08[\text{Environment}] \end{aligned} \quad (1)$$

where “Quota” is the percentage which the municipality receives in the portion arbitrated by state legislation; “5th grade scores” is a 0–1 index, calculated using the average scores of 5th grade students in basic education achieved at the Portuguese and mathematics tests in the SPAECE (*Sistema Permanente de Avaliação de Educação Básica do Ceará*) – Permanent Evaluation System of Basic Education in the State of Ceará, or the Prova Brasil (literally “Brazil Test”), depending on the year; “4th to 5th grade school pass rate” is a 0–1 index of passing rates in the municipal education system; “2nd grade literacy” is a 0–1 index calculated based on the average scores of 2nd grade students in basic education in the municipal education system achieved on standard reading and comprehension tests in the SPAECE test; “TMI” is a 0–1 index for measuring advancements in the reduction of child mortality rates; and “Environment” is a binary variable, being 1 for municipalities certified by the state department of environment in terms of appropriate waste disposal.

For all the indicators that are part of Eq. (1), there were pre-established goals from SWAP Project.¹¹ Thus, in the sequence of events previously described, the law became an incentive design mechanism, so that the municipalities could become partners of the state in accomplishing goals. This would occur through the increase in ICMS shares for those that would collaborate more profusely in the advancement of those indicators.¹² The following section discusses the strategy for identifying the impact of rule (1) on those indicators.

3. Impact identification strategy

The proposition for impact evaluation stems from the following question: what would have occurred to the municipalities in the state of Ceará, in terms of the discussed indicators, had the law change not come into effect? Thus, the definitions are, as usual: (i) two potential results for each indicator, (Y_{0i} , Y_{1i}), where the subscript 0 indicates the result without the law change, and the subscript 1 indicates the result otherwise, and i indicates the municipality; and (ii) a binary variable, where $T_i = 0$ if the municipality has not been subjected to treatment (the law change), and $T_i = 1$ otherwise. With those definitions in place, the answer to the original question would come from an anal-

¹¹ The complete list for the indicators involved in that operation can be found at <http://www2.ipece.ce.gov.br/SWAP> or in <http://www.worldbank.org/projects/P106765/br-ceara-inclusive-growth-swap-ii?lang=en>.

¹² A more thorough discussion on these issues and several simulations are presented in Holanda et al. (2008). For further discussion on the political context in which the proposition for this came to be, see also Nogueira et al. (2011).

ysis of $(Y_{1i} - Y_{0i} | T_i = 1)_{i=1}^n$ for the n municipalities of the state of Ceará. However, as it is impossible to observe $(Y_{0i} | T_i = 1)_{i=1}^n$, the counterfactual, such a list does not exist.

The alternative for this analysis begins by defining a mean effect given by $\mathbb{E}(Y_{1i} - Y_{0i} | T_i = 1)$, which is known as average treatment on the treated (ATT). Given the absence of the counterfactuals, it is not possible to estimate $\mathbb{E}(Y_{0i} | T_i = 1)$. However, observing similar municipalities in another state where there was no law change (control group), it is possible to estimate $\mathbb{E}(Y_{0i} | T_i = 0)$. And under certain hypotheses¹³ the two measures can be interchanged without causing a bias in the ATT estimation (or mitigating the bias, as in Angrist and Pischke, 2008).

As for the control group, given that it is expected that it will mimic the treatment group counterfactuals, it is natural to select the municipalities of another state in the Northeast region. In that sense, Pernambuco and Piauí can be discarded, as those states adopted similar laws to those present in Ceará. Therefore, analyzing the region's socioeconomic indicators cataloged by Bezerra and Carvalho (2011), the municipalities of the state of Bahia were chosen, as these show similar characteristics to the municipalities of Ceará.

Having defined the control group, it can also be perceived that there are public policies which are common to both states, which can influence the indicators related to the law (e.g., the PAIC actions and the PSF¹⁴). Thus, taking that into account, it is necessary to give more structure to the ATT estimation. In that sense, when one observes the indicators for the treatment and control groups in two moments in time, $t=0$ for before the treatment and $t=1$ for after the treatment, a conventional ATT estimator in situations such as these is the differences in differences estimator (ATT_{DD}) described below:

$$\text{ATT}_{\text{DD}} = [\mathbb{E}(Y_{it} | T_i = 1, t = 1) - \mathbb{E}(Y_{it} | T_i = 1, t = 0)] - [\mathbb{E}(Y_{it} | T_i = 0, t = 1) - \mathbb{E}(Y_{it} | T_i = 0, t = 0)] \quad (2)$$

There are two main hypotheses to guarantee consistency for this estimator¹⁵: the temporal trajectory of the indicator mean studied in the control group represents what would occur with the treatment group if there was no treatment, i.e., the possible improvement of an indicator for the state of Ceará (due to the law change and policies in common) should be discounted from the equivalent improvement in the state of Bahia (due only to common policies); and (ii) the treatment and control groups' characteristics are not altered in any significant way between the before and after periods concerning the intervention (this hypothesis is relaxed later on).

