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LOCAL LEADERS AND THE ENVIRONMENT: LITTLE RESILIENCE AND
INFLUENCE TO PRODUCE A SUSTAINABLE ENVIRONMENT

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Dissertation presented to Fundação Getúlio Vargas,
in partial fulfillment of the requirements for obtaining
a master's degree in Business Administration.

Research Line: Business Strategy

Advisor: Prof. PhD. Paulo Roberto Arvate

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ABSTRACT

The Legal Amazon region (LAR) consists on a complex area where multiple actors coexist with conflicting interests. Indigenous population, agribusiness entrepreneurs and small producers are examples of individuals with different behaviors concerning the economic development and deforestation of the area. In this sense, research has been conducted in order to evaluate the impacts of agricultural development and the rise of deforestation levels, the influence of economic incentives on economic development and deforestation and the impact of institutional incentives on deforestation reduction. However, the role of local leadership on these matters has not been analyzed so far. An efficient local leader would be the one who is resilient (e.g. promote both economic development and deforestation reduction on his municipality). Therefore, in our study we test if local leaders are resilient in the Legal Amazon environment, whether or not they make use of economic and/or institutional incentive to promote economic development and deforestation reduction and whether or not sustainable top leaders (e.g. state governors) influence the actions of local leaders (e.g. mayors). For this, we use a Regression Discontinuity methodology and a quasi-randomized experiment (elections with a margin of victory close to zero). Our sample comes from multiple databases and includes over 18000 observations from 755 LAR distinct municipalities for the period between 1996 and 2016. Amongst our results, we identify that local farmer leaders promote economic development but do not produce significant changes on deforestation levels. We also identify that economic incentives are used by these local leaders, but institutional incentives are not. Finally, we identify that top level leaders do not influence local leaders on their actions on behalf of being resilient.

Key-words: Local leadership, Legal Amazon, Rainforest deforestation.

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1 INTRODUCTION

The Amazon rainforest covers an area equivalent to 40% of South America, in eight different countries. The area contains over 1.4 billion acres of forests, corresponding to half of planet's remaining tropical forests¹, and plays an important role in mitigating global warming effects (FEARNSIDE et al., 2009). Amazon's population exceeds 25 million people only in Brazil, including over 200 thousand indigenous distributed between more than 70 groups². The region is also known for its livestock production, which is mainly developed in an extensive way and represents over 40% of Brazil's total production³ and for its agricultural production, being soy the most popular product (STABILE, et al., 2020).

The characteristics previously described make the Amazon region one of the most complexes environments on Earth. Amongst the region's stakeholders it is easy to identify categories such as agribusiness developers, focused on higher returns on their investments but also have recently become more concerned about environmental impacts of their activities due to market restrictions applied to companies who are not willing to comply to non-deforestation agreements, indigenous groups aiming to preserve their cultural identities and maintain their reserves intact, and small producers and workers focused for better living conditions and minimal impact on deforestation when compared to agribusiness developers with large properties.

The emergence of conflicts due to stakeholders' opposite interests has been reported by different means, from media outlets to academic researchers. One of the most common debates occur between indigenous and the other stakeholders. Indigenous held the other stakeholders responsible for the expansion of land use through deforestation and argue that the livestock production is not as sustainable as it should be due to the availability of land made possible through illegal activities such as land grabbing^{3 4 5 6 7}. Greenpeace

¹ <https://www.worldwildlife.org/places/amazon>

² <https://www2.camara.leg.br/atividade-legislativa/comissoes/comissoes-permanentes/cindra/amazonia-legal/mais-informacoes-sobre-a-amazonia-legal>

³ <https://imazon.org.br/imprensa/imagemdodia-quem-mais-desmata-a-amazonia/>

⁴ <http://imazon.org.br/a-pecuaria-e-o-desmatamento-na-amazonia-na-era-das-mudancas-climaticas/>

⁵ <https://climainfo.org.br/2019/12/10/estudo-liga-incendios-a-criacao-de-gado-na-amazonia/>

⁶ <https://www.dw.com/pt-br/o-papel-de-gado-e-soja-no-ciclo-de-desmatamento/a-52151786>

⁷ https://www.wwf.org.br/natureza_brasileira/areas_prioritarias/amazonia1/ameacas_riscos_amazonia/desmatamento_na_amazonia/agropecuaria_na_amazonia/

has produced a series of reports with the same perspective^{8 9}. On the academic side, researches have been conducted and pointed to similar conclusions concerning the growth on livestock and agricultural productions and deforestation (BARRETO et al., 2008; RIVERO et al., 2009). Other studies addressed the conflict existent due to the expansion of production limits through legal reserves and protected areas (KAUANO et al., 2020; KRÖGER, 2020; PAIVA et al., 2020; YANAI et al., 2020) and few studied the relation between credit policies and deforestation rates (ASSUNÇÃO et al., 2013, 2020).

On the other hand, studies have questioned whether the implementation of policy measures have influenced the way cattle ranchers and soy producers expanded their activities and also if the increased agricultural production can happen despite the rise on deforestation (MACEDO et al., 2012) and some propositions on manners that could lead to a reduction on deforestation while increasing the agricultural production have been made (BRANDÃO et al., 2020; STABILE et al., 2020).

So far, studies (BÖRNER et al., 2014; P. M. FEARNSIDE, 1993; GIBBS et al., 2016; JUSYS, 2016; NEPSTAD et al., 2014; VERBURG et al., 2014) have focused on two different sides, the cattle ranchers and agricultural producers, usually declared as the villains of the forest, and the Federal Government as the body responsible for developing effective policies to avoid deforestation via federal legislations (including Forest Code, Decrees and Laws).

Our proposal is to use an exploratory analysis in order to verify if the local leadership which emerges between the existent stakeholders produce a sustainable environment. We do so by evaluating the impact of the election of local leaders (mayors) with different professional backgrounds on the economic development, which is identified by the creation of new businesses, and on the environmental conservation. Additionally, we investigate whether or not local leaders create economic incentives that are used to generate economic development. We also investigate a set of extrinsic incentives related to municipalities' legislations, in order to verify if institutional incentives are used to preserve the forest by these leaders. Finally, we expand our investigation from the local

⁸ <https://www.greenpeace.org/usa/wp-content/uploads/legacy/Global/usa/planet3/PDFs/slaughtering-the-amazon-part-1.pdf>

⁹ <https://www.greenpeace.org/usa/wp-content/uploads/legacy/Global/usa/report/2010/2/eating-up-the-amazon.pdf>

level to higher hierarchical government levels. We evaluate the development of new environmental policies as a consequence of the interaction of actors in different levels, in our study more specifically state governors and mayors. We investigate whether a sustainable top leader (individual who promote the development of new companies without promoting higher deforestation levels when comparing to other governors) influence the low-leaders on their region.

Our results show that agribusiness developers generate more new firms on the Legal Amazon but do not produce any effect on deforestation. Therefore, they produce an unsustainable environment. We show that these leaders use local economic incentives to generate these results (agricultural expenditure) without using any legal instrument (set of municipal law to preserve to environmental in Brazil). We also observe that local leaders are very little resilient or influenced by superior leaders because these leaders do not produce a different result when the state which the municipality is the governor produce better results in terms of sustainable development (a state with both: new business above the median of other states and deforestation below the median of other states).

The last result exposes an important question on political terms: the question of sustainability must start at the local level. Several times the discussion on media on the question is on a superior level.

Our results contribute to the leadership literature on several points: Firstly, we test the influence of the professional background of local leaders (e.g. agribusiness) on promoting the creation of new companies via economic incentives and on the control of local deforestation via legal instruments. Secondly, we show that local leaders (mayors) have not been influenced by regional leaders (state governors) when governors achieve better levels of sustainable development, although the complexity of the Amazon region requires coordinated efforts of local and regional leaders. This last result contradicts the expectation of benefits that would be expected when top level leaders influence positively lower level leaders.

Our results are robust because we observe the causal effect of local leaders on our main variables using the regression discontinuity methodology where the local leader is chosen

through a quasi-electoral experiment (ARVATE, P. R. & STORY, 2020; LEE et al., 2004).

This methodology also permits verifying if other local observable stakeholders produce results on the environment. We test this possibility and we do not observe any significant result.

In addition to the introduction, our article has the following sections: Institutional Background, Data Description, Methods, Results, Discussion, Implications of policies, Main Results, References and Online Supplementary Material.

2 INSTITUTIONAL BACKGROUND

2.1 Legal Amazon

Currently, the Legal Amazon region covers the states of Acre, Pará, Amazonas, Roraima, Rondônia, Amapá and Mato Grosso, as well as municipalities in the states of Tocantins and Goiás located north from the 13° south parallel and municipalities in the state of Maranhão located west from meridian 44° west. The current definition is found in the Federal Law 12651/12, approved on May 25, 2012. To understand the relevance of the region, its area corresponds to approximately 60% of Brazil's territory¹⁰.

In order to protect such particular biome, multiple legislations have been created. The first action taken during Brazil's republican period was proposed shortly after the Constitution of 1934 via Federal Decree 23793/34 (BRASIL, 1934). President Getúlio Vargas, at that time, enacted a series of rules for forest exploration according to different areas classifications. Private properties could have up to 75% of their areas deforested given they did not locate in specific places, such as riverside areas. The Federal Decree 23793/34 is known as the first Brazilian Forest Code and although it gave states and municipalities authorities the power to inspect and even punish transgressors, its efficacy has been questioned (RAJÃO et al., 2018).

After few decades, the Legal Amazon region was brought to attention again due to the creation of the Superintendence of the Amazon Economic Valorization Plan (*Superintendência do Plano de Valorização Econômica da Amazônia – SPVEA*), through Federal Law 1806/53 (BRASIL, 1953). This plan allocated 3% of Brazil's taxes revenues to the region and was created in order to promote the occupancy and the development of economic activities. Amongst other reasons, this initiative was motivated by the crisis in the rubber market due to the competition from Asiatic products and the development of synthetic rubber, and also by territorial concerns. Thus, one of the main goals of SPVEA was to identify other economic possibilities for the region, including timber production (RAJÃO, et al., 2018).

¹⁰ <https://www.ibge.gov.br/geociencias/cartas-e-mapas/mapas-regionais/15819-amazonia-legal.html?=&t=o-que-e>

In the middle 1960's, the beginning of Brazilian's military regime, the region had both military and economic conceptions of control, as defined by Rajão and Hayes (2009). The new Forest Code, Federal Law 4771/65 (BRASIL, 1965), defined rules for Areas of Permanent Preservation and created the Legal Reserve areas. These areas were established as 50% of properties located in the Legal Amazon region and could not have their native vegetation removed. Again, by allowing the exploration of half of the properties' areas, the government tried to stimulate the occupancy of the region and to control the deforestation (RAJÃO, et al., 2018).

From the end of 1980's up to the end of 1990's there was a rise of ecological concerns and the Forest Code was supplemented by a series of presidential decrees that imposed a bigger (80% of the property) Legal Reserve for properties located in Legal Amazon (SOARES-FILHO et al., 2014). The conception of control shifted for an Ecological one (RAJÃO & HAYES, 2009). Despite these efforts, deforestation increased in the early 2000's, fact that brought criticism to the Forest Code existent and its efficacy. However, after few years the deforestation rates fell again and using this momentum the agribusiness sector was able to lobby its way to approve a new Forest Code, what happened in 2012 with the Federal Law 12651/12 (BRASIL, 2012).

The current Forest Code, approved in 2012, reduced the requirements concerning the Permanent Preservation Areas and created a new market in which areas where the exploration is not feasible may be sold in order to compensate Legal Reserve Debts, as long as both áreas belong to the same biome (MINISTÉRIO PÚBLICO DO ESTADO DE GOIÁS, 2012). On the other hand, new regulations concerning the duty of registering rural properties were expected at the time to lead to the reduction of deforestation levels.

