Broadband connection and election in Brazil: what is role of the internet?

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Abstract

We investigate the relationship between broadband internet velocity and election outcomes in Brazil (2008, 2010 and 2012). Using a robust identification strategy, a RDD applied to the roll out of Backhaul program, we explore jumps in internet velocity according to population size as identification strategy. Results indicate no relationship between internet speed and political outcomes – turnout, blank and null percentage votes, left parties vote share, small party or young candidate vote share and campaign budget. Our findings diverge from some positive/negative results reported before, usually applied to democracies with institutional backgrounds distinct of the one observed in Brazil, suggesting that the relationship between internet and electoral outcomes does not apply everywhere.

Keywords: Internet, RDD, elections.

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Introduction

The aim of this paper is to asses the impact of broadband internet velocity on political outcomes: turnout, vote share, types of votes and campaign budget.

The way how people get informed about politics has changed dramatically over the years (Bimber 2003). If in XIX century newspaper was the main source of information, in the beginning of XX's radio took its place, surpassed by television in the middle of the same century. Today, a new type of media seems to be taking the lead: the internet.

Although the world wide web is an almost 30 years-old technology, broadband connection is an even recent event (Maddux & Johnson 1997). Internet velocity capable of streaming videos became popular just in the XXI century. Social networks, like Facebook, YouTube and Twitter are relatively infant phenomenons[1], becoming popular globally only in the late of 2000's. Mobile broadband connections, thanks to 3G technology (followed by 4G) and massification of smartphones[2], helped internet to reach a greater number of users. New social medias, like WhatsApp, Instagram and Telegram are now everyday tools[3], with popularity increasing in an exponential fashion, being common even for business. A new wave, with 5G technology and the "internet of things" is coming to continue the revolution begun in the past century, with connections speed and quality increasing every day, with new possibilities of business.

Thus, information dissemination gained range and speed, reaching more people, almost instantaneously, nearly in any part of the world. Geographic barriers were broken and the amount of information are vast. Before these new possibilities, a question arises: how this new scenario affects social interaction? Furthermore, how do people are doing politics in this new environment? In particular, if people have tools to be more informed, do they increase their participation in elections? Could vote preferences change with introduction of this new technology? Or, on contrary, have this new possibilities of entertainment deviate people from political discussion? Is it possible that internet did not change politics at all?

These questions are not easy to be answered for several reasons. Availability of internet is not random and characteristics like income, schooling and geographic conditions may determine if an internet service provider will be accessible for individuals (Falck *et al.* 2014; Miner 2015; Campante *et al.* 2017). Also, institutional and political backgrounds may possible influence internet-political relationship.

[1]Facebook was launched in 2004, YouTube in 2005 and Twitter in 2006.
[2]The first Iphone was launched in 2007.
[3]WhatsApp was launched in 2009, Instagram in 2010 and Telegram in 2013.

This is not a novel issue. Relationship between internet and politics has been focus of study in several fields (Bimber 1998; Larson 2004; Czernich 2012; Jaber 2013; Falck *et al.* 2014; Gavazza *et al.* 2015; Poy & Schüller 2016; Campante *et al.* 2017), and this paper aims to contribute with this literature, studying internet velocity impacts on politics in Brazil. Focusing on a single country, we have best tools to control for possible confounders, and taking advantage of a specific rule for broadband roll out, where number of inhabitants determines the internet velocity of municipalities (the backhaul program), we have a robust identification strategy, which creates an ideal instrument to deal with internet velocity endogeneity. Following Cattaneo *et al.* (2018), we use multiple cumulative cutoffs design to estimate effects.

In the most recent Brazilian presidential election, internet had a major role in result. In 2018, Mr. Bolsonaro, with a little fraction of financial resources used by his opponents[4] and with only eight seconds of national advertising time in television[5], managed to go to the second round of presidential elections, with 46.03% of votes, and won elections with a 10 p.p. margin difference. According to Brazilian newspapers, the strength of Mr. Bolsonaro in the social medias was capital to his victory[6], which makes Brazil an interesting case of study regarding the relationship between internet and elections.

We go back a little in time and study if the beginning of broadband internet played a role in election outcomes. Results suggests that, in general, broadband internet speed is not related to political outcome in Brazil. It seems that internet velocity did not influence turnout, blank or null percentage votes, left parties vote share, the number of candidates, a small party and young candidates vote share and campaign budget, in 2008, 2010 and 2012 elections, which covers a national and two local suffrage. The offices considered (president, mayor, deputies or local legislators) did not make difference in results. These finds are different from previous results reported in the literature, meaning that institutional background or local idiosyncrasies may play an important role in studies relating politics and internet. Positive and negative relationship are reported for Germany, Italy and United Kingdom (Falck *et al.* 2014; Gavazza *et al.* 2015; Campante *et al.* 2017), all of them with distinct political

[4]While Mr. Bolsonaro expended R$ 2.46 million in his campaign, the second place, Mr. Haddad, expended R$ 37.5 million, a figure 15 times higher. Complete figures are available in http://divulgacandcontas.tse.jus.br/.

[5]https://agenciabrasil.ebc.com.br/politica/noticia/2018-08/tse-apresenta-tempos-de-radio-e-tv-de-presidenciaveis

[6]https://www.correiobraziliense.com.br/app/noticia/politica/2018/10/28/interna_politica,715584/bolsonaro-fez-das-redes-sociais-o-caminho-certo-para-uma-provavel-vito.shtml, https://g1.globo.com/politica/blog/cristiana-lobo/post/2018/12/31/redes-sociais-mudam-completamente-a-relacao-dos-eleitores-com-seus-representantes.ghtml, https://noticias.uol.com.br/politica/eleicoes/2018/noticias/2018/10/09/como-midias-sociais-e-orcamentos-enxutos-derrubaram-cinco-mitos-eleitorais.htm

institutional background compared with Brazilian's.

This paper is organized as follows: the first section presents the theoretical framework linking internet to political outcomes, while the next one reports the previous findings regarding its application. The third section reviews the Brazilian institutional political background, followed by the section with empirical strategy, data bases and descriptive statistics. The fifth section presents our results, with a final discussion in the sixth and last section.

1 Theoretical framework

There are some theories looking to explain why people vote (Downs 1957; Riker & Ordeshook 1968; Ferejohn & Fiorina 1974; Uhlaner 1989; Aldrich 1993). One approach is to treat as a microeconomic problem in the following way. In elections, individuals' problem is to choose the best candidate(s) according to their preferences. But, there is an asymmetry of information: there are many candidates (not considering uncontested elections), and voters are not fully informed about their abilities. Acquire information about them is costly, since they have to spend resources to consume information (e.g. from television, radio, newspaper, internet or another people), that may include money and time. Show up to cast the ballot also requires resources (transportation and time, for example). More accurate decision requires more information, which demands more resources, i.e. is more costly. So, it can be viewed as a maximization problem from the microeconomics point of view, which can be solved by equalizing marginal costs and benefits. Benefits can be viewed as the policies the most preferred candidate will conduct, a civil duty or being party of the democratic process (Ali & Lin 2013).

This problem changes over time with entrance of new technologies (Gentzkow 2006). For example, when radio, television and internet were not available, there were fewer options to people get informed about candidates. Also, there were available less leisure alternatives. With emergence of radio, then television and, finally, internet, these costs and substitution effects may have changed. A first natural question that someone could ask is: did these new technologies affect the decision of voters? For newspaper, Gerber *et al.* (2009), Gentzkow *et al.* (2011) and Drago *et al.* (2014) report effects on elections participation. According to Strömberg (2004) and Horacio & Monteiro (2014), radio affects people perception about politics, while DellaVigna & Kaplan (2007), Enikolopov *et al.* (2011), Durante & Knight (2012), Gentzkow (2006) and Oberholzer-Gee & Waldfogel (2009) shows the impact of television (through news) on elections results.

How about the internet? Relationship between internet and politics has been investigated since the end of 1990's (Bimber 1998). The effect on information acquisition may be ambiguous depending on the hypothesis used: if internet makes available new possibilities of entertainment, people may substitute the time spent learning about politics with these new type of leisure; on the other hand, if internet bring to people new sources of politics information and channels of discussion, people may be pushed toward politics. Finally, the cost and the time needed to find candidates information or to find new possibilities of entertainment may have changed relative prices. Once someone has access to internet, it is possible to consume a variety of information with, in general, no additional cost. The same is valid to leisure. A last possibility is that the only thing substituted is the technology used to consume information and leisure, making no difference in resources allocation at all[7].