Based on the rule described in (1), this work will focus on evaluating the impact on the following indicators¹⁶:

- The average for the test scores of 5th grade students in basic education of the municipal education system in standardized tests for Portuguese and Mathematics, the test being the Prova Brasil, measured by the INEP,¹⁷ following the SAEB scale of 0–500;
- The average school passing rate from the 4th grade to the 5th grade of basic education in the municipal education system, also measured by the INEP, following a 0–100% scale; and
- The municipal infant mortality rate per thousand live births (TMI), measured by the Ministry of Health.

Table 2 below presents the mean, standard deviation and number of observations for the analyzed variables for the municipalities of Ceará and Bahia in the years 2007 and 2009 (before and after the law implementation). Furthermore, the table's last line features the ATT_{DD} estimations given by Eq. (2), for each of the aforementioned indicators.

¹³ The conditional independence hypotheses presented in the seminal work by Rosenbaum and Rubin (1983). This will be detailed later on in the text.

¹⁴ PAIC stands for *Programa de Alfabetização na Idade Certa*, and PSF stands for *Programa Saúde da Família*, respectively Program for Literacy in the Right Age and Family Health Program. These will be discussed further on.

¹⁵ Details in Bertrand et al. (2004).

¹⁶ Note that two indicators which are part of Eq. (1) will not be analyzed. The first is the environment, as it has already been debate by Nogueira et al. (2011). The second is the 2nd grade literacy variable, as it is measured exclusively by the SPAECE, and there is no comparable measure for the control group.

¹⁷ Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (Anísio Teixeira National Institute of Educational Studies and Research), part of the Ministry of Education.

Table 2

Mean, standard deviation, number of observations and ATT_{DD} estimations for test scores in Portuguese (POR) and mathematics (MAT), school passing rates (TAP), child mortality rate (TMI) for the municipalities in the states of Ceará (CE) and Bahia (BA) – years 2007 and 2009.

Year	Statistic	POR		MAT		TAP		TMI	
		CE	BA	CE	BA	CE	BA	CE	BA
2007	Mean	211.71	213.53	222.91	224.63	76.82	62.65	17.21	19.52
	Std. dev.	11.37	12.02	10.65	12.08	8.99	11.97	7.33	9.47
	Observ.	161	296	161	296	161	296	168	316
2009	Mean	227.05	222.14	228.58	225.78	79.37	64.75	16.67	18.98
	Std. dev.	10.98	14.24	13.69	13.44	9.26	11.28	7.67	9.01
	Observ.	165	297	165	297	165	303	168	316
$\hat{E}(Y_{it} T_{i,t} = 1) - \hat{E}(Y_{it} T_{i,t} = 0)$		15.34	8.61	5.67	1.15	2.55	2.10	-0.54	-0.54
ATT _{DD}		6.73*		4.52*		0.45		0.00	

Source: Made by the authors using data from INEP and DATASUS.
* Statistically different from zero at the 1% significance level.

For the average test scores of 5th grade students, one can observe advancements for both states in the years analyzed. For the Portuguese tests, the advancement in Ceará was of 15.34 points, and in Bahia it was of 8.61 points. For Mathematics, the advancement in Ceará was of 5.67 points, and for Bahia it was of 1.15 point. By the ATT_{DD} estimate, the law's impact was of 6.73 and 4.52 points in Portuguese and Mathematics, respectively. In both cases, the null hypothesis of the effect being zero is rejected at the 1% significance level. On the other hand, concerning the average school passing rates and TMI¹⁸ indicators, one cannot rule out the null hypothesis of the law effect being zero, significance levels less or equal to 10%.

In short, two aspects can be concluded thus far: (i) there is evidence of advancements in the indicators of average proficiency in the municipalities of the state of Ceará, when compared to the municipalities of the state of Bahia; and (ii) the same advancement is not observed concerning school performance and decrease in child mortality.

