UNIVERSIDADE FEDERAL DE PERNAMBUCO
CENTRO DE CIENCIAS SOCIAIS APLICADAS
PROGRAMA DE PÓS-GRADUAÇÃO EM ECONOMIA - PIMES
TESE

THREE ESSAYS ON URBAN ECONOMICS: EVIDENCES FROM BRAZIL

Aluno: Luís Eduardo Barbosa Carazza
Orientador: Raul da Mota Silveira Neto

Recife, 2016

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LUÍS EDUARDO BARBOSA CARAZZA

THREE ESSAYS ON URBAN ECONOMICS: EVIDENCES FROM BRAZIL

Tese apresentada ao Programa de Pós-Graduação em Economia da Universidade Federal de Pernambuco, como requisito parcial para a obtenção do título de Doutor em Economia.

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ABSTRACT

The present study examines the impact of three public policies in Brazil. The first essay examines the juvenile curfew in the interior of São Paulo and our estimates shows that this policy was responsible for the reduction of approximately 17.5% in the theft rate when compared to cities that did not adopt the curfew. The second article estimates the effect of the Dona Lindu Park in the price of real estate in the city of Recife, Pernambuco. The results indicate an increase in the value of approximately 7.7% of properties located up to 600 meters from the park and for properties located at 600 and 1000 meters from the park there is was negative impact on the real estate price of approximately 11.9%. In the third essay we studied the impact of the expansion of the Federal Network of Professional and Technological Education on Human Capital and migration variables and, according to our analysis; there was a positive impact of 2.59% on the proportion of short-term immigrants.

Keywords: Differences in Differences, Public Policies in Brazil, Crime, Housing and Education.

RESUMO

O presente estudo analisa o impacto de três políticas públicas no Brasil. O primeiro ensaio examina o toque de recolher para crianças e adolescentes no interior de São Paulo e mostra que esta política foi responsável pela redução de aproximadamente 17,5% na taxa de furtos, quando comparado a cidades que não adotaram o toque de recolher. O Segundo artigo estima o efeito do parque Dona Lindu no preço dos imóveis na cidade de Recife, Pernambuco. Os resultados encontrados indicam um aumento no valor dos imóveis localizados até 600 metros do parque de aproximadamente 7,7% e para imóveis localizados a 600 e 1000 metros do parque há um impacto negativo no preço dos imóveis de aproximadamente 11,9%. No terceiro ensaio estudou-se o impacto da expansão da Rede Federal de Educação Profissional e Tecnológica em variáveis de Capital Humano e migração e, segundo nossa análise, houve um impacto positivo de 2,59% na proporção de imigrantes de curto prazo.

Palavras-Chaves: Diferenças em Diferenças, Políticas Públicas no Brasil, Crime, Habitação e Educação.

Summary

INTRODUCTION

Urban economics emphasizes the spatial arrangements of households, firms, and capital in metropolitan areas; the externalities which arise from the proximity of households and land uses; and the public policy issues which arise from the interplay of these economic forces (Quigley, 2008). Thus, the Urban Economics is a vast area of economic study of urban areas. This way, it involves the use of economic tools to analyze the issues of cities, such as crime, education, public transport, housing and local government finance. More precisely, it is a branch of microeconomics that studies the urban spatial structure and location of households and firms (Quigley, 2008).

Thus, this thesis aims to determine the impact of three public policies on the area of urban economics in Brazil. The first essay studies the impact of the juvenile curfew on the reduction of criminality for Brazilian cities in the state of São Paulo. The second paper examines the effect of a building of a Park on the real estate value for the city of Recife, Brazil. The third article analyzes the effect of the Expansion of the Brazilian Federal System of Vocational Education and Technology on the local Human Capital and Migration variables in the country.

In 2005, the city of Fernandópolis, located in São Paulo, reached the juvenile curfew for minors and adolescents. This decision did not come from the municipal level, but a courtroom decision. Subsequently, some municipalities in the state of São Paulo also decided to implement the juvenile curfew. In order to verify the effect of the ordinance in reducing crime, this article uses the difference in difference estimation to calculate the causal impact of the implementation of the ordinance in relation to municipalities that not adopted. Thus, the ordinance caused a decrease of 17.5% in thefts per thousand inhabitants in municipalities that adopted the ordinance.

In 2011 the Park Dona Lindu Park was built in Boa Viagem neighborhood at Recife. This article investigates the impact on real estate price in the region around the Park. Thus, the results obtained indicate that the properties are located up to 600 meters of the D. Lindu have an average increase of 7.7% in the real estate price. On the other hand, the properties situated between 600 and 1000 meters from the Dona Lindu Park had a decrease in the price of approximately 11.9%. The results suggest that the positive effect to properties nearby the

park probably have a positive effect on the real estate properties and for the properties located more distant from the D. Lindu there was a strong negative impact.

The expansion of the Federal System of Vocational Education and Technology, between 2000 and 2010, created more than 214 new Federal Institutes. This present study investigated whether some of the government's proposals were accomplished and, specially, the impact of the creation of a Federal Institute on our set of Migration and Human Capital variables. In this way, we found some important contributions of the expansion of the Federal System of Education in the Migration Variables. Thus, when a new Federal Institute was built in some municipality that did not have a FI before, there was a growth in the proportion of short-term immigrant in these municipalities, more precisely; there was an increase of 2.59% in the proportion of short-term immigrant in the municipalities with a new FI.

Thus, this effect was not large, because the proportion of short-term immigrants decreases in the treated municipalities from 33%, in 2000, to 26.4%, in 2010. This means for municipalities with new Federal Institutes this ratio fell less than for municipalities without a new FI, indicating that the expansion of the Federal System of Education only avoid greater falls on this ratio.

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Juvenile Curfew and Crime Reduction: Evidence from Brazil

1. Introduction

A survey conducted by the Brazilian Ministry of Justice in 2011 demonstrated that property crimes such as theft and robbery (43.7% of total) and involvement with drug trafficking (26.6%) were the most frequent of committed crimes by minors in State Care Institutions fulfilling social-educational measure (Costa, 2014). About a tenth of them were involved in crimes against life, 8.4% of homicides and 1.9% of armed robberies resulted in human deaths.

In August 2005, reflecting concerns about crimes committed by minors, the County of Fernandópolis adopted the curfew for children and adolescents. The city of Fernandópolis is sited in the northwest of São Paulo, Brazil and it is 554 km away from São Paulo city. It has a high literacy rate of around 94% (IBGE, 2010) and the Municipal Human Development Index (M-HDI) is 0.832, which is considered very high (IPEADATA, 2010). The ordinance follows the ensuing determination: the Police (civil and military) and the Guardianship Council must gather children and adolescents, unaccompanied by a parent or responsible adult, in some risk situations (e.g., minors with contact with alcohol, drugs or prostitution), guiding them to the parents immediately, as a measure of protection by warning. In case of repeated negligence, other measures should be employed such as fines to parents and the treatment of young drug addicts (Pelarin, 2009). The juvenile curfew is the name that was attributed to a decision of the Court of the Children and Youth of Fernandópolis County. The County of Fernandópolis is composed of the cities of Meridian, Macedonia and Pedranópolis, all are in the state of São Paulo, Brazil. Thus, this decision did not come from the Municipal or Federal level, but it was a court decision (Pelarin, 2009).

Moreover, since the start of the curfew, it was issued a public recommendation that parents do not leave their youngsters alone in the streets or in other potentially dangerous places after 11 pm. In July 2005, after several meetings organized by the Magistrates, the Judiciary ordered the formation of a task force, along with the public Security Forces (Civil and Military Police) and Guardianship Council (Pelarin, 2009). Also it was invited the Brazilian Bar Association (OAB) for the carrying out and the enforcement of the resolution reached by the by the Fernandópolis Court. The objective was to draw from the streets minors at risk situation.

In this way, other municipalities followed the same path of Fernandópolis. It is estimated that in 2011, according to data from the Brazilian National Council of Justice (CNJ), 41 municipalities in 16 states have reached this practice as a strategy to prevent and protect the children and adolescents of the several risks that surround them (CNJ, 2011). As the violence in Brazil continues to increase (Anuário Brasileiro de Segurança Pública, 2014), several other cities in Brazil look for ways to control crime and the juvenile curfew is an option with a relatively easy application. There are even projects in the House of Representatives aimed at implementing the curfew in Minas Gerais, another Brazilian State, and also nationwide (Ferreira, 2011 and Noble, 2013).

In the State of São Paulo, Figure 1, besides the municipalities of Fernandópolis County, the cities of Ilha Solteira, Itaperuna and Mirassol followed the same path of Fernandópolis and adopted in 2009 the juvenile curfew following the same modus operandi. In 2010, the Cajuru municipality also implemented the juvenile curfew, and in the following year, it was the city of Barretos that followed the same path.

FIGURE 1: Municipalities That Have Implemented the Juvenile Curfew in the State of São Paulo

Note: Own Elaboration

However, in 2012, the Superior Court of Justice (STJ) of São Paulo declared illegal the decree which determined juvenile curfew in the city of Fernandópolis (CANCIAN, 2012). The Court considered that the government should draw up measures to protect children and adolescents without affecting rights under the Brazilian laws and international treaties.

According to Adams (2003), the law enforcement community, composed by the Prosecutor's Office and the Magistrates, generally favors curfew laws in part because they provide police with additional authority and opportunity to stop and question suspicious youngsters. In this process, the police may detect criminal behavior that might otherwise go unnoticed. Even the possibility of being stopped and questioned may have a deterrent effect on juveniles who are contemplating wrongdoing. These crime control benefits can accrue in addition to any crime reduction effects that compliance with the curfew restrictions may have.

Another attractive aspect of curfew laws is that they are a seemingly inexpensive way of addressing juvenile crime problems. While the actual costs of curfew enforcement depend on operational details, such as whether the violator is issued a citation or taken into custody, there seems to be a general notion that curfew enforcement can simply be added to the list of an officer’s law enforcement duties without need for any significant increase in police resources. However, the curfew enforcement, which involves a relatively minor offense, detracts from the time that an officer can devote to dealing with serious crime.

Thus, as Adams (2003) highlights, the curfews are attractive to a broad audience that encompasses a wide variety of philosophical and political persuasions. As an instrument of social policy, curfews can be used to reinforce parental responsibility and strengthen family ties. The Curfew laws emphasize parental responsibility and they view parents as the first line of this enforcement. Many curfew laws sanction both parents and children for violations, and some exclusively target parents. As a related matter, family ties may be strengthened as children spend more time at home, and there may be benefits in other domains, such as school performance. As a crime control instrument, curfew laws promise to reduce both juvenile offending and victimization. They also provide law enforcement with an additional tool to investigate and detect juvenile crime more aggressively.

Perceived effectiveness of curfews as a crime prevention measure appears to lead to strong support for these laws. For example, in a New Orleans, USA survey, 81% of parents and 76% of teenagers agreed or strongly agreed that a juvenile curfew helped reduce juvenile delinquency in their city (Reynolds, Thayer, and Reufle 1996). Perceived efficacy also is a

major consideration of public officials in deciding to enact curfew laws and of judges in determining their constitutionality. For example, 88% of mayors in the US cities with curfew laws believe that enforcement of these laws make the streets safer (Cochran, 1997).

In fact, there is a small but growing literature on the effects of the curfew on juvenile delinquency. Juvenile curfew statutes are used in hundreds of cities across the United States to prevent juvenile offending and victimization. In spite of their seeming popularity, there is disagreement in the existing literature as to whether juvenile curfews are truly effective in reduction of juvenile criminality (Wallace, 2016).

McDowall, Loftin and Wiersema (2000) used a panel data from a sample of US cities and states to examine the effects of the curfew in juvenile crime rates. The analysis estimates the impact of the new laws in the juvenile homicides and arrests of teenagers for a variety of offenses. The results showed, for the municipal level, that there was a statistically significant decrease in the robbery, thievery, assault and prisons after the adoption of the curfew. The homicide rates were not affected by application of the curfew; both in the cities or states, and, according to the authors, any preventive effects of the curfew appeared to be small. Donohue and Levitt (2001) investigate the role played by the legalization of abortion to explain the reversal trends in crime in the US in the 1990s, and this is due to the fact that with the legalization of abortion, there was a reduction in the supply of people – mostly youngsters – that were more prone to crime and a consequent drop in the number of offenses.

On the other hand, Adams (2003) established an empirical review of research on the juvenile curfew and concluded there was no evidence of the reduction of the crime and the victimization. The juvenile delinquency and victimization are more likely to stay unchanged after the implementation of the curfew laws. It is assumed that adolescents will not change their delinquent activities in ways that accommodate a curfew, but the delinquents may shift their activities to hours when the curfew is not in effect. They might also relocate their delinquent activities to nearby towns or areas that do not have a curfew. Temporal or geographic displacement of delinquent behavior could mean that the net effect of curfews on total crime is negligible.

More recently, Kline (2012) studied the impact of juvenile curfews on juvenile and non-juvenile arrest rates in cities across the United States. The author evaluates the effectiveness of curfew ordinances by comparing the arrest behavior of various age groups within a city before and after curfew enactment. He found that curfews decreased arrest rates for those

directly affected by the law. The evidence indicates that arrest rates for older individuals decline, suggesting that juvenile curfews have spillover effects. The interpretation of these results is complicated by the nature of arrest rates: they were a function of both of criminal behavior and police behavior, and curfew laws likely affect both. Curfews might give police more opportunity to stop and search young-looking individuals, potentially increasing detection of crime. Alternatively, for marginal offenses, police might substitute from making formal arrests to detaining youth for curfew violations. The advantage of looking at arrest rates is that the age of the offender is known; however, the impact on crime rates is the primary outcome of interest when evaluating the cost-effectiveness of this policy. The impact on arrest rates can provide only suggestive evidence on that front.

Carr and Doleac (2014) use a new source of US data on gunfire incidents, and tests the incapacitation effects of two interventions in Washington, DC: juvenile curfews, and rain. Both work primarily by keeping presumed offenders indoors. The first is a common, but controversial, policy used in cities across the United States, and its impact is likely highly sensitive to how it is enforced. The latter is an intervention over which we have no control, but it can be thought of as a perfectly-enforced incapacitation policy: anyone who stays outside during a rainstorm gets wet. They used exogenous variation in the hours affected by each intervention to estimate its causal impact on gun violence and reported crime. The authors found minimal evidence that juvenile curfews are effective, but rainstorms result in large, statistically-significant reductions in gun violence and others crime.

Wallace (2016) studied the effectiveness of a change in the juvenile curfew statutes in Baltimore, USA. Data consist of police arrest records for the months preceding and following the curfew change. The OLS regression analyses address both change in totals arrest and change in the ratio of youth to adult arrests and the ratio of arrests within curfew hours to outside of curfew hours. Results indicate an increase in the ratio of youth to adult arrests during curfew hours. However, totals arrest was decreasing at the time of the curfew change.

In the case of the Brazilian juvenile curfew, the Guardianship Council reported that the juvenile curfew was responsible for an 80% reduction of illegal acts and 82% of the complaints in the Council, in the municipality of Fernandópolis (Siqueira, 2009). And, the city's Juvenile Court Judge highlights that the number of the offenses has been falling year by year (Siqueira, 2009). In 2005, there were 378 incidents, compared to 74 in 2008. The largest reduction was in the incidence of thefts, which diminished 91% in four years. The occurrence

numbers fell sharply also in the possession of narcotics, personal injury, minors carrying firearms, and in the final year of the survey, this value reached zero. In the Guardianship Council, there was also a reduction of offenses against troubled minors and the severity of the complaints about youngsters also had decreased.

Thus, according to the Guardianship Council information, the resolution issued by the Juvenile Court Judge of Fernandópolis had the desired effect; it would have diminished the violence and it had the support of the population (Pelarin, 2009). Also, Pelarin (2009) shows the ordinance was legal, from a constitutional point of view, and it was based on a joint action enters the Judiciary and other Public Officials (Pelarin, 2009). Nevertheless, it is necessary to check to what extent the reduction in crime is due to ordinance or is a felicitous coincidence, for example, a basic education policy that can also affect crime rates.

The evidence available about the conditions of the urban violence in Brazil tends to highlight the role of the share of youngsters in the population (De Mello and Schneider, 2007; Menezes et al. 2013; Chioda, De Mello and Soares, 2015). For example, De Mello and Schneider (2007) displayed the role that the proportion of the youngster influences the violence; hence, they showed a 1% increment in the male population aged 15 to 24 increased by 4.5% the homicide rate.

Despite the experience described above, the juvenile curfew policy is barely studied in Brazil. The discussion of the juvenile curfew issue in Brazil regards the legality of the ordinance and if it is breaking the Statute of Children and Adolescents and the Brazilian Constitution, because it impose limits to the freedom of individuals to come and go. Several national and international authors raised hypotheses agree or dissent on the legality of the ordinance (Hemmens and Bennett, 1999; Tavares, 2010; Saliba and Brega Filho, 2012; and Lepore and Rossato, 2012). Even considering the relevance of their legal status, it also seems essential to understand the effectiveness of this policy regarding the reduction of urban violence in Brazil and this is the proposal of this article.

Specifically, using a Difference-in-Difference identification strategy, we use a data panel database to investigate a causal relationship between the implementation of the juvenile curfew – the adoption of the curfew in nine cities– and crime (thief and robbery). In our survey, we found that there was a reduction of 17.5% in the theft rate for the treated municipalities that adopted the juvenile curfew. On the other hand, we found no impact on the robbery rate, as well as, other variables related to crime, such as, homicide rates, vehicle theft,

vehicle robbery and armed robberies resulting in human deaths. The results are robust to the consideration of different control groups and forms of the model misspecification.

The paper is organized as follow: in the section 2, we present the empirical strategy and descriptive statistics; in the section 3, we present and discussed the result, and in the section 4 we carry out the Robustness Checks and Falsification Tests. Finally, in the section 5, we present the discussion and final considerations.

2. Empirical Strategy and Descriptive Statistics

In order to investigate the existence of a possible causal relationship between the juvenile curfew and the decreasing in the crime rate – in the absence of social experiment associated with such public policy – our strategy is based on a model of differences-in-differences (DiD). This approach estimates the effect of a treatment – in our case, the juvenile curfew, that is, a response variable or dependent variable, in this case, crime – comparing the average change over time in the result variable for the treatment group (cities that adopted the juvenile curfew) and the mean variation over time in the control group (cities that not adopted the juvenile curfew) (Angrist and Pischke, 2008).

Such strategy may be subject to certain problems (as selection bias, for example), although it is intended to wipe out some of these bias effects. As there are different periods of adoption of the juvenile curfew in the state of São Paulo, it permits us to compare cities that implemented first the curfew with cities that implement it later, which eliminates in part the problem of heteroscedasticity (Biderman, De Mello and Schneider, 2007). We identified nine cities that adopted the ordinance curfew in different moments in time: in 2005 it was the county of Fernandópolis, composed by the cities of Fernandópolis, Macedonia, Meridiano, and Pedranópolis. In 2009 it was the time of the cities of Ilha Solteira, Itapura and Mirassol, in 2010, Cajuru city and, finally in 2011 the city of Barretos adopted the juvenile curfew. The other cities in the state of São Paulo are the control group used to obtain the counterfactual.

More formally, we will estimate parameters of several versions of the following model:

$$Crime_{it} = \beta_0 + \beta_1 CF_{it} + Year_t + M_i + \Phi X_{it} + \theta(OAB_i * T_t) + \varepsilon_{it} \quad (1)$$

Where *i* refer to the cities in the state of São Paulo and *t* is the year. CF is a dummy that takes the value 1 if the curfew was implemented in the city *i* at time *t*, and zero otherwise.

Thus, for the cities that have not adopted the ordinance and cities that have implemented curfews before the adoption of the same, the variable assumes zero value. Year is a series of dummies for the period from 2002 to 2011. And M_i is a complete set of dummy variables for *i* municipalities and it measures the fixed effect of city. The term OAB_{i} indicates the average rate of the total of crime in the municipality *i* in the base year, 2002. Multiplying OAB_{i} by T_t, a linear time trend, we obtain a specific linear trend for each municipality. This trend captures crime convergence between municipalities with different initial conditions. If the juvenile curfew was originally installed in cities with high criminality, and these municipalities tend to advance on crime indicators more quickly than others for others reasons than due to the juvenile curfew, our coefficient of interest would be overestimated. Thus, this control helps us to isolate the influence of long-term factors associated with the advancing of criminality and simultaneously with the introduction of policies directed to public safety.

Finally, X_{it} is a vector of time-varying controls and $\varepsilon_{\mathrm{it}}$ is the error term that will be organized by cluster at the city level in all the estimates to take into account the heteroscedasticity and serial correlation of the characteristics observed between the attributes belonging to the same city (Bertrand et al., 2004). Crime is our variables of interest and it is measured by the rates of theft[1] and robbery. The literature of crimes uses as dependent variables the rate per one hundred thousand inhabitants (De Mello & Schneider, 2007) and so we will follow this pattern along this exercise. Thus, the estimative of causal impact of the juvenile curfew should be the value of β_1, that is, the average effect on the treated municipalities (ATT).

