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ESCOLA DE ECONOMIA DE SÃO PAULO

BRUNA MIRELLE DE JESUS DA SILVA

EDUCATIONAL IMPACTS OF ELECTRIFICATION: EVIDENCE FROM BRAZIL

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Dissertação apresentada à Escola de Economia de São Paulo como pré-requisito à obtenção de título de mestre em Economia de Empresas.

Orientador: André Portela Fernandes de Souza.

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Resumo

Essa dissertação usa a expansão do programa Luz para Todos na zona rural do Nordeste brasileiro de forma a capturar os efeitos da eletrificação em organização, matrículas e infraestrutura escolar. Utilizando dados em painel a nível escolar construído a partir do Censo Escolar e utilizando a estratégia de efeitos fixos com variável instrumental, nós encontramos evidências de que eletrificação significantemente aumenta, para Educação de Adultos, as matrículas e turmas no período noturno, matrículas femininas e masculinas e aumento de matrículas das faixas etárias mais jovens e da mais velha. Há evidências de que eletrificação nas escolas também tem efeitos na margem extensiva, expandindo o números de escolas que oferecem educação de adultos. **Palavras-chave**: eletrificação; educação ; variável instrumental.

Abstract

This dissertation uses roll-out of the Light for all program in rural Northeastern Brazil in order to assess the effects of electrification on school organisation, school enrollment and infrastructure. Using school-level panel data from School Census and fixed effects instrumental variables strategy, we find evidence that electrification significantly raises nighttime Adult Education enrollments and classes, female and male enrollment, and younger and older cohorts enrollment. There are evidences that school electrification affects also in extensive margin, expanding the number of schools offering adult education
Keywords: electrification; education; instrumental variable.

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1 Introduction

According to the International energy Agency (2016), at least 1.1 billion people lack access to electricity. Over the years, there was an increased effort by countries to expand electrification access and overcome these statistics. In spite of this effort, little is known about the direct effects that new access to energy will have on school outcomes.

The main goal of this dissertation is to analyze the impact of school access to electricity on enrollment and classes for different school levels and periods. Moreover, we analyze effects on enrollment by gender and age cohort. We estimate the impact of school electrification on outcomes in rural Northeastern Brazil by leveraging variation in school access to electricity induced by a government program of electricity expansion to rural areas known as Light for all (*Luz Para Todos*).

The electricity coverage level of municipalities in 2000 is the most relevant criterion for participation in the Light for all program. Municipalities with less than 85% of electric energy coverage in 2000 are given priority in program rollout. We propose to use this criterion along with the distance of a school to the nearest transmission line in order to evaluate the effects of electrification on schools.

In this dissertation, we use a fixed effects instrumental variables strategy to identify the impact of electricity on school outcomes. In our main approach, we instrument school access to electricity with a triple interaction between the Light for all eligibility criterion, the distance of a school to the nearest transmission line in 2000 and time dummies. In order to conduct this estimation, we construct a panel with School Census data and match it with georeferenced data on transmission lines and coverage data from the Brazilian Population Census (2000).

Longer distances from transmission lines raise the average cost of a school connection, making distance in past years an important factor in predicting school electrification. Also, the eligibility rule of the Light for All program increases the probability of eligible areas to receive electricity as years pass. The interaction between both (along with time effects) may thus provide a source of exogenous variation – especially if we control for unobserved time-invariant school heterogeneity (fixed effects) – that may allow us to identify the effects of interest. We provide first-stage estimates that show our instruments are relevant. We also report placebo experiments with urban areas and from periods before the program started that support the validity of our strategy.

Our results suggest that the arrival of electricity in schools leads to a significant increase in nighttime period enrollment and in the number of classes for Adult Education. Female enrollment also increases in Adult Education. By age cohort, we see an increase in

enrollment in ages 15-17, 18-24 and for those older than 39 years. For Basic Education, the results point to increases in daytime classes, and a fall in nighttime enrollment and male enrollment. We also investigate the impacts of electricity on school infrastructure and find significant and positive increases in the number of employees and in the presence of computers for student use, though these estimates are not robust.

There is a large literature on the impacts of electrification (as described in Chapter 2 below). Our main contribution is to analyze the impacts of the arrival of electricity *at schools* on outcomes. In addition, this study explores the electrification effects on nighttime schooling and on little explored subjects such as adult education.

The remainder of this paper is organized as follows. Chapter 2 briefly surveys the literature on the impacts of electrification and the main mechanisms at work. We introduce the Light For All Program used in our IV strategy in Chapter 3. Chapter 4 describes our data and empirical strategy. Chapter 5 presents the results of our estimation. Chapter 6 concludes.

2 Literature

Access to electricity directly impacts the quality of life of human beings, especially among the rural population. Group (2008a) shows that electricity provides access to home appliances that facilitate the domestic chores and, therefore, provide more free time. There is more access to information and technology since people may buy computers and televisions. Besides that, refrigerators modify how food is stocked, which can impact family nutrition. Lighting also impacts education, providing better quality with increased illumination, and the expansion of night classes.

The effects of electrification are not just restricted to the household environment. There can also be impacts on trade and labor markets. Electricity creates new business opportunities, which were previously impossible due to the lack of infrastructure.

There is an extensive literature about rural electrification. Most of these studies concern electrification as a government policy in developing countries. Some of them are financed by the World Bank, which provides analyses after the implementation.

The related literature is concerned, in general, with the impact of electrification on dimensions of welfare in developing countries. We can divide the empirical results on effects by age (adults, children and teenagers). We may also divide studies in different dimensions of analysis: impacts on the community, household and school.

First, when a household receives electricity, it is reported that people invest in lighting, powering television and household appliances, as can be seen in Bernard (2012), Barnes (2007) and Group (2008b). This increases the productivity of domestic duties and, as a consequence, people have more free time to do other activities. There are interesting empirical results about the electrification effects on the productivity of domestic duties, small-scale enterprise development and rural industrialization, which we briefly describe below.

Dinkelman (2011) studied the effects of rural electrification on labor markets in South Africa. This study used the land gradient as an instrumental variable. As a result, she found an increase in female employment opportunities and in productivity of domestic work, a fall in female's wages and a rise in male's wages. These changes are accompanied by increasing engangement of rural women in market-based work. Köhlin (2011) found similar results for women in Sub-Saharan Africa. For Bangladesh, Chowdhury (2010) and Abul Barkat (2002) show that electrification increases the employment probability of women and that it decreases the total time that women spend on unpaid work. Also, people spend a greater share of their evening hours in household-based income generating activities and increase the productivity of domestic work.

Alby et al. (2013) study when electricity arrives at the community level. In some developing countries, electricity provision is scarce, with the result that many enterprises must contend with an insufficient and unreliable supply of electricity. They introduce firm size and credit constraints in a small moral hazard model to show that unreliable electricity input may have heterogeneous negative effects which are concentrated in small firms and in sectors that are more reliant on electricity – these facts are then validated by the data. On a related note, Dinkelman (2011) shows that there is an increase in the productivity of domestic work with new machines.

Shahidur R. Khandker and Samad (2012) analyzed the relationship between the adoption of electricity and income, expenditures and education in Bangladesh. Household's access to electricity is predicted using instrumental variables in a probit regression and household's location within or beyond 100 feet of an electricity line is used as an instrument. They reported a positive impact on household income. Khandker et al. (2013) carried out a similar study for Vietnam and found similar results.

Lipscomb et al. (2013) study the effects of electrification on local development in Brazil. The effects of electricity grid expansions are instrumented through the predictions of a model of Hydropower plant placement based on topographic considerations, which generates exogenous variation unrelated to the demand-side. The authors find an increase in regional income, human development index (HDI), and more formal and informal employment.

In India, Shahidur R. Khandker and Barnes (2014) analyzed the impact of electrification on time allocation, labor supply, income, employment and schooling. They found that rural electrification reduces time allocated to fuelwood collection by household members and increases the labor supply of men and women; there is also an increase in household *per capita* income and expenditure, which amelliorates poverty.

Also in Rural India, van de Walle et al. (2013) find gains from household electrification in consumption and earnings. They claim the latter may be attributed to changes in market labor supply. They also find evidence of external effects, i.e. households without electricity seem to benefit from village electrification. Wage rates appear to remain unaffected by these changes.

There are also some studies which focus on the effects of household electrification on children and teenagers. Access to electricity extends the time available for activities that need good lighting and propitiates access to electronic devices such as computers, which may facilitate learning. Children can do homework and reading into the evening. Changes in home-based technology further reduce household dependence on female child labor and the opportunity cost of sending girls to school.

Bensch et al. (2011) examines the effect of electrification status on lighting usage,

the time children dedicate to studying at home, energy expenditures, and income using cross-sectional data from Rwanda. They did not observe an effect of access to electricity on children's study time at home. In contrast, Shahidur R. Khandker and Samad (2012) reported more study hours and completed schooling years at the individual level in Bangladesh and Shahidur R. Khandker and Barnes (2014) noticed an increase in time allocated to studying by boys and girls and increased schooling for both genders. Similarly, Lipscomb et al. (2013) found reductions in the illiteracy rate and in the proportion of the population with less than four years of education, and increased years of study in Brazil. van de Walle et al. (2013) finds positive effects on schooling for girls but not for boys.

Dasso et al. (2015) examines the impact of rural electrification on educational outcomes in rural Peru. They used panel data with region fixed effect and found that access to electricity has no effect on boys' educational outcomes. However, treatment increases female school enrollment, as well as the amount of money spent on girls' education. Looking at electricity access at schools, they saw that treated schools have lower test scores than non-treated schools. But, among treated schools, longer treatment exposure increases scores in reading for boys and girls; and improves performance in math, only among boys.

In the present study, we define electricity access at school as our treatment. Our main contribution to the literature is to analyze the electrification effects on different school outcomes. In addition, this study explores the electrification effects on nighttime schooling. We also study the effects on little explored subjects such as adult education. Finally, we explore the effects on enrollments by age and gender.

3 Light For All Program

Decree no. 4.873, dated November 11, 2003, set up the National Program for Universal Access to and Use of Electricity, Light for all program. The Program was conceived as an instrument for development and social inclusion, since, according to the census of the Brazilian Institute of Geography and Statistics - IBGE, in 2000 there were two million rural households not served by the electricity provider. Therefore, approximately ten million Brazilians lived in rural areas without access to this public service, and about ninety percent of these families had monthly incomes lower than three minimum wages.

In its first stage, the Program aimed to bring electrical energy, up to 2008, to those rural domains identified by IBGE. However, during the execution of the Program, new families were located without electric power in their homes, which resulted in the issuance of Decree No. 6.442 of April 25, 2008, expanding the program objectives and extending the deadline for the end of 2010.

Subsequently, through Decree No. 7,324, dated October 5, 2010, the Federal Government ensured the extension of the deadline for the execution of the connections destined to the service in electrical energy, until 31 of December 2011, with the purpose of guaranteeing the completion of the contracted works or that were in the contract Process by October 30, 2010.