Taken into account the context presented, we gathered data from 760 municipalities from Legal Amazon, which corresponded to the totality of municipalities in the region. Deforestation levels were analyzed from 2000 to 2016, due to the data available from the monitoring program.

Figure 1- Brazilian and Legal Amazon Map



Source: Machado and Anderson (2016)

2.2 Municipal Legislation

Although the Forest Code and the Constitution include the definitions and requirements that regulate deforestation, they also bring up the possibility of states and municipalities to monitor the sustainable development of their respective regions. For instance, Resolution 237/1997 from the National Environment Council (*Conselho Nacional do Meio Ambiente* – CONAMA) defines that environmental licensing may be approved by municipalities and states considering the level of environmental impact that the activity proposed may have (CONSELHO NACIONAL DO MEIO AMBIENTE, 1997). The same Resolution (1997) defines the activities that are subject to environmental licensing, amongst which are lumbering, livestock and agricultural production.

Considering the possibility of municipalities being active in monitoring the sustainable development of their areas, we focused on two legal steps that might have been taken in the municipalities from Legal Amazon region. The first measure analyzed was the creation of a municipal legislation concerning the preliminary environmental impact analysis. This analysis consists on the evaluation of the impacts that the development of any activity may cause and may also include recovery plans for the degraded area or even the evaluation of compensation measures that could be taken in order to minimize the environmental damage. The second legal step analyzed was the creation of specific legislation in order to classify the municipalities' areas and identify areas with special environmental interest through the creation of zoning. The so called Ecologic-Economic Zoning was first introduced by the National Environment Policy (BRASIL, 1981) and regulated by the Decree 4297/02 (BRASIL, 2002). Recent efforts have also been made

by the Ministry of the Environment with the goal of providing guidelines for the implementation of the Ecologic-Economic Zoning across municipalities (MINISTÉRIO DO MEIO AMBIENTE, 2018).

Taking into account the two municipal initiatives previously described, this paper analyzes whether municipalities have created so far any of these laws. The year of creation is also analyzed, as we aim to identify if the creation of such law had any relation with the professional background of local leaders that were in power when these laws have been approved. If a law was created during someone's turn or prior to their turn, we created a dummy variable with a value of 1, otherwise the value of the variable was equal to zero.

2.3 Municipal Elections

Brazil's municipal elections rules were established by the Constitution proclaimed in 1988. Constitution's Article 29, from Chapter IV, defines that mayor, vice-mayors and councilors must be elected every four years. The politicians may also be reelected for a second term, according to the same Constitution, and elections must be held as one round elections for municipalities with total number of voters below 200 thousand and through two rounds elections in municipalities with total number of voters above 200 thousand when none of the candidates reach a number of votes superior than 50% of valid votes.

From the 760 municipalities sample containing all municipalities belonging to the Legal Amazon area, only 8 were discarded from our final database due to the occurrence of elections in two rounds because of their number of voters being superior than 200 thousand. The choice to discard these 8 municipalities has been made to avoid misinterpretation of the different strategic choices that voters make when dealing with single or dual-ballot systems. These differences were described by Durverger (1951) and tested by Fujiwara (2011) and indicates that the single-ballot (one round elections) would favors the two party system as voters tend to avoid to "waste" their votes with candidates that are not expected to win the poll. This strategic voting approach would force voters to identify the candidate with whom they share most values, opinions and ideas amongst the two candidates with the higher propensity to be elected. Thus, there is an identifiable polarity between the two most voted candidates, who concentrate the vast majority of the total number of votes in the municipality.

3 DATA DESCRIPTION

Our data comes from ten different sources and replicable. We explicit the label, the description, construction/period and source of each variable used in our exercise on Table 1.

Table 1- Variables: Label, description, construction, and source

Variable	Label	Description of variable	Construction of variable/Period	Source
Running Variable	Margin of victory	Difference in the percentage of votes between farmers and non-farmers candidates for mayor, considering the candidates in first and second places in the one round elections. We use other occupations of mayors. Among them doctors, lawyers, and professors. The occupation is defined pre-candidature.	The margin of victory was calculated using the margin obtained for each candidate (number of votes divided by the total of votes of the municipality).	Superior Electoral Court (TSE) for the municipal elections for mayors. (www.tse.gov.br)
			Period: 2004,2008,2012, and 2016 (years of elections) The electronic data from TSE comes from 1996. However, the standard for defining occupations has become the same only after the 2004 election	
Business Creation	Business creation	Number of firms created in the municipality	We calculated the mean of the number of firms created each year during the four years following each term period (2001/2004,2005/2008,2009/2012). For the election of 2012, the mean was calculated using the years of 2013, 2014 and 2015, due to restrictions of the data obtained.	RAIS – Annual Report of Social Information on workers in firms in the formal sector - produced by the Ministry of Employment and Labor.
	Category 1 firms	Number of firms created in the municipality belonging to the following sectors of activities: agriculture, cattle breeding, forest exploration and fishing.		
	Category 2 firms	Number of firms created in the municipality belonging to the following sectors of activities: coal, oil and minerals extraction.		
	Category 3 firms	Number of firms created in the municipality belonging to the following sectors of activities: manufacturing of products not using inputs from categories 1 and 2 firms	Period: We use information data from 2001 to 2015. The information is provided annually by firms (information centralized in December)	
	Category 4 firms	Number of firms created in the municipality belonging to the following sectors of activities: manufacturing of products using inputs from categories 1 and 2 firms		
	Category 5 firms	Number of firms created in the municipality belonging to the following sectors of activities: services and retail		
Agricultural and Livestock Production	Herd size	Total number of animals created in the municipality (e.g. swine, cattle, chickens and others)	We used the annual sum of number of heads existent in each municipality for each term (2001/2004,2005/2008,2009/2012, 2013/2016)	IBGE - Brazilian Institute of Geography and Statistics – Municipal Livestock Production Report – Table 3939
			Period: We use information data from 2001 to 2016	

Agricultural and Livestock Production	Planted area	Area planted or destined for harvest	We used the annual sum of number of heads existent in each municipality for each term (2001/2004,2005/2008,2009/2012, 2013/2016)		IBGE - Brazilian Institute of Geography and Statistics – Municipal Agricultural Production Report – Table 5457
			Period: We use information data from 2001 to 2016		
Forest Conservation	Deforestation	Accumulated deforestation.	The accumulated deforestation was calculated as the sum of the annual deforestation of the four years following each election. (2001/2004,2005/2008,2009/2012, 2013/2016)		INPE – National Space Research Institute – Amazon deforestation monitoring program (PRODES)
			Period: We use information data from 2001 to 2016		
Mayor Characteristics	Woman Mayor	Mayors who are female	Dummy variable equal to 1 when the mayor is woman and equals to 0 otherwise.	Period: 2004,2008, and 2012 (years of elections)	Superior Electoral Court (TSE) for the municipal elections for mayors (www.tse.gov.br)
	Mayor with Elementary School	Mayor with (in)completed elementary education	Dummy variable equal to 1 when the mayor attended the elementary school and equals to 0 otherwise.		
	Mayor with High School Education	Mayor with (in)completed high school education	Dummy variable equal to 1 when the mayor attended the high school education and equals to 0 otherwise.		
	Mayor with Superior Education	Mayor with (in)completed superior education	Dummy variable equal to 1 when the mayor attended the superior education and equals to 0 otherwise.		
	Single Mayor	Mayor with single marital status	Dummy variable equal to 1 when the mayor is single and equals to 0 otherwise.		
	MDB	Mayor member of MDB party (Brazilian Democratic Movement)	Dummy variable equal to 1 when the mayor is a member of MDB party and equals to 0 otherwise.		
	PSDB	Mayor member of left-wing parties (Brazilian Social Democratic Party)	Dummy variable equal to 1 when the mayor is a member of PSDB party and equals to 0 otherwise.		
	DEM	Mayor member of left-wing parties (Democrats)	Dummy variable equal to 1 when the mayor is a member of DEM party and equals to 0 otherwise.		
	PL	Mayor member of left-wing parties (Liberal Party)	Dummy variable equal to 1 when the mayor is a member of PL party and equals to 0 otherwise.		
	Age	Age of the mayor	Numerical variable measured in years.		

Firms Characteristics	Number of employees	Average number of employees per company	<p>We calculated the average number of employees per company on each municipality for each term.</p> <p>Period: We use information data from 2001 to 2015. The information is provided annually by firms</p>	RAIS – Annual Report of Social Information on workers in firms in the formal sector - produced by the Ministry of Employment and Labor.
	Median remuneration	Median of remuneration in December (in terms of minimum wage)	<p>We calculated the median remuneration on each municipality for each term.</p> <p>Period: We use information data from 2001 to 2015. The information is provided annually by firms</p>	
Municipal Characteristics	Unemployment Benefits	Number of individuals which granted unemployment benefits	Period: We use information data from 2001 to 2016	Ministry of Labor
	Work Card Issued	Number of new work card issued		
	% rural population	Percentage of rural population on the total population of municipality	Period: We use information data from 2001 to 2016	IBGE - Brazilian Institute of Geography and Statistics
	Per capita GDP	GDP per 1000 inhabitants (GDP*1000/population)	Period: We use information data from 2001 to 2016	
Municipal Characteristics	% water	% of household with potable water	Period: We use information data from two censuses: 2000 and 2010. We use the 2000 information for the term 2004/2008 and the 2010 information for the 2009/2012 and 2013/2016	IBGE - Brazilian Institute of Geography and Statistics (CENSUS)
	% sewage	% of household with treated sewage		
	Vaccines	Number of (public) vaccines applied to individuals (eight types)	Period: We use information data from 2001 to 2016	DATASUS (SIM-Sistema de Informações Municipais); Ministry of Health
	Tax property	Total revenue from municipal property tax (nominal value per year)	<p>We calculated the average total revenue on each municipality for each term.</p> <p>Period: We use information data from 2001 to 2016</p>	The Brazilian National Treasury (https://www.gov.br/tesouro-nacional/pt-br/estados-e-municipios)
Agricultural Characteristics	Coffee dependency	% of municipal area occupied with coffee plantation	Period: We use information data from 2001 to 2016	SIDRA (Sistema IBGE - Brazilian Institute of Geography and Statistics – de Recuperação Automática)
	Sugar dependency	% of municipal area occupied with sugar plantation	Period: We use information data from 2001 to 2016	
	Soy dependency	% of municipal area occupied with soy plantation	Period: We use information data from 2001 to 2016	
Municipal Legal Characteristics	Environmental zoning legislation -Law 121	Existence of legislation concerning environmental or ecological-economic zoning	Dummy variable equal to 1 when there is such legislation in the municipality (created prior or during the mayor's term) and equal to 0 otherwise.	IBGE - Brazilian Institute of Geography and Statistics – Search for Basic Municipal Information (MUNIC, 2018)
	Environmental impact analysis legislation – Law 211	Existence of legislation concerning preliminary environmental impact analysis	Dummy variable equal to 1 when there is such legislation in the municipality (created prior or during the mayor's term) and equal to 0 otherwise.	