The two initial controls in X_{it} are the most straightforward ways to take into consideration the heterogeneity over the time. Thus, the controls include the logarithm of GDP per capita, because it measures the local level of development and the share of young people between 15 and 24 years, thus in this age period that happens the greatest number of deaths and cases of violence (De Mello & Schneider, 2007). These variables are observed on a yearly basis, and, for the dependent variable, the observations were weighted by the average population. This is because crime does not always occur frequently or are not reported clearly in small towns. Thus, there is much less variance in small towns compared to large urban centers; the weighting corrects part of this problem. In addition, weighting the observations

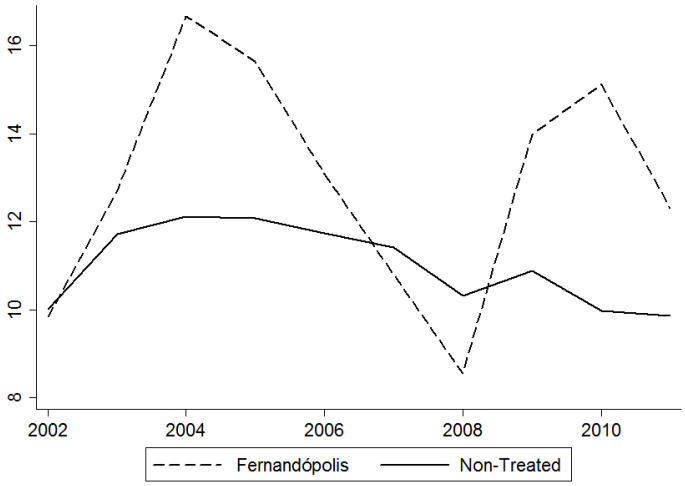
[1] We will use theft as a synonym for crimes which there were no kind of violence involved, such as car or house thefts which there was no violence, only the appropriation of someone property. We also use robbery as a synonym for crimes which there was violence involved, as, for example, the use of physical violence, melee weapons or firearms to commit a crime.

by population serves two purposes. First, it emulates a regression at the individual level, i.e., weighting observations provides estimates closer to a random sample in the state of São Paulo. Second, the crimes rates are not a common occurrence and observations from small cities are much noisier than those from larger cities (its variance decreases with population). Thus variation from smaller cities should be discounted. In order to avoid giving more weight to observations in the later part of the sample, the weight is the city population in 2002.

In addition to the controls for the per capita income and the share of young people, we also use as controls the expense of each municipality in culture, health, education, social security and social assistance and public safety. According to Cerqueira, Mello and Soares (2014), this last variable serves as a proxy to the police budget. The city-level enforcement variables are particularly important in two ways. First, these expanses show the municipality concern about the youngsters, because most of these variables are linked to the power of the city to care about its minor's population and it reinforces the role of the city in ensuring culture, health, education and social care for their inhabitants. Second, the city is the main law enforcer by constitutional mandate and the empirical literature has established the link from the city enforcement to crime (Marvell and Moody, 1996; Corman and Mocan, 2000; Di Telia and Schargrodsky, 2004; Levitt, 2002).

To illustrate the evolution of the crime rates, the Figures 2 and 3 show the dynamics of theft and robbery rates in the Fernandópolis city, respectively. As the Figure 2 evidence, the theft rates show a clear decline after the acceptance of the ordinance and the mean of the theft rate of the non-treated cities have hardly changed over the time. On the other hand, for the robbery rates, Figure 3, the Fernandópolis city does not have a downward trend after the implementation of the curfew, both datasets are barely constant over time and there is not a decrease in this crime modality, as evident in the previous figure.

FIGURE 2: The Theft Rate (per one thousand inhabitants) – Fernandópolis and the Non-Treated cities – 2002 a 2011



Note: The data is from the SEADE Think Tank

FIGURE 3: The Robbery Rate (per one thousand inhabitants) – Fernandópolis and the Non-Treated cities – 2002 a 2011

Note: The data is from the SEADE Think Tank

The data used in the study were primarily obtained from two sources. The first one is the SEADE[2], a foundation linked to the Department of Planning and Management of the State of São Paulo. In this database there are information about theft and robbery and it has annual

[2] The SEADE, Fundação Sistema Estadual de Análise de Dados, a think tank linked to the Department of Planning and Management of the State of São Paulo. For further information, see www.seade.gov.br.

frequency. This database also contained information such as the municipal GDP per capita, data on demographics, such as the share of young people between 15 and 24 years, and the population in each municipality over the period of analysis. In addition, data such as expense in education, culture, health, social assistance, social security and public safety are found in that database and follows the same annual frequency of the data on crime. The crime variables are from the DATASUS[3], the database from the Ministry of Health. The analysis period begins in 2002 and ends in 2011. The Table 1 presents the information about the treated and not treated municipalities before and after treatment, the juvenile curfew.

TABLE 1: Summary Statistics

	Pretreatment Period (2002-2005)			PostTreatment Period (2006-2011)		
Variable	Non-treated	Treated	Mean Difference	Non-treated	Treated	Mean Difference
Theft Rate	10.92	14.77	-3.85*	11.12	11.13	-0.01
	(7.202)	-9552		(6.511)	(6.793)	
Robbery Rate	1.632	0.617	1.015**	1.625	0.653	0.972***
	(2.432)	(0.505)		(2.279)	(0.659)	
Logarithm of GDP Per Capita	9.011	9.109	-0,098	9.481	9.564	-0.083
	(0.529)	(0.439)		(0.574)	(0.456)	
Proportion of Young People	0.0944	0.0909	0.0035***	0.0901	0.0808	0.0093***
	(0.00717)	(0.00440)		(0.0105)	(0.00652)	
Population	61,781	31,703	30.078	61,662	22,793	38,869
	(443,931)	(34,873)		(442,51)	(27,945)	
Logarithm of Expense in Culture	9.633	8.513	1.12	10.83	7.741	3.089***
	(5.063)	(6.678)		(4.644)	(6.513)	
Logarithm of Expense in Education	15.77	15.77	0	16.09	15.72	0.37
	(1.303)	(1.355)		(1.399)	(1.210)	
Logarithm of Expense in Health	15.47	15.70	-0.23	15.85	15.63	0.22
	(1.363)	(1.170)		(1.430)	(1.068)	
Logarithm of Expense in Public Safety	4.247	5.330	-1.083	5.075	4.572	0.503
	(6.274)	(6.573)		(6.660)	(6.572)	
Logarithm of Expense in Social Assistance	13.82	14.02	-0.2	14.12	13.94	0.18
	(1.356)	(1.109)		(1.326)	(1.050)	
Logarithm of Expense in Social Security	8.874	13.30	-4.426***	8.185	11.24	-3.055***
	(6.635)	(3.433)		(7.014)	(5.147)	
Observations	2,544	36		2,544	36	

Note: Data from SEADE and DATASUS. SD is in parentheses. *** p<0.01, ** p <0.05, * p <0.1 *** p<0.01, ** p<0.05, * p<0,10. The crime variables are the rate per one hundred thousand inhabitants.

[3] The DATASUS, Departamento de Informática do Sistema Único de Saúde. For further information, see www.datasus.gov.br.

Table 1 shows the average and the differences between the set of variables before and after the treatment, the implementation of juvenile curfew. From the total of 645 municipalities of the state of São Paulo, nine (1.4%) adopted the juvenile curfew at different points in time. For the pretreatment period, the treated municipalities have a higher theft rate and a lower robbery rate. They have quite the same per capita income and percentage of young people, but a smaller population compared to the non-treated municipalities. As all municipalities that are treated are small to medium size cities, we observed significant differences in the rates of municipal expense, such as culture, social assistance, education. After the treatment, the theft rate declined for the treated group and had rates similar to the control group. The robbery rate hardly changed for both groups. Again the per capita incomes are similar, but the percentage of young people decreased more in the treated group.

3. Results

Aiming to analyze the effect of the juvenile curfew on the crime rates for the State of São Paulo, we will build a panel containing the period before the intervention, 2002 to 2005, and the post-intervention period, after the adoption of the curfew, after 2005 to 2011. We procedure with the strategy of DiD to estimate the causal effect of the ordinance. We use data from 645 cities, from which nine were treated, because they implement the juvenile curfew.

Table 2 presents the results of estimates of equation (1). The first three (columns (1) through (3)) show the impact on theft for all cities that have adopted the curfew compared to those not implemented in the theft rate. The first column, with no control and no fixed effects, indicates a negative but not statistically significant impact of the juvenile curfew in the theft rate. The second column, when we add the controls, has the same pattern, a negative effect but not statistically significant. But, when we add the fixed effects of time and city and the trend, it was found that there was an impact of -2.589 in the theft rate per one hundred thousand inhabitants and it was statistically significant at 10%. And it represents a considerably reduction in this modality of offense of 17.5%.

TABLE 2: The Impact of the Juvenile Curfew on the Crime Rates

	Theft Rate			Robbery Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Juvenile Curfew	-0.439	-0.040	-2.589*	0.207**	0.116	-0.127
	(1.056)	(1.117)	(-1.361)	(0.094)	(0.103)	(0.152)
Logarithm of GDP		-1.146***	0.333		0.019	-0.055
		(0.205)	(0.626)		(0.072)	(0.367)
Share of Young People		23.871*	-176.765**		2.595	-26.863*
		(14.445)	-75.281		(2.212)	-13.787
Logarithm of Expense in Culture		0.015	-0.039		0.000	-0.005
		(0.018)	(0.042)		(0.003)	(0.010)
Logarithm of Expense in Education		0.416**	0.054		0.170**	0.032
		(0.168)	(0.077)		(0.077)	(0.037)
Logarithm of Expense in Health		0.068	0.078		0.034	-0.004
		(0.096)	(0.066)		(0.026)	(0.019)
Logarithm of Expense in Social Assistance		-0.035	-0.003		0.015	-0.008
		(0.063)	(0.060)		(0.016)	(0.038)
Logarithm of Expense in Social Security		0.007	0.028		-0.001	0.028
		(0.016)	(0.029)		(0.004)	(0.018)
Logarithm of Expense in Public Safety		-0.007	-0.042		0.016***	0.012
		(0.021)	(0.033)		(0.005)	(0.011)
Municipal Controls	No	Yes	Yes	No	Yes	Yes
Fixed Effect of City	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect of Time	Yes	Yes	Yes	Yes	Yes	Yes
Trend	No	No	Yes	No	No	Yes
Observations	5,775	5,775	5,775	5,775	5,775	5,775
Adjusted R^2	0.0000	0.0537	0.328	0.0011	0.4974	0.514

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

On the other hand, the impact of the curfew on the robbery rates, column (4) through (6), had an initial unforeseen effect. In column (4), with no fixed effects or controls the impact of the curfew on the robbery rate was positive and statistically significant, but when we add the controls, the effect was not statistically significant, although it still positive. In the last column, when we add the fixed effects of time and city, the impact was negative and it was not statistically significant, despite being a negative signal, according to expected.

Of course, the estimates found in the previous estimation provided the average effect on the treated municipalities (ATT) of the ordinance in the crime over the period of the post-treatment. These estimates, however, can be non-uniform in relation to the effect of the

curfew in specific years after its enacting, because it takes time to the curfew really work and, indeed, reduce the crime rate. Thus, it is possible that the ATT varies over time depending on the evolution of crime rates in the cities that adopted the ordinance.

With the aim to capture this effect, we estimate the model of equation (2):

$$Crime_{it} = \beta_0 + \sum_{2003}^{2004} \beta_{-\tau} CF_{it} + \sum_{2005}^{2008} \beta_{+\tau} CF_{it} + Year_t + M_i + \Phi X_{it} + \theta(OAB_{\mathrm{i}} * T_t)\, \varepsilon_{it} \quad (2)$$

And this equation is noteworthy, because the non-linear effects allow the ordinance in crime rates of the treated cities. The CF coefficient is equal to 1 for cities that had reached the juvenile curfew and zero, otherwise. Crime is still robbery and theft rates. The coefficients β_{2003} and β_{2004} allows two leads or anticipatory effect. The β_{2005} is the effect of the curfew in the year it was launched and the coefficients β_{2006}, β_{2007} and β_{2008} allow three lags or post-treatment effects. As emphasized above, this model will report the effect of treatment before the ordinance was applied, the anticipatory effects, and these should be statistically equal to zero to reinforce the causal interpretation of the impact (Angrist and Pischke, 2008). The results are shown in table 3 and to facilitate the interpretation of the parameters, only the ATT is displayed.

Table 3 shows the lead and lags estimation. In column (1), we estimate the leads and lags estimation for the theft rates. Note that the impact on this kind of offense for the first two years before and the year of treatment are not statistically significant. This strengthens our argument that the treatment and municipal controls have similar dynamics in the behavior of the theft rate (Angrist and Pischke, 2008). The outcomes also suggest that the negative impact of the juvenile curfews on theft rate has increased over the time. Specifically, after the adoption of the ordinance, the effect increased, reaching the double in the third year after the kickoff of the curfew. The robbery rate, column (2), has similar behavior for the theft rate, but in the last year has a positive impact, however, as will be seen in the next section, this estimation for the robbery rate is not robust, indicating that we cannot infer any effect of the ordinance on this variable. Thus, we can assume that both variables satisfied the common trend hypothesis.

TABLE 3: The Common Trend Assumption and the Lead and Lags Estimation

	Theft Rate	Robbery Rate
	(1)	(2)
Curfew Two Years Before	1.062	0.344
	(1154)	(0.288)
Curfew One Year Before	-0.689	0.091
	(2.852)	(0.139)
Curfew in the Year Zero	-2.206	0.218
	(2.395)	(0.134)
Curfew One Year After	-2.487	0.093
	(1.564)	(0.193)
Curfew Two Years After	-2.541*	-0.085
	(1.493)	(0.220)
Curfew Three Years After	-5.016***	0.169*
	(0.952)	(0.090)
Municipal Controls	Yes	Yes
Fixed Effect of City	Yes	Yes
Fixed Effect of Time	Yes	Yes
Trend	Yes	Yes
Adjusted R^2	0.002	0.180
Observations	5,775	5,775

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

One possible explanation for the increasing in the effect on theft rate through the time is that a public policy can take some time to be effective, thus when it is launched, people are not sure if the juvenile curfew is for real. Hence, as time passes and the ordinance is still functioning, the tendency is the effect increases over the time and, in addition, to the greater coercion for the families to keep their youngsters at home because of the possibility of fines imposed by the ordinance.

Finally, despite the negative effect of the juvenile curfew on the theft rate, we got above; it is possible that their evidence can reflect a more general trend of some crimes reduction in these municipalities not directly associated with this policy. The SENASP, the National Secretary of Public Security of the State of São Paulo, estimates that minors are responsible for 0.9% of all offenses committed in Brazil. If we consider only murder and attempted murder, the percentage drops to 0.5% (Costa, 2014). Here, we investigate this possibility by

considering some other types of offenses not directly related with minors, such as homicide[4], vehicle robbery, vehicle theft and armed robberies resulting in human death. The data on others kinds of offenses were from the SEADE´s database. The table 4 presents the new results.

TABLE 4: The Impact of the Juvenile Curfew on Others Modalities of Crime

	Homicide	Vehicle Robbery	Vehicle Theft	Armed Robberies resulting in Human Death
	(1)	(2)	(3)	(4)
Juvenile Curfew	0.040	-0.082	0.095	0.000
	(0.026)	(0.055)	(0.185)	(0.002)
Municipal Controls	Yes	Yes	Yes	Yes
Fixed Effect of City	Yes	Yes	Yes	Yes
Fixed Effect of Time	Yes	Yes	Yes	Yes
Trend	Yes	Yes	Yes	Yes
Observations	5,775	5,775	5,775	5,775
Adjusted R^2	0.820	0.583	0.467	0.187

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

As the numbers of the Table 4 makes clear, none of these other different types of crimes appear to be affected by juvenile curfew. According to the Anuário Brasileiro de Segurança Pública (2014), these types of offenses are not commonly committed by minors. Thus, we can infer that the juvenile curfew has a heavier impact on crimes more prone to be perpetrated by minors and others public policies with intent to diminish the crime, parallel with the curfew, did not work.

4. Robustness Checks and Falsification Test

In order to check the robustness of the above results, in this section we obtain new results considering different control groups of controls, and implementing a falsification test for them. This way, we will precede three tests to verify the robustness of the estimates found in the former section. The first robustness test is to eliminate neighboring municipalities which implemented the ordinance, because the criminals might relocate their delinquent activities to

[4] For the homicide data, we were also considered the numbers of unknown cases. This is because the deaths are not properly classified as homicides, that is, some part of the homicides were added to the numbers of deaths from wounds, but it was ignored that were accidentally or not (Levin, 2000). Therefore, in addition we use data on unintentional injury deaths; we also regard the deaths with unknown intent, given the low variance of homicides in some cities in the state (Levin, 2000).

nearby towns or areas that do not have a curfew and this might generate a positive bias in ours outcome (Adams, 2003; Menezes et al., 2013). The second robustness test uses a Propensity Score Matching approach with DiD strategy to verify if the outcomes are robustness for municipalities with closer characteristics. In the last test we eliminate the trend and we only estimate with the last year before the juvenile curfew, 2004, and the last year of the ordinance, 2011. The point is to verify if, even we remove the other years of the sample, and consequently the trend, the outcomes keep the same.

As Adams (2003) made clear, criminals can migrate to other cities that have not reached the curfew with intent to commit offenses. So, we removed from the sample cities that are neighbor to the treated sites – 38 cities – it may be that the delinquents commit crimes in this region instead of perpetrating crimes in the curfew municipalities. The goal is to verify that, even eliminating the neighbors of the treated cities, which can be impacted negatively, the result remains the same. The columns (1) and (2) of the Table 4 displayed the results. Thus, even when we eliminated the neighbors of cities that implement the juvenile curfew the result still closer to that we had found in the previous Table. The impact of the ordinance in the theft rate was -2.577 and the outcome was statistically significant at 10%. So, it indicates a reduction of 17.45% in this kind of offense. The effect of the curfew on the robbery rate has a negative signal, as expected, but it still not statistically significant.

TABLE 5: The Robustness Checks – without the Neighbors for All the Cities That Have Implemented the Juvenile Curfews, the Propensity Score Matching and the First and the last Year of the Ordinance

	Without the Neighbors		Propensity Score Matching		First Year before and last Year after of the Ordinance	
	Theft Rate	Robbery Rate	Theft Rate	Robbery Rate	Theft Rate	Robbery Rate
	(1)	(2)	(3)	(4)	(5)	(6)
Juvenile Curfew	-2.577*	-0.133	-3.591***	-0.187	-6.679***	0.815
	-1.388	(0.154)	-1.241	(0.173)	-2.234	(0.626)
Municipal Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect of City	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect of Time	Yes	Yes	Yes	Yes	No	No
Trend	Yes	Yes	Yes	Yes	No	No
Observations	5,436	5,436	4,299	4,299	1,091	1,091
Adjusted R^2	0.324	0.515	0.348	0.540	0.233	0.091

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

The following step is to use a strategy based on the Propensity Score Matching for considering a new control group, in order to improve the balance between the treated and untreated units. Specially, we will use a matching strategy for the municipalities before the estimation of equation (1), which is implemented through the Kernel method[5]. Then, we apply the kernel matching strategy, and afterward, we estimate the model of the differences-in-differences considering only the subset selected by the matching process. The columns (3) and (4) of Table 4 displays the result.

The Kernel matching constructs a match for each program participant using a weighted average over multiple cities in the comparison group (Smith, 1997). As discussed by Ho et al. (2006), when done properly, the matching before the estimation can reduce model dependence and variance, lower mean square error, and also generate less potential for bias. Hence, when we compared a subset of more likely municipalities, the impact of the juvenile curfew in the theft rate strengthens, and it had an impact of -3.591 per one hundred thousand inhabitants and statistically significant at 1%. On the other hand, the impact of the curfew in the robbery rate, one more time, was not statistically significant.

So far, in all our estimations, we used in the regression a specific linear trend for each municipality of the crime rate. Thus, we will eliminate this trend of the sample and we will estimate the impact of juvenile curfews only for the first year before treatment, 2004, and the last year before the ordinance be suspended by the STJ-SP in 2011. The table 4, columns (5) and (6), shows the results.

The outcome found in the column (5) of the Table 4 suggests that the impact of the curfew on the theft rate, even when we ignore the trend, is statistically significant at 1% and the impact was -6.679, a stronger effect of the policy. Then, this much higher value reflect the omission of the lag component of crime rate (trend) and it is consistent with the results of the Table 3 (the Leads and Lags estimation), that indicates an increasing impact through the time. That is, even whether we eliminate the trend and the time fixed effects, the impact of the curfew in the theft rate remains. On the other hand, the robbery rate was not statistically significant and we can infer, one more time, that there was no impact of the curfew in the robbery rate.

Briefly, the juvenile curfew was responsible for a strong decrease in the theft rate of approximately 17.5%, column (3) of Table 2. This result respects the common trend

[5] We first estimate a Logit model with the same controls used in the standard model.

hypotheses, Table 3, and it was robust for all tests we performed in this section. However, the impact of the curfew in the robbery rates, while respecting the hypotheses of common trend, was not statistically significant in any specification and we can infer that there is no impact of the curfew in the kind of offense.

Finally, despite the negative effect of the juvenile curfew on the theft rate, we got above; it is possible that their evidence can reflect a more general trend of some crimes reduction in these municipalities not directly associated with this policy. So, we will perform a test to verify this hypothesis. Thus, we estimate the benchmark regression, but as dependent variable, we used suicide and drowning rates, because we hope that none of these variables are impacted by the implementation of the ordinance. These final results are presented in the following Table 6.

TABLE 6: The Falsification Test I – Drowning and Suicide Rates

	Drowning Rate	Suicide Rate
	(1)	(2)
Juvenile Curfew	0.006	0.006
	(0.005)	(0.014)
Municipal Controls	Yes	Yes
Fixed Effect of City	Yes	Yes
Fixed Effect of Time	Yes	Yes
Trend	Yes	Yes
Observations	5,775	5,775
R^2	0.137	0.119

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

The results of Table 6 indicate, once more, that the effect of the curfew was not statistically significant, even considering the trend of these two variables, the fixed effects of time and cities and the other covariates in the model. The evidence, thus, strongly suggest that the juvenile curfew did not impact the suicide and the drowning and so there is a very small risk of our results be spurious and the reduction in the rate theft cannot be attributed to other unobservable policies, for example, some basic education police, supporting the causal effect of the curfew in reducing this kind of offence.

5. The Discussion and Final Considerations

The impact of interventions such as juvenile curfews depends crucially on how they are implemented and how police officers, law-abiding citizens, and would-be offenders respond.