These changes may also take time to happen. Many types of media on internet depends on broadband connection (like video streaming), only available to the large public in the beginning of the XXI century. Moreover, all content we have today were not available with the launch of the internet. The same was true for television, where the diversity of programs and shows existing today took time to be developed and aired. Emergency of new technologies and its spread also affects relative prices both for information and leisure over time with this development.

While newspaper, radio and TV content production are more restricted and with barrier entries, internet have opened doors to virtually anyone produce information and media, interact with people and organize groups of common interest, everything at a lower cost and time. Thus, it is likely to exist a shift both in the demand and supply of information and entertainment with internet arrival. It can potentially alter the manner of how politics are made, since, with internet, politicians can reach more people, quickly and at lower costs when compared with other medias.

One situation this new scenario brings is the social media consumption of "fake news"[8] and its possible impact on elections. In the problem treated here, misleading information may have a market that deviate people from optimal choice (see Allcott & Gentzkow 2017 for a theoretical framework). Media capture by politicians put an additional flavor to this discussion (Besley & Prat 2006), where internet could break other types of media control or enhance an existing control.

[7]If there is no, or little, consumption of politics information with an older technology, it might be the case that, even with a new technology, there is no preference for this type of information, resulting in no, or limited, shifting in its demand.

[8]Fake news is a popular term to define, in general, the spread of misleading or false information like if it were real. See Lazer *et al.* (2018) for a brief discussion.

With this framework in mind, we analyze previous researches in the field in order to collect results and identification strategies, pointing resemblances and contrasts between them. Common outcomes between internet and politics relationship are voting turnout, election results, public polices and politician's accountability.

2 Literature

Sources from where people consume information and leisure are not exogenous. For example, if television or internet is expensive, only people with enough income can have access. If this kind of people have particular preferences regarding candidates, then there is a bias if relationship between internet and politic outcomes is treated as unconditional. The same is valid for another characteristics, like race, schooling, age or housing location.

Due to this endogeneity of internet supply and demand, geographical characteristics (e.g landscape or rainfall) or previous telecommunication infrastructure are common strategies taken to instrumentalize internet in order to link it to political outcomes. Campante *et al.* (2017) study the impact broadband diffusion on political participation for municipalities of Italy between 1996 and 2013 with this strategy. Miner (2015) take similar path for Malaysia, Czernich (2012) and Falck *et al.* (2014) for Germany, Gavazza *et al.* (2015) for UK, Jaber (2013) for USA and Menezes (2015) for Brazil. With slightly different approach, Lelkes *et al.* (2017) explore variation in state laws related to internet infrastructure to study influence of this technology on polarization in USA, while Poy & Schüller (2016) use similar strategy to analyze broadband effects on turnout and vote share in rural and sparse areas in Italy.

For Italy, Campante *et al.* (2017) report a negative effect on turnout in elections following high speed internet implantation (2008), changing its direction for later elections (2013). An interesting result reported in Italian case is that internet affected ideological groups distinctly, according to vote share results, paving the way for organization of new political groups, formed in online platforms. Poy & Schüller (2016) echoes these results, linking high speed internet (ADSL2+) to increases in turnout in 2008 and 2013 Italian elections, as well transitory increases in vote share of some parties (center-left and right-fringe).

In Malaysian case, Miner (2015) reports important effects of internet in 2008 election results (vote share of opposition parties), but not in turnout and limited effects in turnover. It is interesting to note that the political background for the Malaysian case is different from the Italian one, although the identification strategy is similar.

A negative effect of internet on turnout is reported by Falck *et al.* (2014) for Germany.

The mechanism is related to an increase in leisure consumption that crowds out television entertainment, since internet can be viewed as a substitute in this kind of consumption[9]. The impact reported is heterogeneous: west Germany was affect, while in east Germany no effect was observed, while effects on vote shares were not observed in neither places. On the other hand, Czernich (2012) found positive effects on participation in German 2002-2005 election.

Gavazza *et al.* (2015) report for UK negative effects of internet on turnout in 2006-2010 elections, with stronger results for less-educated and younger voters. Furthermore, incumbents seems to take advantage, diminishing election competitiveness. Taking a step further, the UK study suggests effects on public policies, lowering public expenses and taxes in areas with higher internet access (with similar heterogeneity effects reported for turnout).

In Brazilian case, Menezes (2015) shows that internet is associated with increases in vote share of small candidates in 2010 elections, but no relation with turnout nor with no candidates votes (blank votes). This is an important result once the victorious of last Brazilian presidential election (2018) won with a very limited advertisement time on radio and television in the first round.

For USA, results presented by Lelkes *et al.* (2017) seems to bring light to mechanisms underlying the effects of internet on politics outcomes. States with less restrictive laws (and more likely to have broadband coverage) induces people to be exposed to partisan information and be more extreme in partisan preferences. This mechanism is compatible with results presented in Jaber (2013), who reports a positive impact on turnout, donations to political campaigns and democrats vote share in 2008 presidential elections. In an early study, with weaker identification strategy, Tolbert & McNeal (2003) suggests that, in 1996 and 2000 presidential election, individuals with internet and online elections news reading are more likely to vote.

It is important to note that countries have distinct political regimes, which could potentially affect results reported. Minard & Landriault (2015) bring this to discussion analyzing how maturity of democracy regimes in Asia responds to internet availability. Immature regimes seems to be more affected by internet than solid democracies according to 2006 cross-country analysis. Hence, the cross country variation suggests that there are institutional factors playing action on internet-politics relationship, which puts caution to external validity of results.

To sum up, it is clear that there are different results for different countries (even inside

[9]If we consider that people have a fixed amount of time to enjoy leisure activities, internet enters as a new option to compete with television, potentially reducing the time spent with the latter.

the same country), with possible changing effects over the time. Also, the majority of studies are concentrated in 2000 decade elections, focusing on the begging of the broadband internet. Few studies report results for elections held in 2010 decade, when smartphone revolution and social media gained strength. Even more, there are no studies about the effects of mobile broadband and smartphones on elections.

In this paper we will address fixed line broadband roll out, studying the Brazilian case, one of the largest democracies in the world. As pointed before, peculiarities of each country seems to be determinant for results, which demands closer analysis of the political system in order to compare our results with those presented before.

3 Brazilian political institutional background

Brazil is a Federal Republic, with three layers of government: central (or Federal), states and municipalities[10] (see Souza (2005) for a discussion about the federalism in Brazil). It is a young presidential democracy[11], with bicameral legislative system (Chamber of Deputies and Senate, the National Congress), holding election every four years. President is elected by direct vote since 1989 in national elections, as well national congress, state governors and state assemblies (1994 onward). Local elections, for municipal mayors and local legislators are also held every four years, since 1996[12]. While mayors, senators and the president are elected in a majoritarian system, all the other candidates are elected by proportional representation, where voters choose first a party and then a candidate[13]. Also, parties, until 2018, could create coalition[14] to run in proportional elections, while in majoritarian elections, coalitions are (and still) permitted. With this system, in 2018, 35 parties ran in the elections. Table 1 presents all parties and the number of candidates that participated in elections from 2000 to

[10]Brazil was under Portugal's control from 1500 to 1824, when its indecency was declared and Dom Pedro, son of Portugal's king, became the ruler.

[11]Brazilian Republic was proclaimed in 1889, initially ruled by military and then by São Paulo, Rio de Janeiro and Minas Gerais oligarchies alternating power until 1930. In 1930, Getúlio Vargas took the power until 1945, and, after that, the country had free elections until 1960.

[12]Brazilian dictatorship begun in 1964 and ended in 1985, with general election in 1986, except for president (elected indirectly in the previous year). Before 1985, all other elections (except for president) had direct vote, but under military rules. In 1988, a new constitution was promulgated and in 1989 the president was elected by direct vote again, after 29 years. In 1990, there were elections for state governors, state assemblies and national congress. In 1992, municipal mayors and local assembly members were elected. By 1994 onward, national elections (president, state governors, state assembly and national congress) happens every four year, while local elections (municipal mayor and municipal assembly) happens every four years, since 1996. Thus, Brazil has elections every two years since 1994.

[13]There is the option to vote only for a party.

[14]Altered by the Constitutional Amendment 45, available in http://www.planalto.gov.br/ccivil_03/constituicao/Emendas/Emc/emc97.htm

2018.