The second hypothesis used in the formulation of the ATT_{DD} estimator, concerning the characteristics of the control and treatment groups not being altered in any significant way in time, can now be relaxed by inserting a X_{it} vector containing covariates which can influence the results. As demonstrated in Angrist and Pischke (2008) or Smith and Todd (2005), among others, to relax this hypothesis, in a panel data context, the differences in differences model points to the δ parameter of the equation below as measure of ATT:

$$Y_{it} = \alpha_0 + \alpha_1 t + \alpha_2 T_i + \delta(tT_i) + \beta X_{it} + \epsilon_{it} \quad (3)$$

where Y_{it} is the indicator of impact evaluated in municipality i in year t ($t=0$ for 2007 and $t=1$ for 2009); T_i indicates treatment or control; X_{it} is a column vector of covariates; ϵ_{it} is the error term; and $\alpha_0, \alpha_1, \alpha_2$ and δ are parameters, and β is a line vector (of parameters) to be estimated.

As in any regression model, under the hypothesis that $\mathbb{E}(\epsilon_{it} | T_i, t, X_{it}) = 0$, the parameter δ can be consistently estimated through least squares. But, considering the context of this evaluation, the studied indicators can potentially be explained by the quality of municipal governance, or something of the sort, which is not observable by the researcher. Thus, the identification hypothesis can be violated by the omission of an important explanatory variable.

Therefore, the strategy here is to use a non-observed linear effect model, considering: $\epsilon_{it} = c_i + u_{it}$; where c_i is an index for the non-observed variable in municipality i and u_{it} is the error term. The parameters in Eq. (3) can then be measured by fixed or random effects estimators – selecting the estimations based on the appropriate hypothesis tests.

However, as discussed in Bertrand et al. (2004), even by improving the identification strategy for the law's impact, the wrong choice of control group can still cause a bias in the ATT estimation. Thus, to mitigate a possible bias of that nature, it is proposed to estimate the parameters of Eq. (3) in a sub-sample of the observations, which have been filtered through a propensity score matching process.

¹⁸ Rocha and Soares (2010) show that the effect of the PSF program, a policy which is present in both states analyzed, is extremely significant for the reduction of this indicator.

Table 3
 Probit regression results for the dependent variable T_i for the year 2007.

Covariate	Parameter	Std. dev.
Constant	0.409	0.214
Successor in the same political group	0.890	0.154
Electric power consumption per capita	−0.401	0.202
% of households with waste disposal services	−1.807	0.356

Pseudo- $R^2 = 0.139$. Log-likelihood = −215.583. Observ. = 484.

In that context, [Rosenbaum and Rubin \(1983\)](#) show that the results of the control group mimic the counterfactuals of the treatment group under two hypotheses¹⁹ (omitting the indexes for municipality and time period): (i) there is a “selection on observables” such that $(Y_0, Y_1) \perp (T|X)$, meaning that the potential results are independent from the treatment conditioned to the observable characteristics; and (ii) there is a “common support” such that $0 < \mathbb{E}(T = 1|X) = p(X) < 1$, meaning that there are no observations where the researcher knows for certainty that the municipality was or was not submitted to treatment when observing the covariates.

In practical terms, as described in [Becker and Ichino \(2002\)](#) or [Khandker et al. \(2010\)](#), to sustain these two hypotheses, one chooses a sub-sample following the protocol of matching the treatment and control groups (leaving the sub-sample components sufficiently similar in terms of covariates). In the first part of the protocol, a $p(x)$, is estimated through a Probit or Logit model, and the common support observations are selected – where x is a subset of the covariates used in (3). Afterwards, the common support is split into various intervals, and the null hypothesis is tested in which the vector containing the control group’s covariates’ mean is equal to the treatment’s. If the null hypothesis is not rejected interval to interval, the sub-sample is selected from the common support for the ATT estimation through Eq. (3). And if it is rejected, another x vector is tested until a suitable matching – which is usually done by the visual inspection of a kernel estimator of the density of $p(x|T)$ under common support.

Thus, the ATT identification strategy follows the ensuing steps: (1) a matching protocol is done between the treatment and control groups in $t=0$, using a covariates vector that characterizes the municipality; (2) Eq. (3) is estimated for the indicators in education and health using a matched sub-sample, computing least squares estimators, as well as fixed and random effects estimators; and (3) through these statistical tests, one makes conclusions about the best ATT estimation.

Given that the unit of observation is the municipality, the covariates used in each step should be “municipal supply indicators” related to the results. Taking that into account, the supply indicators can be divided into four categories: (i) those related to municipal government, e.g., the mayor’s educational level or if he/she has been reelected; (ii) those related to the socioeconomic development, such as sanitation conditions and characteristics of the local economy; (iii) those related to basic education, such as the structural characteristics of schools that belong to the municipal education system; and (iv) those related to TMI, e.g., PSF medical care. As such, a database was elaborated with indicators to be tested during the procedures.