We show that in the cities of the state of São Paulo, at least, there is compelling evidence that the juvenile curfew policy reduces the theft rate. Thus, the results of this exercise show that there was a decrease in theft rates for the municipalities that adopted the curfew. Specially, the initial estimate showed a reduction in the theft rate around 2.589 per one hundred thousand inhabitants compared to the pretreatment period, what represents a sharp reduction of around 17.5% in this type of offense. As some information on crimes is not officially registered by the authorities, we must believe that this effect could be even greater (Oliveira and Simonassi, 2013). In contrast, the robbery rate was not affected by juvenile curfew.

The reduction in the theft rate associated with the juvenile curfew we have found is in line with the evidence provided by McDowall, Loftin and Wiersema (2000) and Wallace (2016). And it represents an empirical support for this kind of policy for cities and states suffering excessive violence.

The result remained when we performed different kinds of robustness tests, suggesting that the impact of the juvenile curfew, found in the Table 2, is robust to different compositions of the samples. Furthermore, the other rates of crimes, such as robbery and vehicle theft, murder and armed robberies resulting in human death were not affected by the curfew. The falsification test shown that suicide and drowning rates were also not affected by the curfew, indicating that the results found were not a spurious regression, once, we expected that the ordinance did not affect these modes of death and it again reinforces the causal effect of it.

Nevertheless, the general application of this policy has to be viewed cautiously. As Adams (2003) highlights, there is an evidence that keeping minors at school does seem to have a greater effect on crime reducing and, this is, unintentionally, it is far more effective at than curfews are. Second, in the case of Brazilian cities, the application of the juvenile curfew may involve serious violations of the Statute of Children and Adolescents and the Brazilian Constitution since the ordinance limits the right to come and go (Hemmens and Bennett, 1999; Tavares, 2010; Saliba and Brega Filho, 2012; and Lepore and Rossato, 2012).

A clear extension of this work would be to compare the cost/benefits between the juvenile curfew and those from other policies regarding minors in the reduction of the offenses rate. For example, we can verify the cost/benefits of the investment in basic education or other programs for the youngsters, such as the integral school, which the student stays all day at school, in the reduction of the criminality rates.

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Public Space and Value of Real Estate: An Analysis of the Case of the Dona Lindu Park in the City of Recife, Brazil

1. Introduction

Green areas such as squares, parklands, bodies of water and a pleasant environment provide amenities and services that fundamentally contribute to the quality of life in cities (Van Herzele and Wiedemann, 2003).

However, it is difficult to measure the value of nature and the benefits these amenities bring to the urban environment and the impact that these benefits have on the value of the property prices due to a lack of market for them (Freeman III, Herriges and Kling, 2014). Recently an increased concern has risen regarding the urban green space and environmental quality due to the rapid urbanization and the spread of the cities (Jim and Chen, 2006a). Green areas, sited near residential urban areas in the developing world cities are closely related to the amenities and the health of residents. There are constant concerns about the vulnerability to damage and the improper utilization of these areas, as shown by Jim and Chen (2006b).

In fact, urban green spaces have several functions in cities and they may include provision of leisure and amusement opportunity to the local population. Thus, such spaces have value to society that is difficult to measure, given the absence of market to set the price of these amenities. Consequently, they are generally ignored or underestimated by urban planners, which results in the diminishing of the green places in cities and these remaining areas are being gradually overrun by the urban sprawl. So from that perspective, the impact of parks and green areas has been understudied in the Brazilian cities.

Vacant lots are problems in many cities and are not exclusivity to Recife or Brazil. Thus, some cities have recently begun to explore these areas to reverse them into green fields as a management strategy to reduce the negative influence of the vacant space. This is important, as waste land, usually, does not bring positive amenities and it decreases the potential provision of real estate in the region, in addition, there exists a market to negotiate these lands (Freeman III, Herriges and Kling, 2014), different from the public spaces. In this way, green spaces and parks generate positive amenities on the properties surrounding them to incorporate the amenities offered by this area; nevertheless, there is no market to measure the value of this space in the city (Freeman III, Herriges and Kling, 2014). Given this difficulty in the measurement, this article proposes to quantity the impact of Dona Lindu Park, until then a

vacant area turned into a park, on the value of real estate in the district of Boa Viagem, Recife, Brazil. That is mainly due to the potential outcome of this new green area and its positive or negative amenities in the value of properties in the region.

Recife is one of the most important Brazilian cities, with an estimated population of 1,608 million people, with an area of 218,435 km² and the headquarters of the largest metropolitan region in the Northeast of Brazil (IBGE, 2014). The city is a metropolis with a very uneven spatial distribution; the richest group of the city lives in the best locations of the municipality, that is, the wealthy people resides in locations with adequate urban infrastructure and closer to the local amenities offered in the city: parks, squares, beaches and the Rio Capibaribe (Seabra, Silveira Neto and Menezes, 2015). The district of Boa Viagem is a very good example of this reality; their inhabitants live in buildings equipped with security services, to protect them from the city violence, near shopping malls and they have access to a high standard of services (Oliveira and Silveira Neto, 2016).

A mapping done in 2012 by Oliveira et al. (2012) shows that green spaces exist in the metropolis, though it is extremely uneven distributed. The survey is scoured with aerial images, including all 94 districts of the city. Situated in the North Zone, the Guabiraba district appears as the greatest lung of the city, with almost 75% of all its area covered by trees (Oliveira et al., 2012). It is the greatest and the most wooded district of the metropolis. On the opposite ranking, Brasilia Teimosa, in the South Zone, stands out as the least green space with scarcely 1.89% of its territory occupied by vegetation.

The picture drawn from the study is encouraging. Almost 45% of 222.93 km² of Recife is made up of green fields. There are, more precisely, 99.61 km² of trees, grasses, shrubs and all kinds of vegetation (Oliveira et al., 2012). Thus, the green density per inhabitant of Recife is high and it is near to the 65 thousand m² of greenery per inhabitant. There are, however, important differences between the regions of the city. Nearly, half of all the green cover of the capital is reduced in a single region, the North Zone, formed by neighborhoods of Casa Forte, Apipucos, Dois Irmãos, Sítio dos Pintos, Casa Amarela, Guabiraba and its neighbor Pau-Ferro, primarily the latter two are responsible for the high rate of afforestation (Oliveira et al., 2012).

Due to its rapid urbanization and the high urban densification (the fourth largest in the country according to IBGE), Recife still lacks open public green areas, particularly parks, in the neighborhoods with high urban density and little green density, e.g., the district of Boa

Viagem. Before the installation and construction of the Dona Lindu Park, the main public parks of the city were the Jaqueira Park, Treze de Maio and the Horto de Dois Irmãos, all of them located in the North Zone of the city.

The Park Dona Lindu was officially inaugurated on 30 of December 2008, although incomplete and with the initial budget of R$ 18 million and it reached a cost of more than twice as much, attaining an estimated value of R$ 37 million (Agência de Notícias UFPE, 2012). It was constructed in an area of 27 thousand m², it began to be built on a land of Aeronautics, which had been vacant for several decades, and was transferred to the municipality by the Federal Government, but was engulfed with lawsuits filed by homeowners' associations and it took almost 1000 days to be completed (Agência de Notícias UFPE, 2012).

Cheshire and Sheppard (1995) argue that a property represents not just a set of specific structural features of the building, but also a set of characteristics related to their location. When adding to location the coordinates and the area, along with the other characteristics of the real estate, it is possible to estimate the value of a given attribute via the hedonic pricing method. Thus, it is possible to calculate the value of specific features of the real estate prices, as, for example, the value of the amenities. The hedonic pricing method has been widely applied to estimate the value of nature and, consequently, of the amenities (Price, 2003), for example, the impact of green spaces and housing prices.

In developed nations, there are a series of surveys displaying a positive impact on green areas and parks with housing prices. For US cities, for example, Espey and Owusu-Edusei (2001); Crompton (2001); Lutzenhiser and Netusil (2001); Geoghegan (2002); Anderson and West (2006); Cho, Bowker and Park (2006) and Heckert and Mennis (2012), present evidence of the positive effect on real estate properties located near parks. In others developed nations, especially in Europe, there is also a vast literature showing positive externalities of parks with housing properties; for example, Luttik (2000) for Netherlands, Aalborg, Panduro and Vein (2013) for Denmark, Kolbe and Wüstemann (2014) for Germany, and Schläpfer et al. (2015) for Switzerland, found a positive impact of parks on the real estate properties.

For Australia, Pearson, Tisdell and Lisle (2002) examine the valuation of the Noosa National Park in an urban area in Queensland. Hence, they used the hedonic pricing model to set the value of the impact of this green area in the price of the real estate. The study found a 7% increment in the price of the properties near the Park. However, this value changes

according to the location of the buildings. Properties located south of the park have 85% greater value than real estate just north of the Park. The authors also found that the variables with the greatest effect on the monetary value of the real estate are the distance to the ocean and sea views.

Therefore, the literature has long recognized that green areas tend to raise the value of the properties, since they seem to have a positive effect on the welfare of the population. Research on green spaces shows many other positive impacts on surrounding communities of this area, including the improvement of environmental conditions (Nowak et al, 2006) increases the satisfaction of the population living near parks (Ellis et al, 2006) and the green areas also had a positive impact on mental and physical health (Maas et al, 2009).

Nevertheless, it is also well documented in the literature, the negative indirect effects of open areas (Lim and Missios, 2007 and Smith et al., 2002). Thus, the construction of parkland also can face typical problems of the urban environment, i.e., the increase in the crime rate (Linden and Rockoff, 2008 and Troy and Grove, 2008), excessive trash (Lim and Missios, 2007) and noise (Smith et al, 2002).

Smith et al. (2002), for example, examined the effect of noise in open areas in the United States and used the hedonic pricing model to estimate the impact of disturbance on the value of the properties. The authors establish that people valued negatively noise in relation to real estate prices. And this is noteworthy, because the park attracts people, plays host to concerts, and events can generate a heavy amount of noise, waste, and traffic congestion, which reduces the welfare of nearby residences, negatively impacting the value of real estate. Lim and Missios (2007), in a survey in Canada, showed how landfills negatively affect the perception of welfare of the individuals, because, the parks might attract hundreds of masses in a single day and the waste produced by them can also negatively affect the value of the immovable property.

Linden and Rockoff (2008) study the relationship between property value and the risk of crime, in the United States, and show that people who live in violent regions have two options: choose politicians who fight against violence or move away. Both negatively affect the value of properties. Thus, the building of a park can lead to greater attractiveness of the region, with more people moving through the region, in that respect, the likelihood of crime is greater (Becker, 1974), which can generate a negative effect, given the possible increase in the violence. More specifically, Troy and Grove (2008) examine the relationship between the

value of the real estate located around parks and regions with a high criminality rate, in the city of Baltimore, USA. The author's results indicate that the proximity of a park is evaluated positively by the real estate market, but the results also indicate a negative influence of parks when they were surrounding by a high rate of theft and rape.

More recently, Pope and Pope (2015) demonstrated the effect of urban density in the construction of new units of supermarkets and the possible negative effect of the congestion and how this affects the price of buildings nearby this location. Thus, the densification process in this region of a park might, as well, generate possible negative effects in the real estate price.

In developing nations, the literature on the impact of the green areas on real estate prices is much smaller compared to developed countries. Among these few works, Jim and Chen (2006a), in a study in Guangzhou, China, found different characteristics of the impact of amenities than those found in Western States. The sight of a green area and proximity to bodies of water positively impact the monetary value of residential housing. However, the proximity of a wooded area, which cannot be used by residents, did not contribute to residential price, which implies that the usability of green space could be more attractive than just proximity. Moreover, exposure to traffic noise has little impact on the real estate price, suggesting high local tolerability.

Kong and Nakagoshi (2007) found a positive effect of the amenities of the urban green space on housing prices in the city of Jinan, China. Jim and Chen (2009) in a study in Hong Kong evaluated the price of the amenities for the two primary types of natural landscape in the country: harbor and mountain views. Just overlooking the harbor was valued positively among individuals and can increase up to 2.97% of the value of the property. Furthermore, the view of a mountain can have a negative effect of roughly 6.7% on the real estate price.

According to ours best knowledge, there is no study of impact of a building of a park on the real estate price in Brazil. But, there are a few studies that use the hedonic pricing model to estimate the effect of a several facilities in the properties price. For example, Hermann and Haddad (2005) through the POF (Family Budget Survey) data in the year 1999, displayed that proximity to the train stations, the presence of the green fields and the strictly residential urban zoning increased the value of property, while criminality reduces its price for the city of São Paulo, Brazil. In the same city, Fávero, Belfiore and Lima (2008) indicated that there is a positive effect on the price of the real estate located in the district of lower and middle socio-

demographic profiles in the variables related to the proximity of private schools and subway stations. And the same goes for the proximity of the private hospitals, the shopping mall and the green areas in the districts with medium and high income profiles.

In Recife, Brazil, Dantas et al. (2007) used data granted by the Caixa Econômica Federal, for apartments sold between the years 2000 and 2002, with the aim to evaluate some attributes to the urban center of Recife. They concluded that the properties are depreciated between 6% and 8% as one moves away from the Jaqueira Park and the beach. Emerenciano and Magalhães (2008) evidenced that individuals are willing to pay up to 13% more for buildings located close to green areas and 9% for properties near the bodies of water. Seabra, Silveira Neto and Menezes (2015) showed that one kilometer of distance from parks decreases by 1.2% the value of the property. And, the influence of the parks on the property value is negligible for greater distance than 1.5 kilometers.

In this research, we use a Difference-in-Difference identification strategy to simulate an experiment and try to find a causal relationship between the construction of the Dona Lindu Park and the real estate price, in a region with a large number of amenities, in particular the proximity of the sea. Brazil has relegated the presence of the green areas in the urban centers for a long period of time, because of the fast urbanization that occurred in the country. Thus, using an appropriate method, and a database with information about property characteristics for more than ten years (ITBI database), we found that the real estate that is 600 meters away from the park had an increment in the price of 7.7%. In contrast, the housing properties located 600 meters to 1000 meters distant from the park had a reduction in their value of 11.9%. The results are robust to the consideration of different control groups and forms of the model misspecification.

The paper is organized as follow: section 2 presents the institutional background of the Dona Lindu Park; section 3 describes the data and the empirical strategy; section 4 describes the results; section 5 describes the robustness tests and the falsification tests and section 6 presents the discussion and final considerations.

2. The Institutional Background

The district of Boa Viagem is one of the largest of Recife, around 123 thousand inhabitants (IBGE, 2010) and it is a region with high building standards and it has a population with high purchasing power. Due to the rapid urbanization and an extremely

important positive amenity, its proximity to the ocean, there was a great demand for this region in recent years, and therefore, the neighborhood went through a very strong verticalization process where most buildings located in the area are skyscrapers (Franklin, 2014).

Dona Lindu Park is located along the seafront in the Boa Viagem district. This land was vacant for over 60 years and only manages to remain resistant to pressure of the real estate, because it belonged to the Air Force. The site founded as an operation base during World War II and its main function was to observe German ships, which, perchance, moved ahead into Brazilian waters. With the conclusion of the War, the land lost its use and remained vacant for several years.

In 2004, residents of the Boa Viagem district delivered a petition with 17 thousand signatures to the then President Luiz Inácio Lula da Silva, requesting the transfer of the land to the city from it was ownership of the Air Force. In the same year, the then mayor of Recife, João Paulo, met for the first time with Air Force representatives to talk about the construction of the Park (Franklin, 2014). Intense negotiations followed and the provision of the site was achieved with the signing of the concession contract in September 2006. Then, it was announced by the City Hall that the architect Oscar Niemeyer was the author of the park project, which caused a big commotion in the city (Franklin, 2014) due to its relevance[6]. The only project of the architect in Recife, a residential building on the same street of the park, was demolished years ago, giving room for another skyscraper (Franklin, 2014).

The initial idea of the project was a park with a large green area, something rare in Boa Viagem with intent of providing a refuge in the hottest neighborhood in Recife (Barros and Lombardo, 2012), and a community leisure area. However, the municipality demanded the architect a metropolitan center of culture and leisure, a cultural park, different from the initial idea of the residents, which led to a discussion between civil society and the state government.

It is important to highlight that the Dona Lindu Park was "opened" several times, the first in December 2008, by the then Mayor, João Paulo, and in 2010 it was again "handed over" to the public. However, the park was only fully operational in March 2011.

[6] Oscar Niemeyer was one of the most important Brazilian architects, considered one of the key figures in the development of modern architecture (Deckker, 2001).

Since the kickoff of the park project, there have always been several controversies. One, for instance, is the value of the work, which increased the final value in over 100%, totaling over R$ 37 million (UFPE News Agency, 2012), compared to R$ 18 million of the initial project. And even the park's name was a cause of polemic, with the purpose to honor the northeastern migrants; the park was named after Dona Lindu, the mother of then President Luiz Inácio Lula da Silva, who was an immigrant.

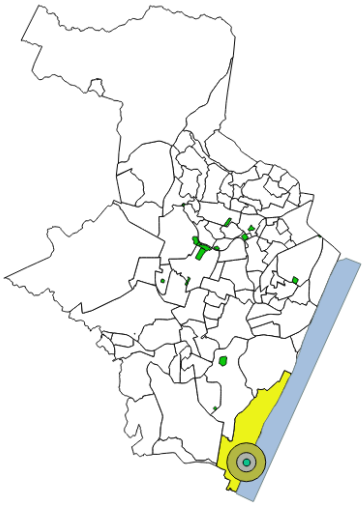
Currently, the Dona Lindu covers an area of 27,166.68 m², with 60% covered by a green area (Agência de Notícias UFPE, 2012), much more than the initial prediction. For comparison, the Jaqueira Park, another big park of the city, has approximately 70 thousand m² and Santana Park with 63 thousand m². The D. Lindu Park includes bicycle paths, running trails, skateboard and sports courts, playgrounds, areas for relaxation and fitness, restaurant, toilets, baby changers and also a technical center.

3. Data and Empirical Strategy

The aim of this research is the study of the impact on the value of the properties due to a building of a new green area in the city of Recife, Brazil, the Dona Lindu Park. With this goal in mind, this research utilizes the database provided by the City Hall of the Recife, specifically derived from the ITBI database (Tax on Goods and Property Transfer). And, as we shown below, we will use the basic idea of the hedonic pricing model, which the price of real estate reflects the its own characteristics, along with an identification strategy based on the difference-in difference estimator (DiD) to estimate the impact on the price of the real estate near to the park.

The Figure 1 shows the location of Dona Lindu Park and the map of the city of Recife. In the figure, the district of Boa Viagem is in yellow and the parks are green (we do not consider green areas, just parks). The green dot, in the referred district, corresponds to the location of the Dona Lindu Park and we also made two radiuses of 500 and 1000 meters from the Park, this is the treatment area. Before the installation and construction of Dona Lindu Park, the main public parks of the city were the Jaqueira Park, Treze de Maio and the Horto de Dois Irmãos, all of them located in the North Zone of the city.

Figure 1- Recife and its Parks



Note: Based on information the Municipal Administration of Recife.

To estimate the effect of the construction of the Dona Lindu Park in the housing prices, we will consider the different physical characteristics of real estate in different periods of time, since it provides information on the features of the property for the period prior to the construction[7] of the park (January 2000 to September 2006) and later the park was finally delivered, but now 100% complete, (March 2011 to December 2012). More formally, we will estimate parameters of several versions of the following model:

$$y_{idt} = \beta_0 + \beta_1 DL_{it} + \Phi X_{it} + \theta_t + \eta_d + \varepsilon_{idt} \qquad (2.1)$$

The DL coefficient is equal to 1 if the property is within the treatment area in the period when the park was already handed over to the public and zero, otherwise. That will be considered the treated group and spreads over the period from March 2011 until December 2012. The y_{idt} variable is the logarithm of the price of a given property *i*, located in the district *d*, in period *t*; β_1 the coefficient of interest and it is linked to the fact that if the property is a distance from the park, for example, a radius of 500m or 1000m. Thus a series of regressions will be estimated to measure sensitivity in the housing prices given the distance to the park. The X_{it} vector consists of structural features of buildings and represents a control for these attributes.

The θ_t coefficient denotes the fixed effect of time (year, month, and their interactions) and the η_d is the fixed effect of district. The district fixed effects included in the model control for

[7] This period of time was used to eliminate the effect of the park announcement in the housing prices. During this section we will make this choice clear.

time-invariant unobservable district characteristics while the time fixed effects control for yearly differences between property prices. The ε_{idt} is the error term that will be organized by cluster at the district level in all the estimates to take into account the heteroscedasticity and serial correlation of the characteristics observed between the attributes belonging to the same neighborhood (Bertrand et al., 2002). Thus, we can interpret the parameter of interest, β_1 as the causal effect of the construction of the park in the real estate prices. In other words, this coefficient represents the difference in the average real estate price before the advent of the park minus the difference of the average price of the real estate after the park.

In the specific case of the D. Lindu Park, we obtain an estimative of the impact of the Park building on the properties values. In this way, we have at least four major obstacles. The first one is the need for information for periods before and after the foundation of the park and this is provided by the ITBI database. The second issue is the problem of contamination of the announcement of the park in the housing market prices, due to the delay between the announcements of the park and the delivered of it to the population. The third point is the definition of the treatment region and the fourth point is the definition of the control group region.

It is important to highlight, in the Brazilian case, that the ITBI database has an advantage over other databases with real estate information. As these transactions are recorded in the registry office, the amount and the quality of data are usually much more complete because there is coverage in all regions of the city. Yet, there was another really important advantage in this database. Individuals have incentives to report the values more believable as possible; the undervaluation of the descriptive value is not advantageous to the buyer, because in case of a future sale of the property, there is a tax on the gain from appreciation. On the other hand, the overvaluation brings losses to the buyer, because it brings a higher value of IPTU (Urban Building and Land Tax). This information also tends to have a higher quality to those found on offer (ads), since they also reflect the demand side. However, this database information is associated with taxes; inevitably, its scope is restricted to the formal market, which tends to represent improperly the situation for the population with the lowest income (Silveira Neto, Duarte and Sampaio, 2014).