Municipal Fiscal Characteristics	Agriculture expenditure	Municipal agriculture expenditure Composition of municipal expenditure: administrative (salaries), credit for plant and animal production, health defense, supply, rural extension, irrigation, land reform, and colonization.	We calculated the average total revenue on each municipality for each term. Period: We use information data from 2001 to 2016	The Brazilian National Treasury (https://www.gov.br/tesouro-nacional/pt-br/estados-e-municipios)
	Incentives for enterprise implementation	Incentive mechanisms for enterprise implementation	Dummy variable equal to 1 when the municipality contains incentive for enterprise implementation (year) and equals to 0 otherwise.	
Municipal Fiscal Incentives	Tax property – partial exemption		Dummy variable equal to 1 when the municipality establishes (year) partial tax property and equals to 0 otherwise.	IBGE – Brazilian Institute of Geography and Statistics – Search for Basic Municipal Information (MUNIC) – several years
	Tax property – total exemption		Dummy variable equal to 1 when the municipality establishes (year) total tax property and equals to 0 otherwise.	
Municipal Fiscal Incentives	Service tax - exemption		Dummy variable equal to 1 when the municipality establishes (year) service tax exemption and equals to 0 otherwise.	IBGE – Brazilian Institute of Geography and Statistics – Search for Basic Municipal Information (MUNIC) – several years
	Fees exemption		Dummy variable equal to 1 when the municipality establishes (year) fees exemption and equals to 0 otherwise.	
	Land concession		Dummy variable equal to 1 when the municipality establishes (year) land concession and equals to 0 otherwise.	
	Land donation		Dummy variable equal to 1 when the municipality establishes (year) land donation and equals to 0 otherwise.	
	Other incentives		Dummy variable equal to 1 when the municipality establishes (year) other types of incentives and equals to 0 otherwise.	

3.1 Running Variable

The running variable used in the regression discontinuity design proposed was the margin of victory between local leaders. We do know what previous leader's characteristic does them more or less committed with development and environment. Thus, we solve to explore the previous occupation of political leader as source of difference between leaders.

For example, it is intuitive to imagine that farmer leader into of Legal Amazonia will be more pro-development than other occupations and a public servant will be more pro-environment than other occupations. In fact, each candidate has a previous occupation before the election which can signal a preference. We get to identify different types of occupations (see the procedure on how was defined the most recurring occupations in the supplementary material): farmers, administrators, lawyer, merchant, business owner, physician, politician (mayors and councilors), professors and public servant. To avoid any discretion on choice, we solve to test (using the main methodology explicit below) what leader (through their occupations) produce results on development or/and environmental. We observe that only mayors with the occupation of farmers (vs non-farmers) produce results on economic development variable. We test different occupations with the same methodology (see tables S1.1, S1.2 and S1.3 in the appendix)

and we do not observe robust effects on our dependent variables. Thus, we focus our development between farmers and non-farmers (other occupations).

3.2 Dependent Variables

We use a set of dependent variables to test the Hypothesis 1. Two groups to test the economic development. The first set of dependent variables is related to business creation in general and to business creation according to businesses' sectors of activities. The second set of variables is composed of two variables: herd size and planted area. The first set of variables represents the group of formal firms on region. We opt to test the effects on the second set of variables to avoid that only formal firms were represented: those which are registered and pay fees to achieve a formal status (ULYSSEA, 2018). The informal sector could not be evaluated without this group of variables. Finally, we use the result on deforestation to evaluate the results environment.

To test the hypothesis 2a, we use a set of dependent variables to observe which fiscal instruments (expenditure and incentives) are being used by local leader (mayor) to produce the results of economic development. The municipal agriculture expenditure is an important instrument to capture incentives to the agricultural activity (herd size and planted area) and the municipal instruments of incentive (the existence of incentive for enterprise implementation, partial or total exemption on tax property, exemption on service tax, fees exemption, concession or donation of lands, and other types of incentives).

In different way, we use two types of local legislation which the leader local can implement to help the preserve the forest, our hypothesis 2b: establishing zones of environmental or ecological-economic place (LAW 121) or the mandatory use of preliminary environmental impact analysis before of implementation of any economic project (LAW 211).

3.3 Covariates

The application of the regression discontinuity design (IMBENS AND LEMIEUX, 2008) establishes that the internal validity of experiment depends on other municipal variables are not influencing the electoral result. Thus, we use different covariates to observe if this

influence exists or not. Among them, we have mayor characteristics (gender; schooling: elementary school, high school, and superior education; marital status: single; belong to the most important electoral parties – four parties with the higher number of elected mayors on sample: MDB, PSDB, DEM, and PL; age), municipal firms characteristics (number of employees, median remuneration of employees), municipal characteristics (unemployment benefits, work card issued, % of rural population, per capita GDP, % of households with water and sewage, vaccines applied, and tax property: revenue), agricultural characteristics (% of coffee, sugar, and soy on the total planted area: we use different types of agriculture culture because each one them has a different level of productivity; for example, soy culture present the highest productivity of cultures existents and it is dominant in terms of planted area: average 16% of municipal area).

Table 2 shows the descriptive statistics of variables used in our exercise for the sample as whole (farmers and non-farmers local leaders) and for each one in isolation.

Table 2- Descriptive Statistics

The 2004, 2008, and 2012 elections									
Dependent variables	Farmers and non-farmers			Farmer leader			Non-farmer leader		
	Mean	Std. Dev	Obs	Mean	Std. Dev	Obs	Mean	Std. Dev	Obs
Business creation	5.24	10.07	352	5.49	11.77	170	5.01	8.18	182
Category 1 firms	0.89	1.23	352	0.89	1.21	170	0.90	1.26	182
Category 2 firms	0.004	0.034	352	0.002	0.027	170	0.006	0.040	182
Category 3 firms	0.25	0.67	352	0.26	0.78	170	0.25	0.55	182
Category 4 firms	0.10	0.27	352	0.12	0.33	170	0.08	0.19	182
Category 5 firms	3.98	8.61	352	4.20	10.16	170	3.77	6.88	182
Herd size	227010.5	689470.2	412	210248.2	380425.7	197	242369.5	883136	215
Planted area	22257.05	71716.2	411	19271.37	65274.49	196	24978.88	84176.01	215
Deforestation	45.68	110.52	412	42.12	101.34	197	48.95	118.44	215
Agriculture Expenditure	336910.4	497652	412	309365.3	403682.6	197	362424.3	570106	215
Incentives for enterprise implementation	0.46	0.49	412	0.40	0.49	197	0.51	0.50	215
Tax property – partial exemption	0.13	0.34	412	0.10	0.30	197	0.15	0.36	215
Tax property – partial exemption	0.12	0.32	412	0.09	0.28	197	0.15	0.36	215
Service tax exemption	0.10	0.30	412	0.08	0.28	197	0.11	0.32	215
Fees exemption	0.11	0.31	412	0.10	0.30	197	0.12	0.32	215
Land concession	0.15	0.36	412	0.15	0.36	197	0.15	0.36	215
Land donation	0.24	0.42	412	0.24	0.43	197	0.23	0.42	215
Other incentives	0.06	0.23	412	0.06	0.24	197	0.05	0.23	215
Environment laws – Law 121	0.09	0.29	412	0.08	0.27	197	0.11	0.31	215
Environment laws – Law 211	0.11	0.32	412	0.11	0.31	197	0.12	0.33	215

4 METHODS

Following our objective of identifying whether farmers leaders influence positively the creation of new businesses, environment and which of instruments are used, we use a sharp regression-discontinuity (RD) design, as used by Arvate *et al.* (2018), Arvate and Story (2020), Eggers *et al.* (2015) and Flammer and Basal (2017). The method was initially proposed by Thistlethwaite and Campbell (1960) and after randomized experiments is one of the best alternatives to infer causality when the treatment although not applied randomly is applied following a specific cut-off explicitly determined (ANTONAKIS *et al.*, 2010; COOK *et al.*, 2008). In our scenario, the elections defined a clear winner between farmers and non-farmers leaders, and the narrow margins that established the winner implies that the candidate elected is essentially quasi-randomized (LEE, 2008). This fact, as described by Arvate and Story (2020), avoids any potential selection bias on leader definition.

Using the methodology proposed, we first identify the leaders whose occupations prior to the elections were related to farmers (i.e. self-farmers and cattle breeders). We define as our treatment variable $D_{i,t}$ a dummy variable which is equal to one when a candidate related to farmer defeats a candidate whose profession was not related to farmer in municipality i in year t . The control group, where $D_{i,t}$ equals zero, is composed by municipalities where candidates with professions not related to farmer were elected. We also tested other occupations of sample (mayors with lawyers, professors, councilors, administrators, merchants and others). Different occupations do not produce influence on our dependent variables. Thus, the occupation relevant of a leader for this group of municipalities are farmers or not.

We then defined the variable $Margini,t$ as our running variable (see definition on table). The cut-off point occurs when the $Margini,t$ equals zero, positive margin values indicate that a candidate related to farmer was elected and negative margin values otherwise.

The average effect of the treatment applied, in this case the change in dependent variables after a candidate related to farmer being elected, is measured as proposed by Lee and Lemieux (2010) and following described in Equation 1:

$$\tau = \lim_{\varepsilon \downarrow 0} E\{Y \mid X = c + \varepsilon\} - \lim_{\varepsilon \uparrow 0} E\{Y \mid X = c + \varepsilon\} \quad [1]$$

where τ is the average treatment effect, Y is the outcome variable (i.e. business creation, deforestation, agriculture expenditure, incentives, and environmental legislation) and X corresponds to the running variable (i.e. *Margini*, t). In this case, we continue to use voting margins as our running variable.

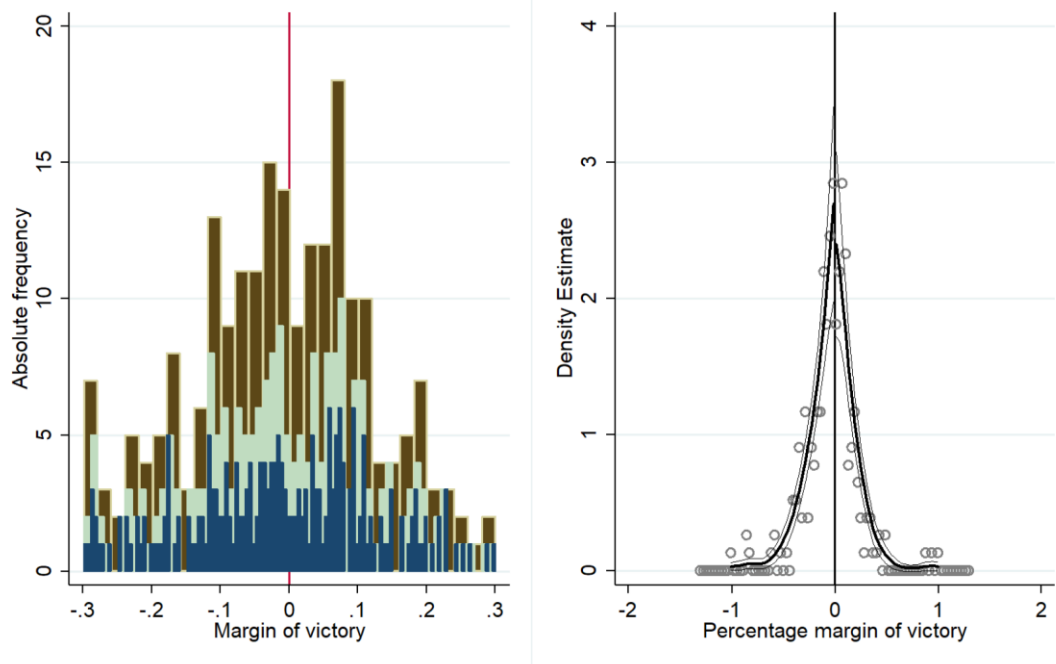
As the quasi-randomized behavior is expected to happen close to the cut-off, we needed to define limits to the margin's bandwidth analyzed. We used a mean square error (MSE) optimal bandwidth, following Calonico et al. (2014, 2020) and a fourth order polynomial as local estimator. As robustness we investigate the treatment effects using lower order polynomials as estimators as well (i.e., second and third polynomial) because Gelman and Imbens (2019) reveal caution against using higher-order polynomials in RD design.