Lastly, a subset of the covariates was selected using the following criteria: (i) the subset used was the one that better adjusted to matching, and regarding the estimation of $p(x)$ and the visual inspection of $p(x|T)$ under common support; and (ii) besides the covariates used in the matching procedure, more were added which are related to basic education and TMI, and were shown to be statistically significant in the estimations of Eq. (3). Such variables and their descriptive statistics are featured in this work’s appendix.

4. Estimated results and evaluation

In terms of the matching procedure, [Table 3](#) presents the results for the Probit regression for $p(x)$ for the year of 2007. The covariates used were: (i) a binary variable indicating if the mayor was reelected or if a candidate of his political

¹⁹ Together, these hypotheses are known as *conditional independence*.

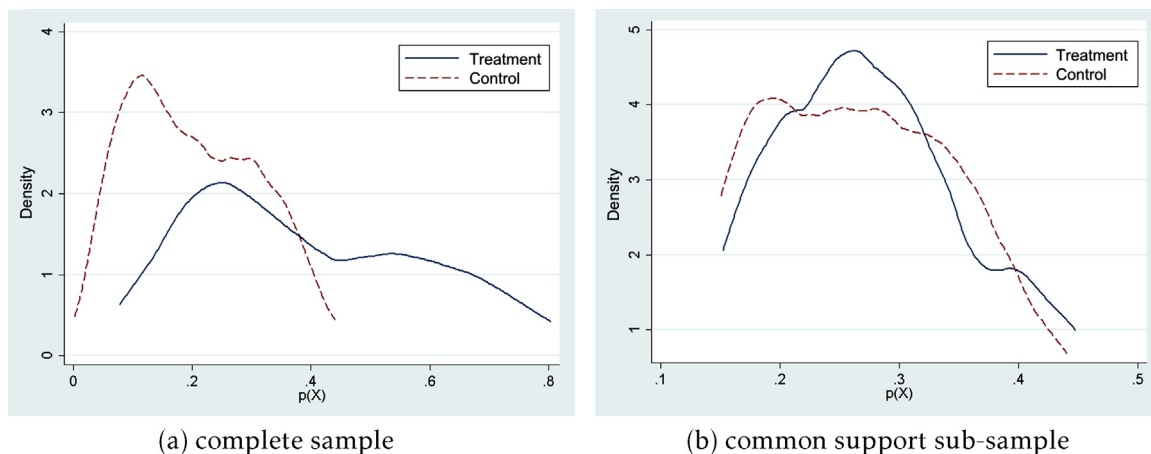


Fig. 1. Graphs for the propensity score density functions estimated through the kernel method for the two samples, the complete sample and the one restricted to common support, considering information for the year of 2007.

group was selected in the 2008 elections²⁰; (ii) the electric power consumption per capita in the municipality²¹; and (iii) the percentage of households which benefit from regular waste disposal services.²² The first aims to capture the population's perception in terms of what good political management is, and the other two seek to capture the level of municipal socioeconomic development.

Based on the estimated results for $p(x)$, the common support was defined by the interval [0.149; 0.448]. Of the 168 municipalities in the state of Ceará that were observed, 66 are in the common support. And of the 316 municipalities in the state of Bahia, that number is 169.

Fig. 1 shows graphs for the propensity score density functions estimated through the kernel method for the complete sample and the one restricted to common support. Comparing the densities, it can be observed that there is a superposition in the sub-sample curves. This indicates that, when observing only the covariates for the municipalities, it is not possible to distinguish to which state it belongs. Therefore, visual inspection signals good matching quality.²³

Having presented the matching results, Table 4 shows the estimated results for Eq. (3) through the least squares method (LS), fixed effects (FE) and random effects (RE), using the 235 cross-sectional units observed in the common support (in a panel for the years 2007 and 2009).

Note that according to the procedures described in the previous section, for each indicator studied, a covariate is also added that was not used during the matching. In the case of the education indicators²⁴: the teacher/school ratio in the municipal education system; and the percentages of schools with computer labs, roofed sports courts and libraries. The former aims to capture the teachers' work overload effect, and the latter the quality of physical infrastructure.²⁵ And, in terms of health, the number of PSF physicians per thousand inhabitants,²⁶ is added, aiming to control its effects on the TMI (see Rocha and Soares, 2010).

Columns 1–6 in Table 4 present the estimated results for the dependent variable average *Prova Brasil* test scores in Portuguese for 5th grade students in basic education. Each column presents the results of an estimator (LS, FE and RE) with the matching and additional covariates. All the ATT measurements are statistically significant (at least at 5%) and

²⁰ Data was obtained from the *Tribunal Superior Eleitoral* (TSE).

²¹ Data obtained from *Instituto de Pesquisa e Estratégia Econômica do Ceará* (IPECE) and *Superintendência de Estudos Sociais e Econômicos da Bahia* (SEI).