Thus, we will use the municipal data ITBI for the years 2000 to 2012, provided by the city of Recife, with more than 97 thousand observations in the period. This data gathers information on the characteristics of the properties, such as the number of floors, the number

of apartments in the building, the building area, the standard of construction and the real estate transaction value in the city, this data is shown in table 1.

Table 1 -Description of the variables

Variables	Description
Price-BRL[8]	Logarithm of the property price
Area (m2)	Private built area of the property
Floors	Number of floors of the property
Apartament	Number of apartaments of the property
House	Assumes value equal to 1 for house
Low standard	Low construction standard (dummy)
Medium standard	Medium construction standard (dummy)
High standard	High construction standard (dummy)
Year of construction	Year property was built
Regular	Property considered to have fair conservation conditions (dummy)
Good	Property considered to have good conservation conditions (dummy)
Excellent	Property considered to have excellent conservation conditions (dummy)
Dona Lindu500	Assumes value equal to 1, if the property stays 500 meters of distance of the park
Dona Lindu500-1000	Assumes value equal to 1, if the property stays 500-1000 meters of distance of the park
Dona Lindu1000	Assumes value equal to 1, if the property stays 1000 meters of distance of the park

Note: Based on information the Municipal Administration of Recife.

When there is the announcement of a specific project that can appreciate the price of real estate, various agents might build or leave the region even before the launch in the expectation that there is an appreciation or depreciation (Pope and Pope, 2015). In the year of 2010, approximately 10% of all real estate properties launched in Recife were located 500 meters from the park – according to our database – which can cause some effects on ours results. To eliminate this problem, we use a strategy similar to that proposed by Pope and Pope (2015) to estimate the impact on the price of real estate due to a new Walmart store in the United States.

The park had several opening dates, in this way, we chose as the reference the first time it was delivered to the public, December 2008, but the Dona Lindu was not 100% operational, so it could not generate any positive amenities. So, we have removed from the sample the

[8] Brazil's currency is the Real (R$). Over the study period of this paper, the exchange rate with the dollar fluctuated in an interval between approximately R$ 1.57 and R$ 3.86 US$, with a rough average of R$ 2.22 US$.

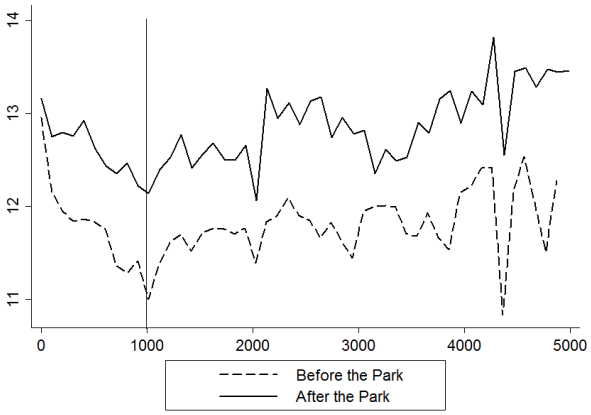
period of the assignment and construction of the park in September 2006 until the date of the first opening, December 2008, and the same amount of time forward, December 2008 to March 2011. The last date coincides with the definitive delivery of the park to the population, but now the park is finally done and can generate positive or negative amenities to the population. In other words, we had eliminated two years and four months before and after the park was first delivered in December 2008, with the aim to eliminate any effect of the Dona Lindu announcement on the real estate prices. Later in the robustness tests, were we taken different times of periods, and the result remained quite closed.

There is, however, the possibility that after the construction of the park, part of the demand for real estate might be changed in the region, which it makes difficult to define the treatment region. Even when we utilize the strategy proposed by Pope and Pope (2015), which withdrew two years and four months before and after the first hand over of the park, the advent of D. Lindu might has changed the dynamics of the real estate market in the region. With this concern in mind, we will follow an approach proposed by Linden and Rockoff (2008), which the authors study the relationship between the property value in Mecklenburg, North Carolina, with the risk perception of crime (represented by the number of sexual assault records in the region).

To follow this strategy, it is necessary to compute the distance between the properties and the boundary of the Dona Lindu. The addresses of the properties are available in our database, and for each property, we obtain the distance via georeferencing using *ArcGIS* software. Then, for the set of properties, we estimated by local polynomial regressions the gradient for the relationship between the property values and the distance to the boundary of the Dona Lindu Park. This gradient allows us to observe possible differences regarding the property value and the distance to the treatment region before and after the park, and thus to identify the distance that occurs possible the contamination stops being relevant[9]. The figure 2 shows the gradient.

[9] With data on the property values and distances from the boundary of the area subject to the Park, the idea is to estimate the following gradient: $m(d_i)$: $Y_i = m(D_i) + e_i$, where Y_i is the value of propriety and i and Di is the distance of that property from the boundary. At a specific distance d_0, note that $E(Y_i|D_i) = E(d_0) = m(d_o)$. For various distances from the boundary, different values of this gradient are obtained by minimizing the expression $\sum_{i=1}^{n}\{(Y_i - \sum_{j=0}^{p}\beta_j(D_i - d_0)^j\}^2 . h^{-1}K(\frac{D_i - d_0}{h})$ with respect to β_j, where p is the exponent of the polynomial, *K* is a kernel function that forces local minimization and *h* is its window. For each specific distance from the boundary, d_o, a value of de $\beta_0 = m(d_0)$ is obtained. We use the Epanechnikov kernel with optimal window and $p = 3$. For more details, see Gutierrez, Linhart and Pitblado (2003).

Figure 2: Property value gradients: distance and price of the properties before and after the building of the Dona Lindu Park



Note: Based on information the Municipal Administration of Recife.

In Figure 2, we present the gradient estimated for the relation between the property values and the distance from the boundary of the Dona Lindu Park for the period after the construction of it, represented by the straight line. And, as it is clear, there is a tendency for property prices to decrease as they move away from the boundary of the Park. This can happen due to a possible contamination effect, caused by the emigration of potential property buyers in the treated area. To investigate this effect, this figure also shows the gradient estimate the relationship between prices and distance to the boundary of the park for the period before the construction of the park, the dashed line. Both lines have a different behavior, especially until 1000 meters from the Park, represented by the vertical line. The results begin to be quite closer after this distance. Then, it showed that the behavior pattern of the prices in relation to the distance did not differ before and after the building of the D. Lindu, which suggests that the effect of the treatment is restricted to only 1000 meters away from the park.

Rossi-Hansberg, Sarte and Owens III (2008) estimated that housing externalities decreased by half around every 1000 feet or, approximately, 300 meters. In that way, after 4000 feet, or, approximately, 1200 meters, the housing externalities should be very small, around 6.25% of the price properties, which reinforced the treatment area we found in the gradient. In a study of the city of Recife, Seabra, Silveira Neto and Menezes (2015) showed that one more kilometer away from the parks decreases by only 1.2% the property value. Thus, this result shows that the influence of the parks on the property value is negligible for a distance greater than 1.5 kilometers. This gives an additional support for the selection of the

one kilometer limit on the impact of the real estate price due to the building of the D. Lindu Park.

A survey conducted worldwide by the company TomTom[10], specializing in GPS (Global Positioning System), in March 2015, brought worrying issues about mobility in Recife. According to the document, the capital is the slowest city in the country in the evening peak time of days, from 17h to 19h. In a year, an average individual loses up to 94 hours behind the wheel only returning home after work. Recife also ranked sixth in the world ranking and third in the Brazil. The survey assessed the traffic in 200 cities through information gathered in GPS's produced by the company. According to the data, the congestion charge in Recife is as high as 82% in the evening rush, ahead of cities like Los Angeles and Rio de Janeiro, where it loses 93 hours a year on average and the congestion charge is 81%.

Due to the limited mobility, the high population density in Recife, the gradient, the decrease of the housing externalities (Rossi-Hansberg, Sarte and Owens III, 2008) and the previous study of Seabra, Silveira Neto and Menezes (2015), we believe that the effect of the park in the housing prices is strictly local. So we do not expect that there is an impact for regions with more than one kilometer away from the park, because people hardly shift far away to enjoy the complex. Thus, we have initially created two radiuses leaving the park's boundary, an arbitrary radius of 500 meters, in gray, and another at 1000 meters, in brown – figure 1. Note that this allows heterogeneous effects in the housing marker, a positive effect on the proximity of the park and a negative effect, as the distance increases from the Park. These radiuses will be our treatment groups, because this area is impacted in the real estate prices due to the building of the Dona Lindu Park.

Finally, there is a question associated with definition of the control region. At first, we could only use the Boa Viagem district or region with similar amenities, for example, the proximity to the ocean. However, we cannot simply eliminate the other districts of the city and not take into account the dynamics of other districts in the model. So, we will use all the city's districts as a control group region. At this point, it is important to note that all these considerations are important and will be tested in the robustness section, with different periods and control groups.

[10] Data available in: https://www.tomtom.com/pt_br/trafficindex/#/.

Table 2 contains information of the variables for the treatment group (within 1000 meters from the park) as for the control group (all other residences with more than 1000 meters away) and for both the pre-treatment period as the post-treatment period (effective hand over of the park). For both periods, the property prices in the region subject to the treatment were on average larger than the area untreated. However, this difference can be both linked with higher properties and most recently built (year of construction) and with a higher percentage of high standard properties. Treated properties also tend to have a larger number of floors than the region that is more than 1000 meters away from the park. Despite the change in the housing prices between the period before and after treatment, a simple average of the comparison shows that there was a small increase in the monetary value of the treated properties (247%) when compared to the value of control region (352%).

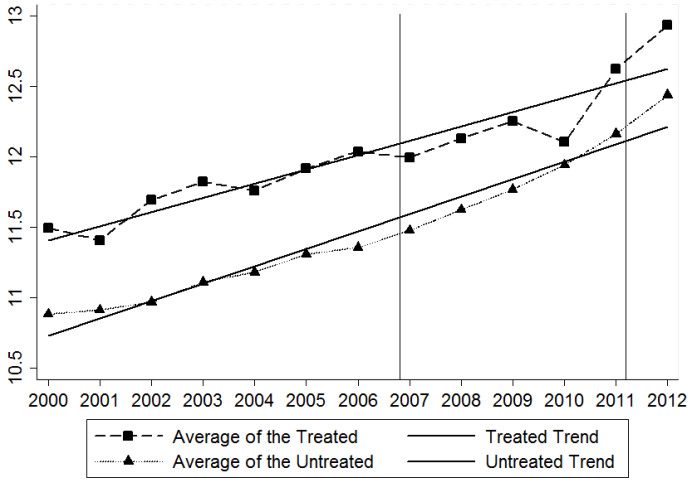
Table 2 - Descriptive statistics of property characteristics

	Pre-treatment Period (Before September 2006)			Post-Treatment Period (After March 2011)		
Variable	Not Treated	Treated	Mean Difference	Not Treated	Treated	Mean Difference
Price-BRL	90,081	146,974	-56,893***	316,698	362,994	-46,296***
	(96,229)	(210,340)		(314,276)	(239,365)	
Area (m2)	124.1	143.6	-19.5***	105.6	122.3	-16.7***
	(84.22)	(100.3)		(76.36)	(75.46)	
Year of construction	1,986	1,991	-0.005***	1,997	1,998	-0.001*
	(15.81)	(10.73)		(16.58)	(12.90)	
House	0.207	0.0246	0.1824***	0.114	0.0245	0.0895***
	(0.405)	(0.155)		(0.317)	(0.155)	
Low standard	0.417	0.125	0.292***	0.219	0.0821	0.1369***
	(0.493)	(0.330)		(0.413)	(0.275)	
Medium standard	0.409	0.571	-0.162***	0.383	0.494	-0.111***
	(0.492)	(0.495)		(0.486)	(0.500)	
High standard	0.174	0.305	-0.131***	0.398	0.424	-0.026*
	(0.379)	(0.460)		(0.490)	(0.494)	
Regular	0.00508	0	0.00508***	0.00246	0.000790	0.00167
	(0.0711)	(0)		(0.0495)	(0.0281)	
Good	0.0325	0.0339	-0.0014***	0.0144	0.0134	0.001
	(0.177)	(0.181)		(0.119)	(0.115)	
Excellent	0.962	0.966	-0.004	0.983	0.986	-0.003
	(0.190)	(0.181)		(0.129)	(0.118)	
Floors	9.558	13.91	-4.352	16.91	17.82	-0.91***
	(8.766)	(8.796)		(10.02)	(8.559)	
Apartments	33.91	43.04	-9.13***	57.35	49.04	8.31***
	(45.10)	(45.04)		(47.26)	(37.91)	
Observations	36,826	3,653		15,458	1,235	

Note: Authors' calculations based on information the Municipal Administration of Recife.

The estimation via difference-in-difference requires that the trend in the pre-treatment period, in this case January 2000 to September 2006, is the same for both sets of the treated and the untreated group (Angrist and Pischke, 2009). And in the post-treatment period, March 2011 to December 2012, the trend has to be different from the same data set. The Figure 3 shows the yearly average price of real estate and the trend in the pre and post-treatment of the treated and untreated group. The two vertical lines show the period that has been removed from the sample to eliminate the effect of the announcement of the park in the housing prices. As noted, the trend in the period prior to the advent of the park is very similar for both sets of sample and different when we consider the post-treatment period. So it suggests that our estimation via DiD fits the model assumptions and, in fact, imply causality of the effect of the park in the property price at a distance of 1000 meters from the park.

Figure 3: Evolution of the Treated and Untreated Group (1000ms) and their Trend



Note: Based on information the Municipal Administration of Recife.

4. Results

4.1 Initial Evidences

The aim of this research is to evaluate the impact on the value of the properties due to a building of a new park, the Dona Lindu Park, in the city of Recife, Brazil. For this, we will use the basic idea of the hedonic pricing model, which the price of the real estate reflects the its own characteristics (Cheshire and Sheppard, 1995), along with the identification strategy based on the difference-in-difference estimator (DiD) to estimate the impact on the price of the real estate nearby the park.

Thus, the first stage of this essay is to work with the treatment area of 1000 meters, as established in the last section. The objective at this point is to test the sensitivity of the outcome of treatment area. We consider three different types of specification (columns (1) to (3)); indicating different subsets of the control variables included in our basic model and different treatment areas. The Table 3, columns (1) to (3), displays the results for the estimation, considering as treated all properties within a radius of 1000 meters from the park.

Table 3 – The Impact of the Park Dona Lindu in Prices of Real Estate Properties: the Benchmark Estimation for the 500 and 1000 meters Radius

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D. Lindu 1000	0.813***	-0.108***	0.005				
	(0.000)	(0.021)	(0.014)				
D. Lindu 500				0.962***	0.084***	0.087***	0.081***
				(0.000)	(0.018)	(0.014)	(0.016)
D. Lindu 500_1000							-0.095***
							(0.014)
Area (m2)			0.004***			0.004***	0.004***
			(0.000)			(0.000)	(0.000)
House			0.271***			0.271***	0.271***
			(0.046)			(0.046)	(0.046)
Medium Standard			0.194***			0.195***	0.194***
			(0.036)			(0.036)	(0.036)
High Standard			0.536***			0.537***	0.535***
			(0.052)			(0.052)	(0.052)
Year of Construction			0.005**			0.005**	0.005**
			(0.002)			(0.002)	(0.002)
Regular			-0.120			-0.120	-0.120
			(0.083)			(0.083)	(0.082)
Good			0.039			0.039	0.039
			(0.062)			(0.062)	(0.062)
District FE	No	Yes	No	No	Yes	No	No
Year FE	No	Yes	No	No	Yes	No	No
Month FE	No	Yes	No	No	Yes	No	No
Year-Month FE	No	No	Yes	No	No	Yes	Yes
District-Year FE	No	No	Yes	No	No	Yes	Yes
Observations	57,182	57,182	57,182	57,182	57,182	57,182	57,182
Adjusted R^2	0.0271	0.5496	0.7562	0,0201	0,5495	0,7563	0,7562

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

In column (1) of Table 3, we estimate the regression with only the variable of interest with the price of real estate (in logarithm), without considering neither structural feature of the

property and any fixed effect and it shows a positive and statistically significant effect of the building of the park in the real estate prices. But, the column (2), by including the fixed effects of year, month and district, these effects become negative and statistically significant, indicating a possible negative effect of the price of the properties and the positive initial effect was associated to the characteristics of the district.

However, when we introduced the controls with the characteristics of properties, the fixed effects of district-year and month-year, column (3), the impact of the Park on the real estate was not statistically significant. This indicates that the negative signal was associated to the physical features of the properties. The year of construction also has a positive outcome, indicating that when younger the property higher its value. There is, furthermore, a positive effect on the real estate value if it is a house, which is to be expected, because in the Boa Viagem district most of the buildings consists of apartments and the few houses that remain are highly valued. And the zero-effect possibly occurs due to the probable negative influence such as congestion and noise that cancel out the prior positive effects associate to the direct amenity of the proximity of the Park.

In the last section, we showed that the influence of the park D. Lindu on the value of the properties stands until 1000 meters of the Park´s boundary. As there are potentially different kinds of effects (positive and negative) of the parks in the value of the real estate, we begin by exploring the existence of a positive effect associate to the amenities being located near to a green area (the Dona Lindu Park) and, thus, considering the impact on the properties located until 500 meters from the boundary of the Park. The objective at this point is to test the sensitivity of the outcome of treatment with different distances. The Table 3, columns (4) to (6), presented the results.

In column (4) of the Table 3, we estimate the regression with only the variable of interest with the price of real estate (in logarithm), without considering neither structural feature of the property nor any fixed effect. The estimation of this parameter indicates that there is a positive relationship between the advent of the park with the value of the property and shows a statistically significant at 1% and impact of 96.2%. In column (5), it was added the fixed effects of month, year and district, intended to capture the effect of seasonality in the real estate market. And the impact of the D. Lindu Park for properties situated 500 meters away from it was 8.4%

In column (6), besides the controls with features of the property and with fixed effects control of month-year, we added specific controls to capture the effect of the district and month together. And it is important, because it takes into account the price variation between month-year and district-month combinations not parametrically. In this specification, the impact of the building of the Dona Lindu park on the residential prices in March 2011 until 2012 (treatment group) was 8.7%, when compared to the prices of the control group. Specifically, the area, the medium and high construction standards have positive influences in the property values, while other characteristics are unchanged. Nevertheless, it is important to observe that the estimates presented in Table 3 show the impact on the price of real estate in the post-treatment period.

Now we will work with two radiuses of treatment, up to 500 meters and 500 to 1000 meters from the park and the results are also presented in Table 3, column (7). The motivation behind this point is to verify different kinds of effects depending on the distance of the Park. Thus, in Table 3, in column (7) there was a positive impact in the real estate prices of 8.1% for properties within 500 meters from the Park and a reduction in the housing prices of 9.5% for real estates located within 500 and 1000 meters from the D. Lindu. The result suggests that the properties located up to 500 meters from the park are those that the value of the real estate has increased in the post-treatment period, between March 2011 and December 2012 compared to the pre-treatment period, from December 2000 to September 2006. On the other hand, the statistically significant outcome with a negative signal found in the radiuses of 500 to 1000 meters from the park is consistent with the strong performance of the negative effects associated with the presence of the park, such as congestion, noise, garbage and crime (Lim and Missios, 2007; Smith et al., 2002; Linden and Rockoff, 2008; Troy and Grove 2008).

There are some others studies that had found negative effects due to a green area. For example, Lim and Missios (2007) and Smith et al. (2002) found negative indirect effects of garbage and noise in the real estate values, respectively. Linden and Rockoff (2008) and Troy and Grove (2008) argued that the construction of a park may increase the crime rate. And some others work that found different effects of the impact of the park, for example Pearson, Tisdell and Lisle (2002) found a 7% increment in the price of the properties near the Noosa Park, Australia. However, this value changes according to the location of the buildings. Properties located south of the park have 85% greater value than real estate just at north of the Park.

Note that our results are analogues to the ones obtain by Nelson (2004) and Pope and Pope (2015). Nelson (2004), for example, studied the issue of aircraft noise on the property value and he showed that an airport has different impact on the real estate depending on where the property is located. This way, a certain household located in the region of 55 decibels would be sold for about 10-12 percent less if it was placed in a region with 75 decibel noise. This is explained by the fact that these properties located near to the airport, but do not suffer from loud noise, have a clear benefit, easy access to the airport, but without great inconvenience caused by excessive noise. Pope and Pope (2015) demonstrated a possible negative effect of the congestion due to the new Walmart store. Thus, the densification process in this region of a park might, as well, generate possible negative effects in the real estate price.

By choosing 500 meters radius from the Park, solely based on the half distance between the boundary of the Park and the treatment area might generate results that could potentially be only a product of this choice. Here, we show that the positive and the negative effects of the Park on property's value effectively occurs much closed to the ones we assumed. In Table 4, we present new estimations of the impact of the D. Lindu on the properties' value, but now, we are considering different regions of treatment; according to 100 meters distance to each other, being the more near radius is up to 100 meters from the park and the more distance radius from the park is up to 900 to 1000 meters.

This way, the real estate properties distance up to 100 meters away from Dona Lindu has presented an increase of 13.4% in their prices. For properties located between 100 and 200 meters from the Park the impact of the D. Lindu is not statistically significant. On the other hand, for real estate sited in the radius of 200 and 300 meters away from the park, the outcome is statistically significant, with an appreciation of the real estate of 13.6%. And the positive effect of the Park on the real estate holds until 600 meters from the Park. However, there is a positive, but declining, effect of 4% for the households located in the radius of 500 to 600 meters. From this point on, the effects on the real estate become negative and statistically significant at 1%. And, for example, in the radius of 600 to 700 meters from the park, house prices decrease by 21.1%.

These sets of evidence reinforce the idea that up to 500 meters of the park, the impact of this is positive and, after this distance, the value of the enterprise in the housing prices becomes negative. Within the radius of 500 to 600 from the park, the impact decreases and

loses its statistical significance – now it is 5% – and the effect it is only 4% on the value of the properties. Probably, from this point on, homeowners face a reduction in the impact and start to present negative effect on the price.