Table 1: Parties and number of candidates in Brazilian elections, 2000-2018

Party	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018
NOVO									137	390
PAN	1,382	393	3,030	465						
PC do B	1,978	181	4,499	338	7,119	757	12,200	752	11,173	745
PCB	171	19	453	87	666	73	395	97	203	60
PCO	60	112	313	95	31	9	11	23	45	43
PDT	24,465	996	22,272	1,189	22,334	909	25,317	900	23,960	853
PEN/PATRIOTA								780	9,366	1,077
PFL/DEM	42,481	803	32,644	848	25,346	703	21,139	537	20,023	622
PGT	1,465	504								
PMB									4,082	386
PMDB/MDB	49,231	1,112	40,331	1,192	39,377	1,085	42,266	1,089	40,754	977
PMN	4,901	325	6,538	565	6,034	606	7,142	466	6,733	655
PPB/PP	33,177	805	27,613	622	24,837	743	28,086	664	25,775	691
PPL							1,896	388	3,265	522
PPS/CIDADANIA	19,388	823	21,159	937	15,748	724	16,698	556	15,408	593
PR/PL	19,551	920	25,101	701	19,757	636	20,913	689	20,791	658
PRB/REPUBLICANOS				80	8,610	516	12,764	651	16,526	793
PRN/PTC	1,194	164	4,893	449	4,669	741	7,109	649	8,058	724
PRONA	1,284	357	2,595	460						
PROS								395	10,093	1,000
PRP	4,607	313	6,053	489	5,048	492	7,564	762	7,853	864
PRTB	2,689	409	4,182	363	3,767	479	5,928	584	5,954	847
PSB	15,599	1,139	16,649	1,035	19,612	999	24,588	1,147	24,786	841
PSC	8,221	568	8,803	690	10,843	770	15,202	822	15,148	791
PSD	10,308	363					22,414	596	27,066	629
PSDB	38,131	964	33,810	1,040	30,675	976	33,254	951	32,843	829
PSDC/DC	3,532	285	6,141	477	4,910	338	6,857	627	6,923	655
PSL	5,198	340	6,522	408	6,131	661	9,349	678	9,662	1,334
PSN/PHS	2,863	338	5,756	568	5,160	515	7,805	808	10,926	894
PSOL				535	2,679	771	4,262	1,056	4,479	1,170
PST	4,639	471								
PSTU	347	210	546	102	213	108	272	234	258	133
PT	25,829	1,495	36,600	1,144	31,765	1,243	40,022	1,190	21,842	1,126
PT do B/AVANTE	3,103	389	4,503	492	4,472	516	7,155	653	6,842	942
PTB	30,268	863	25,919	802	22,833	894	23,819	813	20,653	584
PTN/PODEMOS	1,919	223	4,353	299	4,473	444	6,775	528	8,952	844
PV	6,021	609	10,887	970	13,322	1,154	17,464	918	15,619	811
REDE									3,435	762
SD/SOLIDARIEDADE								465	13,711	723
Total candidates	364,002	16,493	362,165	17,442	340,431	17,862	428,666	21,468	453,344	25,568
Total parties	30	30	27	29	27	27	29	32	35	35

Source: TSE

Obs.: Parties which changed their names are considered as an unique party.

Considering that there are a large number of parties in Brazil, to make the vote share analysis manageable, parties were classified as left, center or right orientation based on Power & Zucco Jr (2012) party index[15]. Table 2 presents this organization.

[15]The authors construct a party index based on legislative surveys from 1990 to 2009, taking into consideration the ideological position of congress members in their activities.

Table 2: Party classification according to orientation (left, center or right)

Left	Center	Right
PC do B	PCB	PFL/DEM
PCO	PDT	PMN
PSB	PMDB/MDB	PPB/PP
PSOL	PPL	PRN/PTC
PSTU	PPS/CIDADANIA	PRTB
PT	PR/PL	PSDC/DC
	PRB/REPUBLICANOS	PSL
	PRONA	
	PRP	
	PSC	
	PSD	
	PSDB	
	PSN/PHS	
	PT do B/AVANTE	
	PTB	
	PTN/PODEMOS	
	PV	
	SD/SOLIDARIEDADE	

Obs.: Division of parties based on quantiles of party index (0.25, 0.75, 1)
Obs.2: Parties out of party index were allocated based on party description available on their internet page.

The party index has some aggregation of parties as "others", so another classification criterion was necessary. Parties web pages were consulted to analyze their history and beliefs in order to designate parties to the groups. This methodology may arise questions if some parties labeled as right are actually centrists. To avoid this issue, we focus on left parties vote shares in results section, since their classification are more direct and mostly based on the party index.

The relatively large number of parties in Brazilian makes both elections and politics complex processes (Pettersson-Lidbom 2008; Boulding & Brown 2015). In order to help understanding this process, Table 3 shows the winners, by party, in the last five elections for the national congress, while Table 4 shows the same information for state governors and municipalities[16].

Table 3 shows that no party had more than 20% of the deputies. The workers party (PT), who won four out of five last presidential elections (2002 to 2014), did not have the majority of the congress in any year (at least, without building a block of parties). In the Senate, the party with more seats had around 1/4 of the house until 2010, with more competitive elections since then, specially in 2018. So, in order to run the country, the president needs

[16]Since 1988, Brazil has 26 states and the Federal District. In 2018, there were 5,568 municipalities, with two districts, the Federal capital and the district of Fernando de Noronha, in Pernambuco. National Congress has 513 Federal Deputies and 81 Senators

Table 3: Distribuition of winners by party in National Congress, 2002-2018

	2002		2006		2010		2014		2018	
Party	Deputy	Senator	Deputy	Senator	Deputy	Senator	Deputy	Senator	Deputy	Senator
NOVO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0
PAN	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PC do B	2.3	0.0	2.5	3.7	2.9	1.9	2.0	0.0	1.8	0.0
PDT	4.1	7.4	4.7	3.7	5.3	3.7	3.9	14.8	5.5	3.7
PEN/PATRIOTA	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	1.0	0.0
PFL/DEM	16.4	25.9	12.7	22.2	8.4	3.7	4.1	11.1	5.7	7.4
PMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMDB/MDB	14.8	16.7	17.4	14.8	15.2	25.9	12.7	18.5	6.6	13.0
PMN	0.2	0.0	0.6	0.0	0.8	1.9	0.6	0.0	0.6	0.0
PPB/PP	9.4	0.0	8.0	3.7	8.6	7.4	7.4	3.7	7.2	9.3
PPL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
PPS/CIDADANIA	2.9	1.9	4.3	3.7	2.3	1.9	2.0	0.0	1.6	3.7
PR/PL	5.1	3.7	4.5	3.7	8.0	7.4	6.6	3.7	6.4	1.9
PRB/REPUBLICANOS	0.0	0.0	0.2	0.0	1.6	1.9	4.1	0.0	5.8	1.9
PRN/PTC	0.0	0.0	0.6	0.0	0.2	0.0	0.4	0.0	0.4	0.0
PRONA	1.2	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROS	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	1.6	1.9
PRP	0.0	0.0	0.0	0.0	0.4	0.0	0.6	0.0	0.8	1.9
PRTB	0.0	0.0	0.0	3.7	0.4	0.0	0.2	0.0	0.0	0.0
PSB	4.3	5.6	5.3	3.7	6.8	7.4	6.6	11.1	6.2	3.7
PSC	0.2	0.0	1.8	0.0	3.3	1.9	2.5	0.0	1.6	1.9
PSD	0.8	1.9	0.0	0.0	0.0	0.0	7.0	7.4	6.6	7.4
PSDB	13.7	14.8	12.9	18.5	10.5	11.1	10.5	14.8	5.7	7.4
PSDC/DC	0.2	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.0
PSL	0.2	0.0	0.0	0.0	0.2	0.0	0.2	0.0	10.1	7.4
PSN/PHS	0.0	0.0	0.4	0.0	0.4	0.0	1.0	0.0	1.2	3.7
PSOL	0.0	0.0	0.6	0.0	0.6	1.9	1.0	0.0	2.0	0.0
PST	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT	17.7	18.5	16.2	7.4	16.8	20.4	13.4	7.4	10.9	7.4
PT do B/AVANTE	0.0	0.0	0.2	0.0	0.6	0.0	0.2	0.0	1.4	0.0
PTB	5.1	3.7	4.3	11.1	4.3	1.9	4.9	7.4	2.0	3.7
PTN/PODEMOS	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	2.1	1.9
PV	1.0	0.0	2.5	0.0	2.5	0.0	1.6	0.0	0.8	0.0
REDE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	9.3
SD/SOLIDARIEDADE	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	2.5	1.9

Source: TSE

Obs.: Parties that changed their names are considered as an unique party.

to build alliances, otherwise it is unlikely to pass its bills. The number of parties necessary to form at least 60% of the deputies[17] has risen from at least four to eight, including both situation and opposition parties, which means that the necessary number of parties required to rule is even higher. In the senate, the number has risen from three to seven.