²² Data obtained from DATASUS.

²³ The balancing property test also indicates good matching quality – for further details, see Becker and Ichino (2002). Furthermore, using only the sub-sample, it is verified that when reestimating $p(x)$, the pseudo- R^2 approaches zero – a fact that also corroborates the good quality of the procedure.

²⁴ Data obtained through INEP.

²⁵ Biondi et al. (2009) and Vasconcellos et al. (2009) use similar structures in their analyses.

²⁶ Data obtained through DATASUS.

Table 4

Estimated results for Eq. (3) for the dependent variables Portuguese test scores (POR) and mathematics test scores (MAT), school passing rates (TAP), and child mortality rate (TMI) through least squares (LS), fixed effects (FE) and random effects (RE) – robust standard deviation of the estimates is in parentheses.

Dep. variable	POR						MAT					
	1	2	3	4	5	6	7	8	9	10	11	12
Model and estimator	LS	FE	RE	LS	FE	RE	LS	FE	RE	LS	FE	RE
Constant	204.53*	216.51*	205.13*	206.48*	216.39*	207.44*	220.18*	222.58*	220.21*	222.06*	223.27*	222.09*
	(1.50)	(6.08)	(1.79)	(1.55)	(6.30)	(1.83)	(1.53)	(5.48)	(1.84)	(1.55)	(5.74)	(1.85)
Treatment	−0.28		−0.28	−2.86*		−3.28*	−0.91		−0.86	−3.31*		−3.37*
	(1.14)		(1.16)	(1.38)		(1.47)	(1.11)		(1.12)	(1.34)		(1.45)
Time	7.98*	8.86*	8.03*	7.77*	8.71*	7.83*	0.87	0.88	0.86	0.73	1.11	0.82
	(1.09)	(0.90)	(0.73)	(1.10)	(1.03)	(0.74)	(1.08)	(0.78)	(0.65)	(1.09)	(0.91)	(0.66)
Time × treatment	7.49*	6.91*	7.46*	6.42*	5.47*	6.09*	4.98*	5.60*	5.05*	3.94*	4.75*	4.09*
	(1.63)	(1.20)	(1.05)	(1.64)	(1.30)	(1.09)	(1.74)	(1.37)	(1.22)	(1.71)	(1.50)	(1.28)
Political successor	−1.17	−10.68	−1.31	−1.13	−9.73	−1.32	−1.02	−10.05	−1.18	−0.98	−9.19	−1.18
	(0.92)	(7.36)	(1.16)	(0.90)	(7.72)	(1.15)	(1.00)	(7.17)	(1.21)			
Electric power per capita	5.68*	2.78	5.57*	5.01*	7.08	5.39*	2.10*	6.87*	2.68*	1.50	9.96*	2.45*
	(0.90)	(3.54)	(1.02)	(0.89)	(4.78)	(0.98)	(1.13)	(3.14)	(1.41)	(1.09)	(4.16)	(1.36)
% of Households with r.w.d. ^a	9.41*	−4.39	8.57*	5.84*	−4.90	5.22*	5.37*	0.97	4.94*	1.97	0.26	2.05
	(2.03)	(8.60)	(2.49)	(2.10)	(8.25)	(2.53)	(2.07)	(7.73)	(2.54)	(2.10)	(7.55)	(2.53)
Teacher/school				−3.60	−29.93	−10.52				−3.70	−23.95	−7.95
				(5.61)	(19.74)	(6.05)				(5.77)	(18.35)	(6.27)
Computer lab/school				16.97*	34.45*	23.84*				14.56*	16.46*	14.00*
				(6.56)	(8.98)	(6.80)				(7.29)	(10.57)	(7.12)
Sports court/school				21.25*	3.57	17.71*				26.43*	14.00	25.02*
				(5.33)	(15.88)	(6.22)				(5.71)	(15.80)	(6.28)
Library/school				−3.78	0.82	−1.71				−7.22	−6.25	−5.54
				(4.17)	(7.58)	(4.36)				(3.22)	(8.87)	(4.58)
PSF medical appointments												
R-SQR**	352.78	159.20	179.03	346.78	156.18	176.28	365.03	167.19	188.52	358.52	166.00	188.45
R ² ***	0.23	0.84	0.80	0.26	0.85	0.81	0.04	0.80	0.74	0.07	0.80	0.74
F****		3.87			3.85			3.72			3.59	
Hausman*****		3.76			9.55			2.60			7.07	

Table 4 (Continued)