Table 4 – The Impact of the Park Dona Lindu in Prices of Real Estate Properties: Benchmark Estimation for a 100 meters Radius until 1000 meters

Variables	(1)	(2)	(3)	(4)	(5)	(6)
D. Lindu 100	1.300***	0.354***	0.347***	0.353***	0.142***	0.134***
	(0.000)	(0.023)	(0.025)	(0.030)	(0.031)	(0.027)
D. Lindu 100_200	0.868***	-0.046**	-0.045**	-0.040*	-0.023	-0.024
	(0.000)	(0.022)	(0.021)	(0.023)	(0.016)	(0.016)
D. Lindu 200_300	1.052***	0.135***	0.137***	0.137***	0.135***	0.136***
	(0.000)	(0.022)	(0.021)	(0.020)	(0.016)	(0.016)
D. Lindu 300_400	0.884***	-0.040*	-0.043**	-0.044**	0.076***	0.073***
	(0.000)	(0.022)	(0.022)	(0.022)	(0.015)	(0.014)
D. Lindu 400_500	0.946***	0.034	0.032	0.031	0.085***	0.083***
	(0.000)	(0.022)	(0.021)	(0.021)	(0.016)	(0.015)
D. Lindu 500_600	1.026***	0.097***	0.099***	0.093***	0.040**	0.040**
	(0.000)	(0.022)	(0.021)	(0.019)	(0.019)	(0.019)
D. Lindu 600_700	0.467***	-0.482***	-0.491***	-0.484***	-0.208***	-0.211***
	(0.000)	(0.023)	(0.023)	(0.027)	(0.023)	(0.021)
D. Lindu 700_800	0.722***	-0.226***	-0.227***	-0.240***	-0.144***	-0.147***
	(0.000)	(0.023)	(0.023)	(0.022)	(0.011)	(0.010)
D. Lindu 800_900	0.666***	-0.226***	-0.219***	-0.218***	-0.116***	-0.113***
	(0.000)	(0.021)	(0.021)	(0.021)	(0.019)	(0.018)
D. Lindu 900_1000	0.346***	-0.542***	-0.539***	-0.533***	-0.159***	-0.155***
	(0.000)	(0.021)	(0.020)	(0.020)	(0.018)	(0.017)
Property Features	No	No	No	No	Yes	Yes
District FE	No	Yes	Yes	Yes	Yes	No
Year FE	No	Yes	Yes	No	No	No
Month FE	No	No	Yes	No	No	No
Year-Month FE	No	No	No	Yes	Yes	Yes
District-Year FE	No	No	No	No	No	Yes
Observations	57,182	57,182	57,182	57,182	57,182	57,182
Adjusted R^2	0.0283	0.5499	0.5510	0.5523	0.7432	0.7566

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

4.2 Baseline Estimation

Therefore, the positive effect of the building of the D. Lindu Park still holds for a greater distance than the arbitrary radius of 500 meters away from it. As the last column of table 4

makes clear, the positive effect of the Park in the real estate properties hold until 600 meters from the Park. In the light of the set of evidence, from now on, we considered two treated regions, up to the 600 meters from the Park and the region between 600 and 1000 meters from it. In Table 5, we present evidence considering these two treated regions.

Table 5 – The Impact of the Park Dona Lindu in Prices of Real Estate Properties: Benchmark Estimation for the 600 and 600-1000 meters Radius

Variables	(1)	(2)	(3)	(4)	(5)	(6)
D. Lindu 600	0.987***	0.067***	0.066***	0.067***	0.078***	0.077***
	(0.000)	(0.022)	(0.021)	(0.021)	(0.016)	(0.016)
D. Lindu 600_1000	0.516***	-0.404***	-0.404***	-0.402***	-0.118***	-0.119***
	(0.000)	(0.022)	(0.021)	(0.022)	(0.016)	(0.015)
Area (m^2)					0.004***	0.004***
					(0.000)	(0.000)
House					0.262***	0.271***
					(0.044)	(0.046)
Medium Standard					0.202***	0.194***
					(0.038)	(0.036)
High Standard					0.542***	0.535***
					(0.054)	(0.052)
Year of Construction					0.004**	0.005**
					(0.002)	(0.002)
Regular					-0.128	-0.120
					(0.079)	(0.083)
Good					0.031	0.039
					(0.060)	(0.062)
District FE	No	Yes	Yes	Yes	Yes	No
Year FE	No	Yes	Yes	No	No	No
Month FE	No	No	Yes	No	No	No
Year-Month FE	No	No	No	Yes	Yes	Yes
District-Year FE	No	No	No	No	No	Yes
Observations	57,182	57,182	57,182	57,182	57,182	57,182
Adjusted R^2	0,0291	0,5488	0,5491	0,5515	0,7436	0,7564

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

Hence, in Table 5, in column (1) the properties located in the radiuses of 600 and 600 to 1000 away from the Park are statistically significant and positive, which, in principle, indicate a positive impact of the construction of the park in the housing prices for the both radiuses. Nevertheless, after introducing the fixed effects of district, month and year, in the columns (2), (3) and (4); the signal of the properties until 600 meters remains positive, but the treated

properties that were within 600 to 1000 meters still are statistically significant, but now with a negative effect, similar to what happened in the Table 4.

In the column (5), the effects remained statistically significant and with the same opposite signs found in the former columns and the positive impact of the building of the Park in the real estate market was 7.8% for properties situated until 600 meters from the D. Lindu and a negative effect of 11.9% for properties located up to 600 meters and less than 1000 meters way from the Park. Column (6) introduces, in addition to the controls of the characteristics of the properties, the fixed effects of the month-year and the month-district in order to get these specific effects and it sustained no main changes from the previous column.

Clearly, the estimations found in the previous Tables showed the impact of the Dona Lindu Park in the housing prices in the post-treatment. Depending on the evolution of demand for real estate in the area near to the park and the offer of real estate in the substitute's districts, it is expected that the effect of observed treatment may vary over time. To capture these temporal heterogeneities, we estimated the model exhibited in the equation 2.2, which allow non-linear effects of the park's advent in the average price of the treated properties and the estimation also checks if the common trend assumption is valid. Also, as emphasized in section three, this model informs the effect before the construction of D. Lindu (anticipatory effects) and these should be equal to zero to ensure causal interpretation of the observed effect. It follows the following equation, similar to equation (2.1):

$$y_{idt} = \beta_0 + \sum_{2004}^{2006} \beta_{-\tau}\, DL600_{it} + \sum_{2011}^{2012} \beta_{+\tau}\, DL600_{it} + \sum_{2004}^{2006} \delta_{-\tau}\, DL600\_1000_{it} + \sum_{2011}^{2012} \delta_{+\tau}\, DL600\_1000_{\_it} + \theta_t + \Phi X_{idt} + \gamma \eta_{id} + \varepsilon_{idt} \quad (2.2)$$

The DL coefficient is equal to 1 if the property is within the treatment area in the period when the Park was already handed over to the public and zero, otherwise. This way, we have two treatment regions, so we have to create different coefficients for both regions. The coefficients β_{2004}, β_{2005} and β_{2006} allow three leads or anticipatory effects and the coefficients β_{2011} and β_{2012} allow for two lags or post-treatment effects for the radius of 600 meters away from the D. Lindu Park. On the other hand, the coefficients δ_{2004}, δ_{2005} and δ_{2006} allow three leads or anticipatory effects and the coefficients δ_{2011} and δ_{2012} allow for two lags or post-treatment effects for the region of 600 to 1000 meters from the Park.

Table 6 – The Impact of the Park Dona Lindu in Prices of Real Estate Properties: The Yearly Estimation – The Lead and Lags Estimation

Variables	(1)
2004* D. Lindu 600meters	0.007
	(0.011)
2005* D. Lindu 600meters	0.025
	(0.033)
2006* D. Lindu 600meters	0.142
	(0.048)
2011* D. Lindu 600meters	0.044**
	(0.018)
2012* D. Lindu 600meters	0.003**
	(0.002)
2004* D. Lindu 600_1000meters	0.053
	(0.055)
2005* D. Lindu 600_1000meters	-0.023
	(0.022)
2006* D. Lindu 600_1000meters	-0.014
	(0.023)
2011* D. Lindu 600_1000meters	-0.018*
	(0.017)
2012* D. Lindu 600_1000meters	-0.188***
	(0.027)
Property Features	Yes
District FE	No
Year FE	No
Month FE	No
Year-Month FE	Yes
District-Year FE	Yes
Observations	55,483
Adjusted R^2	79.81

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

First, note for both groups of residences, the outcomes are statistically insignificant at the pre-treatment period. This strengthens the argument that both the treatment group and the control group had the same dynamic of pricing before the building of the Park. Second, the estimations for the region up to 600 meters of the park had the highest effect in the first year, 4.4%, and a reduction in the second year after the shock, with 0.3% of appreciation. While the region of 600-1000 meters has a negative effect 1.8% in the first year and 18.8% in the second year indicated a considerable decline in the real estate price due to the building of the

Dona Lindu Park. Note that these specifications included controls for the characteristics of real estate, fixed effect of year-month and district-month.

5. The Robustness Tests

In this section we present a series of robustness tests based on both alternative control groups and periods of treatment, once the results we have found come from a non-experimental evaluation. We also performed a falsification test by assuming a false period of building of the Dona Lindu Park. In the Table 7, the column (1), we present the benchmark model, column (6) of the Table 5. In this section, will made eight robustness tests and the first four will be displayed in the Table 7. The first set of robustness test considers the possibility of the influence of non-observable characteristics associate with the potentially imperfect control group.

Initially, it is important to highlight that in the 2000s, the Suape harbor has been enhanced and revitalized, which drew many workers from other cities to RMR (Metropolitan Region of Recife), in particular to the Boa Viagem district, closest neighborhood to the Harbor. This way, in the column (2), we considered only the Boa Viagem district as a control. The effect of the Park on the real estate properties remained robust and statistically significant at 1%, with an impact of 3.7% on properties in the region within 600 meters and a negative effect of 13.3% on real estates in the region between 600 and 1000 meters away from the park.

The column (3) has as control only the Boa Viagem district, but has also introduced a limit of 500 meters away from the ocean. The importance of this point is to maintain a close comparison between the properties. This came from the fact that the Boa Viagem district, despite being one of the wealthiest neighborhoods of Recife, slums essentially surrounds the neighborhood. So we eliminate households located more than 500 meters away from the beach, and we will be comparing more similar properties. Now, there was a positive impact of 12.6% on properties located 600 meters from the Park and the outcome was statistically significant at 1%. The effect of the building of the D. Lindu Park on the properties within 600 and 1000 meters away from the Park had a negative impact of 34.2% and it was also statistically significant at 1%. Thus, for this control group we got stronger effect of the Park on the property's value.

Table 7 –The Robustness Check I: Different Control Groups According to the Distance from the Park

Variables	(1)	(2)	(3)	(4)	(4)
	Benchmark Equation	Only the District of Boa Viagem as a Control	Until 500 meters from The Sea	Eliminating the distance between 1000 and 1500 meters from the Park	Propensity Score Matching
D. Lindu 600	0.077***	0.037***	0.126***	0.064***	0.095***
	(0.016)	(0.023)	(0.023)	(0.018)	(0.020)
D. Lindu 600_1000	-0.119***	-0.133***	-0.342***	-0.134***	-0.429***
	(0.015)	(0.019)	(0.042)	(0.017)	(0.038)
Property Features	Yes	Yes	Yes	Yes	Yes
District FE	No	No	No	No	No
Year FE	No	No	No	No	No
Month FE	No	No	No	No	No
Year-Month FE	Yes	Yes	Yes	Yes	Yes
District-Year FE	Yes	Yes	Yes	Yes	Yes
Observations	57,182	16,072	7,670	54,766	8,536
Adjusted R^2	0.7581	0.812	0.793	0.754	0.8417

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

Thus far, as defined in section 3, the area of influence of the Park in the value of the real estate is restricted to 1000 meters from the D. Lindu. However, it may occur that the distance somewhat larger than 1000 meters from the Park could also be contaminated by the building of it. Thus, we will proceed with a robustness test, column (4), which we eliminated the region that sited between 1000 and 1500 meters away from the Park. One more time, the results are aligned with the previous columns, there was a positive impact of 6.4% for properties located 600 meters from the Park and it was statistically significant at 1%. For the region situated between 600 and 1000 meters away from the D. Lindu there was a negative effect on the real estate prices by 13.4% and it was also significant at 1%.

Finally, in order to improve the balance between the treated and untreated units, we also use a matching strategy for the properties before the estimation of equation (2), which is implemented through the method of the two nearest neighbors[11]. This form of matching involves a trade-off between variance and bias. It trades reduced variance, resulting from

[11] We also implemented through the method of Kernel estimation and the outcome was closer to the results found in this section. The results are available upon request.

using more information to construct the counter-factual for each participant, with increased bias that results from on average poorer matches (Smith, 1997).

For this, we first estimate a Probit model for each property in the sample with the same complete regression used in the benchmark model, the Table 5. Then we apply the method commonly used by second nearest neighbors and then, after the matching, we estimate the model the difference-in-difference strategy. The matching occurs in the physical features of the property, less suitable than the other tests. The column (5), table 7, shows the results. When comparing a subset with more similar dwellings, the impact of the Park on the real estate had intensified, in the region up to 600 meters from the D. Lindu and it had an impact on the value of real estate of 9.5% and the for properties on the region between 600 and 1000 meters had a strong negative impact of 42.9%. Hence, when we compare properties with similar characteristics the effect of the Park in the real estate value has intensified.

The following Table 8 demonstrates the robustness tests when we change the treatment periods. In the first column of the Table 8, we included each year of the sample which was removed before, with the intention of eliminating the effect of the announcement. The intention of this test is whether, even at reintroducing the years that were removed from the sample, the result keeps the same. This result is shown in column (1) of the Table 8. Even when we consider the years we removed from the sample, the result did not change significantly. For the treated area, within 600 meters from the park, the appreciation of the properties was 9.1%, as in the region of 600 to 1000 meters the devaluation was 9.7%, close to what was found in the benchmark model.

In the next column of the Table 8, we consider the period of the original sample (which we had removed the period of 2 years and 4 months backwards and afterwards the first opening of the park, in December 2008), dropped from the sample the six months before the announcement of the construction of the park in September 2006. The goal is to test if the announcement has any consequence on the price of the real estate. Column (2) shows the result and they were very close to that found in the main equation, with an appreciation of 7.8% for properties up to 600 meters from Dona Lindu and depreciation of 11.7% for real estates placed between 600 and 1000 meters from the park.

Table 8 – The Robustness Check II: Control Groups According to the Periods of analysis

Variables	(1)	(2)	(3)	(4)
	The Whole Sample	Without the 6 Months Prior to the Announcement	Without the Year of 2006	Whole sample Without the Year of 2009 and 2010
D. Lindu 600	0.091***	0.078***	0.078***	0.081***
	(0.018)	(0.016)	(0.016)	(0.017)
D. Lindu 600_1000	-0.097***	-0.117***	-0.118***	-0.103***
	(0.015)	(0.015)	(0.014)	(0.014)
Property Features	Yes	Yes	Yes	Yes
District FE	No	No	No	No
Year FE	No	No	No	No
Month FE	No	No	No	No
Year-Month FE	Yes	Yes	Yes	Yes
District-Year FE	Yes	Yes	Yes	Yes
Observations	97,433	53,649	52,542	78,281
Adjusted R^2	0.7229	0,7569	0,7545	0,7628

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%, ** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

In the column (3) of Table 8, we eliminate the entire year of 2006 and the goal is the same as the previous column, reinforce that there is no contamination by the announcement in the pre-treatment period. And, indeed, the results are very close to the previous column, indicating that there is no contamination in the pre-treatment period.

One more time, in the final robustness test, the idea is to check if there was a contamination of the outcome by the announcement of the Park. Remember that we had eliminated the period of 2 years and 4 months backwards and afterwards the first opening of the park in December 2008. Now, we will continue to examine the possible effects of changing only the pre-treatment period. This way, we use the whole sample, but without the years 2009 and 2010 and we verify whether, even when we considered this period of time, the results were aligned with the others outcomes found before. The result is displayed at column (4) of Table 8. The effect of the Park on the real estate stays on and it was robust to the test proposed and the building of the D. Lindu Park impacted on the real estate properties was 8.1% in the region within 600 meters away from the park and a there was an effect of -10.3% on properties within 600 to 1000 meters.

As a final falsification exercise, we investigate the existence of differences in time trend of the pre-treatment in the prices of real estate subjected to the effect of the park. In this practice, we will falsely assume that the announcement of the park was made a year before, in September 2005, and we will do the same exercise, but now comparing the average price of the properties of the control group and the treatment group only in the years of 2000 to 2005. The estimations for these coefficients will be displayed in the table 9. These results suggest that the effect of the false release of the Dona Lindu Park is not statistically significant. In summary, the results indicate that there is no difference in the change in the price of real estate between the treated and untreated area. Then, as the exercise of leads and lags also suggests, the falsification check provides sufficient evidence for different trends before of the construction of the park, validating our empirical results found in the previous section.

Table 9 – The Falsification Test: Treatment period

Variables	(1)
D. Lindu 600	0.025
	(0.016)
D. Lindu 600_1000	-0.022
	(0.014)
Property Features	Yes
District FE	No
Year FE	No
Month FE	No
Year-Month FE	Yes
District-Year FE	Yes
Observations	57,182
R^2	0.8092

Note: Clustered standard errors are presented in parentheses, *indicates a significance of 10%,** indicates a significance of 5%, *** indicates a significance of 1%; all specifications include a constant not reported.

6. The Discussion and Final Considerations

Recife is one of the densest cities in Brazil (IBGE, 2010) and with a very poorly distributed green area (Oliveira et al., 2012), most of this green space is located on the districts in the North Zone of the city, away from the district of Boa Viagem, where Dona Lindu Park is situated. Moreover, it is one of the oldest capital cities of Brazil and suffers from a number of similar urban problems of other cities. Its advanced age and the lack of the urban planning incorporating a modern transportation system, for example, makes the city extremely sensitive to the population and the political changes that might affect the price of

the real estate. In this regard, the construction of an urban park in one of the wealthiest and densest districts of the city (Oliveira and Silveira Neto, 2016) can clearly impact the price of the properties around the park. Thus, the aim of this paper is to estimate the causal impact on the price of real estate properties nearby the Dona Lindu Park.

One of the most significant contributions of this paper is to estimate the impact of a park on the property values for a city of a developing country with few green areas available. And, giving our best knowledge, there was no study in such area for Brazil. The database used in this paper is from the municipal government and holds information about the property features and values from the year of 2000 to 2012. The identification strategy via difference-in-difference allowed us to estimate the value of the impact of the park in the housing prices between the region treated (the radius less than 1000 meters away) with the area not subject to treatment (greater than 1000m). The estimates obtained indicate that the properties are located up to 600 meters of the D. Lindu have an average increase of 7.7% in the real estate price. On the other hand, the properties situated between 600 and 1000 meters from the Dona Lindu Park had a decrease in the price of approximately 11.9%.

The results suggest that the positive effect to properties nearby the park probably has a positive effect on the real estate properties and for the properties located more distant from the D. Lindu there was a strong negative impact. This is probably because the high density of the district of Boa Viagem and the adverse effects on this area, such as congestion, noise or excessive garbage, are greater that the positive effect on this region.

Nevertheless, it is important to highlight that the effect of the building of the Park on the real estate vary over time and might also be different for each property, because ours estimates are non-uniform in relation to the building of the D. Lindu Park. We also point out how a single building may have very different impacts, positive and negative effects, in such a restricted area – 1000 meters from the Park (Pearson, Tisdell and Lisle, 2002). However, ours results are important because they indicate how work conducted by the public sector is able to affect the prices of the individual properties.

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Evaluating the Regional Expansion of the Federal System of Vocational Education and Technology: Evidence from the Brazilian Experience

1. Introduction

The amount of Human Capital in a region is one of the strongest predictors of sustained economic vitality. Studies of regional economies have linked higher levels of Human Capital to increases in population and employment growth, wages, income and innovation (Glaeser et al., 1995 and Florida et al., 2008). Moreover, larger amounts of local Human Capital have been shown to lead to more rapid reinvention and long-run economic growth (Glaeser et al., 2004; Glaeser, 2005). These empirical findings are explained by the fact that Human Capital increases individual-level productivity and idea generation (Becker, 1964). In addition, the concentration of Human Capital within a region may facilitate knowledge spillovers, which further enhance regional productivity, fuel innovation and promote economic growth (Lucas, 1988; Romer, 1990 and Moretti, 2004).

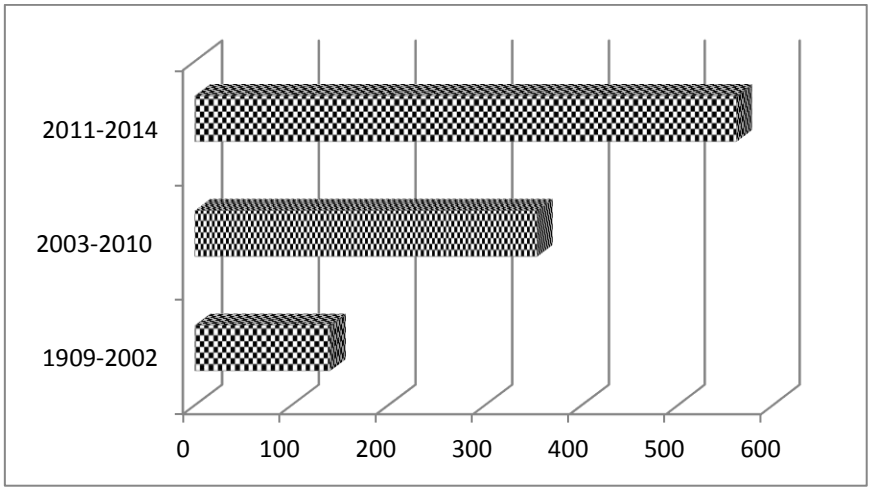
State and regional economic development agencies in the United States as well as in other nations are increasingly driven toward strategies designed to leverage the emerging knowledge-based economy of their respective regions. Many of these strategies have focused on public universities as the primary public producers of knowledge. Technology transfer programs, university-industry partnerships and educational curricula tailored to match the skill demands of local knowledge-based industries provide just a few examples of such economic development programs. These university activities, along with others such as conducting basic research and serving as a regional repository of expertise, heavily influence the abilities of regions to attract and retain technology-intensive firms, to provide the regional labor force with modern knowledge skills and to respond flexibly to uncertain and rapidly changing economic circumstances (Lucas, 1988; Drucker and Goldstein, 2007 and Florida et al., 2008).