Competitiveness observed in National Congress elections is also present in subnational suffrage. Table 4 shows that most dominant party had around 20% of mayors and 25% of governors, not necessary the same party in each election, adding another layer of complexity in

[17]Bills that alter constitution require at least 308 votes of deputies and 49 votes of senators, i.e. 60% of the National Congress, in two rounds.

Table 4: Distribuition of winners by party in local executive elections, 2002-2018

	2000/2002		2004/2006		2008/2010		2012/2014		2016/2018	
Party	Mayor	Gov.	Mayor	Gov.	Mayor	Gov.	Mayor	Gov.	Mayor	Gov.
NOVO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7
PAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PC do B	0.0	0.0	0.2	0.0	0.7	0.0	1.0	3.6	1.5	3.7
PDT	5.4	3.7	5.5	7.4	6.3	0.0	5.5	7.1	6.0	3.7
PEN/PATRIOTA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
PFL/DEM	18.6	14.8	14.2	3.7	8.9	7.4	5.0	0.0	4.9	7.4
PMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
PMDB/MDB	22.2	18.5	19.0	25.9	21.7	18.5	18.4	25.0	18.9	11.1
PMN	0.3	0.0	0.6	0.0	0.8	3.7	0.7	0.0	0.5	0.0
PPB/PP	11.0	0.0	9.9	3.7	9.9	0.0	8.6	3.6	9.0	3.7
PPL	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0
PPS/CIDADANIA	3.0	7.4	5.5	7.4	2.3	0.0	2.2	0.0	2.2	0.0
PR/PL	4.2	0.0	6.8	0.0	6.9	0.0	5.0	0.0	5.4	0.0
PRB/REPUBLICANOS	0.0	0.0	0.0	0.0	1.0	0.0	1.4	0.0	1.9	0.0
PRN/PTC	0.1	0.0	0.3	0.0	0.2	0.0	0.4	0.0	0.3	0.0
PRONA	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.9	0.0
PRP	0.3	0.0	0.7	0.0	0.3	0.0	0.4	0.0	0.3	0.0
PRTB	0.1	0.0	0.2	0.0	0.2	0.0	0.3	0.0	0.2	0.0
PSB	2.6	14.8	3.1	11.1	5.6	22.2	7.9	10.7	7.4	11.1
PSC	0.5	0.0	0.4	0.0	1.0	0.0	1.5	0.0	1.6	7.4
PSD	1.9	0.0	0.0	0.0	0.0	0.0	8.9	7.1	9.7	7.4
PSDB	17.6	25.9	15.7	22.2	14.3	29.6	12.5	21.4	14.5	11.1
PSDC/DC	0.1	0.0	0.2	0.0	0.1	0.0	0.2	0.0	0.1	0.0
PSL	0.5	3.7	0.4	0.0	0.3	0.0	0.4	0.0	0.5	11.1
PSN/PHS	0.1	0.0	0.4	0.0	0.2	0.0	0.3	0.0	0.7	3.7
PSOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PST	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT	3.5	11.1	7.4	18.5	10.0	18.5	11.5	17.9	4.6	14.8
PT do B/AVANTE	0.1	0.0	0.4	0.0	0.1	0.0	0.4	0.0	0.2	0.0
PTB	7.5	0.0	7.6	0.0	7.4	0.0	5.3	0.0	4.6	0.0
PTN/PODEMOS	0.0	0.0	0.1	0.0	0.3	0.0	0.2	0.0	0.5	0.0
PV	0.2	0.0	1.0	0.0	1.4	0.0	1.8	0.0	1.8	0.0
REDE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
SD/SOLIDARIEDADE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0

Source: TSE

Obs.: Parties that changed their names are considered as an unique party.

the Brazilian Federal System (see Cancela & Geys (2016) for a discussion about coordination in multilevel elections in Brazil).

Until 2017, parties had the Party Fund[18] and private donations (since 2016, companies are not allowed to donate for elections[19]), which includes own resources from candidates. There are maximum values allowed to be expend by candidates in campaign, stipulated

[18]The *Fundo Partidário*, created by the Law 9,096/1995, available in http://www.tse.jus.br/legislacao/codigo-eleitoral/lei-dos-partidos-politicos/lei-dos-partidos-politicos-lei-nb0-9.096-de-19-de-setembro-de-1995.

[19]According to a Supreme Court (STF) decision, ADI 4,650/2015 and the Law 13,165/2015. Available in http://redir.stf.jus.br/paginadorpub/paginador.jsp?docTP=TP&docID=10329542 and http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2015/Lei/L13165.htm

each year by the Supreme Electoral Court (TSE - *Supreto Tribunal Eleitoral*). The Party Fund is distributed by the following rule: 5% is equally given to registered parties[20] and 95% according to votes won in the last deputies elections. In 2017, with prohibition of companies donation, another fund was created, the Electoral Fund[21], which is distributed with following rule: 2% equally between registered parties; 35% to parties with, at least, one deputy; 48% according to deputies proportion; and 15% according to senators proportion. For example, in 2018, the Fund Party was R$ 888.7 million (US$ 156 million), while the Electoral Fund was R$ 1.7 billion (US$ 299 million).

Another important aspect of Brazilian suffrage regards campaign advertisement. There are national, free of charges and mandatory programs during campaign time, booth aired daily in radio and television, broadcasting the same content in all regions of the country. There is a fixed amount of time for electoral advertisement in these channels, 2/3 distributed according to current party presence in legislatures and 1/3 among candidates[22], and only this time is allowed to be used in these channels. Ads on newspaper are also restricted, even though being a less important media compared to TV and radio. Internet is exception, where candidates can use it, almost freely, to reach voters, since 2009, except for anonymously or paid advertisement (which includes social medias like Twitter, Facebook, Instagram and YouTube)[23].

So, all this set of rules concentrate resources for some parties and candidates, making the internet an important alternative in elections. As aforementioned, in the presidential election of 2018, internet was pointed out as crucial for the result.

Looking now to electorate, in Brazil, voting is mandatory to literate citizens aged 18 to 69. For people aged 16 to 17 and 70 and over, voting is optional. Voters absent in election must justify or pay a small fine. If they fail to justify three consecutive polls, voter registration is canceled and some rights are lost (issue or renew passports and national identification, receive wages as public servant or from any institution linked to government, participate in public

[20]In 2017, the Constitution Amend 33 created the rules to access the Party Fund, so called *Cláusula de Barreira* (Barrier Clause). In 2019, the party must had 1.5% of valid votes for deputies in 2018, distributed at least in 1/3 of the states and with at least 1% of the votes in each one, or had nine deputies in at least 1/3 of the states. This rule will be more rigid in 2023, with 2% of the votes or 11 deputies, under the same rules. In 2027, the figures will be 2.5% (and at least 1.5% in 1/3 of the states) or 13 deputies and in 2031, they will be 3% (and at least 2% in 1/3 of the state) or 15 deputies.

[21]Called *Fundo Especial de Financiamento de Campanha*, it was created by the Laws 13,487/2017 and 13,488/2017. Available in http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2017/Lei/L13487.htm and http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2017/lei/L13488.htm.

[22]The same rules of the *Cláusula de Barreira* (Barrier Clause) is also applied here.

[23]There is a set of other rules stipulated by the Supreme Electoral Court in each election, like size of advertisement material, schedule for rallies etc.

competition for resources, request loans from institutions held by the government, apply to jobs as public servant, enroll in public education or engage in any public act that requests military service or income task discharge). This set raises the question if this rule changes incentives to acquire information about politicians and participate in elections, specially by poorer population. Table 5 shows the total number of voters as well total population with voter registration canceled from 2005 to 2019.