In spite of the significant results observed in the implementation of the set Goals, new demands were mostly found in the North and Northeast of the Country, which already had the highest exclusion rates in 2003. In addition to the logistics difficulties for the execution of the works, these regions concentrate, among others, a significant portion of the population Quilombola, Indigenous and Communities located in Extractive Reserves and Areas of Enterprise of the Electric Sector, whose responsibility is not defined for the Executor of the Enterprise.

Thus, in order to meet this demand, Decree No. 7,520, of July 8, 2011, established the Program for the period from 2011 to 2014, and was extended by Decree No. 8,387, dated December 30, 2014, to the year 2018. By April 2017, more than 3.3 million households were served, benefiting 16 million people in the rural area.

With the objective of providing electricity access to the rural population that does not have access to the Program, on April 27, 2018, it was published Decree 9.357, extending the Program until the year 2022

According to the Light for All Program Manual MME (2004), financial resources should prioritize electrification projects in areas and municipalities that met as many of

the following criteria as possible:

I - Municipalities whose rural electrification coverage is less than 85% (based on the 2000 Population Census);

II - Municipalities human development index lower than the state average;

III - public schools, health centers, and water wells;

IV - rural settlements;

V - rural electrification projects targeted at the productive use of electric power and at fostering local integrated development;

VI - Households affected by hydroelectric power plants or by electrical system works whose liability is not defined for the project developer;

VII - development of subsistence agriculture or of family-run handicraft activities;

VIII - smallholdings and medium-sized rural estates;

IX - rural electrification projects stalled for lack of funds and aimed at rural communities and villages;

X - rural electrification projects for populations living in the vicinity of nature conservation units; and

XI - rural electrification projects for populations in areas specifically used by special communities, such as racial minorities, remaining *quilombo* communities , extracting communities, etc.

4 Data and Empirical Strategy

4.1 Data

For the main analysis of the school effects of electrification, we construct a ten-year panel (2001-2010) of school aggregate variables using the Brazilian School Census, produced by the National Institute for Educational Studies and Research "Anísio Teixeira" (INEP), a research agency linked to the Ministry of Education. To this school-level panel, we add in two additional pieces of data: the geolocation of transmission lines in 2000, collected from the Brazilian Electricity Regulatory Agency (ANEEL), and municipality electricity coverage data from the Brazilian Population Census (2000), produced by The Brazilian Institute of Geography and Statistics (IBGE).

The unit of analysis for the IV strategy is a school-year. We restrict our analysis to the Brazilian Northeast region, which had a rural population of 30,9% in 2000 and covers 9 states (Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia) and 1793 municipalities. Our rural school-level panel has around 30,231 schools per year and 278,576 observations in total. For further placebo analyses, we expand the school-level panel data from 1997 to 2000 and include urban areas.

Table 1 presents means, standard deviations, minima and maxima of key variables used in the main analysis. This table provides descriptive statistics of baseline (2001) variables for the full sample of schools (column 1), and separately (column 2) by schools which are in municipalities eligible to the Light for all program , i.e, these municipalities that have total household electrical coverage percentage less than 85% (Chapter 3).

Table 1 – Control variables

	Total mean/sd/min/max	Eligible mean/sd/min/max
Distance (km)	36.49079	41.67683
	(91.0259)	(61.84585)
	.041036	.041036
	7723.387	1080.319
Electrical coverage percentage (%)	73.83226	64.13162
	(18.08119)	(14.75106)
	7.692308	7.692308
	99.50249	84.98845
N	27281	17890

The main outcome variables this article analyzes are number of enrollments, classes and class size; therefrom, we analyze the gender and age composition. The descriptive

statistics of each dependent variable for all school levels and periods are in Appendix A. School Census methodology changed across years, but we made adaptations to construct the variables. We divided our analysis in two aggregate school levels: Basic Education and Adult Education.

First, Basic Education is subdivided into three school levels in our analysis: Elementary School, Middle School and High School. We adapted these school levels to Brazilian school patterns; therefore, Elementary School corresponds to 1st-4th grades when complete primary education has eight years and 1st-5th grades when complete primary education has nine years. Also, Middle School corresponds to the final years of complete primary education, i.e, 5th-8th grades when the duration is eight years, and 6th-9th grades when the duraton is 9 years. In addition, High School corresponds to 9th-11th or 10th-12th, also dependent on duration. The main difference between Basic Education and Adult Education is that, in the Basic, students are taught the contents at the "correct" age, as defined by government standards.

Finally, Adult Education pervades all contents of Basic Education. It is aimed at young people, adults and the elderly who did not have access to education in the conventional school at the appropriate age. So, in this analysis, we have Elementary School, Middle School and High School inside Adult Education.

Both in Basic education and in Adult education, we separate the analysis into daytime and night time periods when it is possible; also,we analyzed gender among the different school levels and, particularly, for Adult Education we analyze different age cohorts. Again, all the variables and descriptive statistics are in Appendix A.

In the end, we analyzed some infrastructure variables as presence of computer, TV, internet and number of classrooms. Additionally, we analyze if, with electricity access, the school happens to have school meals and new employees.

4.2 Empirical Strategy

4.2.1 Identification

Let y_{it} be school outcomes (for example, school enrollment or school class) for school i in time period t. d_{it} is an indicator variable for whether a school has electricity access in time period t. Initially, if electrification d_{it} was randomly assigned across schools we expected to estimate this simple equation by fixed effects:

$$y_{it} = \alpha_i + \beta_t + \delta d_{it} + \xi' X_{it} + \epsilon_{it}, \tag{4.1}$$

where α_i and δ_t are time and school fixed effects, $\mathbf{X}_{it}$ is a set of controls and ϵ_{it} is

an idiosyncratic error term.

But, d_{it} is endogenous. School outcomes y_{it} can influence a school's electricity d_{it} status, for example, if for some reason the demand for enrollment increases, this can draw the attention of the state and make it improve the infrastructure of the school, such as access to electricity, thereby making d_{it} dependent on y_{ij}, contrary to the relationship in equation. Such a joint determination of y_{it} and d_{it} raises an issue of what causes what. Another potential source of endogeneity could be if, in the period of analysis, a school was assigned a new proactive director, who seeks school improvements on outcomes and in infrastructure (electricity) as well. This is a time-varying unobserved school characteristic that affects *both* electricity d_{it} status and outcomes and it cannot be controlled.

To deal with endogeneity, we will employ a fixed effects instrumental variable approach. We have two different sources of exogenous variation in electric power distribution: 85% coverage criterion of Light for all program and school distance to transmission lines. For the panel data approach, we constructed these variables and use the interaction (along with time dummies) as instrumental variables, as described next (Section 4.2.2).

First, of the priority criteria for participation in the Light for all program, the most relevant is the 85% coverage criterion. Our variable is constructed as:

$$\text{coverage}_{2000m} = \left(\frac{\text{electrified\_households}_{2000m}}{\text{total\_households}_{2000m}}\right).100,$$

where $\text{electrified\_households}_{2000m}$ is the total number of households in the municipality (m) that have access to public electricity in 2000 and $\text{total\_households}_{2000m}$ is the total number of households in the municipality (m) in 2000.

Using this coverage_{2000m} variable, we construct the indicator variable rule_m as follows:

$$\text{rule}_m = \begin{cases} 1, \text{ if coverage}_{2000m} \leq 85\% \\ 0, \text{ otherwise} \end{cases}$$

The eligibility rule of the Light for all program implies exogenous variations on access to electricity, since they were defined based on the 2000 census data. For example, it is expected that, in 2006, schools located in municipalities with less than 85% of electric power coverage in 2000 would have more expansion in electricity access than those schools that, in 2006, were located in municipalities with electric power supply equal to or greater than 85% in 2000.

The second exogenous variable represents a cost variable. It is the euclidean distance in kilometers between the school and the nearest transmission line in 2000:

$$\text{distance}_{2000i} = |\text{transmission\_line}_{2000i} - \text{school\_loc}_i| \text{ (km)},$$

where $\text{transmission\_line}_{2000i}$ is the nearest transmission line to school i and school_loc_i is school location.

School access to electricity depends in part on historical proximity to the power transmission lines and transmission lines are typically located on engineering criteria. Thus, proximity in 2000 should not influence educational outcomes other than through its effects of electrification, especially if we control, as we do in a panel setting, for time-invariant school heterogeneity.

Figure 1 shows the expansion from 2000 to 2010 of school access to electricity in the Northeast. The variables shown in the map are the percentage of schools with electricity in each municipality and the location of transmission lines (red lines). From the left map, in 2000, we can see a correlation between municipality with high levels of electricity access by schools and the proximity to transmission lines; also, the same is seen on the right map in 2010.

In the next section, we will see how our exogenous variables will be interacted in order to deal with the endogeneity problem. To simplify the exposition, we will write dist_i for the distance (in 2000) variable for school i, and rule_i for the indicator variable which equals 1 if i is in an eligible municipality (we will say it is an *eligible* school).

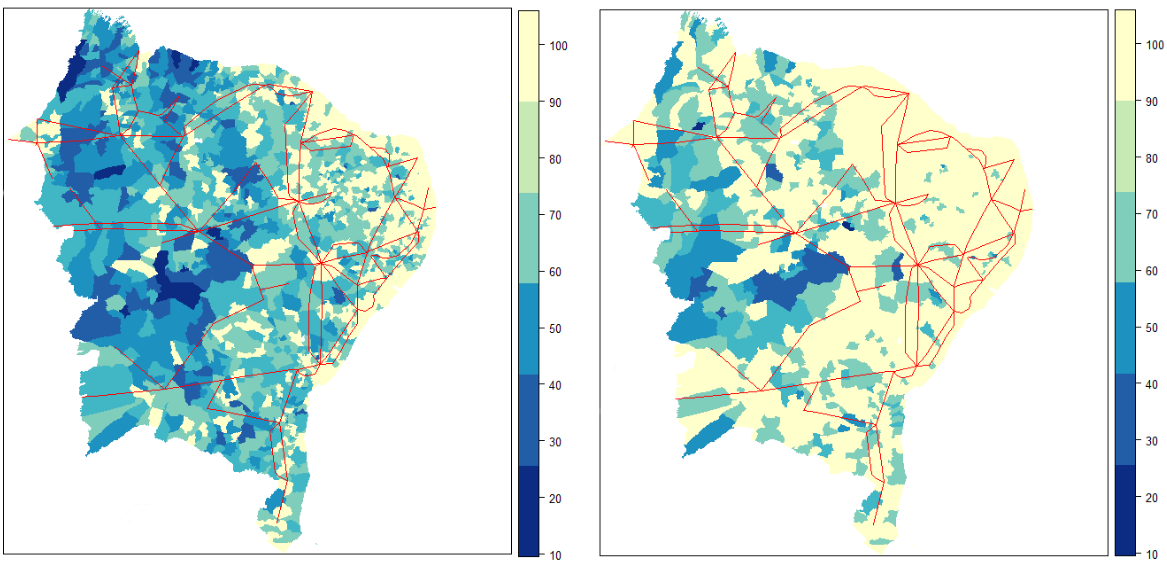

Figure 1 – 2000 and 2010 Northeast Region maps

4.2.2 Estimation

We have access to a sample of schools from the population of interest, which we observe over T periods, i.e. $\{\{y_{it}, d_{it}, \text{rule}_i, \text{dist}_i, X_{it}\}_{t=1}^{T}\}_{i=1}^{N}$. We consider the model:

$$y_{it} = \alpha_i + \beta_t + \gamma_t \text{rule}_i + \omega_t \text{dist}_i + \delta d_{it} + \xi' X_{it} + \epsilon_{it} \tag{4.2}$$

where we control for school fixed effects, aggregate time trends, eligibility-specific time trends; distance-specific time trends (in a linear fashion); and other time-varying controls (X_{it}). The coefficient of interest is δ, the effect of lighting on the outcome of interest, which can be endogenous.