According to the IBGE, the Brazilian Institute of Geography and Statistics, in 2011, the literacy rate of the population was 90.4%, meaning that 13 million (9.6% of population) people are still illiterate in the country; functional illiteracy has reached 21.6% of the population. The illiteracy is highest in the Northeast, where 19.9% of the population is illiterate. Menezes-Filho (2001) argued that income inequality is largely the consequence of a poor existing educational distribution, both interpersonal and between groups of people with similar characteristics. So, there is a dense concentration of masses with low qualifications

among afro-descent or mulattos, living in non-metropolitan areas, especially on the North and Northeast of the country.

In fact, Brazilian workers experience one of the largest differences in earnings according to the level of education. Tertiary-educated adults earn over 2.5 times more than those with upper secondary education. That is considerably higher than the OECD average multiplier of about 1.6, and is the second highest of all OECD (OECD, 2014). In addition, adults without an upper secondary education suffer the greatest penalty in their wages, earning 42% less than people with that qualification.

With this scenario, in the 2000s, the Brazilian Federal Government conducted a process of amplification of the Federal System of Vocational Education and Technology (hereinafter: Federal System of Education or just FSE) with the aim of bringing quality vocational and college education in the areas of the country with low levels of education. Particularly, between 2003 and 2010, more than 240 new Federal Institutes (FIs) were created (BRAZIL, 2016a). As noted in Figure 1, there was an increase of over 250% in the creation of institutions with this type of vocational training. This expansion process continued in the following decade by lifting the significant number of 562 Federal Institutes and covering all of the micro regions in the country (BRAZIL, 2016a).



Note: Data are from the Ministry of Education and the Federal Institutes.

Figure 1 – Evolution of the Federal System of Vocational Education and Technology (1909-2015)

The criteria defined by the Ministry of Education (MEC) to establish a new FI satisfied three dimensions: social, geographical and economic development (BRAZIL, 2008).

And it should prioritize cities that have low per capita income, limited access to the Federal University system and focus on LPA's (Local Productive Arrangements). The Institutes should have strong insertion in the area of research and extension, aiming to stimulate the development of technical and technological solutions and extending its benefits to the community.

The institutional mission of the Federal Institutes (BRAZIL, 2016a) must, as regards the relationship between training and work, be guided by the following objectives: offering vocational and technological education, as an educational and research process in all levels and modalities; guide the provision of courses in line with the consolidation and strengthening of the Local Production Arrangements; stimulate applied research, cultural production, entrepreneurship and cooperatives, supporting the educational processes leading to the generation of jobs and income, as well as promoting the retention of skilled labors and attracting qualified workforce to the region. Half of the vacancies shall be set aside for the provision of technical courses of high school level, in particular integrated curriculum courses (BRAZIL, 2016a).

Actually, it is still an open question if this Brazilian strategy will improve local Human Capital. In this regard, the first studies of the economic impact of universities began to appear in the 1980's in the United States, Canada and, more occasionally, Europe (Ciriaci and Muscio, 2010; Monsalvez, Peraita and Pérez, 2015). They all present a common approach, based on one central idea: assuming that everyday activities of universities have positive effects on the local economy, they attempt to quantify the impacts of teaching and research activities on the variables traditionally used to measure the regional economic development (Drucker and Golstein, 2007). As well as the impacts attributable to universities' current spending on staff and infrastructures, studies of the effects of universities on economic development have focused on the following types of impacts: knowledge creation, creation of human capital, transfer of existing technical knowledge, technological innovation, capital investment, leadership, creation of infrastructures for the production of knowledge – Human Capital– and, finally, influence on the economy (Monsalvez, Peraita and Pérez, 2015).

In large part, the impact-study framework is limited by information availability in providing quantitative estimates for the range of regional economic effects. Most case studies estimate the direct and indirect impacts of university spending, investment, and employment in a region through growth accounting, regional input-output modeling, estimation of

Keynesian multipliers, or occasionally a broader economic forecasting model (Candell and Jaffe, 1999; Thanki, 1999). For example, Harris's (1997) analysis of the University of Portsmouth finds an employment multiplier between 1.55 and 1.79 and an output multiplier of 1.24 to 1.73, and Glasson (2003) estimates an output multiplier of 0.70 to 1.12 for Sunderland University. Felsenstein (1996) uses an econometric model based on input-output relationships to estimate that Northwestern University added more than 10,000 jobs (an employment multiplier of 1.55) and half a billion dollars in output to the Chicago region in 1993.

In Brazil, Kureski and Rolim (2009) showed that Brazilian Federal Universities have employment multiplier of 3.15 and income multiplier of 1.94. Otherwise, promising quantitative frameworks such as benefit-cost analysis or calculation of return on investment to public expenditures are often unworkable in practice because of the lack of appropriate data or the impossibility of attributing impacts to particular universities or programs (Bessette, 2003).

Unlike the multiplier calculation, there have been numerous attempts made to assess the impacts of the activities undertaken by institutions of higher education. The approaches and methodologies have varied widely, and have produced a wide range of estimates regarding the impacts of universities on their regional economies. Particularly, research on regional impacts indicates that universities contribute to their host regions in several ways: directly impacting the economy (Armstrong, 1993), upgrading the quality of local economies and political systems (Benneworth et al., 2010), contributing to knowledge creation and transfer (Faggian and Mccann, 2009; Power and Lundmark, 2004; Breschi and Lissoni, 2003), also contributing to regional growth, competitiveness (Lucas, 1988), structural change (Boschma et al., 2009) and to human capital accumulation (Lucas, 1988; Faggian and Mccann, 2009).

However, some researchers also have focused on quantifying outputs rather than attempting to translate them into economic variables (Drucker and Goldstein, 2007). Examples include counting spin-off firms (Adams, 1991; Steffensen, Rogers, and Speakman 2000; Feller, Ailes, and Roessner 2002), assessing the number and quality of university-industry linkages (Jones-Evans et al. 1999; Rip 2002; Walshok et al. 2002), and measuring technology transfer outcomes such as patents and licensing agreements and income (Azzone and Maccarrone, 1997 and Glasson, 2003). Candell and Jaffe (1999) use patent citations as a proxy for approximating the sectoral distribution of technology innovations arising from

public research that encourage further private-sector spending on applied research and product development.

While the pathways through which these higher education activities can act to raise local Human Capital levels are clear, systematic empirical evidence documenting the existence and magnitude of such relationships is scarce. State governments are an important source of established higher education institutions and much of the existing literature has attempted to examine the relationship between the production of degrees and stock of college graduates, hence, from that perspective, most of those exercises were focusing in the return on the government investment (Bound et al., 2004; Groen, 2004).

As evidenced by Liu (2015), the presence of universities can lead to two types of local spillovers: direct local spillovers from research and education activity and indirect spillovers – general agglomeration economies – from a larger population that universities bring to the area. Direct spillovers can happen through two possible mechanisms, direct interaction between faculty and local business establishments and training of students – attraction of skilled workers – who remain in the area and enhance the quality of the labor pool.

Regarding immigration, the extent to which universities perform as talent magnets depends, in turn and ceteris paribus, on their quality and on its effect on the decisions of students and graduates to migrate (Niedomysl, 2006). A student may decide to migrate to study in search of a better university and after graduation, the quality of the university from where he graduated will act as a signal to firms (Spence, 1973) and it will influence his decision on where to live (Ciriaci and Muscio, 2010). To the extent that the decision of individuals about where to study and to work is influenced by the supply (and quality) of local universities, these institutions contribute to the process of regional Human Capital accumulation (Mixon and Hsing, 1994).

According to the best of our knowledge, there is no study of impact of the expansion of the FSE, the focus of this research. Specifically, using a Differences-in-Differences identification strategy and the country´s census data, we simulated an experiment to find a causal relationship between the expansion of the FSE – the creation of 165 new Federal Institutions – and the set of dependent variables of Human Capital and Migration. This set of variables includes twelve Human Capital and Migration variables that possibly may be affected by the expansion of the FSE. Ours results imply that just two variables were impacted by the expansion of the Federal System of Education: the short-term immigrant and

the college migrant – student of higher education that is also short-term immigrant. Therefore, the outcomes show that those municipalities that had a new Federal Institute present an increase in the proportion of short-term immigrant of 2.59% and a growth of 0.8% of the ratio of short-term college migrant. Despite the positive and small impact, the results are robust to the consideration of different control groups and forms of the model misspecification.

In addition to this Introduction, this paper is organized as follow: section 2 presents the institutional background of the Federal System of Education; section 3 describes the identification strategy and methodological aspects of the work; section 4 presents the data and descriptive statistics; section 5 describes the results; section 6 shows the falsification and robustness tests, and section 7 presents the discussion and final considerations.

2. The Brazilian Federal System of Vocational Education and Technology and its Recent Expansion

According to the Brazilian Ministry of Education, the FSE began on September 1909, creating 19 Apprentice Craftsmen Schools (Escolas de Aprendizes Artífices). These schools were more focused on the social inclusion of disadvantaged youth than skilled labor work force. Between the 1930s and 1940s, in the government of Getúlio Vargas, technical education began to be understood as strategic for the development of the economy. The Apprentice Craftsmen Schools have been transformed into the Industrial Lyceum – secondary education establishments - and later came to be called Federal Technical Schools (BRAZIL, 2016a). Lasting until the end of the decade of 1960, where they managed the pedagogical and administrative autonomy, transforming itself in the Federal Technical Schools.

In 1978, the Federal Centers of Technological Education (Cefets) became a reference in technological education and turned the standard unit of the FSE with the aim of forming engineers and technological trained specialists, absorbing the Technical and Federal Agrotechnical Schools (BRAZIL, 2016a). During the 1980s, a new economic and productive scenario was established with the development of new technologies. To meet this demand, the professional education institutions sought to diversify programs and courses to raise the education quality offered in Brazil (BRAZIL, 2016a).

More recently, in 1997, the president Fernando Henrique Cardoso, FHC, regulates the article of the Law of National Education Bases and Guidelines (Lei de Diretrizes e Bases da Educação Nacional) regarding the organization of vocational education. This decree became

more rigid to the FSE to expand and open new schools, because it was a necessary partnership with private foundations. The decree also determined that the technical training must be performed separately for the general formation of students, that is, the first parallel to high school, while the second, later. The most controversial part of the decree was the termination of integrated technical formation in high school (BRAZIL, 2016a). As a resolution, these policies have guided this modality of education, mainly, with the separation of high school education from vocational instruction.

In the following decade, between 2003 and 2010, less than ten years since the beginning of the reforms of the 1990s, under a new government, a new legislation was promulgated for the regulation of vocational education. The decree of FHC was repealed in 2004, and replaced by the Decree no. 5.154, as one of the promises of the new Lula´s government to expand and further distribute the professional and college education throughout rural Brazil (BRAZIL, 2016a). So, in 2008, the then President, Luiz Inácio Lula da Silva, signed the Project of Law which creates 38 Federal Institutes of Education, Science and Technology (FI) in the country. In this way, 31 federal centers of technological education (Cefets), 75 decentralized units of teaching (Uneds), 39 schools, 7 federal agrotechnical schools and 8 schools linked to Federal Universities were ceased to exist to form the Federal Institutes of Education, Science and Technology (BRAZIL, 2016a).

From the year 2003, the Lula government started actions to increase the offer of vocational education in the nation, through a plan for expansion of the Federal System of Vocational and Technological Education (BRAZIL, 2015). The first stage of the plan, 2003 to 2007, included the building of 64 new teaching units in order to add to the 140 which already existed. Soon afterwards, the Ministry of Education began the second stage, 2008 through 2010, expanded to more than 150 news schools and totaling 354 new institutions between 2002 and 2010. Specially, between 2003 and 2010, more than 240 new Federal Institutes (FIs) were created (BRAZIL, 2015). As Figure 1 highlighted, there was an increase of over 250% in the creation of institutions with this type of vocational training.

Figure 2a shows how the distribution of the Federal Education System was in 2000. There was little national coverage, with most of the FIs spread over the Brazilian coastal areas. There were also a few schools in the rural inland, mainly in the North and Midwest. The expansion process that happened in the 2000s – Figure 2b – shows an internalization of the Federal Education System. Unlike the previous figure, the new map of the Federal System

shows that there was an increase into the interior of Brazil. Nowadays, All 558 Brazilian micro regions include at least one Federal Institute.

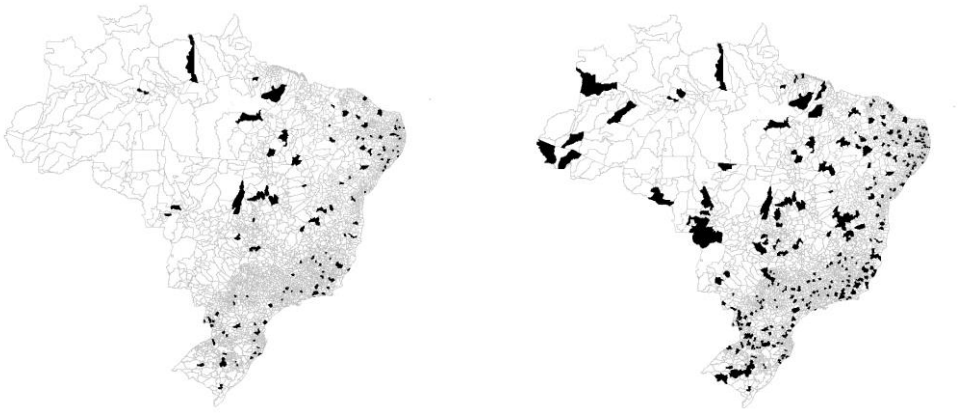


Figure 2a – 2000 Figure 2b – 2010

Figure 2 – Expansion the Federal System of Vocational Education and Technology in the Brazilian Municipalities

Between 2011 and 2014, the MEC has invested more than R$ 3.3 billion in the expansion of professional education (BRAZIL, 2016a). Of the 208 new units for the period, all went into operation, with a total of 562 schools in activity. Currently, there are 38 Federal Institutes present in all states, offering qualification courses, high school integration, vocational classes, bachelor´s degrees and also postgraduate program.

3. Empirical Strategy

We are interested in measuring the impact of the expansion of the Federal System of Education on the variables of Human Capital and Migration. Regarding Human Capital, we will analyze the effect of the expansion of the FSE on the proportion of the students enrolled in high school. This variable is measured by the ratio between the people attending high school and the people within school age (15 to 18 years old). The second Human Capital variable is the people attending college education and it is measured by the ratio between the people attending college education and the people within college age (18 to 25 years old). Finally, we will also check the impact on the proportion of graduate students in high school and higher instruction due to the expansion of the FSE.

The Federal institutes have focused on training of professionals engaged in applied science and focusing on LPAs. This way, we will verify if there were changes in the proportion of professions that are possibly more prone to be affected by a new FI. Thus, we expect that areas such as Agricultural Sciences, Biological Sciences and Technological Sciences should be affected by the expansion of the FSE. These variables are formed by the percentage of the employed labor force in those respective areas. We also consider the sum of these variables above, which we denote by skilled labor, and we will identify if there was any change in the qualified work force in the municipalities with a new FI. Finally, we will check if there has been any effect on the acquired education level, measured as years of study, in these municipalities.

Regarding immigration, we analyze the changes in the proportion of the short-term immigrants due to a construction of a new Federal Institute. This is significant, because the FI could attract people from other municipalities or regions seeking a study opportunity. And as this process of expansion is recent, the majority of immigrants that possibly could be affected by a Federal Institute must live less than five years in the municipality, hence, they are considered short-term immigrants. Thus, the first variable of migration is the short-term immigrant, that is, a ratio between short-term immigrant, people who lived less than five years in that municipality, and immigrant.

In addition, we investigate the effect of the expansion of the Federal System on the proportion of short-term migrant students enrolled in high school and college education. The high school migrant variable is the people attending high school that are also short-term immigrant, divided by the people within school age, 15 to 18 years old. The college migrant variable is the people attending college education that are also short-term immigrant, divided by the people within college age, 18 to 25 years old.

In an ideal situation, we would be to compare our dependent variables of the municipalities that experienced the implementation of a new FI to what the dependent variables of the same units would have been if the creation of a new FI did not occur. However, it is impossible to get such counterfactuals. So we use a quasi-experiment approach and consider the Difference-in-Differences estimator (DiD). This estimator seeks to compare the change in the outcome of the treated group (municipalities that experienced a creation of a new Federal Institute) before and after the intervention with the change in the outcome of the

control group (municipalities that did not experienced a building of a new Federal Institute), in the same two periods[12] – 2000 and 2010.

The DiD estimator seeks to compare the change in the outcome of the treated group (municipalities that had a new Federal Institute) before and after the intervention with the change in the outcome of the control group (municipalities that did not have a new FI), in the same two periods. The change of outcome in the control group is an estimate of the true counterfactual, i.e., what would occur with the treatment group if there were no intervention – in this case, the creation of a new Federal Institute. For this purpose, a common trend is necessary in the trajectory of the outcome variable for both the untreated and treated municipalities (Angrist and Pischke, 2008). This is the key identification assumption of DiD and it is known as the common trend assumption. An appropriate way to obtain an estimate is the following Difference-in-Differences regression with two periods and two groups as:

$$Y_{it} = \theta + \gamma FI_i + \lambda d_t + \beta FI_i * d_t + \delta x_{it} + \theta_i + \varepsilon_{it} \quad (1)$$

The FI_i is a dummy variable that assumes 1 if municipality "i" has received a new Federal Institute, and 0 otherwise, θ_i is a geographic fixed effect that depending on the specification of the regression, can be state fixed effect, micro region fixed effect or both, d_t is a time dummy that assumes 1 in the post-intervention period and 0 in pre-intervention, x_{it} is a vector of time-varying controls and ε_{it} is the error term. The parameter γ measures the initial difference in our dependent variables between the municipalities that have new Federal Institutes and those that have not; the parameter λ measures the impact of time on the untreated group of municipalities and β it is the parameter of interest, which measures the ATT, the average effect on the treated sample.

There are some advantages in using a DiD model with two periods and two groups instead of using a multi-period DiD. Beatty and Shimshack (2011) highlight that this kind of model provides a more transparent econometric analysis, and the common trend assumption can be tested in a more clear and direct way. Furthermore, as equation (1) is a saturated model, it is not necessary to impose any linearity hypothesis (Angrist and Pischke, 2008). Given these advantages and because of the impossibilities of constructing a panel with multiple time periods and including a relevant set of time-varying controls, we decided to use

[12] These specific years were chosen based on data availability. A large part of the variables are only available in census years (every ten years).

a DiD with two groups and two periods, since most of the control and the dependent variables do not have an annual basis.

Nevertheless, there are some caveats that we should be aware. For example, prior to the expansion of the Federal System that had occurred in the 2000s, other municipalities had FIs; hence, as they are older, it is likely to have received a greater sum of government resources and might generate selection bias. Therefore, municipalities that had Federal Institutes before the 2000s were removed from the sample. Later, we will reinclude them in the sample for the robustness check.

Another concern is that, jointly with the expansion of the FSE, there has also been an expansion in the number of Federal Universities in the period, by REUNI, Support Program for the Restructuring and Expansion of Federal Universities (BRAZIL, 2015). This expansion began in 2003 with the integration of rural areas into professional and college education. Hence, the number of municipalities covered by the Federal Universities rose from 114 in 2003 to 237 by the end of 2011 (BRAZIL, 2015). Since the beginning of the expansion, 14 new universities were created and more than 100 new campuses endorsed the creation of new vacancies and new degree courses. Thus, in order to eliminate the effect of this expansion on our results, the municipalities that had received new campuses, between 2000 and 2010, were removed from the sample.

It's also important to highlight that there was an expansion in the vocational training in the States High Schools via the Initiative of National Program of Access to Technical Education and Employment (PRONATEC) (BRAZIL, 2016b). This Program seeks to strengthen high school vocational training in State Systems of Education and it was launched in 2007. The PRONATEC works in the development of actions aimed the expansion and the modernization of schools in the State Systems of Vocational and Technological Education, in order to expand and increase the provision of technical courses at the secondary level. From 2007 until January 2016, the program has met vocational training institutions from 24 states.

We also have to point out that, in addition to these aforementioned factors, there was also an expansion of private higher education in the country in the 2000s. The Prouni aims to grant full and partial scholarships to undergraduates in private higher education establishments. The Federal Government also created other programs such as FIES (Student Financing Fund) which enables the partial scholarship fund up to 100% of tuition not covered by the program grant. The Prouni added to FIES; the Unified Selection System (SISU), the

Support Program for the Restructuring and Expansion of Federal Universities (REUNI), the Open University of Brazil (UAB) and the expansion of the FSE significantly expanded the access to higher education, contributing to greater youth access to college education in the country. Since we are working with variables that affect Human Capital, these government programs may also have impacted our treatment variables and we should be aware about it. Thus, we will take a series of robust and falsification tests intended to verify it the outcomes found, in fact, resulted from the expansion of the Federal System or from some other governmental programs.

To sum up, we have removed from the sample municipalities with a previous FI, before 2000, and municipalities with a new Federal University, between 2000 and 2010. The point here is to avoid any contamination that might come into play in our set of dependent variables, because our Human Capital and migration variables could be affected by these government policies.