Table 5: Total of volters and voter registration canceled, 2005 to 2009

Year	Voters	Turnout	Turnout %	Canceled	Canceled %
2005	121,391,631	102,526,992	84.46	1,089,662	0.89
2007	125,913,494	104,820,459	83.25	1,652,565	1.30
2009	130,604,430	110,085,172	84.29	553,406	0.42
2011	135,804,433	111,193,747	81.88	1,400,549	1.03
2013	140,646,483	115,807,514	82.34	1,358,901	0.96
2015	142,822,083	115,122,883	80.61	1,717,425	1.20
2017	146,470,911	118,757,780	81.08	1,862,665	1.27
2019	147,306,275	117,364,654	79.67	2,491,271	1.69

Source: TSE

Obs.1: Includes voters registered in Brazil and abroad.

Obs.2: Turnout in the last elections.

Despite the mandatory voting rule, turnout was 82.2% in average from 2004 to 2018, and only 1.09% of voters registration were canceled, which means that more than 90% of those who did not turnout took actions to regularize their electoral obligations. Anyhow, turnout is pretty high when compared to USA or European countries.

According to Downs (1957), low probability to be pivotal in elections explain the "rational ignorance" of voters and low preference to turnout. On the other hand, mandatory vote could change these incentives, making people more inclined to vote (Lijphart 1997). Leon *et al.* (2014) finds that, for Brazilian case, mandatory voting seems not change people incentives to be more informed in voting decision. It seems the case that providing more information about candidates (Banerjee *et al.* 2011), hence lowering the costs for collect information, is more effective than compulsory voting system.

Following Fujiwara *et al.* (2016), we also consider possible persistent habits on voting pattern, incorporating raining information in election days in each municipality. The authors find that rainfall, both in current and past election day, reduces turnout and may possible affect consumption value of voting. Considering the continental size of Brazil, it may be an important contribution for analysis.

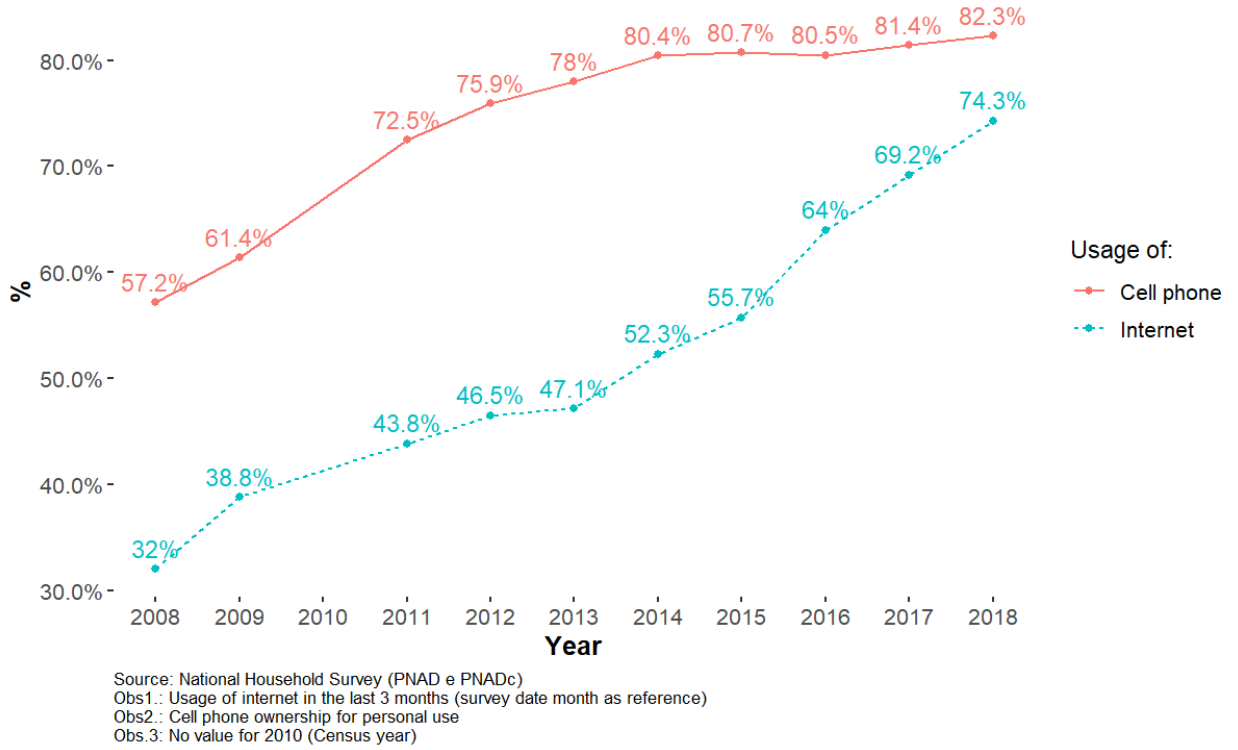
4 Empirical strategy and databases

In this section we describe in detail the empirical strategy, relied on the Backhaul program rules, the databases that support the analysis and the cumulative RDD set up.

4.1 Communication usage

As a glimpse of Brazilian communication consumption, Figure 1 presents internet and cell phone usage from 2008 to 2018.

Figure 1: Internet and cell phone usage in Brazil, % of 16+ years-old population, 2008-2009 and 2011-2018



In 2008, around 1/3 of Brazilians (16 years-old or above, i.e. population in voting age) declared to have used internet at least once in the past three months (September as reference), while almost 58% declared cell phone ownership for personal usage. In order to increase these figures, the government carried out a national plan in the begging of 2008. In 2011, these figures rose to 44% and 73%, respectively, indicating an increasing communication market in Brazil. Even in 2018, there is room remaining for internet and cell phone expansion in the country (around 25% and 18%, respectively).

Hence, this expressive change in communication consumption may have changed how Brazilians face politics, possibly increasing opportunities for information acquisition and social interaction about this matter, or, on the other hand, widening leisure alternatives and lowering politics information consumption.

4.2 Backhaul Program (National Broadband Plan)

In April 2008, the presidential Decree 6,424 changed the former National Plan of Goals for Public Switched Telephone (PST) Network Universalization, adding broadband infrastructure as mandatory (in exchange of the PST obligation). The infrastructure mentioned in the Decree was the Backhaul, a requirement for internet implementation in the country. Backhauls are necessary in order to connect them to the Telephone Companies' Backbones. The plan put as target that, at least, 40% of municipalities should have the necessary infrastructure by the end of 2008, 80% by the end of 2009 and 100% by the end of 2010. Also, minimal internet velocities were set, increasing with population size (Table 6).

Table 6: Backhaul Plan – setup

Population Size	N# municipalities	%	Velocity (Mbps)
Up to 20,000	3,077	89.5	8
From 20,001 to 40,000	268	7.8	16
From 40,001 to 60,000	63	1.8	32
Above 60,001	31	0.9	64
Total	3,439	100.0	

Source: Anatel

According to the National Agency of Telecommunication (Anatel[24]) (Anatel 2010), the majority of municipalities to be covered by Backhaul program were up to 20,000 inhabitants, which is more than half of total municipalities of Brazil[25]. The minimal required velocity (8 Mbps[26]) guarantee improvement in navigation quality, allowing, for example, streaming (of music and videos).

The program had three types of technology to be deployed: fiber, radio and satellite. The first is installed by cables of fiber optic, with less interference and in long distances, being connected directly to the household (FTTH) or to a concentrating point (FTTC), either with a higher cost of installation and maintenance. The second one is usually easier to be installed

[24] *Agência Nacional de Telecomunicações* in Portuguese.

[25] Today, Brazil has 5,568 municipalities and two districts. By the time when the program was created, six municipalities did not exist yet.

[26] Megabit per second.

(by antennas), maintained and reaches broader areas, like rural locales, but have limitations of interference, due to physical barriers, and of internet speed, due to distance. Finally, the third needs a satellite, an antenna in the household and a base antenna to intermediate communication, a set with high costs of installation and maintenance, but capable to reach broader areas, like rural, still being susceptible to weather interference. Considering the costs, radio was the main technology chosen, for 71% of the cities, followed by fiber, for 26%, and satellite for only 3%.

Out of 5,570 municipalities, by 2015, only 85 remained uncovered (Table 7) and 2,125 (38%) already had broadband infrastructure before the program beginning, mainly larger cities. We notice that the program focused on small cities, with average population under 15,000.

Table 7: Backhaul deployment by coverage status, 2015

Situation	# Munic	Avg Pop.
Covered	3,360	14,403
Covered before	2,125	67,151
Uncovered	85	35,372
Total	5,570	34,072

Source: Anatel and IBGE

According to program schedule, 100% of Brazilians' municipalities should has backhaul infrastructure in 2010. However, by this year, only 72% of the goal was achieved. Table 8 presents the roll out of the program by year.