We start by applying a within transformation to remove fixed-effects, which leads to the model.

$$y_{it} - \bar{y}_i = (\beta_t - \bar{\beta}) + (\gamma_t - \bar{\gamma})\text{rule}_i + (\omega_t - \bar{\omega})\text{dist}_i + \delta(d_{it} - \bar{d}_i) + \xi'(X_{it} - \bar{X}_{it}) + \epsilon_{it} - \bar{\epsilon}_i \tag{4.3}$$

where $\bar{A}_i = \sum_{t=1}^{T} A_{it}/T$.

We propose to instrument d_{it} with $T-1$ instruments as follows: for each $\tau \in \{2, 3 \ldots T\}$, define $Z_{it}(\tau) = \mathbb{1}\{t = \tau\}\text{dist}_i \text{rule}_i$, i.e. a triple interaction. In this case, the exclusion restriction becomes:

$$\begin{aligned} \mathbb{E}[(\epsilon_{it} - \bar{\epsilon}_i)Z_{it}(\tau)] = 0 \quad \forall t = 1, \ldots T \quad \forall \tau = 2 \ldots T \implies \\ \implies \mathbb{E}[(\epsilon_{it} - \bar{\epsilon}_i)Z_{it}(t)] = 0 \quad t = 2 \ldots T \implies \\ \implies \mathbb{E}[(\epsilon_{it} - \bar{\epsilon}_i)\text{dist}_i | rule_i = 1] = 0 \quad t = 2, \ldots T \end{aligned} \tag{4.4}$$

In words, we require deviation of time-varying unobservables from their time average to be uncorrelated with distance in eligible municipalities from $t = 2$ on. Observe that, sufficient for this is.

$$\mathbb{E}[\epsilon_{it}\text{dist}_i | rule_i = 1] = 0 \quad t = 1 \ldots T \tag{4.5}$$

i.e. time-varying unobservables are uncorrelated with distance in eligible municipalities at *all* years. We can interpret this as a "balancing in unobservables" requirement: unobservables in eligible municipalities should be balanced across distances. Put another way, we require that, among elibigle municipalities, and conditional on controls, distance affects the outcome only through its effect on d_{it}.

The first stage of our model is as follows:

$$d_{it} = a_i + b_t + c_t \text{rule}_i + e_t \text{dist}_i + \sum_{\tau=2}^{T} \phi_\tau Z_{it}(\tau) + \pi' X_{it} + u_{it} \tag{4.6}$$

and we expect the instruments to be relevant, i.e. $\phi_\tau \neq 0$, for those years the LPT program was active, since it should have led to changes in the association between distance in the base year and d_{it} among eligible municipalities. In the end, our fixed effects IV approach should leverage variation induced by the LPT program.

What is the interpretation of the coefficients ϕ_τ (aside from a projection coefficient)? Notice that, if we are willing to give a conditional mean interpretation to (4.6), then ϕ_τ is given by (assuming X_{it} empty for simplicity):

$$\begin{aligned} \phi_\tau = (\mathbb{E}[d_{i\tau} - d_{i1}|\text{dist}_i = d+1, \text{rule}_i = 1] - \\ -\mathbb{E}[d_{i\tau} - d_{i1}|\text{dist}_i = d, \text{rule}_i = 1]) - \\ (\mathbb{E}[d_{i\tau} - d_{i1}|\text{dist}_i = d+1, \text{rule}_i = 0] - \\ -\mathbb{E}[d_{i\tau} - d_{i1}|\text{dist}_i = d, \text{rule}_i = 0]) \end{aligned} \tag{4.7}$$

i.e. a triple difference. In this case, we may interpret ϕ_τ as a coefficient that computes, for a given eligibility status, the difference in expected growth (from period 1 to period τ) in the probability of having electricity between schools "close" and "far" from transmission lines in 2000; and then takes the difference between schools in eligible and noneligible municipalities. This coefficient is expected to be negative, as the Light for All program should mitigate the influence of distance in 2000 in explaining future increases in the probability of electrification among eligible municipalities. Rearranging the terms, we may alternatively interpret ϕ_τ as the differential, vis-à-vis non-eligible schools, in the time change in the relation between distance at the base and d_{it}. Once again, we may expect this coefficient to be negative, as program rollout should lead to an acuter weakening of the association between distance in 2000 and electricity among eligible schools.

5 Results

5.1 Access to Electricity in Schools

Figure 2 presents the triple difference coefficients between 1997 and 2017. Model 1 differs from Model 2 in that in the latter we control for interactions of variable coverage_{2000m} (defined in Chapter 3) with time dummies[1]. This allows us to capture municipality trends over the years and compare municipalities with similar baseline electricity coverage. Both models have school and year fixed effects; and we cluster standard errors at the school level.

The patterns in Figure 2 indicate that after 2003 (start of the Light for all program) there was a substantial change in the probability of school access to electricity among eligible municipalities. Also, the sign of each coefficient is in accordance with Section 4.2.2, since program rollout should reduce differences between eligible and noneligible municipalities, which reinforces the belief that our IV-variables are capturing some electricity expansion from the Light for all program over those years.

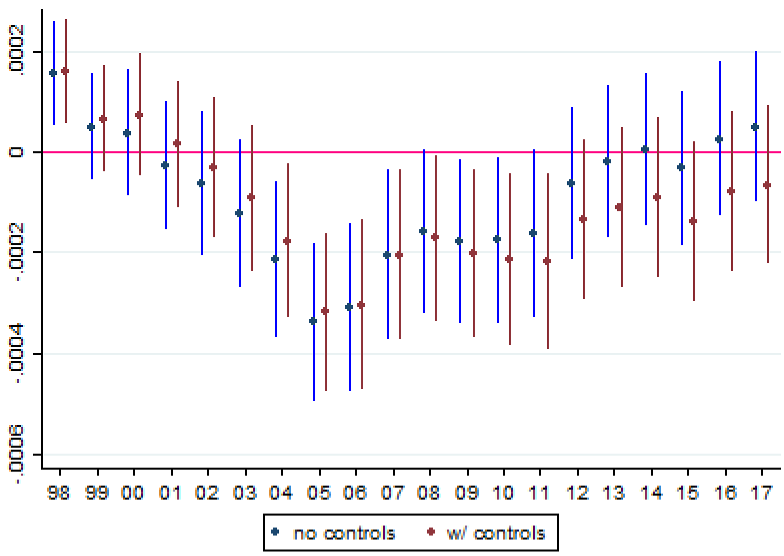

Figure 2 – First Stage Estimates - 1997-2017

Based on these estimates, we restrict our analysis from 2001 to 2010. Table 2 presents the first-stage estimation used in the remainder of this article. The coefficients on

[1] The main variables in the School Census are either fixed in time or are affected by electricity. This is our main justification for the parsimony in the inclusion of controls.

our IV-variables between 2003 and 2010 indicate that the differential (between schools in eligible and noneligible municipalities) in the relation between distance from the closest transmission line in 2000 and the probability of having electricity in a given year falls, vis-à-vis its base value in 2001, by 0.0105 percentage points in 2003, 0.0193 pp in 2004, 0.0318 in 2005, 0.0285 in 2006 etc. Magnitudes do not alter substantially once we control for (base) coverage-specific time trends (Model 2), but in this case estimates are also significant at the 5% level for the year of 2008.

Table 2 – First Stage 2001-2010

Dependent variable: Electricity = [1 0]	(1)	(2)
year 2002 x distance x rule	-0.0000364	-0.0000462
	(0.0000421)	(0.0000429)
year 2003 x distance x rule	-0.000105**	-0.000115**
	(0.0000469)	(0.0000479)
year 2004 x distance x rule	-0.000193***	-0.000196***
	(0.0000559)	(0.0000565)
year 2005 x distance x rule	-0.000318***	-0.000337***
	(0.0000623)	(0.0000638)
year 2006 x distance x rule	-0.000285***	-0.000321***
	(0.0000616)	(0.0000638)
year 2007 x distance x rule	-0.000178**	-0.000221***
	(0.0000695)	(0.0000724)
year 2008 x distance x rule	-0.000135*	-0.000189**
	(0.0000722)	(0.0000753)
year 2009 x distance x rule	-0.000156**	-0.000220***
	(0.0000724)	(0.0000761)
year 2010 x distance x rule	-0.000152**	-0.000231***
	(0.0000734)	(0.0000771)
N	278576	278576
$Controls?$	N	Y
F-statistic on all IV	6.52	7.22
Prob > F	0.0000	0.0000
F-statistic on significant IV	6.88	7.59
Prob > F	0.0000	0.0000
F-statistic on not significant IV	1.76	1.16
Prob > F	0.1723	0.2812

Notes: Robust standard errors clustered at school level.
Year and school fixed effects included in columns.
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.2 Effects of Electrification on Enrollments, Number of Classes and Class Size: OLS and IV estimates

Four different models are estimated to each dependent variable: two OLS-models and two IV-models. For a given estimation method, models differ in that the right-

hand one includes interactions between indicator variables for years and $coverage_{2000m}$ (defined in Chapter 3). As previously emphasized, this allows the comparison between two municipalities with the same level of initial electricity coverage. Each model has school and year fixed effects, and we cluster standard standard errors at the school level.

The following tables present the estimates of the impact of school electrification on enrollment (columns 1 to 4), number of classes (columns 5 to 8) and class size (columns 9 to 12). Each estimate corresponds to a second-stage regression for different school levels and periods. Four different school levels are considered in the analyses: Elementary, Middle, High, and Adult Education. The first three belong to Basic Education, where students follow the curricula at the "correct" age (as mandated by government standards). Adult School in its turn covers all contents of Basic Education, but is aimed at young people, adults and the elderly who did not have access to education in the conventional school at the appropriate age. School levels are separated into two periods: daytime and nighttime classes.

Table 3 aggregates Basic and Adult Education. The next tables are disaggregations of this table for each school level: Table 4 (Elementary and Middle School of Basic Education), Table 5 (Basic Education's High School), Table 7 (Elementary and Middle School of Adult Education) and Table 8 (High School of Adult Education).

Description of aggregate results Table 3 presents aggregate variables for Basic and Adult Education divided into day- and nighttime. Columns 1 and 2, 5 and 6, 9 and 10 show strongly significant OLS coefficients. These estimates generally indicate positive effects of electrification.