Although the municipality does not have full control over the process of the creation of a new Federal Institute (BRAZIL, 2015) – it is conducted by the Federal Government – the process is far from being assigned randomly. A common concern in DiD analysis is the possible existence of time-varying, confounding factors, here meaning variables that are simultaneously explaining the process of the expansion of the Federal System Education and the trajectory of our dependent variables. In such case, the endogeneity problem comes into play, and the coefficients cannot be interpreted causally (Angrist and Pischke, 2008). For this reason, we added a number of controls in equation (1); based on what was discussed in the previous section and that could generate selection bias. These controls belong to two different kinds of potential influence: Socioeconomics (per capita income, Gini coefficient, economically active population, metropolitan area, urbanization rate, manufacturing workers and households with waste collection, electric power and water and bathroom facilities fully completed), and Demographics (people with age 25 years or more and a higher education, population density, immigrant, unemployment, elderly population, male, afro-descent, foreigner and young population).

In addition, we built five robustness tests to ensure that there is no relationship between treatment status and the error term of the regression. First, we are working with

MCAs[13], Minimum Comparable Areas, due to the several secessions had occurred in Brazil (Lima and Silveira-Neto, 2015). Thus, the MCA can consist of more than one municipality and this open up a possibility that, in the same MCA, a municipality had a Federal Institute, but another municipality, in the same MCA, did not. If this is verified, we will remove these MCAs from the sample. In short, for this robustness test, we will only consider those MCAs that all of its municipalities have a new FI.

Second, it may happen that the Federal Universities, even the oldest ones, which was not withdrawn from the sample, might affect our dependent variables, and we will eliminate all municipalities containing any Federal University campuses. Third, a Federal University in the micro region may affect the Human Capital and migration variables. Thus, for test this possibility, we let in a dummy, which it equals one if in a certain micro region there is a Federal University and zero, otherwise.

Next, we will reinclude all municipalities that were dropped from the sample – if they had FI prior the expansion of the Federal System of Education or they had a Federal Universities. The goal of this point is to verify if, even we include these municipalities in the sample the final results were still statistically significant. Finally, we use the Propensity Score Matching with the DiD strategy, because it compares municipalities with more similar characteristics. As argued by Ho et al. (2006), when done it properly, the matching before the estimation can reduce model dependence and variance, lower mean square error, and also generate less potential for bias.

4. Data and Descriptive Statistics

With the purpose of analyzing the effect of the expansion of the Federal System of Education, that had occurred in the 2000´s, on our set of Human Capital and Immigration variables, through a two-group and two-period Difference-in-Differences model (equation (1)), we built a panel data containing the pre-expansion period (2000) and the post-expansion period (2010). We used data from 4,154 municipalities, of which 165 (3.97%) had a new

[13] As common when studying regional growth in Brazil utilizing as observation unit the Minimum Comparable Areas (MCAs), because these are areas have constant borders over time (Lima and Silveira-Neto, 2015 and Reis et al., 2008). This is important because in Brazil there were several secessions of municipalities since 1991 and we will use the MCAs as a geographical unit comparison in our exercise. From now on, we will use the term municipalities as a synonym for MCAs.

Federal Institute built. It is important to highlight that for our analysis, it does no matter how many FIs there are in the municipality, provided that at least one Federal Institute exists, it will be considered as treated.

As discussed in the previous section, to reduce concerns about endogeneity, we included two sets of time-varying controls variables. The first set of controls corresponds to the Socioeconomics variables of the municipalities: per capita income, the Gini coefficient to measure income inequality, the economically active population (proportion), the metropolitan area (if the municipality is within a metropolitan area), the urbanization rate (ratio of population living in urban areas and total population), the manufacturing workers (proportion of population that works in industry), the waste collection (proportion of households with waste collection), the electric power (proportion of households with electric power), the water and bathroom facilities fully completed (proportion of households with water and bathroom facilities fully completed). The second set of controls corresponds to the Demographics variables: the population density (population within area), the immigrant proportion (ratio of immigrant population), the unemployment rate (ratio of unemployed population and economically active population), the proportion of people with age 25 years or more and a higher education, the elderly population (proportion of population over 65 years old), male (proportion of male population), afro-descent (proportion of ethnic afro-descent population), foreigner (proportion of foreign population) and young people (proportion of young people population). All these sets of variables were constructed using data from the Brazilian Demographic Census obtained by the IBGE.

The set of independent variables includes the main socioeconomic and demographic characteristics of municipalities. These variables are important because they have a potential impact on the program's response variables. The first set of controls shows the socioeconomics characteristics of municipalities, for example, greater per capita income and less inequality, if the municipality is in a metropolitan area and the proportion of houses with waste collection and electric power could affect the decision of an individual to migrate or stay and enhance the local Human Capital. The demographic features of the cities display the main characteristics of cities in relation to its population and also play a key role in our Human Capital and Migration variables. All of these variables indicate the capacity of the municipality has to keep these individuals in town. Table 1 presents descriptive statistics for treated and untreated subsamples in the pre-intervention period and post-intervention period. Additionally, mean difference statistics are reported.

Table 1 – Summary Statistics for Pretreatment and Posttreatment Period

	Pretreatment Period (2000)			PostTreatment Period (2010)		
Variable	Not Treated	Treated	Mean Difference	Not Treated	Treated	Mean Difference
High School Students (%)	0.406	0.462	-0.056***	0.562	0.607	-0.045***
	(0.175)	(0.152)		(0.115)	(0.0815)	
College Students (%)	0.0565	0.0799	-0.0234***	0.143	0.189	-0.046***
	(0.0501)	(0.0593)		(0.0753)	(0.0814)	
Complete High School (%)	0.548	0.628	-0.08***	0.654	0.705	-0.051***
	(0.236)	(0.201)		(0.143)	(0.107)	
Complete College (%)	0.0663	0.0988	-0.0325***	0.184	0.251	-0.067***
	(0.0592)	(0.0704)		(0.0965)	(0.108)	
Agricultural Sciences Graduation (%)	0.000531	0.000706	-0.000175***	0.00184	0.00234	-0.0005*
	(0.000818)	(0.000739)		(0.00226)	(0.00218)	
Biological Sciences Graduation (%)	0.000179	0.000325	-0.000146***	0.00122	0.00158	-0.00036***
	(0.000412)	(0.000408)		(0.00150)	(0.00149)	
Technological Sciences Graduation (%)	0.000558	0.00115	-0.000592***	0.00119	0.00256	-0.00137***
	(0.00105)	(0.00139)		(0.00229)	(0.00291)	
Skilled Labor (%)	0.00127	0.00218	-0.00091***	0.00426	0.00648	-0.00222***
	(0.00170)	(0.00208)		(0.00402)	(0.00443)	
Years of Study	8.389	8.663	-0.274**	9.450	9.593	-0.1431*
	(1.714)	(1.500)		(1.081)	(0.818)	
Short-Term Immigrants (%)	0.353	0.330	0.023***	0.259	0.264	-0.005
	(0.0857)	(0.0837)		(0.103)	(0.0772)	
High School Migrant (%)	0.0272	0.0359	-0.0087***	0.0270	0.0363	-0.0093***
	(0.0182)	(0.0134)		(0.0188)	(0.0147)	
College Migrant (%)	0.00667	0.0122	-0.00553***	0.0131	0.0299	-0.0168***
	(0.00956)	(0.0109)		(0.0147)	(0.0218)	
Per Capita Income (R$)	340.3	450.3	-110***	486.8	614.8	-128***
	(189.8)	(212.2)		(232.4)	(252.5)	
Gini Coefficient	0.546	0.570	-0.024***	0.490	0.525	-0.035***
	(0.0641)	(0.0496)		(0.0632)	(0.0551)	
Industry Workers (%)	0.0631	0.0788	-0.0157***	0.0801	0.0905	-0.0104**
	(0.0457)	(0.0421)		(0.0546)	(0.0456)	
Economically Active Population (%)	0.390	0.405	-0.015***	0.437	0.454	-0.017***
	(0.0671)	(0.0594)		(0.0792)	(0.0667)	
Urbanization (%)	0.608	0.769	-0.161***	0.654	0.798	-0.144***
	(0.215)	(0.192)		(0.201)	(0.172)	
Metropolitan Region (0 or 1)	0.0710	0.100	-0.029	0.120	0.176	-0.056**
	(0.257)	(0.301)		(0.325)	(0.382)	
Population Density (Population/Area)	0.105	0.112	-0.007	0.0955	0.0927	0.0028
	(0.311)	(0.302)		(0.275)	(0.233)	
Immigrant (%)	0.312	0.365	-0.053***	0.340	0.374	-0.034***
	(0.156)	(0.153)		(0.155)	(0.144)	
Pop. with more than 25 Years old and Higher Education (%)	0.0244	0.0421	-0.0177***	0.0542	0.0824	-0.0282***
	(0.0227)	(0.0305)		(0.0299)	(0.0379)	
Unemployment (%)	0.106	0.133	-0.027***	0.0643	0.0726	-0.0083**
	(0.0557)	(0.0450)		(0.0353)	(0.0256)	
Elderly Population (%)	0.0667	0.0556	.0111***	0.0861	0.0705	.0155***
	(0.0179)	(0.0166)		(0.0226)	(0.0200)	
Male (%)	0.507	0.499	0.008***	0.504	0.496	0.008***
	(0.0127)	(0.0125)		(0.0145)	(0.0122)	
Afro-Descent (%)	0.0586	0.0596	-0.001	0.0644	0.0726	-0.0082**
	(0.0473)	(0.0370)		(0.0501)	(0.0476)	
Foreigner (%)	0.00123	0.00179	-0.00056**	0.00109	0.00172	-0.00063**
	(0.00322)	(0.00313)		(0.00368)	(0.00362)	
Young People (%)	0.130	0.137	-0.007***	0.120	0.126	-0.006***
	(0.0123)	(0.0103)		(0.0135)	(0.0103)	
Waste Collection (%)	0.823	0.845	-0.022	0.948	0.952	-0.004
	(0.217)	(0.192)		(0.0955)	(0.0700)	
Electric Power (%)	0.879	0.904	-0.025**	0.975	0.977	-0.002
	(0.155)	(0.132)		(0.0520)	(0.0437)	
Water and Bathroom Facilities Fully Completed (%)	0.651	0.699	-0.048**	0.819	0.828	-0.009
	(0.299)	(0.277)		(0.207)	(0.194)	
Observations	3,984	170		3,891	165	

Note: SD corresponds to the standard deviation. The t-values are in parentheses; *** p<0.01, ** p <0.05, * p <0.1. Brazil's currency is the Real (R$). Over the study period of this paper, the exchange rate with the dollar fluctuated in an interval between approximately R$ 1.9 and R$ 3.65 US$, with a rough average of R$ 2.69 US$.

Some numbers of Table 1 should be highlighted. First, there are significant differences between the characteristics of the two groups of municipalities (treated, municipality that had received a new FI and not-treated, municipality that had not received a new FI), a natural consequence of the nonrandomness of the treatment. First of all, it is important to emphasize that this is not an accurate portrayal of the Brazilian reality, since many municipalities were removed from the sample, as stated before.

In the pre-treatment period, municipalities that were treated had a larger per capita income, urbanization rate, immigration, unemployment rate, a similar proportion of males, afro-descent population, foreigners and young people, a higher population with more than 25 years of age and higher education among their inhabitants, higher level of economically active population, income inequality and elderly population than non-treated group. This group likewise has more housing with waste collection, electric power and water and bathroom facilities fully completed. Most of non-treated municipalities were in metropolitan area. In the post-treatment period these relations keep the same. Municipalities that were treated had a larger per capita income, similar urbanization rate, higher immigrants, higher unemployment rate, elderly population, similar proportion of men, afro-descent population, foreigners and young people, a higher population with more than 25 years of age and higher education among their inhabitants, higher level of economically active population and a higher level of income inequality. They also had more households with waste collection, electric power and water and bathroom facilities fully completed.

For both post and pre-treatment period, the treated subgroup has the highest rate of people attending and graduates in both high school and college education. They also had higher percentage of people with degrees on Agricultural Sciences, Biological Sciences and Technological Sciences. In addition, they had a higher number of skilled labor and years of study. On the other hand, the non-treated group had a higher rate of short-term immigrants. All other migration dependent variables are greater for the treated municipalities.

As the Table 1 makes clear, in general, Brazil has evolved considerably in many aspects during the decade of 2000. In this way, there is an improvement of people attending higher education, higher proportion of people with college education, as well as, there was an increase in labor-skilled workers and years of study. Not simply that, Brazil became a richer country, older, with more workers in the industry, with lower unemployment and inequality.

5. Results

As argued in the initial section, it is likely that the process of expansion of the FSE in Brazil, by creating new Federal Institutes in some municipalities (treated group) compared to the municipalities that did not receive a new FI (not treated group), affects our set of dependent variables. In this section, we will test this hypothesis. The question will be answered in parts. In subsection 5.1, we will investigate if the expansion of the FSE indeed generates an impact on Human Capital variables, and in subsection 5.2 we check if that expansion affects Migration variables. This section shows benchmark results for equation (1). To facilitate the interpretation of the parameters, all variables are in logarithmic format.

5.1 Human Capital Variables

One of the main targets of the expansion of the FSE is to increase the number of people who attend higher education (BRAZIL, 2008). But, as there is also an addition in the number of vacancies for high school, we also expect that the proportion of people attending high school or college education might be affected by this program. So, the first dependent variable is the ratio of students enrolled in high school, measured by the proportion of people attending high school and within school age (15 to 18 years old). The dependent college education variable is measured by the ratio of people attending higher education and within college age (18 to 25 years old). Table 2 presents the results.

As shown in Table 2, there is no impact on the attendance of high school pupils. In column (1), there are only municipality features, controls, and there was no impact due to the expansion of the Federal System of Education in the proportion of people attending high school (outcome is not statistically significant). When we add state fixed effect, and micro region fixed effect, column (2), the effect of the FSE in the proportion of people attending high school changed the signal, now are positive, but still not statistically significant. That is an indication that the expansion of the FSE did not impact the high school attendance.

Differently from the results we had found before for high school presence, we found a significant and positive effect on the attendance of higher education scholars. The column (3) of Table 2 shown that the impact of the expansion of the Federal System of Education on the proportion of people attending college education is positive and statistically significant at 1% and has an effect of 1.01% on the proportion of people attending college education if we just considered the characteristics of the municipality. When we add the state fixed effect and the

micro regional fixed effects, column (4), there was a decrease in the ATT measured, but it is still positive and statistically significant at 1% and suggests there is an increase in people attending higher education with approximate ATT of 0.89% on the proportion of people attending college education, compared to municipalities that did not have a new Federal Institute. Nevertheless, this effect is small. In 2000 the ratio of students attending higher education was 7.99% and in 2010 was 18.9%, i.e., the proportion of people attending college education more than doubled. And this indicates that a new FI has a very small effect, 0.89%, in this Human Capital variable.

Table 2 – Effects of the Expansion of the FSE: Individuals Attending High School and College

	High School Students	High School Students	College Students	College Students
	(1)	(2)	(3)	(4)
Intercept	-0.1052*	0.2244***	0.3657***	0.3182***
	(0.0542)	(0.0645)	(0.0254)	(0.0294)
Year	0.0609***	0.0548***	0.0321***	0.0331***
	(0.0025)	(0.0033)	(0.0012)	(0.0016)
Federal System	0.0137***	0.0103**	0.0025	-0.0008
	(0.0051)	(0.0045)	(0.0028)	(0.0022)
Federal System * Year	-0.0031	0.0003	0.0101***	0.0089***
	(0.0057)	(0.0054)	(0.0031)	(0.0031)
Municipalities Features	Yes	Yes	Yes	Yes
State Fixed Effects	No	Yes	No	Yes
Micro Region Fixed Effects	No	Yes	No	Yes
Adjusted R^2	0.5821	0.7083	0.7522	0.8276
Observations	8,209	8,209	8,209	8,209

Note: ***p <0.01, ** p <0.05, * p <0.1. We used robust standard errors that were clustered at the municipal level. The t-values are in parentheses. In all estimation there were a relevant set of time-varying controls: Socioeconomics variables of the municipalities: per capita income, Gini coefficient, economically active population, metropolitan area, urbanization rate and manufacturing workers; and Demographics variables: people with age 25 years or more and a higher education, population density, immigrant, unemployment, elderly population, male, afro-descent, foreigner, young population, households with waste collection, electric power and water and bathroom facilities fully completed.

The following step is to focus on the accumulation of the Human Capital[14]. We will verify if there is an impact on the proportion of the people that concluded high school or college education and both variables are the number of graduates at each level of education divide by the population of each municipality and Table 3 displays the results. It follows that

[14] In this section, we also checked the impact of the expansion of the FSE on work-force areas more prone to be affected due to the building of a new FI, Agricultural Sciences, Biological Sciences, Technological Sciences and the sum of them, the qualified work-force. None of them were statistically significant and there was no effect on these areas due to the expansion of the FSE. The results are available upon request.

if a certain percentage of these graduates stay in the region of origin after graduation, its stock of Human Capital would increase (Vidal, 1998 and Beine et al., 2001).

Table 3 – Effects of the Expansion of the FSE: Accumulation of the Human Capital

	Complete High School	Complete High School	Complete College Education	Complete College Education	Years of Study	Years of Study
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.2528***	0.0557	0.4622***	0.3908***	1.7594***	1.8537***
	(0.0651)	(0.0838)	(0.0301)	(0.0346)	(0.0662)	(0.0734)
Year	0.0158***	0.0039	0.0470***	0.0467***	0.0189***	0.0367***
	(0.0031)	(0.0042)	(0.0013)	(0.0019)	(0.0031)	(0.0041)
Federal System	0.0229***	0.0167***	0.0049*	0.0002	0.0125*	0.0100*
	(0.0061)	(0.0054)	(0.0027)	(0.0022)	(0.0064)	(0.0054)
Federal System*Year	-0.0087	-0.0029	0.0135***	0.0119***	-0.0032	0.0015
	(0.0073)	(0.0069)	(0.0033)	(0.0033)	(0.0072)	(0.0067)
Municipalities Features	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	No	Yes	No	Yes	No	Yes
Micro Region Fixed Effects	No	Yes	No	Yes	No	Yes
Adjusted R^2	0.4882	0.6400	0.7884	0.8514	0.6684	0.7974
Observations	0.4866	0.6396	0.7881	0.8509	8,209	8,209

Note: ***p <0.01, ** p <0.05, * p <0.1. We used robust standard errors that were clustered at the municipal level. The t-values are in parentheses. For more information about the time-varying controls, see Table 2.

Table 3 shows there is no impact on the proportion of people with a high school degree. All the outcomes are negative and not statistically significant, what indicates no effect on the ratio of people that completed high school. On the other hand, there is an effect on the proportion of people who are trained in college education. The variable that measures the impact reveals that the municipalities that experienced an implementation of a new FI increased their proportion of people with higher education about 1.35% compared to the ones that did not if we consider only the characteristics of cities, column (3). When we add the state fixed effect and the micro region fixed effect column (4), the result keeps statistically significant at 1% with impact of 1.19%. The outcomes found in Table 3 are consistent with the outcomes found in the previous Table 2. And, again, this effect is very modest. Initially, the proportion of people with higher education was 9.88% and, in 2010, it was 25.1%. And the outcome shows that a new FI has a very small impact, 1.19%, in the proportion of people with college degree. In the last two columns of Table 3 show there was no effect on the years of study due to the implementation of a new Federal Institute.

To sum up, regarding the education variables, only college education students' attendance and people with college degrees were impacted by the expansion of the FSE and they have been statistically significant and they had a slight impact of 0.89% and 1.19%, respectively, for the most complete specification. Nevertheless, these effects are small compared to the evolution of these variables (see Table 1).

5.2 Migration Variables

With the spread of the Federal Education System into the interior of Brazil, it originates a new possibility of education in areas that lacked in vocational training, and this could affect the migration to these municipalities with a new Federal Institutes. For example, the student may decide to migrate to study in search of a better university (Ciriaci, 2014). Thus, the quality of the university will influence his decision on where to live (Ciriaci and Muscio, 2010). To the extent that the decision of individuals about where to study and to work is influenced by the supply (and quality) of local universities, these institutions might potentially contribute to the process of regional Human Capital accumulation (Mixon and Hsing, 1994). Eventually, the possibility of improving the standard of living through migration might stimulate Human Capital accumulation (Ciriaci, 2014).

The possibility of migrating may increase the incentive to acquire education in the source economy fostering local universities' enrolments. As such, if university quality affects students' and graduates' migration choices, investing in it, especially in source regions, may enhance brain circulation (Ciriaci, 2014). Then, we will take the issue of creating a new FI, as magnets attract talent (Brazil, 2015). Thus, the implementation of a new FI could also impact the proportion of short-term immigrant (short-term immigrant divided by total immigrant), that is, people who lived less than five years in that municipality. Table 4 shows the results for the short-term immigrant and qualified short-term immigrant.

As Table 4 makes clear, there was an increase in the proportion of short-term immigrants in municipalities that had new FIs. If we considered only the city features, there was an impact of 2.58% in the proportion of short-term immigrant and it was statistically significant at 1%, column (1). In the adjacent column, we add the fixed effect of state and fixed effect of the micro region, column (2), the result remained statistically significant at 1% and there was an increase in the proportion of short-term immigrant of 2.59%.