Dep. variable	TAP						TMI			
	13		14		15		16		17	
	LS	FE	RE	LS	FE	RE	LS	FE	RE	
Constant	66.57*	55.43*	65.95*	67.81*	55.82*	67.30*	18.88*	25.88*	18.89*	
	(1.42)	(5.95)	(1.69)	(1.48)	(6.13)	(1.76)	(1.15)	(5.47)	(1.16)	
Treatment	13.43*		13.33*	10.93*		11.00*	−1.51*		−1.51*	
	(1.01)		(1.03)	(1.25)		(1.36)	(0.86)		(0.87)	
Time	2.40*	1.56*	2.36*	2.93*	2.02*	2.81*	−0.22*	0.33*	−0.22*	
	(0.96)	(0.79)	(0.65)	(0.97)	(0.88)	(0.66)	(0.74)	(0.91)	(0.75)	
Time × treatment	0.72	0.32	0.62	1.17	0.23	0.74	−0.74	−0.60	−0.74	
	(1.42)	(1.08)	(0.89)	(1.47)	(1.08)	(0.95)	(1.14)	(1.23)	(1.09)	
Political successor	2.63*	28.25*	3.12*	2.68*	27.71*	3.15*	−0.12	−4.80	−0.12	
	(0.87)	(11.92)	(1.20)	(0.86)	(12.55)	(1.19)	(0.65)	(4.55)	(0.67)	
Electric power per capita	3.40*	−1.00	2.53*	3.53*	0.54	2.73*	−1.70*	0.29	−1.69*	
	(1.35)	(3.77)	(1.35)	(1.36)	(3.85)	(1.37)	(0.75)	(3.33)	(0.73)	
% of Households with r.w.d. ^a	−9.46	9.91	−7.95	−10.38	8.65	−9.03	1.73	−10.15	1.70	
	(11.85)	(8.23)	(12.28)	(10.89)	(8.45)	(12.35)	(1.61)	(8.03)	(1.65)	
Teacher/school				−13.95*	−17.36	−13.84*				
				(6.24)	(12.54)	(7.22)				
Computer lab/school				−9.15	−1.51	−4.64				
				(6.02)	(7.82)	(5.83)				
Sports court/school				18.44*	34.45*	21.27*				
				(5.14)	(15.22)	(6.01)				
Library/school				6.28*	−6.01	1.98				
				(2.69)	(7.15)	(3.89)				
PSF medical appointments							−8.16*	−7.15*	−8.22*	
							(1.80)	(4.86)	(2.43)	
R-SQR**	309.89	136.36	154.81	306.68	135.16	153.87	245.58	169.95	235.99	
R ² ***	0.33	0.87	0.83	0.34	0.87	0.83	0.02	0.53	0.09	
F****		4.12			4.06			1.07		
Hausman*****		20.83			21.30			2.12		

* Estimation statistically different than zero at the 5% significance level.

** Square root of sum of squared residuals (\hat{u}_{it}).

*** R² calculated based on \hat{u}_{it} .

**** Statistics for the F test of LS vis-à-vis FE.

***** Statistics for the Hausman test of RE vis-à-vis FE.

^a Regular waste disposal.

oscillate between 5.47 and 7.49 points in the SAEB scale (values close to those presented in Table 2 using the simple difference in difference model).

Also in terms of the test scores in Portuguese dependent variable, it is worth making a few comments on the estimated parameters for the covariates. In that sense, it can be observed that there is a positive and significant influence of the socioeconomic variables of the municipality (electric power consumption per capita and the percentage of households with a regular waste disposal service) and those that reflect the quality of school infrastructure (percentage of schools with computer labs and roofed sports courts).

Proceeding with the presentation of Table 4, columns 7–12, present the estimated results for the dependent variable average test scores in mathematics. All the ATT measurements are statistically significant (at least at 5%) and oscillate between 3.94 and 5.60 points in the SAEB scale (also close to the values presented in Table 2). Furthermore, in terms of the estimates parameters for the covariates, one can also observe a positive and significant influence of the socioeconomic variables of the municipality and those that reflect the quality of school infrastructure.

As for the other columns in Table 4, these present the estimated results for the dependent variables school passing rates and TMI. For these variables, as was the case in the differences in differences model presented in Table 2, there are no statistically significant ATT measurements.²⁷

In short, the results for all estimators point to a significant and positive effect of the law change only on the students' average proficiency. However, for each of those dependent variables, Table 4 presents six ATT estimations. Thus, aiming to define if one is more adequate than the other, the following test statistics are also presented for each triplet of estimators²⁸: (i) one test is the F' , related to the null hypothesis that the LS and FE results are the same (being the former a restricted case of the latter); and (ii) another test is the Hausman test, which has as its null hypothesis the fact that the FE and RE results do not significantly differ (so the RE model generates consistent and efficient estimates).