Columns 3 and 4 present IV-Model estimates for enrollment with and without controls. Column 3 shows that the number of enrollments, in the model without controls, increases by 33.24 in the aggregate (Basic and Adult Education in both periods) and by 38.20 when it is restricted to the daytime period, both significant at the five percent level. We do not find evidence of these effects in the model with controls, though. Enrollments in Basic Education fall by 26.26 (without controls) and 42.43 (with controls); the latter being significant at the 1% level. Once we disaggregate by period of the day, it is seen that this decrease in Basic Education enrollments is concentrated in the nighttime. As for Adult education, we observe an overall increase of 19.01 (with controls) and 15.39 (without controls) – both significant at the 5% level. This increase appears to be mainly driven by nighttime enrollments.

Columns 7 and 8 present coefficients of the IV-Models with and without controls for classes. In these columns, the overall number of classes increases by 2.451 (without controls) and 1.916 (with controls), and increases by 2.179 (1.716) when it is restricted to day time class. All these estimates are significant at the one percent level. Analyzing

only Basic education, there is an increase of 1.346 (1.112) for the daytime period, both significant at five percent level. Besides, the number of Adult Education classes increases by 0.897 (0.600). In particular, for the IV model without coverage controls, the number of nigh time classes increases by 0.794 with one percent significance; as for the model with controls, the same effect (0.529) is only significant at the 10% level, though.

In contrast with previous results, we do not find class size effects in the aggregate, though we do find an increase in class size for adult education which is somewhat precisely estimated. This increase is concentrated in nighttime classes, as evidenced by estimates in the final cells of Table 3..

Summary Our main results suggest two distinct effects of the arrival of electrical energy in schools. First, enrollment growth patterns suggest that there was a repressed demand of students to attend school. Second, the schools were able to offer more classes with the arrival of electrical energy. In particular, for Adult Education, the number of enrollments increases proportionally more than the number of classes, since there is a significant change in class size.

In order to better understand what is driving our estimated effects, we further disaggregate our variables in the next paragraphs.

Description of results in Basic Education First, we divide Basic Education in Elementary and Middle School (Table 4); and High School (Table 5). These tables have the same structure as the previous tables. OLS estimates are positive and significant as in the previous analyses. Starting from Table 4 and column 3, daytime enrollment increases by 33.70 in the aggregate for Elementary and Middle School. Besides, nighttime enrollment falls by 17.87 in the aggregate. Both estimates are significant at the five percent level. Restricting to Elementary School, an increase of 17.28 in daytime enrollments is observed, which suggests there was a surge in demand for access to school with the arrival of electricity. In addition, Middle School daytime enrollments increase by 16.42 and nighttime enrollments fall by 17.15. Since overall enrollments in Middle school do not seem to change, there appears to be a pattern of substitution away from nighttime enrollment once electricity arrives – though the imprecision in the corresponding estimates with controls (column 4) casts some doubt over this hypothesis.

Columns 7 and 8 present results for the number of classes. The two models do not differ substantially in the magnitude of coefficients, though the model from column 8 is less significant in some estimates. In models 1 and 2 respectively, overall Elementary and Middle school classes increase by 1.652 (1.385); in the daytime we observe an increase of 2.050 (1.581); and finally nighttime classes fall by 0.398 (0.196). The number of Elementary School classes increases by 1.201 (1.427), and increases by 1.110 (1.281) when restricted to

daytime. For Middle School, a similar pattern as the one observed in enrollments emerges: daytime classes increase by 0.939 and night time classes decrease by 0.488. We do not verify these effects once we control for for initial electricity coverage trends, though.

Column 11 shows a decrease of 6.843 in nighttime class size in aggregate (Elementary and Middle School); and a 4.419 reduction for Middle School at night. This suggests that the number of nighttime enrollments falls proportionally more than the number of classes at schools that now have access to electricity.

Summary Summarizing, Table 4 suggests that the main results in Elementary and Middle School variables stem from the increase in the number of daytime enrollments and classes from these school levels, and from the decrease in the number of nighttime enrollments of Middle School. There does also appear to be a pattern of substitution away from nighttime schooling in the Middle School, both from the perspective of students (enrollments) and schools (classes).

The IV models in Table 5 indicate there are no statistically significant changes in High School enrollment, class and class sizes. This result is robust to the inclusion of controls. Column 4 presents the only significant result, which is an increase of 3.0003 in daytime enrollments controlling for initial municipality coverage.

Table 3 – Aggregate variables

	Enrollment				Class				Class Size			
	OLS		IV		OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Basic and	7.097***	6.844***	33.24**	7.261	0.253***	0.232***	2.451***	1.916***	1.784***	1.829***	3.422	-7.492
Adult Education	(0.481)	(0.481)	(14.28)	(13.98)	(0.0205)	(0.0204)	(0.646)	(0.623)	(0.207)	(0.208)	(7.913)	(8.348)
Day time	1.446***	1.367***	38.20***	14.90	0.0747***	0.0572***	2.179***	1.716***	0.611***	0.642***	4.613	-1.260
	(0.416)	(0.416)	(12.15)	(12.00)	(0.0182)	(0.0182)	(0.568)	(0.527)	(0.168)	(0.168)	(5.752)	(5.561)
Night time	5.651***	5.477***	-4.954	-7.642	0.178***	0.175***	0.273	0.200	2.484***	2.457***	7.651*	3.900
	(0.232)	(0.231)	(9.940)	(11.41)	(0.00917)	(0.00909)	(0.337)	(0.365)	(0.113)	(0.113)	(4.154)	(4.852)
Basic Education	4.248***	4.095***	-26.16*	-42.43***	0.111***	0.0989***	0.948	0.956	0.550***	0.578***	-12.27	-18.57**
	(0.384)	(0.382)	(13.88)	(14.90)	(0.0164)	(0.0163)	(0.581)	(0.592)	(0.154)	(0.154)	(7.521)	(7.431)
Day time	0.219	0.256	-1.883	-23.66*	0.00699	-0.000321	1.346**	1.112**	0.357**	0.401***	-4.291	-10.42*
	(0.352)	(0.350)	(11.95)	(14.17)	(0.0155)	(0.0154)	(0.529)	(0.543)	(0.145)	(0.145)	(6.152)	(5.993)
Night time	4.029***	3.840***	-24.28**	-18.77*	0.104***	0.0992***	-0.398	-0.156	1.344***	1.290***	-6.177**	-3.129
	(0.159)	(0.158)	(9.692)	(10.34)	(0.00535)	(0.00529)	(0.274)	(0.287)	(0.0500)	(0.0493)	(2.906)	(2.872)
Adult Education	1.065***	1.125***	19.01***	15.39**	0.0585***	0.0623***	0.897***	0.600**	1.500***	1.515***	12.72***	9.359*
	(0.155)	(0.154)	(6.658)	(6.985)	(0.00697)	(0.00693)	(0.285)	(0.294)	(0.106)	(0.105)	(4.285)	(4.883)
Day time	-0.0382	-0.0503	2.120*	2.091**	-0.00152	-0.00207	0.103*	0.0704	-0.00331	-0.0122	1.076	1.167*
	(0.0327)	(0.0333)	(1.241)	(1.026)	(0.00160)	(0.00162)	(0.0575)	(0.0448)	(0.0253)	(0.0253)	(0.680)	(0.608)
Night time	1.103***	1.175***	16.89**	13.30*	0.0600***	0.0644***	0.794***	0.529*	1.482***	1.504***	12.33***	8.912*
	(0.150)	(0.149)	(6.686)	(6.971)	(0.00672)	(0.00666)	(0.287)	(0.297)	(0.104)	(0.104)	(4.253)	(4.874)
N	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576
Controls?	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4 – Elementary and Middle School

	Enrollment				Class				Class Size			
	OLS		IV		OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Elementary and	6.342***	6.005***	15.83	-7.341	0.210***	0.185***	1.652***	1.385**	0.810***	0.826***	1.645	-6.276
Middle School	(0.454)	(0.451)	(11.34)	(11.58)	(0.0193)	(0.0192)	(0.552)	(0.558)	(0.174)	(0.175)	(6.314)	(6.460)
Day time	1.613***	1.546***	33.70***	9.809	0.0815***	0.0644***	2.050***	1.581***	0.607***	0.644***	4.618	-1.343
	(0.414)	(0.413)	(11.55)	(11.52)	(0.0181)	(0.0181)	(0.553)	(0.510)	(0.165)	(0.166)	(5.727)	(5.544)
Night time	4.729***	4.458***	-17.87***	-17.15**	0.128***	0.121***	-0.398*	-0.196	1.525***	1.456***	-6.843***	-3.979
	(0.186)	(0.183)	(6.895)	(8.575)	(0.00648)	(0.00639)	(0.221)	(0.248)	(0.0593)	(0.0585)	(2.324)	(2.502)
Elementary School	3.506***	3.449***	16.56*	-0.698	0.157***	0.147***	1.201***	1.427***	0.711***	0.716***	4.375	-0.828
	(0.314)	(0.312)	(8.792)	(9.305)	(0.0140)	(0.0139)	(0.438)	(0.458)	(0.170)	(0.170)	(6.417)	(6.367)
Day time	2.133***	2.159***	17.28**	4.709	0.137***	0.128***	1.110***	1.281***	0.497***	0.521***	6.968	3.997
	(0.300)	(0.298)	(8.307)	(8.666)	(0.0138)	(0.0138)	(0.425)	(0.430)	(0.160)	(0.161)	(5.803)	(5.495)
Night time	1.372***	1.290***	-0.719	-5.407*	0.0201***	0.0194***	0.0908	0.146*	0.350***	0.335***	1.860	1.782
	(0.0774)	(0.0763)	(2.222)	(2.884)	(0.00185)	(0.00182)	(0.0757)	(0.0884)	(0.0356)	(0.0354)	(1.212)	(1.398)
Middle School	2.836***	2.556***	-0.734	-6.643	0.0529***	0.0378***	0.451	-0.0423	0.792***	0.757***	-2.446	-4.009*
	(0.295)	(0.294)	(8.468)	(9.079)	(0.0117)	(0.0117)	(0.320)	(0.343)	(0.0681)	(0.0681)	(1.928)	(2.065)
Day	-0.521**	-0.612**	16.42**	5.100	-0.0555***	-0.0634***	0.939***	0.300	0.321***	0.299***	1.194	-2.272
	(0.259)	(0.259)	(7.636)	(7.785)	(0.0106)	(0.0107)	(0.307)	(0.284)	(0.0655)	(0.0654)	(1.900)	(1.960)
Night	3.357***	3.168***	-17.15***	-11.74	0.108***	0.101***	-0.488**	-0.342	0.988***	0.928***	-4.419**	-3.347
	(0.165)	(0.162)	(6.512)	(7.621)	(0.00621)	(0.00612)	(0.218)	(0.242)	(0.0493)	(0.0483)	(1.728)	(2.285)
N	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576
Controls?	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5 – High School

	Enrollment				Class				Class Size			
	OLS		IV		OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Aggregate	-0.309***	-0.285***	-1.593	-0.789	-0.0118***	-0.0111***	-0.105	-0.0679	-0.0234*	-0.0266**	-1.059	-0.884
	(0.0694)	(0.0705)	(4.164)	(3.961)	(0.00218)	(0.00220)	(0.123)	(0.111)	(0.0133)	(0.0135)	(1.590)	(1.384)
Day	-0.128***	-0.129***	2.379	3.003**	-0.00522***	-0.00516***	0.0263	0.0645	-0.0200**	-0.0236**	0.222	0.319
	(0.0440)	(0.0427)	(1.532)	(1.531)	(0.00143)	(0.00139)	(0.0472)	(0.0470)	(0.00988)	(0.0101)	(0.387)	(0.352)
Night	-0.181***	-0.156***	-3.972	-3.791	-0.00661***	-0.00592***	-0.131	-0.132	-0.0351***	-0.0339***	-1.391	-1.336
	(0.0502)	(0.0518)	(3.908)	(3.643)	(0.00154)	(0.00157)	(0.112)	(0.101)	(0.0125)	(0.0126)	(1.579)	(1.381)
N	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576
$Controls?$	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Description of results in Adult Education Table 7 presents the estimates for Elementary and Middle School Adult Education. OLS estimates are similar to the last ones, except for Middle School, which presents negative coefficients. As in the previous tables, columns 3 and 4 report estimates for enrollment from the IV models with and without controls. When compared, both IV models share similar magnitudes; they differ only at the significance level. Results go in the opposite direction of those regarding Basic Education. Columns 3 and 4 show night time enrollment **increases** by 18.46 (14.81) in aggregate; while nighttime enrollment increases by 16.49 (12.87). Restricting to Elementary School, it increases by 12.64 (12.76), and for nighttime elementary enrollment one observes increases of 12.33 (12.50). For Middle School, there is an increase of 1.662 (1.679) in daytime enrollment.