5 RESULTS

5.1 Internal validity of the research design

We validate our quasi-experiment by following the procedures established by Imbens and Lemieux (2008) and Eggers *et al.* (2015). We adopt three procedures. First, we determine whether the electoral process was manipulated. Electoral manipulation for any candidate (i.e., a farmer or a non-framer) invalidates the quasi-experiment. We use a set of histograms with different bins (2%, 1%, and 0.05%) and McCrary's (2008) test to identify electoral manipulation.

Figure 2-Manipulation Tests



T-statistic of McCrary test=-0.13

All elections (2004, 2008 and 2012).

Figure 2 shows our results for three joint elections (2004, 2008, and 2012). We present the same individual result of each one of elections in the online supplementary material (Figure S1, S2, and S3) and they are similar those of joint result. A visual inspection of the histograms on the left side of figures may take the idea that electoral manipulation on cut-off point exists (see the situation when the percentage margin of votes is close to zero). Potential manipulation of the selection mechanism is characterized by a jump in frequency of the running variable (percentage margin of votes) close to the cut-off point. However, based on the procedure proposed by McCrary (2008), right side of each figure, we test the null hypothesis of continuity on density of the running variable (i.e., margin

of votes – right side of each figure) against the hypothesis of an interruption at the cut-off point. Our results indicate that the null hypothesis cannot be rejected for joint elections (see the t-test on the figure’s footnote), indicating no discontinuity around the cut-off point.

We used a second procedure to investigate whether mayor, firms, municipal, agricultural characteristics, and electoral years affected the current electoral result (23 covariates). We also used here the procedure established by Calonico *et al.* (2014). The idea is that there is no “jump” in these variables in elections with a zero margin of votes (i.e., close to the cut-off point). If there is a jump, then the characteristics might explain the current electoral result. For instance, a higher soy dependence when a farmer leader win a close-run election could be a factor that explains their victory.

We needed, therefore, results without a “jump” in these variables. In other words, we needed balanced results for the covariates. Table 3 presents these results. We decided to report the effective number of observations used both to the left and the right of the cutoff.

Table 3 - Baseline characteristics

	<i>Mayor Characteristics</i>	
Woman Mayor	RD Estimate	-0.10 (0.10)
	Effective Observations	363
	Considered bandwidth	0.317
Mayor with Elementary School	RD Estimate	-0.07 (0.20)
	Effective Observations	345
	Considered bandwidth	0.274
Mayor with High School Education	RD Estimate	0.08 (0.21)
	Effective Observations	357
	Considered bandwidth	0.297
Mayor with Superior Education	RD Estimate	0.08 (0.23)
	Effective Observations	362
	Considered bandwidth	0.312
Single Mayor	RD Estimate	-0.17 (0.12)
	Effective Observations	355
	Considered bandwidth	0.293
MDB party	RD Estimate	0.03 (0.12)
	Effective Observations	359
	Considered bandwidth	0.30
PSDB party	RD Estimate	-0.12 (0.08)
	Effective Observations	351
	Considered bandwidth	0.28
DEM party	RD Estimate	0.13 (0.14)
	Effective Observations	354
	Considered bandwidth	0.29
PL party	RD Estimate	0.03 (0.12)
	Effective Observations	359
	Considered bandwidth	0.30
Age	RD Estimate	-3.47 (4.98)
	Effective Observations	362
	Considered bandwidth	0.317
	<i>Firms Characteristics</i>	
Number of employees	RD Estimate	-1.68 (2.58)
	Effective Observations	266
	Considered bandwidth	0.214
Median remuneration	RD Estimate	0.05 (0.21)
	Effective Observations	291
	Considered bandwidth	0.269
	<i>Municipal Characteristics</i>	
Unemployment Benefits	RD Estimate	1.02 (1.44)
	Effective Observations	343
	Considered bandwidth	0.290
Work Card Issued	RD Estimate	0.50 (0.56)
	Effective Observations	337
	Considered bandwidth	0.280

	<i>Municipal Characteristics</i>	
% rural population	RD Estimate	-0.08 (0.08)
	Effective Observations	344
	Considered bandwidth	0.298
Per capita GDP	RD Estimate	2324.5 (5610.5)
	Effective Observations	361
	Considered bandwidth	0.307
% water	RD Estimate	0.29 (0.18)
	Effective Observations	297
	Considered bandwidth	0.273
% sewage	RD Estimate	-0.05 (0.11)
	Effective Observations	311
	Considered bandwidth	0.310
Vaccines	RD Estimate	428.09 (3660.8)
	Effective Observations	368
	Considered bandwidth	0.327
Tax property	RD Estimate	1.8e+10 (2.2E+10)
	Effective Observations	288
	Considered bandwidth	0.231
	<i>Agricultural Characteristics</i>	
Coffee dependency	RD Estimate	-0.06 (0.06)
	Effective Observations	359
	Considered bandwidth	0.302
Sugar dependency	RD Estimate	0.04 (0.03)
	Effective Observations	342
	Considered bandwidth	0.269
Soy dependency	RD Estimate	0.17 (0.16)
	Effective Observations	368
	Considered bandwidth	0.329
	<i>Electoral years</i>	
The 2004 election	RD Estimate	-0.23 (0.24)
	Effective Observations	349
	Considered bandwidth	0.282
The 2008 election	RD Estimate	-0.22 (0.14)
	Effective Observations	336
	Considered bandwidth	0.259
The 2012 election	RD Estimate	0.43* (0.22)
	Effective Observations	347
	Considered bandwidth	0.28

Note: 1) Bias-corrected RD estimates with robust variance estimator using Calonico et al. (2014). Standard errors in parentheses; 2) Municipalities with more than 200,000 electors are excluded to avoid the possibilities of a second round. 3) The bandwidth used in the RD results is generated endogenously (triangular kernel). * Significance at the 10% level, ** at 5% level, and **** at 1% level.

We have ten mayor characteristics statistically well-balanced: gender, elementary school, high school, superior education, marital status (single), the four most important electoral parties (with winner mayors on our sample: MDB, PSDB, DEM, and PL), and age. Two firm's characteristics are also well-balanced (number of employees and median remuneration). Municipal characteristics are also all well-balanced (eight covariates):

number of individuals receiving unemployment benefits, individuals with work card issued, the percentage of rural population, per capita GDP, percentage of households with potable water and with sewage, vaccines, and tax property (revenue). In addition, we also do not find a difference in the agricultural dependency: coffee, sugar, and soy. Beyond that, we observe that all elections are well-balanced: 2004, 2008, and 2012 (at 5% level). Any specific election is not influencing the victory of a farmer leader.

The third procedure investigates the possibility that the observed change could be driven by movements in the municipality (business, agricultural production, and deforestation) of previous mayors in a municipality, instead of local farmer leadership. Therefore, we analyzed whether the observed change in dependent variables occurred before the 2004 election (the 2001-2004 term), which can be considered as a placebo test. In those cases, in which significant change is observed, we ignore these variables in the main result because the result was identified previously: $y_{t-1} \rightarrow y_t$. Thus, it is neither $x_t \rightarrow y_t$ nor $x_t \rightarrow y_{t+\tau}$. We also use the procedure established by Calonico *et al.* (2014) to investigate this issue. All main results are non-significant at 10% and can be seen in the column 1 of table 4 in sequence. This is ideal, otherwise the effect would have been from the past and not from the elected mayor.

5.2 Main Findings

The economic development promoted by farmer leaders is firstly presented as the number of companies created during their terms. This variable consists on the mean number of companies created per year in each municipality. Secondly, the creation of new formal businesses is observed for different business sectors (i.e. agribusiness, natural resources extraction, manufacturing and services). The economic development is also measured through their livestock production (i.e. herd size) and agricultural production (i.e. planted area). Finally, the results for deforestation in municipalities are presented consisting on the accumulated deforestation in hectares. All the results consider the three terms following the elections of 2004, 2008 and 2012 and are presented in the second column of Table 4 (column 2)

Table 4- Effect of a farmer mayor (vs non-farmer mayor) on firm creation, herd size and agricultural production

		Term Before (2001-2004)	Three Terms (2005/08-2009/12-2013/16)
		RD estimate (1)	RD estimate (2)
Business creation	Business creation	24.46 (23.61)	15.15** (6.91)
	Effective observations	80	291
	Considered bandwidth	0.208	0.270
	Category 1 firms	14.86 (13.84)	1.42* (0.76)
	Effective observations	80	292
	Considered bandwidth	0.205	0.272
	Category 2 firms	0.14 (0.13)	0.007** (0.003)
	Effective observations	85	266
	Considered bandwidth	0.229	0.214
Business creation (According to operating sectors)	Category 3 firms	0.71 (0.75)	0.91* (0.51)
	Effective observations	77	295
	Considered bandwidth	0.188	0.280
	Category 4 firms	0.16 (0.14)	0.25 (0.21)
	Effective observations	79	309
	Considered bandwidth	0.199	0.314
	Category 5 firms	8.28 (8.40)	12.53** (5.62)
	Effective observations	84	291
	Considered bandwidth	0.226	0.269
Agricultural production	Herd size	-60110 (160998)	2.3e+05* (1.4e+05)
	Effective observations	104	356
	Considered bandwidth	0.160	0.294
	Planted area	225637 (209888)	1.3e+05 (91595)
	Effective observations	114	355
	Considered bandwidth	0.182	0.295
Deforestation	Deforestation	331.30 (240.5)	20.82 (31.86)
	Effective observations	102	337
	Considered bandwidth	0.157	0.261

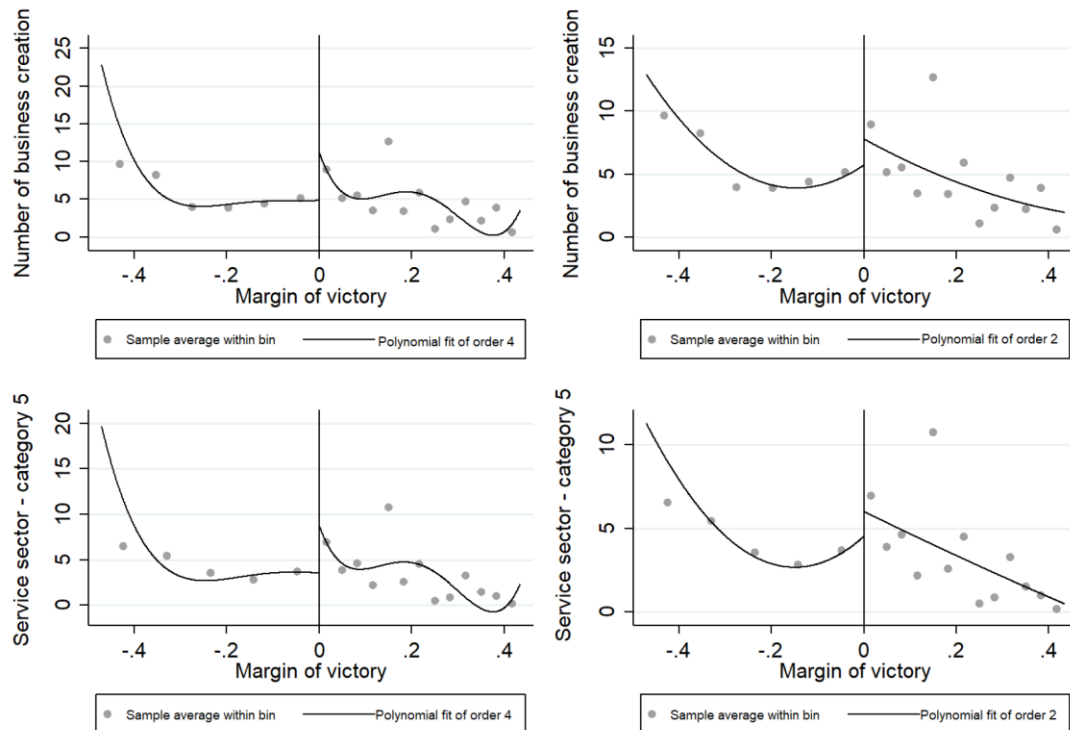
Note: 1) Bias-corrected RD estimates with robust variance estimator using Calonico et al. (2014). Standard errors in parentheses; 2) Municipalities with more than 200,000 electors are excluded to avoid the possibilities of a second round. 3) The bandwidth used in the RD results is generated endogenously (triangular kernel). * Significance at the 10% level, ** at 5% level, and **** at 1% level.