The main point of our identification strategy relies on the velocity discontinuity, which is further analyzed in Figure 2 geographically,[27]. North and Northeast regions are poorer, while South and Southeast are richer[28], being important to analyze how the programs are deployed in the territory.

[27]Since Brazil is a continental country (8,516,000 km² of area, the fifth in the world) with important regional inequalities, regional visualization improve analysis.

[28]For example, the state of São Paulo was responsible for almost 1/3 of Brazilian GDP in 2017. Household income *per capita* of the richest state (Federal District) was 3.84 times greater than the poorest (Alagoas), according to 2014 National Household Survey (IBGE/PNAD). Brazilian Gini index for the same year was 0.517.

Table 8: Backhaul deployment by year

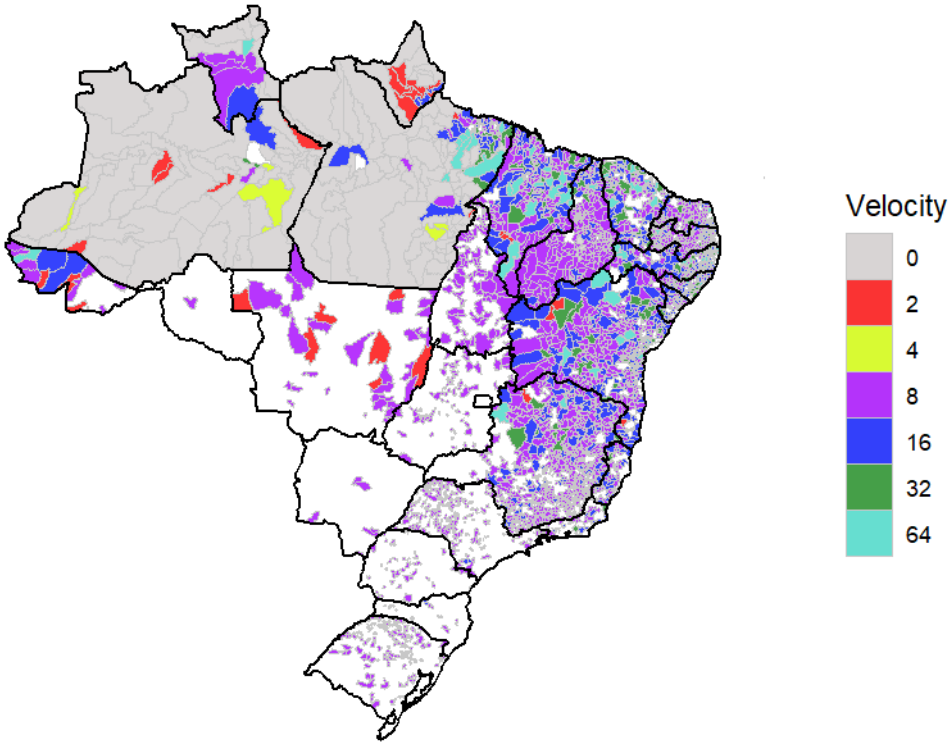
Backhaul year	# Munic	Avg. Velocity	Avg Pop.
2008	1,384	13	16,911
2009	1,388	10	13,340
2010	495	9	9,026
2011	27	2	12,134
2012	7	14	25,531
2013	41	4	20,238
2014	17		38,490
2015	1		13,293
Total	3,360	11	14,403

Source: Anatel.

Obs.1: No velocity information for 2014 and 2015.

Obs.2: Information only for program participants cities.

Figure 2: Internet velocity in backhaul program by municipality



Source: Anatel and IBGE

Figure 2 shows that a big portion of cities in the south and center-west were covered before (blank areas), while the northeast had the largest number of cities in the program. Also, the north region (the Amazon area) had a lot of cities uncovered by the program (gray areas). The most common velocity was 8 Mbps, as showed before in Table 6, corresponding to cities under 20,000 inhabitants.

4.3 Methodology

Following Cattaneo *et al.* (2018), each municipality has a running variable X_i (the size of population) with potential outcomes $Y_i(0)$ (a lower internet velocity) and $Y_i(1)$ (higher – double – internet velocity). Municipalities face three possible cutoffs $C_i \in C$, with $C = c_1, c_2, c_3$. Ranges of population determine which type of treatment a municipality will receive: at least 8 Mpbs if $X_i \leq c_1$, at least 16 Mbps if $c_1 < X_i \leq c_2$, at least 32 Mbps if $c_2 < X_i \leq c_3$ and at least 64 Mbps if $X_i > c_3$.

Denote each treatment as d_j, so $D_i \in \{d_1, d_2, d_3\}$.

The effect for each cutoff, under standard regularity conditions, is identified by:

$$\tau_j = \mathbb{E}[Y_i(d_j) - Y_i(d_{j-1})|X_i = c_j] = \lim_{x \downarrow c_j} \mathbb{E}[Y_i|X_i = x] - \lim_{x \uparrow c_j} \mathbb{E}[Y_i|X_i = x] \quad (1)$$

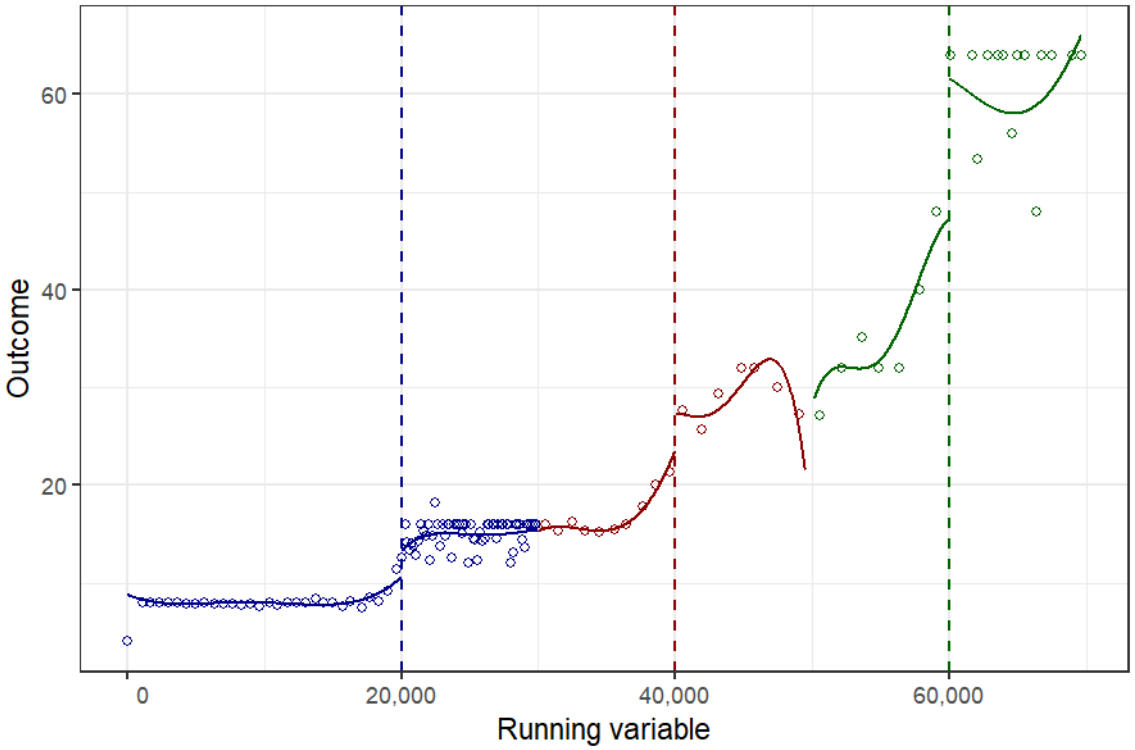
Each observation may be used to estimate two different, and contiguous, treatment effects. For example, looking to the first cutoff, 20,000, municipalities with population above that value are treated (up to the next cutoff – 40,000) when estimating τ_j, but they are controls when estimating τ_{j+1} (and, hence, below the next cutoff – 40,000). An observation can or cannot be used to estimate two effects, depending on bandwidth selection.

All the three cut-offs are considered (20,000, 40,000 and 60,000), with optimal bandwidth chosen by minimizing the asymptotic mean squared error following Calonico *et al.* (2014), Calonico *et al.* (2017) and Calonico *et al.* (2018).[29].