Columns 7 and 8 present class coefficients from the IV-Models with and without controls. The aggregate (Elementary and Middle School content) number of classes increases by 0.877 (0.580), with a 0.781 (0.517) nighttime increase. Restricting to Middle School classes, we report an increase of 0.424 (0.123) in the aggregate number of classes; with 0.0880 (0.06) daytime and 0.336 (0.063) nighttime estimates. Middle School aggregate and nighttime estimates are not significant in the model with controls.

In addition, columns 11 and 12 present class size estimates. General increases in class sizes are observed. Overall class size increases by 12.70 (9.455 in model 2); and nighttime class sizes increase by 12.35 (9.062).

Summary Overall, results in Table 7 suggest there are significant effects of electrification in nighttime enrollment, class, and class size. We observe night time enrollment and class size changes in Elementary School, and nighttime class changes in Middle School. Results indicate there was a demand for Elementary school access and school capacity to expand Middle School classes.

Table 8 presents the estimates of High School Adult Education. In the IV models, we find significant increases in daytime enrollment (0.147 in Model 1; 0.156 in Model 2) and daytime classes (0.00665 in Model 1; 0.00649 in Model 2).

Summarizing this section's results and analyzing tables altogether, we see that daytime increases stem mainly from Elementary and Middle School Basic Education; whereas nighttime increases derive mainly from Elementary and Middle School Adult Education. In both school levels, there is no substantial high school changes. The aggregate results in all tables omit a lot of information, which renders analysis of disaggregated tables quite relevant.

In order to put the magnitude of estimated effects in perspective, consider a nonelectrified eligible school with the mean number of enrollment in Elementary and Middle School Adult Education ($\bar{x} = 10.763$). In this case, a 18.46 increase in Adult Education

enrollment level raises the number of enrollments from 10.763 to 29.223. This massive result suggests that extensive margin effects may be at work (schools are **opening** Adult Education courses). In order to investigate this point, we run our IV model considering an indicator of the presence of Adult Education at the school as a dependent variable. Table 6 reports the result from this estimation. Our IV estimate suggests that electricity in eligible schools increases the probability of a school to provide Adult Education by 45.1 percentage points. This considerable magnitude suggests our results are not driven solely by the expansion of existing Adult Education centers, but also by schools starting to provide adult education.

Table 6 – Extensive margin Effects - Adult Education

	Adult Education = [1 0]
$\widehat{electricity}$	0.451**
	(0.230)
N	278576

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 – Primary and Secondary School - Adult School

	Enrollment				Class				Class Size			
	OLS		IV		OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Elementary and Middle School	1.142***	1.190***	18.46***	14.81**	0.0612***	0.0646***	0.877***	0.580**	1.505***	1.518***	12.70***	9.455*
	(0.154)	(0.153)	(6.618)	(6.937)	(0.00694)	(0.00690)	(0.285)	(0.294)	(0.106)	(0.105)	(4.286)	(4.888)
Daytime	-0.0350	-0.0483	1.973	1.935*	-0.00132	-0.00193	0.0963*	0.0639	-0.00305	-0.0124	1.019	1.100*
	(0.0326)	(0.0332)	(1.218)	(0.997)	(0.00159)	(0.00162)	(0.0564)	(0.0433)	(0.0253)	(0.0253)	(0.672)	(0.594)
Night time	1.177***	1.238***	16.49**	12.87*	0.0625***	0.0665***	0.781***	0.517*	1.488***	1.509***	12.35***	9.062*
	(0.149)	(0.147)	(6.634)	(6.920)	(0.00669)	(0.00664)	(0.286)	(0.297)	(0.104)	(0.104)	(4.254)	(4.879)
Elementary School	1.710***	1.697***	12.64**	12.76**	0.0796***	0.0803***	0.453*	0.457*	1.569***	1.559***	9.656**	7.809*
	(0.133)	(0.133)	(5.222)	(5.532)	(0.00591)	(0.00589)	(0.243)	(0.248)	(0.104)	(0.104)	(3.990)	(4.513)
Daytime	-0.0203	-0.0285	0.312	0.256	-0.000816	-0.00112	0.00837	0.00393	-0.00623	-0.0150	0.485	0.377
	(0.0245)	(0.0247)	(0.773)	(0.617)	(0.00117)	(0.00118)	(0.0376)	(0.0287)	(0.0217)	(0.0218)	(0.581)	(0.480)
Night time	1.731***	1.726***	12.33**	12.50**	0.0804***	0.0814***	0.445*	0.454*	1.558***	1.557***	9.396**	7.908*
	(0.130)	(0.129)	(5.254)	(5.562)	(0.00576)	(0.00573)	(0.245)	(0.251)	(0.103)	(0.103)	(3.966)	(4.525)
Middle School	-0.568***	-0.507***	5.821	2.049	-0.0183***	-0.0157***	0.424***	0.123	-0.147***	-0.109**	4.345**	2.597
	(0.0727)	(0.0724)	(3.575)	(3.976)	(0.00332)	(0.00331)	(0.138)	(0.145)	(0.0459)	(0.0456)	(2.107)	(2.278)
Daytime	-0.0146	-0.0198	1.662*	1.679**	-0.000503	-0.000817	0.0880**	0.0600**	-0.00110	-0.00219	0.713**	0.833**
	(0.0199)	(0.0208)	(0.849)	(0.690)	(0.000966)	(0.00100)	(0.0382)	(0.0274)	(0.0139)	(0.0136)	(0.362)	(0.358)
Night time	-0.553***	-0.487***	4.159	0.370	-0.0178***	-0.0149***	0.336***	0.0630	-0.148***	-0.111**	3.857*	1.815
	(0.0683)	(0.0674)	(3.461)	(3.899)	(0.00308)	(0.00305)	(0.128)	(0.141)	(0.0443)	(0.0440)	(2.083)	(2.252)
N	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576
Controls?	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8 – High School - Adult School

	Enrollment				Class				Class Size			
	OLS		IV		OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Aggregate	-0.0779***	-0.0655***	0.547	0.582	-0.00274***	-0.00229***	0.0193	0.0192	-0.0285***	-0.0235***	0.117	0.0688
	(0.0138)	(0.0130)	(0.560)	(0.553)	(0.000448)	(0.000413)	(0.0168)	(0.0166)	(0.00701)	(0.00680)	(0.287)	(0.269)
Day	-0.00323[2]	-0.00203	0.147**	0.156*	-0.000196**	-0.000138***	0.00665*	0.00649*	-0.000667	-0.0000108	0.105*	0.115
	(0.00174)	(0.00151)	(0.0742)	(0.0807)	(0.0000834)	(0.0000671)	(0.00361)	(0.00381)	(0.00101)	(0.000990)	(0.0616)	(0.0708)
Night	-0.0747***	-0.0634***	0.400	0.426	-0.00254***	-0.00215***	0.0126	0.0127	-0.0285***	-0.0239***	0.0632	0.00772
	(0.0135)	(0.0128)	(0.550)	(0.540)	(0.000426)	(0.000396)	(0.0158)	(0.0155)	(0.00693)	(0.00670)	(0.286)	(0.267)
N	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576
Controls?	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.2.1 Effects on enrollment by gender

In this section, gender composition will be analyzed. As in the last section, the same four models (two IV and two OLS) are estimated for each dependent variable divided between men and women. There is substantial significance of OLS-models estimates in all tables and they underestimate the estimates when the IV-model is significant too. Next follows the description of each table.

Description of results Table 9 shows aggregate school level results, followed by Table 10 that presents Basic Education's Elementary, Middle and High School results. Finally, Table 11 presents the results for Elementary, Middle and High School of Adult Education.

First, Table 9 suggests two substantial effects in dependent variables. Columns 3 and 4 show the number of men in Basic Education falls by 17.23 (model 1) and 15.42 (model 2). For women, the variation is similar, enrollments falls by 14.84 (13.43). In contrast, the number of men in Adult Education increases by 9.821 and for women in Adult Education increases by 11.18 at one percent significance level. There is a lot of information lost with this aggregate table, because of that it is necessary to analyse disaggregate variables.

Table 10 shows the results for Basic Education. Columns 3 and 4 show that the number of men falls by 17.46 in model 1 and 15.67 in model 2 for aggregate Elementary and Middle school, and falls by 12.63 (11.60) when analysis is restricted to Elementary School. There does not appear to be significant effects for High School.

In addition, Table 11 presents Adult Education results. Columns 3 and 4 indicate the number of men in Adult School increases by 9.724 in model 1 at the 10% level (and not significant in model 2). The number of men in Elementary Adult Education increases by 9,474 (6.848). Furthermore, the number of women in Adult Education increases by 11.14 in model 1 (though not in model 2); and the number of women in elementary school increases by 9.046 (5.869).

Summary Overall, our IV estimates capture an increase in the number of men and women attending Adult Education, especially Elementary Adult Education. In contrast, there is a fall in both genders in Basic Education, which also stems from Elementary Education.