As for the estimated results for the dependent variable average test scores in Portuguese, presented in columns 1–3, the $F' = 3.87$ does not corroborate with the acceptance of the null hypothesis that the LS and FE estimates are equal.²⁹ This indicates that the unrestricted model adjusts more adequately to the data – following the logic of a standard F test. Additionally, the Hausman test statistic points that the RE results are better adjusted to the data. Following the same logic for columns 4–12, both for Portuguese and mathematics test scores, for each triplet of estimators, there is indication that the RE results are better adjusted to the data.

Therefore, what remains is testing which of the random effects estimations is more adequate. Note that the model in column 3 is a restricted form for the one in column 6 (for the case of the Portuguese test scores), and that the model in column 9 is a restricted form for the one in column 12 (for the case of the mathematics test scores). As such, another pair of F tests can be constructed using the sum of squared residuals – also presented in Table 4. Following that procedure, there is indication that both unrestricted estimators (column 6 and 12) are better adjusted to the data. In other words, there is indication that the best estimations for the ATT are: 6.09 for the Portuguese test scores; and 4.09 for the mathematics test scores.

However, three questions then appear: (i) why is this effect only observed in the proficiency variables?; (ii) can it be said that this effect is large?; and (iii) how do municipalities generate this effect?

Regarding the first question, in relation to the distribution rule given by Eq. (1), it makes sense that competition between mayors for the quota-share is more present in the improvement of “5th grade test scores”, i.e., in the improvement of the quality of basic education, for the following reasons. The mayor can manipulate the “4th to 5th grade school passing rate” indicator, advising the schools not to retain students in a failing grade. However, this would lead to potentially unprepared 5th grade students, which would not have good test scores and would eventually penalize the quota. So manipulating passing rates cannot be a sustainable strategy.

The mayor can also emphasize in the improvement of teaching in the first years of the basic education cycle, to gain quota in the “2nd grade literacy” indicator. However, since 2004 the state government runs (alongside the federal government) a program called PAIC, Program for Literacy at the Appropriate Age, which acts in conjunction with

²⁷ In relation to the estimates parameters for the covariates, it can be observed that there is a positive and significant influence of the socioeconomic variables of the municipality, and of those that reflect the quality of school infrastructure on the school passing rates. As for the TMI, as in Rocha and Soares (2010), a negative and significant correlation is observed, in relation to the number of PSF medical appointments.

²⁸ Details for these test procedures can be found in Wooldridge (2010), p. 288 and on.

²⁹ Considering degrees of freedom and significance level of 5%. In these conditions, the critical value is 3.01.

all municipalities in an equal manner, ensuring the same training to teachers of the first grades, and using the same teaching material. Thus, such an indicator gives little scope for differentiation and competition for the quota-share.³⁰

A similar reasoning can be used regarding the TMI, for it is a key variable in the PSF family health program. (The PSF program is also a partnership between the state and federal governments.) Hence, as well as the TMI being a difficult variable to modify in the short run, it is also the objective of a larger program, greater than any municipal action.

Lastly, as for the environment variable, not only is its weight in the quota low, it is a simple variable to obtain, being only necessary to gain accreditation with the Environment State Department.³¹

For those reasons, it seems natural that the positive effects of the law change are better defined in relation to the “5th grade test scores” indicator.

As for the magnitude of the estimated ATT, in the Portuguese test scores, the impact close to 6 points is considerable when compared to the one found in Vasconcellos et al. (2009). The authors of that work evaluated the impact of the *Escrevendo o Futuro* (Writing the Future) program in the public schools’ performance at the Prova Brasil Portuguese tests, a project linked to the Brazilian Portuguese Olympiad, and found 1 to 2 point impacts. As for the approximately 4 points of impact in the mathematics test scores, Biondi et al. (2009) found a positive impact close to 2 points in scores for schools enrolled in the Brazilian Mathematical Olympiad. Based on such numbers, it can be said that the impact of the ICMS law change in Ceará generated a considerable effect on student proficiency.

How the municipalities generate such an effect is a question that demands more investigation, and that likely has different answers for different municipalities. But these effects are probably related to an assumption about the alignment of incentives: the programs evaluated by Vasconcellos et al. (2009) and Biondi et al. (2009) focus on encouraging students and teachers; on the other hand, the law focuses on incentives towards the mayors (increasing the available resources during his term).

The incentives geared towards students (or teachers) mobilize only one economic agent, the student (or the teacher). On the other hand, incentives to the mayor allow the mobilization of a wide array of other agents: school principals, teachers, students, secretaries, etc., considering the greater number of institutional instruments that the mayor possesses.

Thus, one can presume that the effect of an incentive policy geared towards the mayors is greater than policies focused only on the school or its students. In that case, the alignment of incentives should be on the mayor, in detriment to the student or the school. But this is also an issue that demands further investigation.