Local farmer leaders influence business creation when elected. The average effect observed was an increase of 15.15 (Standard Error - SE=6.91) on the mean number of new businesses in municipalities where they have been elected. The majority of this effect was observed in the creation of new businesses belonging to services and retail sectors, coded in the present paper as Category 5 companies. The average effect on the mean of new businesses belonging to these sectors was an increase of 12.53 (SE=5.62). Although at 10% of significance, the influence of local farmer leaders on municipalities' economic development was also evidenced through the growth on the herd size where farmer leaders are elected. Contrary it, we do not observe an effect on deforestation increase when the local farmer leaders are elected.

Visual effects: Graphically, the average treatment effects can be observed on the number of companies created during their terms (on total and service sector) in Figure 3 with two

different polynomial (fourth and second degree) where the x-axis corresponds to the running variable ($Margin_{i,t}$) and the y-axis corresponds to the number of companies created. In these graphs, a significant change can be observed close to the cut-off, as predicted, representing the average treatment effect (see the jump to right of cutoff).

Figure 3 - Farmer leaders on total and service sector – business creation



Polynomial orders: Our main results were obtained using fourth order polynomials as local estimators (Table 4). Table S2 in the supplementary material section presents the same main result (column 1: forth degree polynomial) and results when using third and second order polynomials. Except livestock production (i.e. herd size; non-significant at 10% with second degree polynomial), the other variables of business (business creation and business creation on the service sector – category 5) remained significant at 10% level.

Different bandwidths: Calonico *et al.* (2014) used an optimal bandwidth (estimate the best size of bandwidth regarding the distribution of points in the sample). Using the same methodology (CALONICO *et al.*, 2014), we fixed different optimal bandwidths (0.15 and 0.40) and re-estimated our main result (Table 3; column 2). The results are similar those found on Table 4 (see table S3 in the supplementary material). The results for business

creation and business creation on the service sector (category 5) remained significant at 10% level.

Cluster-robust at the municipal level: We re-estimate our main with cluster-robust at the municipal level (see the results on table S4 in the supplementary material). The results for business creation and business creation on the service sector (category 5) are similar those of main results (Table 4).

Considering the results presented, we observe that the election of a local farmer leader influences positively the economic development of the municipality when compared to local leaders with different professional backgrounds. This economic development, specially the growth of livestock production, indicates that local farmer leaders' initiatives helped agribusiness entrepreneurs, what is coherent with the idea that local leaders would aim to benefit their respective groups (BRONEN & CHAPIN, 2013; DEVAS & GRANT, 2003; TWISS et al., 2003). On the other hand, local farmer leaders do not promote any statistically significant interference on the levels of deforestation of their municipalities when elected. These results suggest the lack of environment planning and of policy decisions leading to a more sustainable municipality, what according to Kotter (2001) and Cord et al. (2017) would be required for a leader to be considered resilient.

5.3 Mechanisms

We investigate three categories of extrinsic incentives that could be used by local farmer leaders. The first category investigated is the municipal agriculture expenditure did by local government. The second category is related to taxes incentives in form of taxes exemptions and discounts such as properties taxes partial and total exemption, ISSQN discounts and Fees exemptions given by municipalities. Results are presented on Table 5 and we highlight the results for the municipal agricultural expenditure (the difference is from 594,906 reais (the Brazilian currency; SE: 299,545). There are no fiscal incentives which justify results of economic development.

Table 5 - Mechanisms - Local public incentives and legal environment legislations

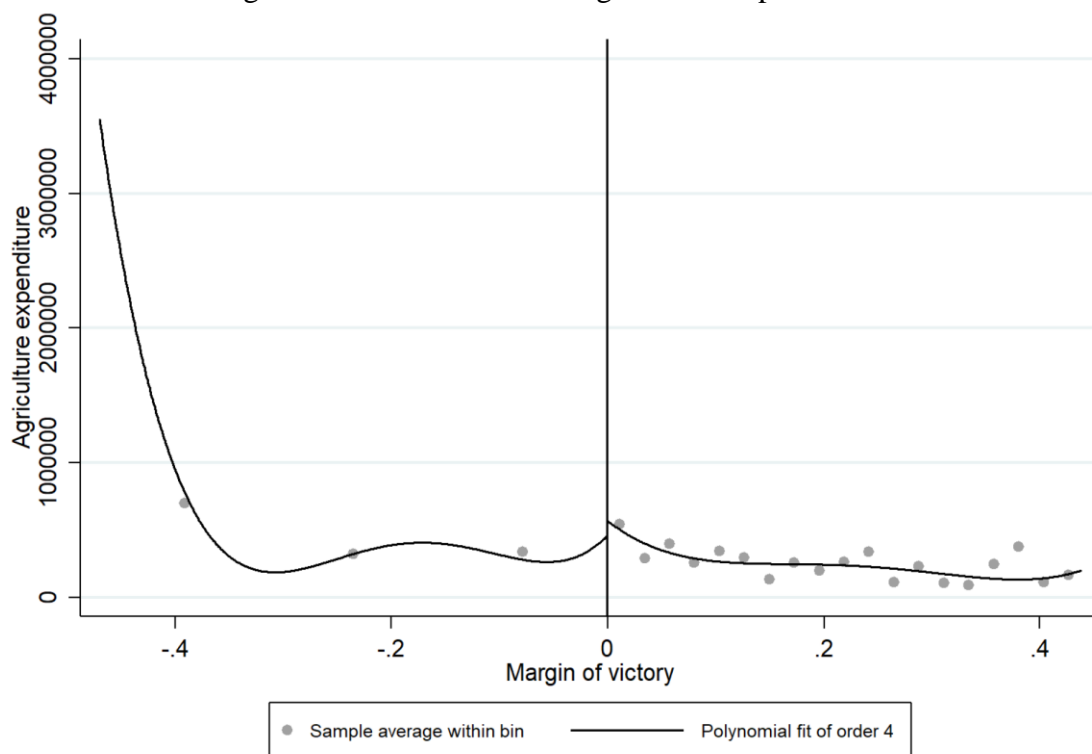
<i>Legal public incentives</i>		
Agriculture expenditure	RD Estimate	594906** (299545)
	Effective Observations	347
	Considered bandwidth	0.276
Incentives for enterprise implementation	RD Estimate	-0.232 (0.218)
	Effective Observations	341
	Considered bandwidth	0.267
Tax property – partial exemption	RD Estimate	0.016 (0.17)
	Effective Observations	362
	Considered bandwidth	0.311
Tax property – total exemption	RD Estimate	-0.178 (0.125)
	Effective Observations	336
	Considered bandwidth	0.256
Service tax exemption	RD Estimate	-0.092 (0.131)
	Effective Observations	356
	Considered bandwidth	0.295
Fees exemption	RD Estimate	-0.014 (0.086)
	Effective Observations	336
	Considered bandwidth	0.253
Land concession	RD Estimate	0.107 (0.138)
	Effective Observations	336
	Considered bandwidth	0.255
Land donation	RD Estimate	-0.076 (0.168)
	Effective Observations	361
	Considered bandwidth	0.306
Other incentives	RD Estimate	-0.102 (0.075)
	Effective Observations	317
	Considered bandwidth	0.218
<i>Legal environment legislations</i>		
Environment laws – Law 121	RD Estimate	0.22 (0.13)
	Effective Observations	359
	Considered bandwidth	0.299
Environment laws – Law 211	RD Estimate	0.04 (0.140)
	Effective Observations	362
	Considered bandwidth	0.311

Note: 1) Bias-corrected RD estimates with robust variance estimator using Calonico et al. (2014). Standard errors in parentheses; 2) Municipalities with more than 200,000 electors are excluded to avoid the possibilities of a second round. 3) The bandwidth used in the RD results is generated endogenously (triangular kernel). * Significance at the 10% level, ** at 5% level, and **** at 1% level.

Our results valid the fact that local farmer leaders have a greater agricultural expenditure than other leaders. These investments may be pointed as one of the reasons behind the higher livestock production observed in these same municipalities, as local investments are believed to promote the agricultural development (LAURANCE et al., 2002) and even make feasible the intensification of agricultural production (BORON et al., 2016; KOCH et al., 2019).

Finally, we investigate whether local agribusiness leaders when elected promoted municipal legislations concerning environmental aspects. We checked the existence of municipal specific legislations focusing on Ecologic-Economic Zoning and the Preliminary Environmental Impact Analysis in the municipalities. Results are also presented on Table 5 (last two results of table) and indicates that local agribusiness leaders are not creating new legislations that justify the forest preservation. The same procedure for our main result, we adopt for the municipal agriculture expenditure. Visually, there is the discontinuity as can be seen on Figure 4 below:

Figure 4- Farmer leaders on agriculture expenditure



Additional results are present on Table S5 (in the supplementary material): different polynomial, bandwidths, and cluster-robust variance.

Our results are aligned with the propositions made by Cunha et al. (2016), Godar et al. (2015) and Verburg et al. (2014) that conservation policies are mostly developed in national level, instead of local level. The use of institutional incentives is not observed, despite the fact that the creation of such legislations could imply on deforestation reduction (ASSUNÇÃO et al., 2015; KOCH et al., 2019) and could lead to better environmental performances by firms (GRAAFLAND & BOVENBERG, 2020).

5.4 The influence of top leaders on low-level leaders

We open this sub-section to discuss if sustainable top (state) leader can influence the choice of low level (local) leaders. We adopt two procedures to achieve this target. First, we define what is a sustainable state leader. We define a sustainable state leader as those state leaders (governors) which produce better results on both development (more business) and the environment (less deforestation). Thus, a sustainable state leader is those in which the state is above the median of other states considering the number of businesses and simultaneously is below the median of other states considering deforestation. Second, we change our initial methodology.

We could use the same methodology from the main results observing the results separately, i.e., with two sub-samples: one with municipalities of the state which the state leader (governor) is sustainable and the other with municipalities of the state which the state leader is not sustainable. This option could leave the number of observations very small to use a non-parametric regression discontinuity (FLAMMER AND BASAL, 2017). Even that it is possible to estimate the results, to avoid problems of efficiency (a small number of observations for each sub-sample), we solve implement a new methodology. Basically, by using a parametric regression discontinuity. We adopt an Ordinary Least Squares (OLS) with a margin of victory of 10% and 5% (between -10% and 10%; between -5% and 5%) including a second-degree polynomial following the equation below:

$$Y_{m,t} = \beta_0 + \beta_1 \text{Margin}_{m,t} * \text{SSL}_{m,t} + \beta_1 \text{Margin}_{m,t} + \beta_2 \text{SSL}_{m,t} + \sum_t \lambda_t T_t + f_{\%votes}(\text{diff_cutoff}_m) + \epsilon_{mt} \quad [2]$$

Where $Y_{m,t}$ are our dependent variables in municipality m at time t ; $\text{Margin}_{m,t}$ is the margin of victory in municipality m at time t (positive margin is farmer leader victory and negative is non-farmer leader victory); $\text{SSL}_{m,t}$ is a dummy equal to one if the state leader is those which the state is above the median of other states considering the number of business and simultaneously is below the median of other states considering deforestation and zero otherwise; $\text{Margin}_{m,t} * \text{SSL}_{m,t}$ our interest variable (the influence from sustainable state leader*margin of victory); T_t is the year t dummy variable; $f_{\%votes}(\text{diff_cutoff}_m)$ is a second-degree polynomial: the square difference between the share of

voters of mayor on the total votes for mayors (farmers and non-farmers) and the zero; and $\epsilon^{m,t}$ is the error term.