Table 9 – Gender Composition - Aggregate Variables

	Men				Women			
	OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Basic and Adult Education	2.825***	2.725***	-7.409	-10.86	3.157***	3.098***	-3.657	-7.955
	(0.206)	(0.204)	(9.241)	(9.132)	(0.193)	(0.193)	(8.633)	(8.315)
Basic Education	2.587***	2.469***	-17.23**	-15.42*	2.941***	2.858***	-14.84*	-13.43*
	(0.190)	(0.189)	(7.972)	(8.101)	(0.180)	(0.180)	(7.864)	(7.613)
Adult Education	0.238***	0.256***	9.821*	4.560	0.216***	0.240***	11.18***	5.475
	(0.0743)	(0.0736)	(5.222)	(4.973)	(0.0635)	(0.0630)	(3.712)	(3.351)
N	278576	278576	278576	278576	278576	278576	278576	278576
Controls?	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10 – Gender Composition - Primary and Secondary School

	Men				Women			
	OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Elementary and Middle School	2.723***	2.598***	-17.46**	-15.67*	3.111***	3.018***	-14.14*	-12.94*
	(0.190)	(0.188)	(7.819)	(8.099)	(0.180)	(0.178)	(7.389)	(7.341)
Elementary School	1.807***	1.773***	-12.63**	-11.60*	1.845***	1.839***	-6.739	-5.928
	(0.134)	(0.132)	(6.162)	(6.592)	(0.122)	(0.120)	(5.148)	(5.285)
Middle School	0.916***	0.825***	-4.827	-4.071	1.266***	1.179***	-7.401	-7.015
	(0.123)	(0.122)	(5.518)	(5.697)	(0.124)	(0.123)	(5.766)	(5.716)
High School	-0.136***	-0.129***	0.230	0.255	-0.171***	-0.160***	-0.702	-0.488
	(0.0254)	(0.0254)	(2.287)	(2.032)	(0.0335)	(0.0334)	(2.457)	(2.305)
N	278576	278576	278576	278576	278576	278576	278576	278576
Controls?	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11 – Gender Composition - Adult School

	Men				Women			
	OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Elementary and Middle School	0.275***	0.290***	9.724*	4.486	0.254***	0.274***	11.14***	5.386
	(0.0737)	(0.0730)	(5.181)	(4.946)	(0.0628)	(0.0624)	(3.701)	(3.338)
Elementary School	0.661***	0.647***	9.474**	6.848*	0.486***	0.486***	9.046***	5.869**
	(0.0626)	(0.0623)	(4.202)	(4.050)	(0.0539)	(0.0535)	(3.002)	(2.750)
Middle School	-0.386***	-0.358***	0.251	-2.362	-0.232***	-0.213***	2.093	-0.483
	(0.0351)	(0.0347)	(2.769)	(2.888)	(0.0294)	(0.0293)	(1.963)	(1.951)
High School	-0.0374***	-0.0335***	0.0968	0.0739	-0.0380***	-0.0333***	0.0448	0.0896
	(0.00644)	(0.00615)	(0.281)	(0.254)	(0.00611)	(0.00577)	(0.249)	(0.229)
N	278576	278576	278576	278576	278576	278576	278576	278576
Controls?	N	Y	N	Y	N	Y	N	Y

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.2.2 Effects on enrollment by age cohort (Adult Education)

Coefficients from OLS and IV regressions by age cohort enrolled in Adult Education are presented in Table 12 for age cohorts 15-17 (columns 1 to 4), 18-24 (columns 5 to 8) and 25-29 (columns 9 to 12), and Table 13 for age cohorts 30-34 (columns 1 to 4), 35-39 (columns 5 to 8) and older than 39 (columns 9 to 12). The first two columns in each age cohort analysis correspond to OLS results, and, in the last two columns, the IV results. We follow the specification of previous sections, where, for a given estimation approach, the second model includes coverage-specific trends. The dependent variable is the number of enrollments for each age cohort and for each school level.

Description of results IV estimates of school electrification effects are larger than OLS estimates and significantly positive for the age cohort 15-17 in Table 12 (Columns 3 and 4). Differently from the results of the OLS models, IV estimates indicate Adult Education enrollment increases by 7.665 in model 1 and 6.289 in model 2. Joint Elementary and Middle School enrollment grows 7.360 in model 1 (6.045 in model 2); at the same time Middle School enrollment increases by 2.349 (2.063). There is no significant increase for Elementary School and High School taken individually. These estimates suggest that the main effect for Adult Education in this cohort comes from Elementary and Middle School and, in this group, the effect stems mainly from Middle School.

Next, we report IV estimates for the 18-24 age cohort (columns 7 and 8). We notice IV estimates are larger than the corresponding OLS ones and larger than the effects observed in the previous age cohort. Enrollment in Adult Education increases by 10.71 (9.048). Joint Elementary and Middle School enrollment grows 10.10 (8.563), although the effect for Elementary school alone is not statistically significant. Middle School enrollment increases by 5.407 (4.801), which is significant at the 1% percent level. The effect on high School enrollment is not statistically different from zero. Again, the main effects in Adult Education come from Elementary and Middle School and, within this group, stem mainly from Middle School.

For older age cohorts, there are different effects in the two estimation strategies. For age cohorts 25-29, 30-34 and 35-39, OLS estimates are significant at the 1% percent level, whereas IV estimates are not statistically different from zero. Moreover, magnitudes in OLS estimates are broadly similar across these cohorts.

Finally, columns 9 to 12 in Table 13 present the results for the oldest age cohort (39 years old or more). IV estimates suggest enrollment in Adult Education increases by 7.219 in model 1 (5.634 in model 2), and both effects are significant the 5% percent level. Meanwhile, aggregate Elementary and Middle School enrollment increases by 7.151 at the one percent level (5.595 at five percent level). Although, individually, the effect on enrollment at Elementary School is not statistic significant; Middle School enrollment increases by 6.902 (5.373), and this effect is statistically significant at the 5% level. As for High School, enrollment increases by 0.317 (0.261).

Summary IV results point to huge increases in Adult Education; Elementary and Middle School Adult Education taken together; and, individually, in Middle School Adult Education enrollment. Effects are driven by the following age cohorts: 15 to 17, 18 to 24 and older than 39 years. For example, in a non-electrified eligible school with the mean number of enrollment in the age cohort 15-17 ($\bar{x} = 1.24$), a 7.655 increase in Adult Education enrollment level raises the number of enrollments from 1.24 to 8.895. This massive result suggests extensive margin effects as the one previously discussed may be at work.

Table 12 – Age Distribution - Adult Education

	15-17				18-24				25-29			
	OLS		IV		OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Adult Education	-0.146***	-0.129***	7.655**	6.289**	-0.0533	-0.0431	10.71**	9.048**	0.190***	0.186***	1.711	1.176
	(0.0291)	(0.0286)	(3.281)	(3.003)	(0.0462)	(0.0459)	(4.950)	(4.476)	(0.0287)	(0.0288)	(2.478)	(2.178)
Elementary and Middle School	-0.137***	-0.120***	7.360**	6.045**	-0.000684	0.00270	10.10**	8.563**	0.204***	0.197***	1.395	0.919
	(0.0290)	(0.0285)	(3.234)	(2.966)	(0.0446)	(0.0444)	(4.657)	(4.219)	(0.0284)	(0.0286)	(2.404)	(2.113)
Elementary School	-0.267***	-0.247***	5.011*	3.982	-0.366***	-0.349***	4.688	3.761	-0.0900***	-0.0891***	-0.434	-0.456
	(0.0223)	(0.0219)	(2.658)	(2.445)	(0.0308)	(0.0308)	(4.010)	(3.629)	(0.0123)	(0.0128)	(2.040)	(1.767)
Middle School	0.130***	0.127***	2.349**	2.063**	0.365***	0.352***	5.407***	4.801***	0.294***	0.286***	1.829	1.375
	(0.0183)	(0.0181)	(1.000)	(0.916)	(0.0325)	(0.0323)	(1.799)	(1.656)	(0.0261)	(0.0260)	(1.159)	(1.063)
High School	-0.00920***	-0.00853***	0.295	0.244	-0.0527***	-0.0458***	0.618	0.485	-0.0137***	-0.0117***	0.316	0.257
	(0.00173)	(0.00184)	(0.186)	(0.171)	(0.00899)	(0.00859)	(0.857)	(0.790)	(0.00252)	(0.00240)	(0.295)	(0.271)
N	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13 – Age Distribution - Adult Education

	30-34				35-39				>39			
	OLS		IV		OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Adult Education	0.119***	0.119***	2.156	1.662	0.0872***	0.0881***	1.069	0.724	0.0538	0.0683	7.219**	5.634**
	(0.0261)	(0.0261)	(1.659)	(1.487)	(0.0240)	(0.0240)	(1.335)	(1.216)	(0.0538)	(0.0532)	(3.003)	(2.620)
Elementary and Middle School	0.195***	0.191***	1.466	1.068	0.155***	0.154***	1.118	0.776	0.160***	0.162***	7.151***	5.595**
	(0.0247)	(0.0247)	(1.181)	(1.084)	(0.0231)	(0.0231)	(1.128)	(1.037)	(0.0519)	(0.0516)	(2.770)	(2.426)
Elementary School	-0.0668***	-0.0646***	0.427	0.374	-0.0608***	-0.0603***	-0.203	-0.176	-0.0947***	-0.0851***	-0.249	-0.222
	(0.00946)	(0.00961)	(1.096)	(0.962)	(0.00754)	(0.00759)	(0.656)	(0.584)	(0.0142)	(0.0141)	(1.126)	(0.999)
Middle School	0.128***	0.126***	1.893	1.442	0.0938***	0.0934***	0.915	0.600	0.0657	0.0765	6.902**	5.373**
	(0.0260)	(0.0260)	(1.634)	(1.467)	(0.0240)	(0.0239)	(1.322)	(1.206)	(0.0535)	(0.0530)	(2.994)	(2.617)
High School	-0.00913***	-0.00752***	0.264	0.220	-0.00667***	-0.00534***	0.154	0.124	-0.0120***	-0.00826***	0.317**	0.261*
	(0.00169)	(0.00159)	(0.176)	(0.159)	(0.00125)	(0.00117)	(0.115)	(0.104)	(0.00323)	(0.00289)	(0.159)	(0.141)
N	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576	278576

Notes: Robust standard errors clustered at school level. Year and school fixed effects included in columns
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.3 Effects of Electrification on School Infrastructure: OLS and IV estimates

Table 14 shows OLS and IV results for dependent variables of school infrastructure. Columns 1 and 2 correspond to OLS models and columns 3 and 4 correspond to IV models. As in the previous sections, the difference between models is the inclusion of additional controls. We take as dependent variables indicators of the presence of computer, Internet, TV and school meals in schools; we also analyze the total number of classrooms and employees.

OLS estimates from columns 1 and 2 suggest that the probability of a school having computer for student use drops by 6.77 and 6.52 percentage points. Also, these columns show a fall of 1.11 and 1.01 percentage points in theprobability of a school having internet access. In same direction, OLS estimates suggest a decrease of 2.92 and 2.87 percentage point in the probability of a school having TV. In addition, these columns show a decrease in the number of classrooms of 6.74 (6.47), and a decrease in the number of employees of 0.160 (0.148). The effect in school meals is not statistically significant.

In contrast to previous results, IV estimates in columns 3 and 4 show muted effects of electrification. Regarding the probability of having a computer for student use, column 3 reports an effect that is not statistically different from zero, but in column 4 there is an increase in this probability of 12 percentage points (significant at the 5% level). At the same time, for the probability of having internet, TV and school meals; and also number of classrooms, the effects are not statistically significant at the 5% level. Column 3 reports an increase in the number of employees of 2.812 that is statistically significant at the 5% level, though the corresponding specification with controls (Column 4) is not statistically significant.