Lastly, it is worth discussing about the relationship between the benefits and costs of a law change. One way to do such an analysis, from the society’s perspective, is to observe that the change generated two movements³²: (i) the expected gain in the quality of basic education (identified here in this work); and (ii) a distortion of quota-shares in relation to a *status quo*, where some municipalities obtained gains, and others collected losses in budgetary resources (as documented in Holanda, 2012).

Considering the perspective in (i), this increase in the quality of education should be reflected in future human capital gains. And these gains, in some way, could be converted into an expected flow of financial benefit for society – since more human capital should generate more wealth. This conversion would come from the simulation of scenarios, as presented in Menezes Filho (2012).

As for the social costs of the law change perspective, for the municipalities that suffer a reduction in transfers, the cost can be great. It can also generate income inequality within the state, for the quota-share is a resource transfer of the unconditional kind (it doesn’t impose any obligation in resource application, for the municipal government, in specific expenses). This characteristic gives the mayors greater autonomy in spending, so less quota-share transfers could also mean lesser investments and resources allocated to social areas (including education). Therefore, this also requires further investigation.

5. Concluding remarks

This work proposed to evaluate the impact of a change in the ICMS tax law in the Brazilian state of Ceará, which occurred in 2007, and apportioned the municipal tax revenue quota-share according to result indicators in health,

³⁰ In a way, such an evaluation is only conjecture, for the effect of the law on “2nd grade literacy” was not evaluated in this work.

³¹ Details in Nogueira et al. (2011).

³² Apart from these movements, the political stress with the arguing about the rule in the Legislative Assembly could also be mentioned.

education and the environment. In that sense, it is observed that there was a positive impact of considerable magnitude only in student proficiency for students of the municipal education system, in standardized Portuguese and mathematics tests.

It was also observed that the ICMS distribution rule is an incentive for the mayor to rationally focus on improving the quality of education, in detriment to health and environment indicators. This is not necessarily bad, considering that the advancements in student proficiency were considerable. But this can be an indication that the rule should be simplified, computing fewer result indicators of only one segment (health, education or environment, and not all at the same time).³³

Lastly, three possible extensions of this work were considered. The first consists of studying the conjecture in which, regarding the education indicators for basic education, the effect of an incentive policy geared towards mayors is greater than policies focused on the school or the students, for the mayor has institutional instruments which can enhance the mayors' actions (e.g., the possibility of choosing school principals or creating incentives better aligned with that municipality's teachers and students).

The second possible extension is to ascertain how mayors managed to achieve the improvements in education indicators. For that purpose, a case study is proposed for some municipalities that stood out in advancing those indicators.

The third extension is the analysis of costs and benefits of such a law change. In the short run, some municipalities increased their revenue, but other lost budgetary resources. As the quota-share is an unconditional transfer, it is necessary to investigate if the advancements in education indicators aren't being achieved at the cost of less investment in other areas (e.g., public transportation or sanitation).

Appendix A. Mean and standard deviation (in parentheses) of the covariates used in the matching and estimation procedures for Eq. (3)

Indicator	CE		BA	
	2007	2009	2007	2009
Municipality in which the mayor's successor in 2009 is of the same political party (%)	39.1 (49.1)		14.5 (35.3)	
Consumption of electric power per capita (kWh)	411.3 (140.3)	317.1 (344.0)	463.3 (380.4)	511.5 (379.0)
Households with regular waste disposal services (%)	59.3 (18.8)	63.6 (18.3)	63.5 (20.3)	68.9 (18.6)
Teacher school ratio for the municipal education system	11.0 (4.6)	12.8 (5.7)	12.4 (8.0)	15.7 (10.1)
Municipal education system schools with computers labs (%)	7.6 (7.4)	15.1 (9.7)	2.1 (4.9)	4.9 (7.1)
Municipal education system schools with a roofed sports court (%)	13.9 (10.8)	14.4 (10.8)	4.8 (6.2)	5.6 (6.9)
Municipal education system schools with libraries (%)	22.5 (14.5)	22.5 (13.6)	6.7 (8.8)	8.8 (8.2)
Annual PSF medical appointments per thousand inhabitants	40.6 (29.5)	34.5 (23.3)	23.8 (25.9)	19.2 (17.1)

Sources: TSE, IPECE, SEI, INEP and DATASUS.

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³³ This indication is also observed in Bruzoni et al. (2008). The authors investigate the case of the Minas Gerais, and observe that the municipalities presented a decrease in education indicators, in detriment to the health indicators. This is possibly because the distribution rules were overtly complicated and favored the specialization in health indicators.

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