Our results are showed on Table 6.

Table 6 - Influence of sustainable state leader on preference of farmer local leader

	Dependent variables			
	Margin of victory between -10% and 10%		Margin of victory between -5% and 5%	
	OLS			
	(1)	(2)	(3)	(4)
	Business creation	Deforestation	Business creation	Deforestation
Margin of victory*Sustainable state leader	12.39 (36.58)	153.2 (136.5)	227.7 (190.3)	549.9 (489.3)
Margin of victory	5.49 (9.23)	-118.5 (151.2)	-47.04 (23.67)	-222.6 (544.7)
Sustainable state leader	16.73*** (2.81)	-49.09*** (11.75)	22.14*** (5.32)	-60.00*** (18.62)
Second degree polynomial (zero – cut-off - less share of votes mayor on the total votes) ²	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
Observations	158	189	84	99
R ²	0.49	0.07	0.58	0.08

Notes: 1) Robust standard errors clustered at the municipal level in parentheses; 2) * Significance at the 10% level, ** at 5% level, and **** at 1% level.

Sustainable state leader: Dummy with value equals to one when the state leader is above median compared with the other states in terms of Business creation and simultaneously is below median compared with the other states in terms of Deforestation; zero otherwise.

Margin of victory: Margin of victory positive (farmer is elected mayor) and margin of victory negative (non-farmer is elected mayor).

We do not present results with controls variables. Even without the initial controls, we do not observe results significant at 5% level. Thus, we have evidence that the top leader (sustainable state leader – governors) does not influence the low-level leaders, being Hypothesis 3 not supported.

Our results suggest that, concerning the creation of environment legislations, there are no strategic leadership path being developed on top hierarchical levels that are followed by local leaders. As predicted by Crosby and Bryson (2010), the absence of such path makes difficult to leaders to deal with the complexity of the region they are managing. We do not observe the alignment of multi-level actors (e.g. mayors and governors), as described by Borowski et al. (2008) and Pahl-wostl (2009), and consequently the results presented are not superior as they were expected to be if the alignment of top-level leaders and middle or low-level subordinates was a reality (ANZENGRUBER et al., 2020; GROVES, 2014).

6 DISCUSSION

During the year of 2020, the Amazon Legal region is the focus of media attention due to record levels of deforestation and the increase of the number of fires observed in recent years, specially from 2019 onwards^{11 12}. The discussion also assumes a political aspect as these increases are associated, at least by a part of Brazilian population, with the rise to power of the President elected in 2018, Jair Bolsonaro, and with some of his government decisions that are considered controversial. Amongst the decisions questioned, we highlight the dismissal of National Institute for Space Research's director Ricardo Galvão in August 2019 after the Institute published worrying data related to increased deforestation and fire outbreaks happened in that year and the nomination of Ricardo Salles as Environment Minister, despite Mr. Salles being defendant in environmental fraud lawsuit.

The Federal Government has also been pointed out by opponents as facilitator of deforestation increases due to some legal measures that, according to government opponents, would benefit land grabbers and producers, such as the reduction of fines applied to offenders¹³.

On the other hand, Federal Government agents argument that the rise of deforestation during recent years is just a continuation of an existing trend that is now changing. The Government highlights the implementation of Brazil Green Operation in May 2020 as one of the efforts made in order to control the Amazon situation. The Operation consists on a combined action of Police Departments, Environment institutes and Military Forces focused on inspect and prevent the occurrence of illegal mining, illegal deforestation and outbreaks of fire.

Leaving aside the political aspect, we observe that the focus of all initiatives proposed is on the Federal Level. As previously cited, we understand that the discussion at national level and the academic analysis of the situation in the Legal Amazon area, usually ignore the influence of local level policies and leadership as part of this system. This is

¹¹ <https://g1.globo.com/natureza/amazonia/noticia/2020/11/13/total-de-alertas-de-desmatamento-na-amazonia-em-outubro-e-o-maior-para-o-mes-na-serie-historica-apontam-dados-do-inpe.ghtml>

¹² <https://jornal.usp.br/ciencias/desmatamento-da-amazonia-dispara-de-novo-em-2020/>

¹³ <https://apublica.org/2020/08/governo-bolsonaro-reduz-multas-em-municipios-onde-desmatamento-cresce/>

essentially the gap we aim to fill with the present paper. Treating all this situation on a national level may not be the most effective way, as we are dealing with an extensive region with several actors and a local reality that may differ significantly from one municipality to another (BEER, 2014; COLLINGE & GIBNEY, 2010; PORTER-BOLLAND et al., 2012). The fact that the region presents a mean population of 23488.9 inhabitants ($SD=45196.6$), with almost 50% of the municipalities having a population of under 13000 inhabitants and 90% of the municipalities having a population of under 50000 inhabitants, brings up a high population dispersion observed in the region, which also reinforces the relevance of local leadership and local policies in order to achieve more sustainable results (DEVAS & GRANT, 2003; LOVELL, 2009; TWISS et al., 2003).

To test the theory that predicts the need for leaders to be resilient in the Legal Amazon region (CORD et al., 2017; FOLKE, 2006; KOTTER, 2001), we investigate whether or not local leaders with different characteristics (professional background) effectively promote economic development and forests conservation. We found statistically significant differences only for mayors with a prior occupation related to agribusiness and cattle breeding. These farmer mayors were more effective on the creation of new business in their municipalities, especially those firms related to the services sector, however they did not promote any reduction on deforestation rates when compared to mayors with different previous occupations.

In sequence, in support of the theory, we found that a mechanism by which agribusiness leaders promote economic development is via the increase on agricultural expenditure in their municipalities, as predicted by previous researches (BORON et al., 2016; KOCH et al., 2019; LAURANCE et al., 2002). Concerning the deforestation rates, we did not identify any significant changes and our tests indicate that no action has been taken by agribusiness leaders differently than other leaders regarding the creation of specific environmental legislations. Bringing these results to practical terms, the election of agribusiness leaders, who are usually pointed out by common sense as villains of the forests, did not lead to more deforestation than leaders coming from other occupations such as lawyers or professors. It is important to highlight, however, that our results do not suggest that they are not devastating the forests, only that they are not promoting deforestation more than others.

Finally, we found that top-leaders (state governors) were not being followed by local leaders when dealing with the creation of municipal legislations aiming to promote the reduction of deforestation. These results were obtained by analyzing the sustainability of top-leaders in terms of economic promotion and forests conservation when compared with governors from different states and then checking whether more sustainable top-leaders would influence local leaders through an alignment of multi-level actors as predicted in previous works (BOROWSKI et al., 2008; PAHL-WOSTL, 2009).

7 IMPLICATIONS OF POLICY

Multiple countries have implemented innovative strategies in order to achieve the internationally agreed strategic goals concerning their sustainable development (VERTAKOVA & PLOTNIKOV, 2017). These initiatives differ according to each nation's reality and may include strategies aiming to deal with social, economic and environmental issues (HASSAN & LEE, 2015).

In Europe, for instance, the efforts have been directed to the creation of policies that promote economic growth and environmental protection through the development of new technologies and rise of people awareness (HUGHES & JOHNSTON, 2005). Canada's mining sector, on the other hand, stimulated the Canadian government to develop policies addressing environmental and social issues derived from the mining activities (HILSON, 2000) and in developing countries such as Brazil and Colombia we observe the implementation of policies mainly focused on conservation of natural resources (ASSUNÇÃO et al., 2015; CARRIAZO et al., 2020; KOCH et al., 2019; NEPSTAD et al., 2014; VERBURG et al., 2014).

Although several policies have been implemented, the role of local leadership on the effectiveness of these measures taken by governments has been neglected. In our research we emphasize the relevance of multiple actors that coexist in an environment where the sustainable development is necessary (e.g. Legal Amazon Region) and the amount of autonomy that these actors have must be taken into account, as well as the development of local policies made by them.

Another aspect that must be analyzed is that, as far as our investigation goes, local leaders are not being influenced directly by their superior leaders, which leads to a fragmented plan of action that needs to be reassessed. As our results suggest, there are cases where these local leaders are promoting economic development, however are not focusing on avoiding deforestation (e.g. agribusiness leaders). There are other municipalities where leaders are not promoting neither economic development, nor forests conservation. And in both cases the state governors are not influencing the decisions made locally.

As important as the establishment of strategic goals, which is usually defined in a Federal or even Global level, it is the comprehension of the behavior of local agents, their

leadership and the influence they exercise on their followers. We must therefore take a step back on our analysis and understand how these local leaders are producing different results, how coherent to higher levels' strategies their actions are and how these strategic path can be better established.

8 MAIN RESULTS

Our first main result concerns the creation of new business in municipalities as consequence of local leadership. We identified that the election of mayors with a professional background on agribusiness stimulated the creation of new firms, especially those related to the services sector. In a sample where the mean number of new companies created in a specific municipality per year is 21.67 (SD=61.24), the election of agribusiness leaders led to the increase of 15.15 (SE=6.91) on the number of new firms created when compared to the election of mayor with different professional background. Considering only the services sector, the increase on the mean of new businesses was of 12.53 (SE=5.62). The economic development due to the election of agribusiness local leaders was also evidenced by the growth of the herd size in these municipalities.

Following, we identified that the economic incentives used by agribusiness local leaders are related to the agricultural expenditure. Municipalities where agribusiness leaders were elected invested 594,906 reais (the Brazilian currency; SE: 299,545) more than other leaders on agricultural investments. No support was found for the use of fiscal or taxes incentives.

Regarding the efforts to reduce the deforestation levels, we found that local agribusiness leaders are not creating more new legislations that justify the forest preservation than its pairs with different occupations.

Finally, our last main result indicates that local leaders are not being influenced by state level leaders (governors) concerning the creation of environment legislations. Top-level leaders that are producing superior results on both economic development and on the conservation of forests are not necessarily followed by mayors led by them. This result also confirms the importance of focusing not only on policies developed on top levels, but also locally.

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APPENDIX

ONLINE SUPPLEMENTARY MATERIAL FOR

Local leaders and the environment: little resilience and influence to produce a sustainable environment

This is the supplementary material for “Local leaders and the environment: little resilience and influence to produce a sustainable environment”. It contains additional tables and results that are necessary to fully document the research contained in the paper and to facilitate the reader’s ability to understand the work.