Table 14 – School Infrastructure

	OLS regression coefficients		IV regression coefficients	
	(1)	(2)	(3)	(4)
Computer	-0.0677***	-0.0652***	0.0446	0.120**
	(0.00207)	(0.00205)	(0.0533)	(0.0518)
Internet	-0.0111***	-0.0101***	-0.0961	-0.0642
	(0.000717)	(0.000695)	(0.0750)	(0.0607)
Classrooms	-0.0674***	-0.0647***	-0.995	-0.929
	(0.0203)	(0.0214)	(1.366)	(1.304)
TV	-0.0292***	-0.0287***	0.358*	0.343
	(0.00285)	(0.00282)	(0.211)	(0.185)
Employees	-0.160***	-0.148***	2.812**	1.581
	(0.0387)	(0.0373)	(1.345)	(1.461)
School meals	0.00111	0.00147	-0.0241	-0.0268
	(0.000989)	(0.000991)	(0.0274)	(0.0258)
N	278576	278576	278576	278576
Controls?	N	Y	N	Y

Notes: Robust standard errors clustered at school level.
Year and school fixed effects included in columns
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.4 First-stage placebo tests

Table 15 and Table 16 present two short placebo exercises for the first stage strategy used in the results. Table 15 presents First-stage estimates for access to electricity in schools between 2001 and 2010 for urban areas. Since the Light for all program prioritizes rural areas, we perform our first stage regression with the same IV-variables and controls used previously and expect estimates to be statistically negligible. Once again, the difference between Model 1 and 2 (left and right) is variable $coverage_{2000m}$, defined in Chapter 4, which is interacted with time dummies and added as controls in the second model.

Estimates in columns 1 and 2 (see also Figure 3) suggest there are no significant (at the 5% level) coefficients in either model, which means that our IV-Variables do not capture time changes (vis-à-vis noneligible municipalities) in the relation between distance and the probability of school access to electricity **in urban areas** during the years of expansion of the Light for All program. At the 10% level, some coefficients are significant, though with the opposite sign from the expected in Section 4.2.2. These patterns are reassuring and lend further credibility to our strategy.

Table 15 – Placebo - Urban

Dependent variable: Electricity = [1 0]	(1)	(2)
year 2002 x distance x rule	0.0000184*	0.0000171*
	(0.0000103)	(0.00000985)
year 2003 x distance x rule	0.0000144	0.0000131
	(0.0000109)	(0.0000104)
year 2004 x distance x rule	0.0000157	0.0000145
	(0.0000109)	(0.0000104)
year 2005 x distance x rule	0.0000149	0.0000126
	(0.0000106)	(0.0000100)
year 2006 x distance x rule	0.0000170*	0.0000148
	(0.00000992)	(0.00000936)
year 2007 x distance x rule	0.0000154	0.0000134
	(0.00000978)	(0.00000924)
year 2008 x distance x rule	0.0000149	0.0000129
	(0.00000975)	(0.00000921)
year 2009 x distance x rule	0.0000160	0.0000140
	(0.00000985)	(0.00000929)
year 2010 x distance x rule	0.0000152	0.0000135
	(0.00000986)	(0.00000933)
N	176840	176840
Controls?	N	Y
F-statistic on IV	0.78	0.75
Prob > F	0.6324	0.6612

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

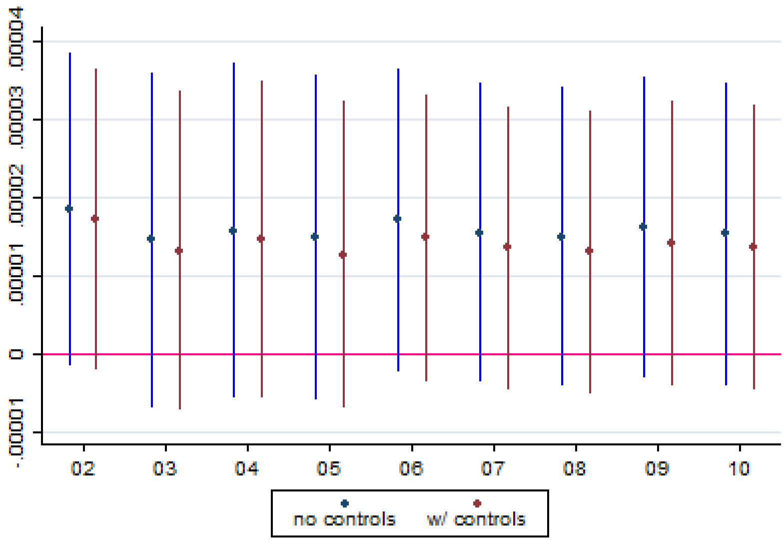

Figure 3 – Triple Difference - Placebo - Urban

Table 16 shows a second placebo exercise where we return to rural areas but estimate our model within the range before the Light for all program, i.e. from 1997 to 2002. Although the 1998 coefficients in columns 1 and 2 are significant at the 1 % level, their signs are the opposite from the expected. Once again, these patterns are reassuring – our source of variation indeed seems to stem from the Light for All program. Figure 4 illustrates the coefficients.

Table 16 – Placebo - Time

	(1)	(2)
year 1998 × distance × rule	0.000139***	0.000146***
	(0.0000531)	(0.0000533)
year 1999 × distance × rule	-0.000000216	0.0000234
	(0.0000547)	(0.0000540)
year 2000 × distance × rule	-0.0000110	0.0000333
	(0.0000646)	(0.0000620)
year 2001 × distance × rule	-0.0000694	-0.0000186
	(0.0000652)	(0.0000630)
year 2002 × distance × rule	-0.000108	-0.0000662
	(0.0000732)	(0.0000703)
Observations	158896	158896
F on IV	6.58	5.46
Prob f > 0	0.0000	0.000

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

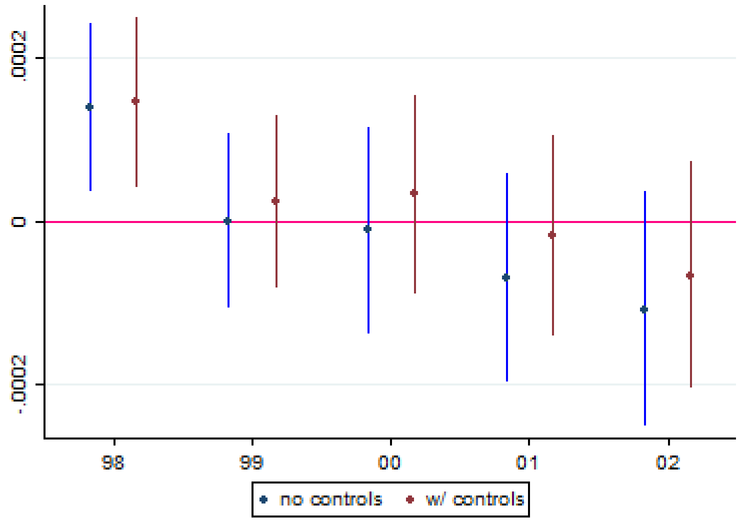

Figure 4 – Triple Difference - Placebo - Time

6 Concluding remarks

This dissertation uses roll-out of the Light for all program in rural Northeastern Brazil in order to assess the effects of electrification on school organisation and infrastructure.

By addressing endogeneity in access to electricity through a fixed-effects instrumental variables approach, we show that enrollment and classes grow in schools that gain access to electricity. We combine School Census data with georeferenced information on electricity transmission lines and electricity coverage data from the Brazil Population Census (2000) in order to understand the changes at work. Results indicate that, for Adult Education, there are large increases in nighttime period enrollment and in the number of classes; whereas for Basic Education, we report large increases in daytime period enrollment and number of classes.

As regards Adult Education, estimates suggest that its overall effects are due to nighttime variation. The results from IV models 1 and 2 indicate, respectively with and without controls, an increase of 16.89 (13.30) in overall nighttime enrollment. This effect is mainly driven by increased enrollment in Elementary and Middle School Adult Education. The effect on the number of classes follows the same direction: the number of classes increases by 0.897 (0.600), and once again this is mainly driven by Elementary and Middle Adult Education. Since enrollments increase proportionally more than the number of classes, we observe a positive growth in class size – 12.33 (8.912) – for nighttime Adult Education. Regarding gender composition, we noticed an increase of 9.046 (5.869) in female enrollment in Elementary Adult Education. For men, we observe a similar pattern, but with less significance, an increase of 9.474 (6.848). As regards heterogeneity by age, we observe positive effects in enrollment for age cohorts 15 to 17 years, 18 to 24 years and older than 39 years; increasing respectively by 7.6555 (6.289), 10.71 (9.048) and 7.219 (5.634). Once again, enrollment patterns are mainly driven by Elementary and Middle Adult education. Our results by age cohort indicate that effects on enrollment in Adult Education are mainly driven by people with a lower opportunity cost of going to school (younger and older cohorts).

In contrast, for Basic Education we noticed effects going in the opposite direction. For Elementary and Middle school taken together there is a fall of 17.87 (17.15) in nighttime enrollment. In the number of classes, we noticed that daytime Elementary and Middle School increases by 2.050 (1.581). At the same time, daytime Elementary School number of classes increases by 1.110 (1.281). Concerning gender composition, we mainly emphasise a fall of 12.63 (11.60) in male enrollment.

The results of this dissertation highlight that there was a huge repressed demand for Adult Education in Northeastern Brazil and that school capacity accompanied these changes by offering more classes once electricity arrived. Also, increased demand for Adult Education was mainly driven by younger and older cohorts; and by an expressive increase in female students.

Our reported patterns raise interesting questions about how adult education expansion could affect adults' choice between education and labor, or if they chose to study while working. Also, as a topic for future research, it would be interesting to analyze effects in labor market for those age cohorts who went back to school. Besides adult education, for Basic Education a research opportunity is to investigate the motivations behind the decrease in male enrollment and if there is a connection with the labor market.

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APPENDIX A – Application: auxiliary tables

In next tables, there are descriptive statistics for each dependent variable used in the previously estimations. They are organized as the estimation tables standard, i.e, they are divided in schools levels, period, gender and age cohort in each correspond table.