Table 4 – Effects of the Expansion of the FSE: Short-term Immigrants and Student Immigrants

	Immigrants	Immigrants	High School Migrant	High School Migrant	College Migrant	College Migrant
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.3373***	-0.3904***	0.0380***	0.0791***	0.0715***	0.0440***
	(0.0523)	(0.0658)	(0.0130)	(0.0152)	(0.0086)	(0.0096)
Year	-0.0570***	-0.0751***	0.0004	-0.0029***	0.0020***	-0.0000
	(0.0021)	(0.0030)	(0.0006)	(0.0008)	(0.0004)	(0.0005)
Federal System	-0.0153***	-0.0221***	0.0045***	0.0026**	0.0004	-0.0011
	(0.0043)	(0.0041)	(0.0010)	(0.0011)	(0.0007)	(0.0007)
Federal System*Year	0.0258***	0.0259***	0.0011	0.0015	0.0085***	0.0080***
	(0.0046)	(0.0047)	(0.0016)	(0.0016)	(0.0013)	(0.0013)
Municipalities Features	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	No	Yes	No	Yes	No	Yes
Micro Region Fixed Effects	No	Yes	No	Yes	No	Yes
Adjusted R^2	0.3466	0.5494	0.0717	0.2636	0.3229	0.4575
Observations	8,209	8,209	8,209	8,209	8,209	8,209

Note: ***p <0.01, ** p <0.05, * p <0.1. We used robust standard errors that were clustered at the municipal level. The t-values are in parentheses. In all estimation there were a relevant set of time-varying controls: Socioeconomics variables of the municipalities: per capita income, Gini coefficient, economically active population, metropolitan area, urbanization rate and manufacturing workers; and Demographics variables: people with age 25 years or more and a higher education, population density, immigrant, unemployment, elderly population, male, afro-descent, foreigner, young population, households with waste collection, electric power and water and bathroom facilities fully completed.

The following step is to understand if there was any change in the short-term immigrant student profile. For this, we will analyze the effect specifically for high school migrant student and college immigrant student – the first is the proportion of short-term immigrant of high school, measured by the proportion between the people that are within school age, 15 to 18 years old, attending high school and are also short-term immigrant and the second variable corresponds to the proportion of short-term migrant of college education and it is measured by the proportion between the people attending college education, and is also short-term immigrant by the people within college age, 18 to 25 years old, and is also short-term immigrant. The Table 4, columns (3) through (6), displays the results.

The column (3) and (4) of Table 4 indicates that is no effect on short-term migration of high school students, even when we take in consideration the fixed effect of state and micro-region. On the other hand, the expansion of the Federal System of Education impacted by 0.85% the proportion of college migrant student, columns (5) and (6), and presents a positive and statistically significant at 1%, when we consider merely the characteristics of municipalities. With the addition of the state fixed effect and the fixed effects of micro region, the results remained statistically significant at 1% with an impact of 0.8%. These results

indicate that the municipalities with a new Federal Institutions presented an increase of 0.8% of the proportion of college education scholars that are also short-term immigrant compared to municipalities that were not part of the expansion of the FSE. In social and economic terms, this represents a small change in the profile of immigrants from municipalities with new FIs. Now, in municipalities where the expansion of the Federal System of Education happened has a greater ratio of immigrants living less than five years in these municipalities.

Our initial results indicate that the cities that had a new Federal Institute had more short-term immigrants and have received more short-term immigrants who are also enrolled in the college education. The short-term immigrants of high school were not impacted by the expansion of the FSE. Actually, the proportion of short-term immigrant decreases for all municipalities in the country, in the treated municipalities there was a reduction of 33% to 26.4%, so, for municipalities with new Federal Institutes this ratio fell less than for municipalities without a new FI. And this strengthens the role of FIs as an attractor of short-term immigration. On the other hand, the proportion of the short-term immigrants of college education increased from 1.22% to 2.99% and the outcome of 0.8% found in Table 6 explains just a little part of this growth.

It is important to highlight that there were in the same period of the extension of the FSE other government policies associated with schooling expansion in Brazil (FIES and Expansion of the Federal Universities, for example). In addition, as we had presented in Table 1, there were important difference between the group of municipalities that received a new FI and those that had not. Although we control of a great variety of time-varying city´s characteristics, these differences can potentially be associated with non-observables factors.

6. Falsification and Robustness Checks

In this section, we present a set of robustness checks together with a falsification test, in order to verify the validity of the obtained results. From here, we will follow only with the variables that were statistically significant in section five[15], i.e., high school students, complete college education, short-term immigrant, and short-term immigrant of college

[15] All of the other variables were statistically significant in the falsification check. In the robustness checks, just technological sciences graduation and qualified work force were statistically significant more than 5% in two tests – FI covered all the MCA and when we eliminated all Federal Universities from the sample – but the outcomes were very small, less than 0.006. All other estimates for the dependent variables were not statistically significant. Results are available upon request.

education. To facilitate the interpretation, all estimation on this section shows results for equation (1) with municipality features and state and micro region fixed effect.

The first test of this section is to investigate the existence of divergences in the temporal trend of pre-treatment of our dependent variables that are subject to the expansion of the Federal System of Education. In this practice, we will falsely assume that the expansion happened a decade earlier, in the 1990s. Thus, we will execute a falsification test. For this, we will use the 1991 and 2000 census data. Therefore, all municipalities treated in 2010 were considered treated on 2000 and will use the DiD strategy with two periods (1991 and 2000) to obtain the estimation with the same database we used before (removing all municipalities that had a new Federal University after 2000 and the municipalities that had FI prior the expansion in the 2000s). The estimates for these coefficients are shown in Table 5.

Table 5 – Falsification Check of the Expansion of the FSE: The Common Trend Assumption

	College Students	Complete College Education	Immigrant	College Migrant
	(1)	(2)	(3)	(4)
Intercept	0.1947***	0.2274***	-0.0013	0.0262***
	(0.0203)	(0.0234)	(0.0012)	(0.0062)
Year	0.0164***	0.0195***	-0.0005***	0.0015***
	(0.0011)	(0.0012)	(0.0001)	(0.0003)
Federal System	-0.0031**	-0.0043***	-0.0001	-0.0007
	(0.0013)	(0.0014)	(0.0001)	(0.0005)
Federal System*Year	0.0079***	0.0123***	0.0000	0.0020
	(0.0025)	(0.0025)	(0.0001)	(0.0021)
Municipalities Features	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Micro Region Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.7538	0.7676	0.4292	0.3759
Observations	8,295	8,295	8,295	8,293

Note: ***p <0.01, ** p <0.05, * p <0.1. We used robust standard errors that were clustered at the municipal level. The t-values are in parentheses. For more information about the time-varying controls, see Table 2 and Table 4.

The results suggest that the effect of the false expansion of the Federal Education System are not statistically significant for only two dependent variables: the short-term immigrants and the short-term immigrant of higher education. In summary, the results indicate that there is no difference in the change in those dependent variables between the treated and untreated period (Angrist and Pischke, 2008). So, this is a strong evidence to discard different trends before the expansion of the Federal System of Education for these two

variables. And it is important, because a common trend is necessary in the trajectory of the outcome variable for both the untreated and treated municipalities (Angrist and Pischke, 2008) to confirm the causal effect of the expansion of the FSE.

Notwithstanding, for the higher education and people who complete higher education were impacted by the falsification treatment which indicates that the results we had found before possibly do not come from the implementation of a new Federal Institute. As we stated before, jointly with the creation of FIs there was an increase in the number of higher education places by other government programs (e.g. REUNI, SISU, FIES, PROUNI and UAB) and by the private sector. And it is probably why these variables failed on the falsification test.

In the previous section, our benchmark outcomes, we eliminate all the municipalities which the FI were created before 2000, as well as all the municipalities that received a new Federal Universities, via REUNI. And the goal of it was to eliminate the possible consequence that these programs can impact on our dependent variables. Thus, in this section we present a set of evidence associated with robustness tests that focus on the different control groups of the municipalities. With this concern, we proceeded with five robustness tests. In the first test, due to several secessions had occurred in Brazil (Lima and Silveira-Neto, 2015), we will consider only municipalities that all cities have a new FI, in other words, the MCA had 100% of its territory covered by a new FI. The goal at this point is to verify if there is any variation in the results when we consider that municipalities are fully met by the FSE.

In the second test, we will eliminate all Federal Universities from the database, because this existence can indicate that non-observables variables could also be associated with the results. The third test will be reinclude all municipalities that were dropped from the sample before, municipalities that had a new Federal after the 2000s and Federal Institutes before the 2000s, because the non-inclusion of these municipalities might generate a sample selection bias. The fourth test we will consider the effect of a Federal University in the micro region in ours results, and this is important, because a Federal University in the micro region could impact the decision of where to study and also the possibility of migration. Finally, the last robustness test we will use a Propensity Score Matching approach with DiD strategy to verify if the outcomes are robustness for municipalities with closer characteristics.

As we stated before, Brazil had several secessions of municipalities since 1991 (Lima and Silveira-Neto, 2015 and Reis et al., 2008). Thus, the observation units usually used in the country are the Minimum Comparable Areas (MCAs), because these areas have constant borders over time. In this way, it is possible to consider treating some MCA, consisting of more than one municipality, which only one of these cities had met a new Federal Institute, while the other cities in this MCA has not received a new FI. Therefore, we will now take only those MCAs that all their cities received a new FI. The others one – 71 municipalities – that were partially covered by a FI were eliminated from the sample. And this is important, because it controls for non-observable variables that could affected the expansion of the Federal System of Education. The results are shown in table 6.

Table 6 – Robustness Check of the Expansion of the FSE: All municipalities in the MCA covered by a Federal Institute

	College Students	Complete College Education	Immigrant	College Migrant
	(1)	(2)	(3)	(4)
Intercept	0.2683***	0.3263***	-0.2708***	0.0411***
	(0.0303)	(0.0357)	(0.0680)	(0.0099)
Year	0.0333***	0.0469***	-0.0750***	0.0001
	(0.0016)	(0.0019)	(0.0031)	(0.0005)
Federal System	0.0001	0.0014	-0.0222***	-0.0011
	(0.0022)	(0.0022)	(0.0042)	(0.0007)
Federal System*Year	0.0093**	0.0088**	0.0207***	0.0078***
	(0.0039)	(0.0044)	(0.0056)	(0.0017)
Municipalities Features	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Micro Region Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.8251	0.8487	0.5491	0.4442
Observations	8,138	8,138	8,138	8,138

Note: ***p <0.01, ** p <0.05, * p <0.1. We used robust standard errors that were clustered at the municipal level. The t-values are in parentheses. For more information about the time-varying controls, see Table 2 and Table 4.

Now, we only consider municipalities that were 100% covered by a FI and the results are, in general, quite similar that we have found on our benchmark estimation. Thus, there was an impact in the proportion of college school students of 0.93% and it was statistically significant at 5%. The proportion of people who complete college education also was affected by the expansion of Federal System of Education with an impact of 0.88% and it was statistically significant at 5%. The creation of a new FI also impacted the proportion of short-

term immigration by 2.07% and it was statistically significant at 1%. Finally, the short-Term immigration of college education was impacted by the expansion of the FSE and the effect was 0.75% and it was statistically significant at 1%. That is, even we consider the possibility of a MCA is whole covered by a FI; all outcomes were statistically significant and robust for these different specifications of the sample.

Even without considering the possibility of a MCA 100% covered by a Federal Institute, we need to check for the possibility of a Federal University's influence on the dynamics of our dependent variables. So, it is possible that there is a Federal University in the micro region of the municipality that enhances the Human Capital of nearby towns, as well as having an effect on migration in this region. So we introduce a dummy to try to capture this effect, that has value one when there is a federal university in the micro region and zero otherwise. The result is shown in Table 7.

Table 7 – Robustness Check of the Expansion of the FSE: Federal University in the Micro Region

	College Students	Complete College Education	Immigrant	College Migrant
	(1)	(2)	(3)	(4)
Intercept	0.3167***	0.3890***	-0.3905***	0.0432***
	(0.0293)	(0.0344)	(0.0658)	(0.0095)
Year	0.0335***	0.0472***	-0.0751***	0.0002
	(0.0016)	(0.0019)	(0.0031)	(0.0005)
Federal System	-0.0020	-0.0012	-0.0222***	-0.0017**
	(0.0022)	(0.0023)	(0.0042)	(0.0007)
Federal System*Year	0.0090***	0.0121***	0.0259***	0.0081***
	(0.0031)	(0.0033)	(0.0047)	(0.0013)
Municipalities Features	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Micro Region Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.8279	0.8517	0.5494	0.4601
Observations	8,209	8,209	8,209	8,209

Note: ***p <0.01, ** p <0.05, * p <0.1. We used robust standard errors that were clustered at the municipal level. The t-values are in parentheses. For more information about the time-varying controls, see Table 2 and Table 4.

The results remain closer to our benchmark estimation, even when we take into account the possibility of a Federal University in the micro region of the municipality. Thus, the expansion of the FSE impacted in 0.90% the enrollment students in college education and it was statistically significant at 1% and also affected the proportion of people with college education by 1.12% and it remained statistically significant at 5%. The building of a new FI

also impacted the proportion of Short-term immigrant by 2.59% and the short-term immigrant of higher education by 0.81% and all of these outcomes were statistically significantly at 1%.

In concurrence with the expansion of the Federal Education System, there was an expansion of the Federal Universities (BRAZIL, 2015). As stated in section 3, we had dropped the new Federal Universities from the sample. However, in that respect, there are other Federal Universities that were prior to this expansion and these were kept in the sample and this might affect the outcome found in the previous estimation. Now, we will remove all 130 municipalities that had Federal Universities before the 2000s in our practice. The goal is to wipe out any overall effect on our dependent variables that can also be affected by the universities that previously existed. The results are shown in table 8.

Table 8 – Robustness Check of the Expansion of the FSE: Without all Federal Universities

	College Students	Complete College Education	Immigrant	College Migrant
	(1)	(2)	(3)	(4)
Intercept	0.2924***	0.3602***	-0.3009***	0.0387***
	(0.0303)	(0.0355)	(0.0681)	(0.0098)
Year	0.0330***	0.0467***	-0.0757***	0.0004
	(0.0016)	(0.0019)	(0.0031)	(0.0005)
Federal System	-0.0007	0.0010	-0.0232***	-0.0010
	(0.0024)	(0.0024)	(0.0045)	(0.0007)
Federal System*Year	0.0069**	0.0092***	0.0266***	0.0063***
	(0.0033)	(0.0035)	(0.0052)	(0.0013)
Municipalities Features	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Micro Region Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.8246	0.8487	0.5481	0.4424
Observations	8,079	8,079	8,079	8,079

Note: ***p <0.01, ** p <0.05, * p <0.1. We used robust standard errors that were clustered at the municipal level. The t-values are in parentheses. For more information about the time-varying controls, see Table 2 and Table 4.

All the results were positive, statistically significant and they also were closer to the outcomes in the Results Section, according to the numbers of Table 8. The expansion of the FSE impacted in 0.69% the enrollment of students in the college education and it was statistically significant at 5%, but the outcome was smaller than the benchmark estimation. The expansion also affected the proportion of people with college education by 0.69% and it remained statistically significant at 5%, and, one more time, the outcome was smaller than we found previously. The building of a new FI also impacted the proportion of Short-term

immigrant by 2.66%, and it is slightly bigger than the results we found in the section four and it was statistically significantly at 1%. And the short-term immigrant of higher education was impacted by 0.63% due to a building of a new FI and it was statistically significantly at 1%.

In the next robustness check, we will consider the whole sample; we reinclude municipalities that had FI previous to the 2000s and the municipalities that had a building of a new Federal University after the year of 2000. Thus, we will use the whole database, keeping all municipalities. The results are depicts in table 9. Again, we want to identify the sensitivity of the outcomes to different combinations of the sample, because it is possible that municipalities with previous Federal Universities and Federal Institutes show more similar non-observable characteristics with the municipalities that had a new FI. All results were slightly smaller, but very similar to those found in the benchmark result, when all dependent variables were statistically significant.

Table 9 – Robustness Check of the Expansion of the FSE: Whole Sample

	College Students	Complete College Education	Immigrant	College Migrant
	(1)	(2)	(3)	(4)
Intercept	0.3056***	0.3743***	-0.3095***	0.0408***
	(0.0310)	(0.0365)	(0.0680)	(0.0109)
Year	0.0333***	0.0473***	-0.0725***	-0.0009*
	(0.0015)	(0.0018)	(0.0029)	(0.0005)
Federal System	-0.0016	-0.0003	-0.0201***	-0.0023***
	(0.0022)	(0.0022)	(0.0041)	(0.0007)
Federal System*Year	0.0076**	0.0103***	0.0254***	0.0067***
	(0.0030)	(0.0033)	(0.0047)	(0.0013)
Municipalities Features	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Micro Region Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.8246	0.8487	0.5481	0.4424
Observations	8,550	8,550	8,550	8,550

Note: ***p <0.01, ** p <0.05, * p <0.1. We used robust standard errors that were clustered at the municipal level. The t-values are in parentheses. For more information about the time-varying controls, see Table 2 and Table 5.

Finally, trying to improve the balance between the treated and untreated units, we will use a matching strategy for the municipalities before the estimation of equation (1), which is implemented through the method of the three nearest neighbors[16]. Smith (1997) suggested using more than one nearest neighbor, because this form of matching involves a trade-off

[16] We also implemented through the method of Kernel estimation and the outcomes were closer of our baseline estimation. The results are available upon request.

between variance and bias; it trades reduced variance, resulting from using more information to construct the counter-factual for each participant, with increased bias that results from on average poorer matches (Smith, 1997). Hence, we use a logistic regression model, considering only the pretreatment period and obtain the propensity scores of the municipalities (defined as the probability of being treated, conditional to the control variables[17]). Then, for each treated municipality, the method chooses the control municipality with the closest propensity score, generating a new sample where the control municipalities are three times bigger than the treated municipalities. As discussed by Ho et al. (2006), when done properly, the matching before the estimation can reduce model dependence and variance, lower mean square error, and also generate less potential for bias. Results are shown in table 10.

Table 10 – Robustness Check of the Expansion of the FSE: The Propensity Score Matching (Three Neighbors)

	College Students	Complete College Education	Immigrant	College Migrant
	(1)	(2)	(3)	(4)
Intercept	0.3137**	0.3854***	-0.6185**	0.0956**
	(0.1252)	(0.1413)	(0.2600)	(0.0419)
Year	0.0410***	0.0536***	-0.0729***	0.0019
	(0.0056)	(0.0064)	(0.0108)	(0.0024)
Federal System	-0.0029	-0.0015	-0.0120	-0.0014
	(0.0039)	(0.0041)	(0.0079)	(0.0014)
Federal System*Year	0.0055	0.0071	0.0228***	0.0042**
	(0.0043)	(0.0048)	(0.0078)	(0.0018)
Municipalities Features	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Micro Region Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.9184	0.9413	0.7072	0.7423
Observations	966	966	966	966

Note: ***p <0.01, ** p <0.05, * p <0.1. We used robust standard errors that were clustered at the municipal level. The t-values are in parentheses. For more information about the time-varying controls, see Table 2 and Table 5.

When comparing municipalities with closer characteristics, via the propensity score matching strategy with three nearest neighbors combined with the DiD estimation, just two of the four dependent variables were statistically significant. That is, the effect for the students in

[17] The control variables are: per capita income, the Gini coefficient, the proportion of people with age 25 years or more and a higher education; the population density, the immigrant proportion, the unemployment rate, the urbanization rate, the rate of elderly population, industry workers, male, afro-descent, foreigner, economically active population, the metropolitan area, young people, and the proportion of households with waste collection, electric power and water and bathroom facilities fully completed.

college education and the people with college education were not statistically significant. The column (3), the impact of a new FI in the short-term immigrants is statistically significant at 1% with effect of 2.28%, smaller than the baseline estimation. The last column shows that there was an impact in the short-term migrant students of college education of 0.42%, also smaller than the baseline estimation, due to the expansion of a FSE and it was 5% statistically significant, compared with municipalities that not had a new FI.

According to the results of the robustness and falsification tests, thus, only the short-term immigrants and the short-term migrant of college education were robust to different compositions of the sample and had not failed on the falsification check, indicating that only those two variables were impacted by the expansion of the FSE. The other two variables that were also statistically significant in the result section – College Students and Complete College Education – failed in both robustness and falsification tests.

7. Discussion and Final Remarks

The higher education is seen nowadays as playing an increasingly crucial role in a country's economic well-being and development, because only higher level education and skills are perceived as being sufficient to allow countries to compete in these globalized knowledge sectors (Faggian and Mccann, 2009). In this way, the expansion of the FSE, between 2000 and 2010, created more than 214 new Federal Institutes. The goal of the FI is to promote the training of qualified professionals, promoting regional development, as well as to stimulate the permanence and attracted qualified professionals in the interior of Brazil (BRAZIL, 2015). It also seeks to expand, extend to the country side the FSE, democratizing and expanding access to jobs in vocational and technological education; as well as to reduce social and regional inequalities in Brazil (BRAZIL, 2008).

This present study investigated whether some of the government's proposals were accomplished and, specially, the impact of the creation of a Federal Institute on a set of Migration and Human Capital variables. From the set of evidence we have presented, it is possible to conclude that the objective of the expansion of Federal Institutes to the interior of Brazil was achieved. Nowadays, all Brazilian micro regions present a FI. In Addition, we found some contribution of the FSE on the migration of people, but not on the local Human Capital.

Specially, when a new Federal Institute was built in some municipality that did not have a FI before, there was an impact of 2.59% on the proportion of short-term immigrant in these municipalities. Thus, this effect was not large, because the proportion of short-term immigrants decreases in the treated municipalities from 33%, in 2000, to 26.4%, in 2010. This means for municipalities with new Federal Institutes this ratio fell less than for municipalities without a new FI, indicating that the expansion of the FSE only avoid greater falls on this ratio.

In addition, we also found that the expansion of the FSE was enhancing by 0.8% the proportion of the college short-term migrant student. Part of this small impact can be explained by the difficulty of the student to continue in the new city, due to the high costs of migration. Some other possible explanation for this, it is the mismatch between the offering of the FIs courses and the local needs. Not just that, the presence of a new university must take some time to impact the local Human Capital variables (Lucas, 1988). Hence, this expansion is recent, it had initiated in 2003, it is expected that the process of extension of the FSE did not affect immediately the Human Capital variables in Brazil.

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