Figure S1- Manipulation tests - Frequency of farmer mayor margin of victory - the 2004 election

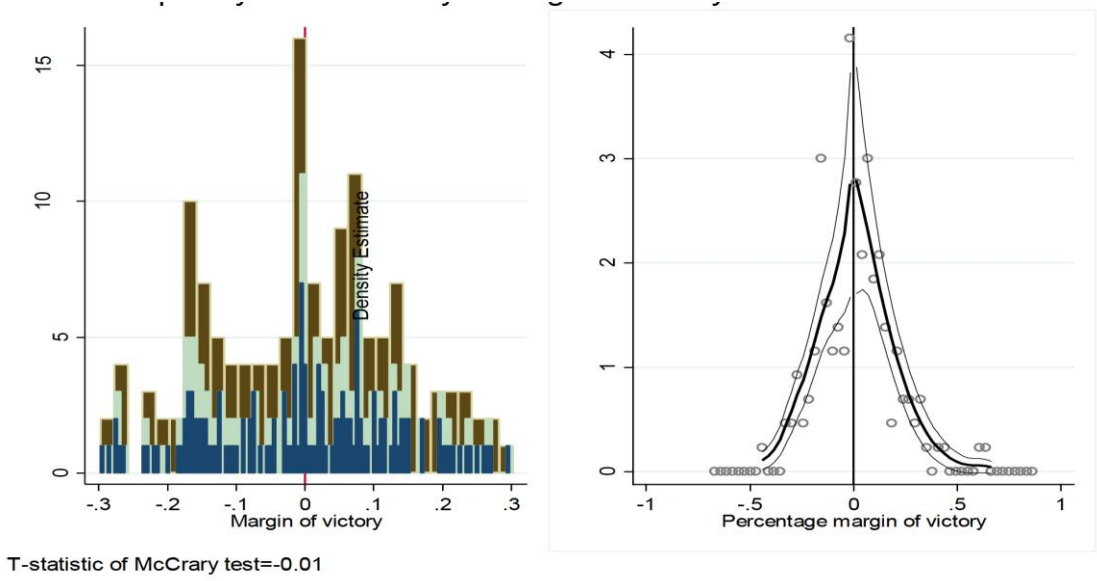


Figure S2 - Manipulation tests - Frequency of Farmer mayor margin of victory - the 2008 election

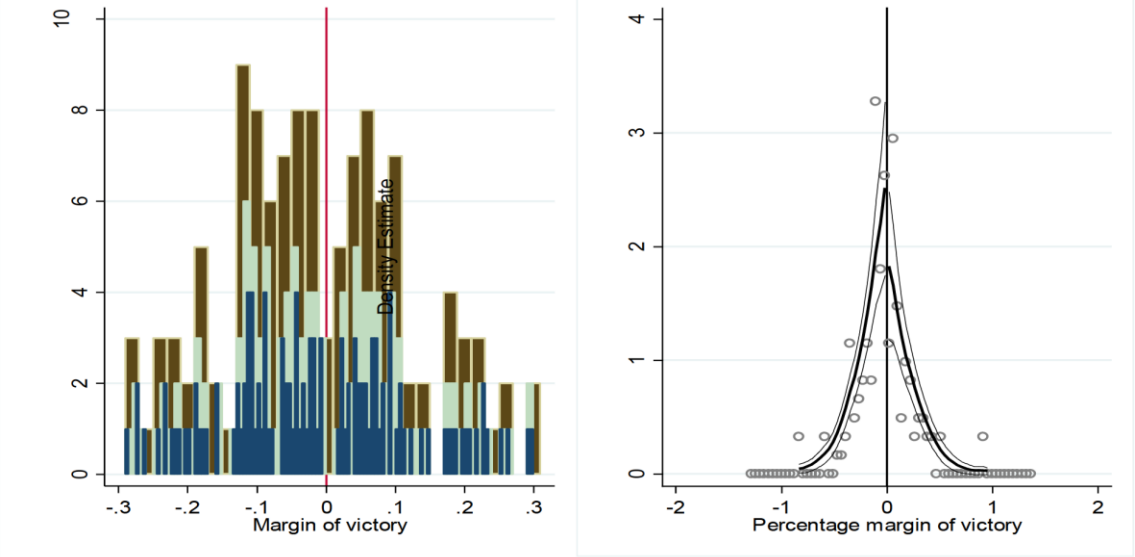
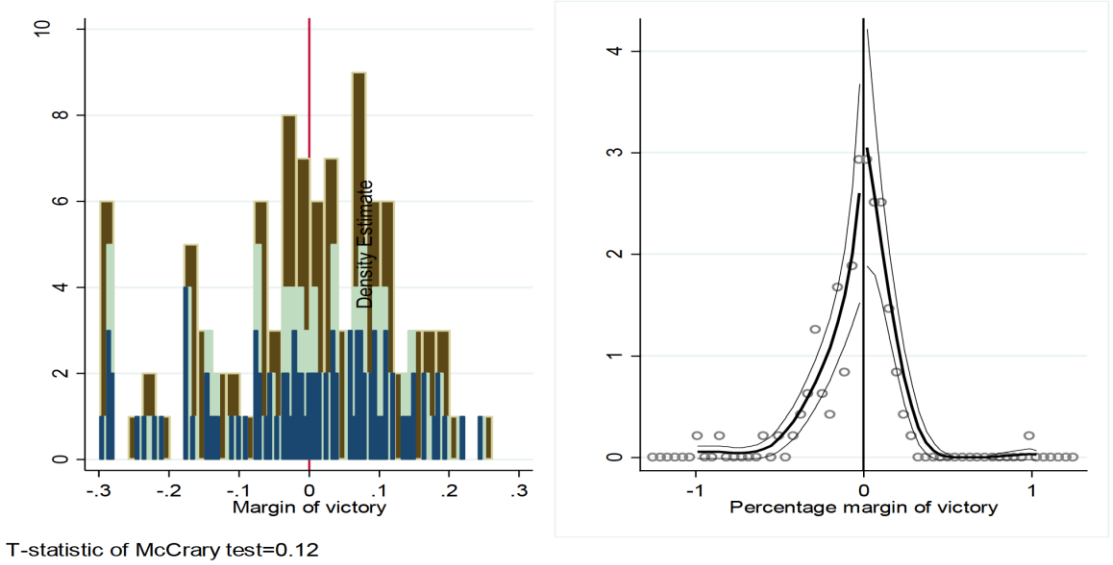


Figure S3- Manipulation tests - Frequency of Farmer mayor margin of victory - the 2012 election



INVESTIGATION ON OCCUPATIONS

As part of our investigation, we aim to analyze the impact of specific mayor's professional backgrounds on the promotion of economic development and deforestation reduction. To do so, we limit our investigation to the most recurring professions, ordering all the occupations that appear according to their frequencies (see Table S1.1). Following, we focus on those that correspond to at least 1% of our sample. This restriction is applied firstly because considering only the professions exercised by more than 1% of our sample we are able to analyze more than 80% of our sample. Secondly, we restrict our analysis to these occupations because we compare the impact of electing a mayor with a specific professional background with the runner up candidate of the municipal election.

In this sense, occupations with less than 1% of the sample would lead to a few number of observations (up to 35 observations), which makes it impossible to use the Regression Discontinuity Design.

Then, similar occupations were combined into a unique category. For instance, Superior and High Education Professors were classified as Professors. The same procedure was used to compile agribusiness producers and cattle ranchers into the Farmers category. Finally, we discarded unspecific descriptions such as "Others" and "Not Informed". The procedures previously cited lead to a list of 10 occupations that we analyze in our paper. They are: farmers, administrators, lawyer, merchant, business owner, physician, politician (mayors and councilors), professors and public servant.

Table S1.1- Frequency of occupations of elected mayors

Occupation	Number of mayors	Frequency	Accumulated Frequency
Mayor	404	11,18%	11,18%
Business Owner	341	9,44%	20,61%
Other	293	8,11%	28,72%
Merchant	221	6,12%	34,84%
Physician	196	5,42%	40,26%
Cattle Breeder	166	4,59%	44,85%
Agribusiness Owner	156	4,32%	49,17%
State Public Servant	142	3,93%	53,10%
Lawyer	110	3,04%	56,14%
Administrator	86	2,38%	58,52%
Not Informed	84	2,32%	60,85%
Councilor	84	2,32%	63,17%
Business Owner*	81	2,24%	65,41%
Municipal Public Servant	72	1,99%	67,40%
Engineer	71	1,96%	69,37%
Basic Education Professor	64	1,77%	71,14%
Agricultural Producer	57	1,58%	72,72%
Agricultural Worker	56	1,55%	74,27%
High School Professor	49	1,36%	75,62%
Accountant	47	1,30%	76,92%
Livestock Worker	43	1,19%	78,11%
President / Ministers	37	1,02%	79,14%
Agricultural Business Owner	36	1,00%	80,13%
Federal Public Servant	36	1,00%	81,13%
Executive Branch Members	34	0,94%	82,07%
Basic Education Professor	34	0,94%	83,01%
Dentist	27	0,75%	83,76%
Agronomist	26	0,72%	84,48%
Agronomy Technician	24	0,66%	85,14%
Salesperson	21	0,58%	85,72%
Economist	20	0,55%	86,28%
High School Professor	20	0,55%	86,83%
Housewife	18	0,50%	87,33%
Congressman	17	0,47%	87,80%
Banker	15	0,42%	88,21%
Public Spectacles Producer	14	0,39%	88,60%
Rural Worker	14	0,39%	88,99%
Veterinary	14	0,39%	89,37%
Administrative Agent	13	0,36%	89,73%
Student	13	0,36%	90,09%
Justice Department Servant	13	0,36%	90,45%

Retired Public Servant	13	0,36%	90,81%
Accounting Technician	13	0,36%	91,17%
Pedagogue	12	0,33%	91,51%
Retired	11	0,30%	91,81%
Social Assistant	11	0,30%	92,11%
Industrial	11	0,30%	92,42%
Industrial Business Owner	11	0,30%	92,72%
Nurse	10	0,28%	93,00%
Senator	10	0,28%	93,28%
Driver	10	0,28%	93,55%
Clergyman	10	0,28%	93,83%
Senator, Deputy and Councilor	10	0,28%	94,11%
Serviceman	9	0,25%	94,36%
Driver (Collective Transport)	9	0,25%	94,60%
Manager	8	0,22%	94,83%
Radio and Television Commentator	8	0,22%	95,05%
Notary	8	0,22%	95,27%
Office Assistant	7	0,19%	95,46%
Pharmaceutical	7	0,19%	95,66%
Accounting Technician	7	0,19%	95,85%
Electrician	6	0,17%	96,02%
Driver	6	0,17%	96,18%
Nurse Technician	6	0,17%	96,35%
Fiscal	5	0,14%	96,49%
Fisherman	5	0,14%	96,62%
Police Officer	5	0,14%	96,76%

Note: 1) Occupations with less than 5 appearances have been discarded in the present Table. 2) Similar occupations have been compiled in the final sample. 3) We observe several modifications on the way professions have been described during the electoral periods analyzed, although these modifications have not interfered on the most prevalent occupations.