Table 17 – Descriptive Statistics - Structure School

	Enrollment		Class		Class Size	
	(1) Total mean/sd	(2) Eligible mean/sd	(3) Total mean/sd	(4) Eligible mean/sd	(1) Total mean/sd	(2) Eligible mean/sd
Basic and Adult Education	113.8489	103.7405	4.098368	3.715567	21.57177	21.37098
	(148.7447)	(125.9845)	(5.176979)	(4.710657)	(19.21363)	(20.00199)
Daytime	90.25135	82.31352	3.189508	2.866721	16.97398	16.465
	(114.3699)	(99.22743)	(4.171182)	(3.849239)	(17.05585)	(17.69339)
Night time	23.59752	21.42699	.9088595	.8488461	9.576458	9.106987
	(51.05251)	(43.76145)	(1.661249)	(1.532039)	(13.12626)	(12.6933)
Basic Education	85.11492	77.55146	2.974231	2.682342	15.02194	14.43722
	(130.453)	(113.4616)	(4.533905)	(4.196936)	(18.05149)	(18.41656)
Daytime	75.66433	68.36832	2.668603	2.375827	14.36986	13.74302
	(109.3159)	(95.29975)	(3.970642)	(3.657623)	(17.15056)	(17.45806)
Night time	9.450594	9.183144	.3056282	.3065153	2.224191	2.204486
	(37.75081)	(33.72982)	(1.151433)	(1.103082)	(8.448337)	(8.126168)
Adult Education	12.91424	10.86304	.5753619	.5052391	7.995618	7.331318
	(29.11428)	(22.3897)	(1.13614)	(.9358829)	(11.70906)	(11.18169)
Daytime	.5238346	.4340003	.0249117	.0213742	.3557634	.318
	(8.49427)	(4.815561)	(.3608581)	(.2069159)	(2.942358)	(2.733253)
Night time	12.39041	10.42904	.5504502	.4838649	7.765092	7.11971
	(26.73495)	(21.5685)	(1.032048)	(.9018657)	(11.6354)	(11.10265)
N	279094	183446	279094	183446	279094	183446

Table 18 – Descriptive Statistics - Structure School - Primary and Secondary School

	Enrollment		Class		Class Size	
	(1) Total mean/sd	(2) Eligible mean/sd	(3) Total mean/sd	(4) Eligible mean/sd	(1) Total mean/sd	(2) Eligible mean/sd
Elementary and Middle School	98.04165	91.17268	3.441175	3.157526	17.33558	16.94833
	(127.5188)	(114.0335)	(4.550304)	(4.295677)	(17.76133)	(18.54277)
Daytime	88.44943	81.13996	3.125001	2.820597	16.7671	16.2735
	(109.9936)	(96.87917)	(4.058838)	(3.780361)	(17.02404)	(17.65922)
Night time	9.592218	10.03272	.3161746	.3369283	2.268047	2.386656
	(33.69423)	(32.89112)	(1.084265)	(1.103028)	(8.051531)	(8.162608)
Elementary School	64.06145	59.00122	2.164801	1.898815	15.55664	14.88285
	(68.53081)	(61.3993)	(2.728946)	(2.525322)	(17.61555)	(18.29155)
Daytime	62.09432	56.79766	2.135865	1.868549	15.10983	14.35197
	(65.97515)	(58.50283)	(2.680986)	(2.471452)	(16.77764)	(17.27366)
Night Time	1.967134	2.203558	.0289355	.030266	.4920809	.521579
	(9.791159)	(10.03325)	(.2573661)	(.2585537)	(4.074461)	(4.177656)
Middle School	33.9802	32.17146	1.276374	1.258711	6.41718	6.465711
	(85.77275)	(78.94672)	(2.769136)	(2.689679)	(11.85743)	(11.76671)
Daytime	26.35511	24.3423	.9891354	.9520483	5.701728	5.64668
	(70.58645)	(64.4552)	(2.330479)	(2.250463)	(11.3848)	(11.25292)
Night Time	7.625083	7.829163	.2872391	.3066623	2.290335	2.401846
	(31.21627)	(30.46178)	(1.032113)	(1.052316)	(7.852026)	(7.858099)
High School	2.892973	1.704782	.0858547	.054911	.4783886	.3420246
	(33.39802)	(21.17033)	(.9053701)	(.6272915)	(4.046202)	(3.327057)
Daytime	1.278083	.7395528	.0395962	.0247495	.2735831	.1854647
	(18.8139)	(11.96987)	(.5353214)	(.3711773)	(2.993679)	(2.396556)
Night Time	1.61489	.9652293	.0462586	.0301616	.3695385	.2534884
	(20.00492)	(13.50042)	(.5355173)	(.3884643)	(3.660786)	(2.934518)
N	279094	183446	279094	183446	279094	183446

Table 19 – Descriptive Statistics - Structure School - Adult Education

	Enrollment		Class		Class Size	
	(1) Total mean/sd	(2) Eligible mean/sd	(3) Total mean/sd	(4) Eligible mean/sd	(1) Total mean/sd	(2) Eligible mean/sd
Elementary and Middle School	12.66678	10.76362	.5680112	.502014	7.965419	7.316154
	(27.45326)	(21.84227)	(1.102993)	(.9252951)	(11.68117)	(11.16946)
Daytime	.5046845	.4262184	.0242701	.0210935	.3506422	.3155806
	(8.161733)	(4.682008)	(.3509638)	(.2037816)	(2.910564)	(2.720195)
Night time	12.16209	10.3374	.5437411	.4809205	7.734912	7.10529
	(25.36901)	(21.07019)	(1.007517)	(.8923108)	(11.60625)	(11.09037)
Elementary School	9.484629	8.320411	.4359616	.3897307	7.147451	6.535943
	(18.61652)	(16.86814)	(.8007395)	(.7392019)	(11.24404)	(10.78599)
Daytime	.3063212	.2755867	.0154833	.0139579	.2464592	.2211459
	(3.577082)	(3.457399)	(.168468)	(.1597326)	(2.3865)	(2.249631)
Night time	9.178308	8.044825	.4204783	.3757728	6.958767	6.365473
	(18.21507)	(16.41027)	(.7799143)	(.7164937)	(11.16885)	(10.70679)
Middle School	3.182149	2.443212	.1320496	.1122833	1.83102	1.588237
	(17.23596)	(11.38102)	(.6376548)	(.4443361)	(6.841179)	(6.098978)
Daytime	.1983633	.1506316	.0087869	.0071356	.1257327	.1120559
	(6.98408)	(2.59173)	(.2910449)	(.1048898)	(1.853693)	(1.692839)
Night time	2.983786	2.29258	.1232627	.1051477	1.745515	1.504099
	(14.53694)	(10.93037)	(.5063109)	(.4259317)	(6.705625)	(5.950564)
High School	.2474644	.0994157	.0073507	.0032251	.0999219	.0440124
	(6.550102)	(3.91166)	(.1709182)	(.1131307)	(1.926715)	(1.222819)
Daytime	.0191501	.0077819	.0006416	.0002807	.008181	.0030026
	(1.706388)	(1.114118)	(.0498523)	(.0345636)	(.5346022)	(.2914328)
Night time	.2283143	.0916338	.0067091	.0029443	.0966863	.041806
	(5.926933)	(3.587846)	(.1540668)	(.1034001)	(1.907565)	(1.199923)
N	279094	183446	279094	183446	279094	183446

Table 20 – Descriptive Statistics - Gender composition

	Men		Women	
	(1) Total mean/sd	(2) Eligible mean/sd	(3) Total mean/sd	(4) Eligible mean/sd
Basic and Adult Education	57.23318	52.05523	51.59068	46.86183
	(72.32975)	(61.13524)	(70.96204)	(59.95413)
Basic Education	51.13518	47.03291	46.28315	42.41647
	(65.47221)	(56.70755)	(65.34448)	(56.32507)
Elementary and Middle School	49.97911	46.37993	44.90103	41.59832
	(62.10638)	(55.19941)	(60.35281)	(53.82184)
Elementary School	35.05704	32.43025	29.64186	27.36153
	(34.89871)	(31.19598)	(30.62375)	(27.27644)
Middle School	14.92206	13.94968	15.25917	14.23679
	(40.01024)	(36.46669)	(41.85452)	(38.28955)
High School	1.156072	.6529805	1.382118	.8181496
	(14.46849)	(8.814317)	(17.22013)	(11.08188)
Adult Education	6.098	5.022326	5.307537	4.445367
	(15.17878)	(11.81503)	(13.22826)	(10.09557)
Elementary and Middle School	5.989954	4.980738	5.197684	4.401165
	(14.43243)	(11.57892)	(12.4334)	(9.826957)
Elementary School	4.451346	3.833332	3.908627	3.39565
	(9.818492)	(8.795923)	(8.613756)	(7.772927)
Middle School	1.538607	1.147406	1.289057	1.005515
	(8.87887)	(6.113642)	(7.674164)	(4.859112)
High School	.1080463	.041588	.1098529	.0442021
	(3.016021)	(1.740469)	(3.217432)	(1.953117)
N	268459	177503	268459	177503

Table 21 – Descriptive Statistics - Age Cohort - 15-17, 18-24, 25-29

	15-17		18-24		25-29	
	(1) Total mean/sd	(2) Eligible mean/sd	(3) Total mean/sd	(4) Eligible mean/sd	(1) Total mean/sd	(2) Eligible mean/sd
Adult Education	1.672016	1.246374	3.400462	2.708349	2.132474	1.823663
	(5.845104)	(4.445994)	(10.36077)	(7.244005)	(5.328179)	(3.883526)
Elementary and Middle School	1.653581	1.239752	3.259257	2.652166	2.084113	1.804535
	(5.758602)	(4.412292)	(9.157328)	(6.740966)	(5.010212)	(3.738226)
Elementary School	.8496379	.659360	1.984987	1.710315	1.606965	1.433624
	(2.800112)	(2.295405)	(4.520932)	(3.975505)	(3.338074)	(3.092745)
Middle School	.8039427	.580391	1.27427	.9418512	.4771475	.3709103
	(4.484509)	(3.396892)	(7.187391)	(4.819815)	(3.386491)	(1.709903)
High School	.0184352	.0066227	.1412042	.0561826	.0483614	.0191289
	(.5476752)	(.2993895)	(3.490821)	(2.062703)	(1.335265)	(.9281338)
N	201028	131215	201028	131215	201028	131215

Table 23 – School Infrastructure

	(1) Total mean/sd	(2) Eligible mean/sd
computer	.0907329	.0748177
	(.2872294)	(.2630976)
internet	.2264517	.2250543
	(.4185355)	(.4176194)
classrooms	2.733732	2.541565
	(4.755345)	(5.536184)
TV	.2924355	.2347394
	(.545367)	(.4998604)
school meals	.9822427	.9824756
	(.1320684)	(.1312149)
employees	9.600537	8.594362
	(19.03125)	(11.70764)
N	279094	183446

Table 22 – Descriptive Statistics - Age Cohort - 30-34, 35-39 and > 39

	30-34		35-39		> 39	
	(1) Total mean/sd	(2) Eligible mean/sd	(3) Total mean/sd	(4) Eligible mean/sd	(1) Total mean/sd	(2) Eligible mean/sd
Adult Education	1.965622 (4.302329)	1.687795 (3.419954)	1.731699 (3.801524)	1.499783 (3.085929)	3.908346 (8.162772)	3.481858 (7.423288)
Elementary and Middle School	1.932631 (4.07149)	1.675807 (3.360012)	1.708662 (3.582928)	1.491407 (3.051876)	3.882315 (8.07431)	3.468651 (7.393806)
Elementary School	1.56615 (3.214176)	1.38805 (2.93923)	1.437128 (3.073641)	1.273307 (2.755013)	3.49504 (7.474701)	3.128217 (6.920844)
Middle School	.3664813 (2.142641)	.287756 (1.311624)	.271534 (1.528422)	.218100 (1.073603)	.387274 (2.342593)	.3404336 (1.849062)
High School	.032990 (.9751426)	.011988 (.5603499)	.023036 (.9707639)	.008375 (.4308882)	.0260312 (.9448122)	.0132073 (.6719318)
N	201028	131215	201028	131215	201028	131215