Figure 3 shows a clear jump in velocity cutoffs for the entire period. The jump around cutoffs are clear, where municipalities just below the population size established in the program face lower internet velocities.

[29]Regressions are performed in R software, with rdmulti package: Matias D. Cattaneo, Rocio Titiunik and Gonzalo Vazquez-Bare (2020). rdmulti: Analysis of RD Designs with Multiple Cutoffs or Scores. R package version 0.6. https://CRAN.R-project.org/package=rdmulti

Figure 3: Discontinuity in Backhaul program velocity by population cut-offs: 20,000; 40,000; 60,000



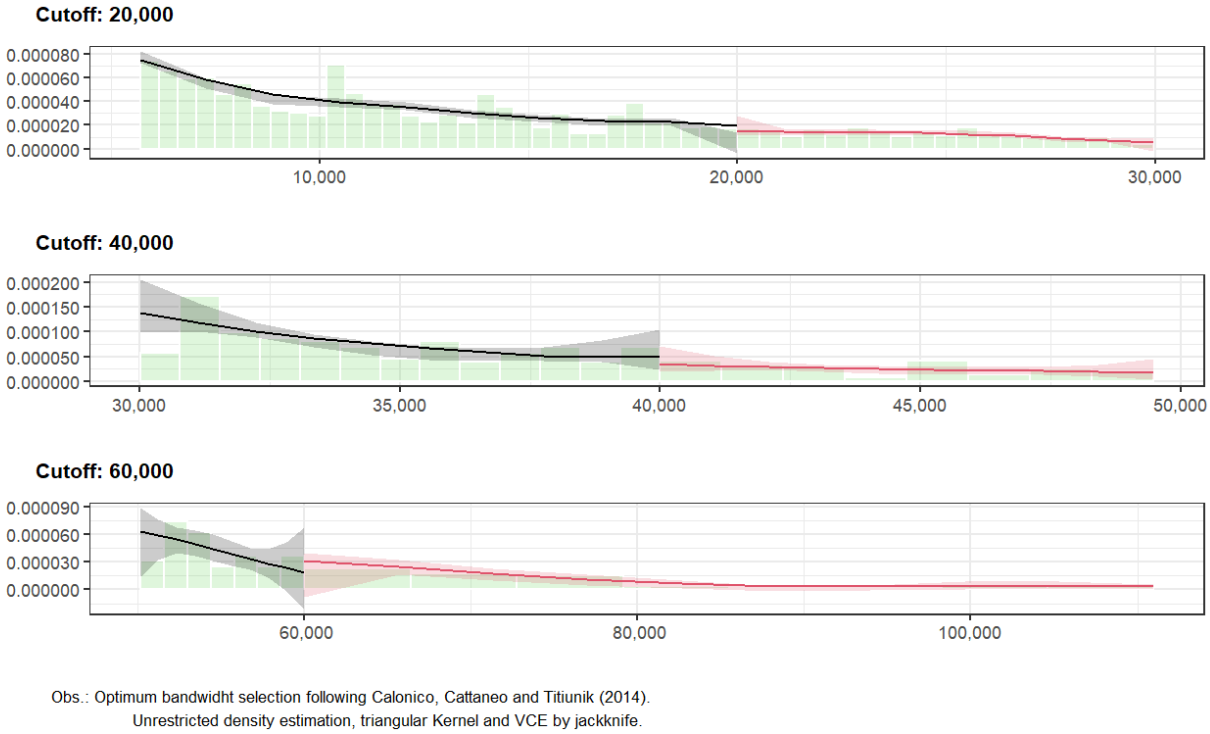
The classical McCrary manipulation test of cutoffs (McCrary 2008) looks if there is a selection into treatment, analyzing the density distribution of the running variable around the cutoff. An alternative test was developed by Cattaneo *et al.* (2019) and Cattaneo *et al.* (2020), where confidence bands are provided, well suited for RDD designs. Results for this test are presented in Table 9 Figure 4 for all three cutoffs.

Table 9: Cattaneo, Jansson and Ma manipulation test of cutoffs

Cutoff	Bw	N	Nl	Nr	T (jackknife)	P.value
20,000	4,768	3,001	305	158	2.399	0.016
40,000	8,245	226	120	58	-0.692	0.489
60,000	13,753	115	47	37	-0.266	0.791

Obs.1: Optimum bandwidht selection following Calonico, Cattaneo and Titiunik (2014).
Obs.2: Unrestricted density estimation, triangular Kernel and VCE by jackknife.
Obs.3: Bw=bandwidth; N, Nl and Nr are total n# of obs., n# on the left and n# on the right.

Figure 4: Density plot - Cattaneo, Jansson and Ma manipulation test of cutoffs



Obs.: Optimum bandwidht selection following Calonico, Cattaneo and Titiunik (2014).
Unrestricted density estimation, triangular Kernel and VCE by jackknife.

The manipulation test, together with Figure 3, suggests that our identification strategy is valid, for all three cutoffs, although the last one in a lower significant level (the cutoff with a lower number of observations). As we can see on Figure 4, the visual inspect confirms the test results. Further, the figure shows that Brazil has an odd population distribution, with unexpected jumps in some population ranges. Monasterio (2013) shows that these jumps occur due to a legislation regarding Federal transfers of resources to municipalities (*Fundo de Participação dos Municípios - FPM*), based on the population size[30]. Despite there are no intersection of running variable and FPM's cutoffs, we control for the later one, in order to avoid any confounder effect regarding this situation in results.

4.4 Databases

Outcomes are election results/information, organized by Superior Election Court (TSE)[31]. We will analyze 2008, 2010 and 2012 elections, covering two municipal and one national

[30] According to the Decree-Law 1,881/1981, there are 17 ranges of population, with increasing possibility of resources distribution for each range. The cuts are: 10,188; 13,584; 16,980; 23,772; 30,564; 37,356; 44,148; 50,940; 61,128; 71,316; 81,504; 91,692; 101,880; 115,464; 129,048; 142,632; 156,216. Available in http://www.planalto.gov.br/ccivil_03/Decreto-Lei/1965-1988/Del1881.htm

[31] *Tribunal Superior Eleitoral* in Portuguese.

suffrage. The main outcomes are: turnout, percentage of blank or null votes[32] and vote shares, for left wing parties (as mentioned before, and using Power & Zucco Jr (2012) party index from Brazilian Legislative Survey[33], left wing parties are those up to quantile 0.25 of the index, center parties are those between 0.25 and 0.75 and right wing are those above), a small party and young candidates (under 30 years-old). Also, we look to the number of candidates and the budget campaign of a small party and young candidates.

Despite the clear discontinuities in the running variable, a set of covariates were collected, in order to control for any further confounders that might remain. Lack of information at municipal level is one of the weakness in Brazilian researches at this territory level. Census occurs only every ten years[34], remaining just few administrative data in the between years, some of them with low quality (mainly for small cities). Even tough, considering this is the only source of the main socioeconomic variables, we use information from the last two censuses (2000 and 2010), organized by Brazilian Institute of Statistics and Geography (IBGE). Also from IBGE, we collect total population estimates and GDP. Considering that direct cash transfers are important in Brazil, we collect data from the two major programs: *Bolsa Família* (PBF) and *Benefício de Prestação Continuada* for elders (BPC), booth organized by Ministry of Citizenship[35]. In addition, we collect the mass of wages (formal labor market) from RAIS database, organized by Ministry of Economy[36]. We also collected information from National Institute of Meteorology, to control for rain and temperature in election day, following Fujiwara *et al.* (2016). Municipalities were joined by the nearest distance between the center of the city and the closest meteorological station. Table 10 summarizes each variable and source.

[32]In Brazilian election, people may put a blank vote, which are not computed for any candidate and is not considered for official results, as well null votes. The difference consists in the way the registration of these votes are made: the blank vote is available as a button in the electronic ballot, while the null vote occurs when someone enters an invalid candidate number into the ballot and confirms the vote.

[33]Version 7, available in https://dataverse.harvard.edu/dataverse/bls;jsessionid=992eedb7e954a17ef718c7078cf5?widget=dataverse%40harvard&q=&types=dataverses%3Afiles%3Adatasets&sort=dateSort&order=desc&page=3

[34]When not delayed. The 1990 census was postponed to 1991, as well as 2020 census is postponed to 2021.