Table S1.2 - Frequency of occupations of elected mayors after compiling similar occupations

Occupation	Number of mayors	Frequency	Accumulated Frequency
Mayor	404	18,30%	18,30%
Business Owner	341	15,44%	33,74%
Farmers	322	14,58%	48,32%
Public Servant	274	12,41%	60,73%
Merchant	221	10,01%	70,74%
Physician	196	8,88%	79,62%
Professors	170	7,70%	87,32%
Lawyer	110	4,98%	92,30%
Administrators	86	3,89%	96,20%
Councilor	84	3,80%	100,00%

Table S1.3 - Investigation on occupations

		Administrator	Lawyer	Merchant	Business Owner	Physician
		RD estimate (1)	RD estimate (2)	RD estimate (3)	RD estimate (4)	RD estimate (5)
Business creation	Business creation	4.47 (16.31)	16.48 (30.37)	5.46 (9.28)	16.17* (8.61)	-19.85 (16.78)
	Effective Observations	66	120	253	280	187
	Considered bandwidth	0.137	0.188	0.267	0.195	0.215
Business creation (According to operating sectors)	Category 1 firms	-0.83 (1.88)	-1.38 (3.29)	-1.03 (1.11)	0.42 (0.72)	-1.44 (0.94)
	Effective Observations	72	121	260	307	198
	Considered bandwidth	0.151	0.193	0.302	0.232	0.235
	Category 2 firms	-0.06 (0.10)	0.002 (0.002)	0.08 (0.05)	-0.02 (0.02)	-0.06 (0.04)
	Effective Observations	87	91	222	317	183
	Considered bandwidth	0.195	0.126	0.204	0.251	0.206
	Category 3 firms	-0.46 (0.66)	0.61 (1.49)	0.26 (0.39)	0.72* (0.38)	-0.65 (0.74)
	Effective Observations	59	119	257	276	183
	Considered bandwidth	0.122	0.181	0.284	0.191	0.208
	Category 4 firms	0.32 (0.65)	-0.59 (0.45)	0.17 (0.24)	-0.12 (0.14)	-0.21 (0.22)
	Effective Observations	72	127	257	317	182
	Considered bandwidth	0.152	0.225	0.285	0.254	0.200
	Category 5 firms	5.94 (13.66)	17.81 (26.65)	7.84 (8.48)	14.65* (7.86)	-17.57 (15.07)
	Effective Observations	65	120	240	280	187
	Considered bandwidth	0.136	0.188	0.240	0.195	0.214
Agricultural production	Herd size	-3005 (227688)	-245238 (220088)	11278 (87359)	20911 (173483)	-62380 (134151)
	Effective Observations	139	164	319	560	285
	Considered bandwidth	0.217	0.165	0.204	0.411	0.217
	Planted area	26717 (16376)	-35705 (95933)	3735 (5326)	-8792 (26029)	-26962 (21280)
	Effective Observations	101	182	306	487	296
Deforestation	Considered bandwidth	0.129	0.199	0.187	0.242	0.230
	Deforestation	91.42 (197.80)	-139.32 (89.61)	-3.66 (49.76)	26.27 (43.51)	118.56 (124.89)
	Effective Observations	92	143	304	313	228
		0.176	0.201	0.263	0.203	0.185

		Mayor	Professor	Councilor	Public Servant
		RD estimate (6)	RD estimate (7)	RD estimate (8)	RD estimate (9)
Business creation	Business creation	0.96 (7.39)	-0.50 (3.35)	4.03 (5.84)	-7.76** ³⁾ (3.35)
	Effective Observations	380	169	75	254
	Considered bandwidth	0.238	0.192	0.174	0.210
Business creation (According to operating sectors)	Category 1 firms	0.79 (0.78)	0.65 (0.53)	0.28 (0.94)	-0.86** (0.41)
	Effective Observations	412	179	85	271
	Considered bandwidth	0.319	0.230	0.227	0.234
	Category 2 firms	0.05 (0.05)	-0.01 (0.01)	-0.02 (0.05)	-0.04 (0.04)
	Effective Observations	358	187	93	283
	Considered bandwidth	0.230	0.245	0.276	0.258
	Category 3 firms	0.20 (0.48)	0.16 (0.19)	-0.35 (0.55)	-0.53** (0.21)
	Effective Observations	384	177	84	244
	Considered bandwidth	0.248	0.220	0.206	0.192
	Category 4 firms	0.03 (0.28)	-0.01 (0.08)	-0.18 (0.12)	-0.29 (0.18)
	Effective Observations	354	173	74	294
	Considered bandwidth	0.205	0.212	0.170	0.288
Agricultural production	Category 5 firms	-0.38 (6.23)	-1.32 (2.86)	4.09 (4.85)	-6.19** (2.74)
	Effective Observations	374	168	74	250
	Considered bandwidth	0.234	0.188	0.172	0.202
	Herd size	120237 (121083)	-124155 (138580)	76040 (84869)	-131441* ⁴⁾ (71179)
	Effective Observations	679	292	157	438
	Considered bandwidth	0.322	0.262	0.210	0.250
Deforestation	Planted area	16124 (23349)	3824 (7996)	63359 (31880)	-27332 (18454)
	Effective Observations	672	275	156	424
	Considered bandwidth	0.317	0.234	0.207	0.230
Deforestation	Deforestation	-65.55 (50.62)	-95.95 (75.55)	-101.32 (62.46)	-65.71 (141.80)
	Effective Observations	424	233	91	384
	Considered bandwidth	0.254	0.262	0.187	0.335

Note: 1) Bias-corrected RD estimates with robust variance estimator using Calonico et al. (2014). Standard errors in parentheses; 2) Municipalities with more than 200,000 electors are excluded to avoid the possibilities of a second round. 3) It is non-significant at 10% level using second-degree polynomial; 4) It is non-significant at 10% level using third-degree polynomial; 5) The bandwidth used in the RD results is generated endogenously (triangular kernel). * Significance at the 10% level, ** at 5% level, and *** at 1% level.

Table S2 - Different polynomials - Effect of a farmer mayor (vs non-farmer mayor) on firm creation, herd size and agricultural production

		Three Terms (2005/08-2009/12-2013/16)		
		Fourth degree polynomial	Third degree polynomial	Second degree polynomial
		RD estimate (1)	RD estimate (2)	RD estimate (3)
Business creation	Business creation	15.15** (6.91)	13.48** (6.41)	10.75* (5.50)
	Effective observations	291	270	227
	Considered bandwidth	0.270	0.218	0.163
	Category 1 firms	1.42* (0.76)	1.17* (0.67)	0.61 (0.47)
	Effective observations	292	277	296
	Considered bandwidth	0.272	0.232	0.281
Business creation (According to operating sectors)	Category 2 firms	0.007** (0.003)	0.0008 (0.0044)	-0.007 (0.007)
	Effective observations	266	246	253
	Considered bandwidth	0.214	0.179	0.191
	Category 3 firms	0.91* (0.51)	0.79* (0.45)	0.69 (0.41)
	Effective observations	295	283	233
	Considered bandwidth	0.280	0.245	0.169
	Category 4 firms	0.25 (0.21)	0.17 (0.18)	0.13 (0.15)
	Effective observations	309	301	273
	Considered bandwidth	0.314	0.291	0.223
	Category 5 firms	12.53** (5.62)	11.13** (5.22)	8.97** (4.54)
Agricultural production	Effective observations	291	270	226
	Considered bandwidth	0.269	0.218	0.160
	Herd size	2.4e+05* (1.3e+05)	2.1e+05* (1.2e+05)	3.3e+05 (2.1e+05)
	Effective observations	312	249	260
	Considered bandwidth	0.213	0.144	0.15
	Planted area	50590 (51370)	43728 (48037)	43728 (48037)
Deforestation	Effective observations	387	335	335
	Considered bandwidth	0.406	0.253	0.253
	Deforestation	20.82 (31.86)	22.48 (37.31)	31.69 (41.00)
	Effective observations	337	312	330
	Considered bandwidth	0.261	0.212	0.237

Note: 1) Bias-corrected RD estimates with robust variance estimator using Calonico et al. (2014). Standard errors in parentheses; 2) Municipalities with more than 200,000 electors are excluded to avoid the possibilities of a second round. 3) The bandwidth used in the RD results is generated endogenously (triangular kernel). * Significance at the 10% level, ** at 5% level, and **** at 1% level.

Table S3 – Different bandwidths - Main results

		Three Terms (2005/08-2009/12-2013/16)	
		RD estimate (1)	RD estimate (2)
Bandwidths		0.15	0.40
Business creation	Business creation	13.76* (7.87)	14.07** (6.52)
	Effective observations	219	331
	Considered bandwidth	0.15	0.40
Business creation (According to operating sectors)	Category 1 firms	1.25 (1.01)	1.28* (0.70)
	Effective observations	219	331
	Considered bandwidth	0.15	0.40
	Category 2 firms	0.004 (0.009)	-0.004 (0.005)
	Effective observations	219	331
	Considered bandwidth	0.15	0.40
	Category 3 firms	0.76 (0.52)	0.86 (0.48)
	Effective observations	219	331
	Considered bandwidth	0.15	0.40
	Category 4 firms	0.38 (0.28)	0.25 (0.20)
	Effective observations	219	331
	Considered bandwidth	0.15	0.40
	Category 5 firms	11.35* (6.29)	11.67** (5.31)
	Effective observations	219	331
	Considered bandwidth	0.15	0.40
Agricultural production	Herd size	3.3e+05 (2.1e+05)	1.9e+05 (1.4e+05)
	Effective observations	260	388
	Considered bandwidth	0.15	0.40
	Planted area	2.1e+05 (1.7e+0.5)	1.1e+05 (86259)
	Effective observations	260	387
Deforestation	Considered bandwidth	0.15	0.40
	Deforestation	-68.62 (54.45)	9.65 (34.92)
	Effective observations	260	388
	Considered bandwidth	0.15	0.40

Note: 1) Bias-corrected RD estimates with robust variance estimator using Calonico et al. (2014). Standard errors in parentheses; 2) Municipalities with more than 200,000 electors are excluded to avoid the possibilities of a second round. 3) The bandwidth used in the RD results is generated endogenously (triangular kernel). * Significance at the 10% level, ** at 5% level, and **** at 1% level.

Table S4 - Cluster-robust variance – Main results

		Three Terms (2005/08-2009/12-2013/15) RD estimate
Business creation	Business creation	15.08** (6.92)
	Effective observations	293
	Considered bandwidth	0.273
Business creation (According to operating sectors)	Category 1 firms	1.42* (0.73)
	Effective observations	291
	Considered bandwidth	0.271
	Category 2 firms	0.007** (0.003)
	Effective observations	270
	Considered bandwidth	0.218
	Category 3 firms	0.91* (0.53)
	Effective observations	296
	Considered bandwidth	0.283
	Category 4 firms	0.25 (0.18)
	Effective observations	307
	Considered bandwidth	0.306
	Category 5 firms	12.48** (5.67)
	Effective observations	292
	Considered bandwidth	0.272
Agricultural production	Herd size	2.3e+05** (1.5e+05)
	Effective observations	356
	Considered bandwidth	0.295
	Planted area	1.3e+05 (87458)
	Effective observations	353
	Considered bandwidth	0.291
Deforestation	Deforestation	19.59 (36.38)
	Effective observations	341
	Considered bandwidth	0.267

Note: 1) Bias-corrected RD estimates with robust variance estimator using Calonico et al. (2014). Standard errors in parentheses; 2) Municipalities with more than 200,000 electors are excluded to avoid the possibilities of a second round. 3) The bandwidth used in the RD results is generated endogenously (triangular kernel). * Significance at the 10% level, ** at 5% level, and **** at 1% level.

Table S5 – Robustness – Agriculture expenditure

	<i>Different polynomial</i>	
	Fourth degree polynomial	Third degree polynomial
RD Estimate	5.9e+05** (3.0e+05)	4.6e+05* (2.5e+05)
Effective Observations	347	327
Considered bandwidth	0.276	0.234
	<i>Different bandwidths</i>	
	0.15	0.40
RD Estimate	7.7e+05* (4.8e+05)	5.2e+05* (2.8e+05)
Effective Observations	260	388
Considered bandwidth	0.15	0.40
	<i>Cluster-robust variance</i>	
RD Estimate	6.1e+05** (2.7e+05)	-
Effective Observations	342	-
Considered bandwidth	0.271	-

Note: 1) Bias-corrected RD estimates with robust variance estimator using Calonico et al. (2014). Standard errors in parentheses; 2) Municipalities with more than 200,000 electors are excluded to avoid the possibilities of a second round. 3) The bandwidth used in the RD results is generated endogenously (triangular kernel). * Significance at the 10% level, ** at 5% level, and **** at 1% level.