[35]PBF is one of the biggest conditional cash transfer program in the world. The target are families under the extreme poverty and poverty lines (in 2020, families earning up to R$ 89 by person, or U$ 16, by month are considered extremely poor, while families above that amount and up to R$ 178, or U$ 31, are considered poor), focused one children. As counter part, school attendance and vaccination are required. PBF reaches around 14 million families in Brazil in 2020. On the other hand, BPC is a program for elderly and handicapped. The poor population in this profile (people aged 65 or over and all handicapped) are eligible for a minimum wage paycheck (R$ 1.045, or U$ 184, in 2020).

[36]In Brazil, every formal company have to fill the Annual Relation of Social Information (RAIS), with the profile of all workers they had in the calendar year, including wages.

Table 10: Variables, description and source, by type

Category	Variable	Description	Source
Outcome	Turnout	Participation percentage of total electorate	TSE
	Vote share	Vote share of parties and/or orientation of parties (left, center or right)	TSE
	Blank and null votes	Percentage of blank and null votes in total	TSE
	Donations	Declared donation received for campaign purpose	TSE
Running	Population	Estimated population	IBGE
Controls	Black	Percentage of blacks in population	IBGE
	College	Percentage of people with college degree	IBGE
	Married	Percetage of people married	IBGE
	Income	Median household income	IBGE
	Population over 60 years	Percentage of population over 60 years in population	IBGE
	Radio	Percentage of households with radio	IBGE
	Rural	Percentage of population in rural areas	IBGE
	Television	Percentage of households with television	IBGE
	Working age population	Percentage of population in working age	IBGE
	GDP	Gross Domestic Product	IBGE
	BPC	Ratio of BPC payments and GDP	MC and IBGE
	PBF	Ratio of PBF payments and GDP	MC and IBGE
	Formal wage	Ratio of formal wages (sum) and GDP	ME and IBGE
	Temperature	Average temperature a week before and after election day	Inmet
	Rain	Rain preciptation in election day	Inmet
	Fibra-optic	Fibra-optic internet infrasctructure in municipality	Anatel
	FPM	FPM transfer per capita	Treasury

Source: TSE, IBGE, Inmet, ME (Ministry of Economy), MC (Ministry of Citizenship) and Anatel.

4.5 Descriptive statistics

Descriptive statistics are separated by population ranges, considering the cutoffs (under 20,000, between 20,000 and 40,000, between 40,000 and 60,000 and above 60,000). Table 11 shows the figures for 2008 year.

We notice that municipalities under 20,000 inhabitants have less percentage of blacks, BPC transfers and fiber-optic technology penetration, while more population in working age, in rural areas, ownership of radio, population over 60 years and married people.

In order to clarify identification validity, Table 12 presents a simple t-test for 20,000 population cutoff with a 3,285 cutoff, the same used before in the manipulation test.

Results for 2008 year in Table 12 (which, indeed, refers to 2000 census for socioeconomic variables) show that there were no significant differences for most of the characteristics between municipalities just above and just below the cutoff, except for formal wages (at 1% of significance), BPC and rural population (at 5% of significance), fiber-optic and television (at 10% of significance). Some results, however, do not hold in 2010, year with values collected from 2010 census and, hence, closer to the year of analysis. Some covariates, like median

Table 11: Descriptive statistics by population size of municipality, 2008

Variable	Under 20k	Above 20k to 40k	Above 40k to 60k	Above 60k
60_anos_2000	0.1	0.1	0.1	0.1
Avg. Temperature	24.2	25.6	26.4	27.2
Black	53.4	65.5	68.1	68.6
BPC	0.3	0.8	0.8	0.9
College	0.7	0.6	0.6	0.8
Fiber-optic	23.1	34.2	33.6	47.2
Formal Wages	11.5	11.5	12.8	13.8
FPM	742.9	326	261.3	214.3
GDP	7.8	6.9	6.3	8.2
Income	603.2	549.6	555.2	645.2
Married	30	24.1	22	22.5
PBF	2.5	3	2.6	2
pop_anterior	8041.5	27272.5	47975.6	97096
Radio	79.3	75.4	75.6	76.1
Rain (elect. day)	3.3	1.7	1.9	2.9
Rural	49.8	46.6	40.3	32.2
Television	69.2	66.4	68.1	73.6
Working Pop.	41.4	38.8	37.9	38.9
Observations	2,733	520	107	72

Source: IBGE, Inmet, ME, MC and Anatel.

Table 12: Covariates means difference t test for 20,000 cutoff, 2008, 2010 and 2012

Variable	Diff 2008	Diff 2010	Diff 2012
Median Income	5.7	-92.6***	-38.4
Pop. over 60 years	-0.11	-0.03	0.23
Rural	4.59**	6.84***	4.28**
Black	-1.51	2.44	0.29
Radio	-1.20	-1.10	0.16
Television	-3.48*	-1.91**	-1.11
College	0.03	-0.26**	-0.16
Married	0.05	0.02	0.66
Working Pop.	-0.73	-2.22***	-0.77
Rain (elect. day)	-0.2	0.1	0.0
Avg. Temperature	0.0	0.4	0.2
PBF	0.24	0.67***	0.48**
BPC	-0.22**	-0.27***	-0.14
GDP	0.8	-2.6	-1.7
Formal Wages	-1.73***	-1.18*	-0.91
Fiber-optic	-8.00*	-3.67	-3.72
FPM transfer (pc)	51.5***	53.2***	73.4***
N. Obs	380	383	384

Source: IBGE, Inmet, ME, MC and Anatel.

Obs.1: Null hypotheses is no difference.

Obs.2: * = significant at 10%; ** = significant at 5%; *** = significant at 1%.

Obs.3: Bandwidth: 3,285

income, rural areas, working age population BPC and PBF seems to be different across municipalities, although in a low absolute difference for the most of then. Results for 2012 is more similar to those observed in 2000, for the most of variables. Overall, Table 12 results

suggests that our identification strategy should work, if controlled for covariates.

5 Results

Considering that there are two rounds for two types of offices, mayor and president, and some municipalities might not have a second round, we focus only on the first one, using, hence, the larger sample size as possible. In tables results, there are always three election years, where two are local (2008 and 2012) and the other is national (2010). A summary of first stage of fuzzy RDD regressions are reported in Table 24 in Appendix, all of then supporting the identification strategy.

We begin our analysis of results looking to the effects of broadband internet in participation. Results in Table 13 suggest no relationship between the velocity of this technology and participation in elections. For all regressions, considering the three cutoffs and the three years, only one had a slightly significant result (2010, for 60,000 inhabitants). Since participation in elections is mandatory in Brazil, and turnout is relatively high (around 80%), maybe there is no much room to improve this situation. These results are in line with Menezes (2015) for Brazil, as well as results reported by Miner (2015) for Malaysia, but differ from results reported in USA and European countries (Jaber 2013; Falck *et al.* 2014; Gavazza *et al.* 2015; Campante *et al.* 2017), where vote is not mandatory, and, hence, an important institutional difference when analyzing this result.

Table 13: Fuzzy-RDD regression results for turnout. Election years: 2008, 2010 and 2012

Year	Cutoff	Bw	Obs.	Coef.	SE	P.value
2008	20,000	3,584	401	0.003	0.010	0.634
	40,000	11,403	265	0.003	0.004	0.229
	60,000	16,997	126	-0.002	0.003	0.168
2010	20,000	4,924	554	-0.001	0.006	0.493
	40,000	12,191	302	0.001	0.002	0.419
	60,000	23,183	200	0.002	0.001	0.071
2012	20,000	10,735	1,335	0.002	0.003	0.507
	40,000	6,617	143	0.001	0.010	0.870
	60,000	11,631	95	0.001	0.003	0.649

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust nearest neighbor variance estimator (three minimum neighbors). Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014). Triangular kernel with quadratic local-polynomial. Turnout for the first round. Results with controls listed in Table 10

Seeing from a different perspective, the new possibility of leisure did not reduce people participation in elections. In other backgrounds, where participation in elections are not mandatory, results may be different (like in Germany and UK, showed by Falck *et al.* (2014) and Gavazza *et al.* (2015), respectively with negative effects).

The next outcome regards to the percentage of blank or null votes (Table 14). Again, there no support in favor of the influence of broadband internet in this type of votes (a *proxy* for "absence of engagement with political process", since these votes can be seen as a "whatever vote"). So, results so far suggests that broadband did not encourage or discourage people to turnout neither people to place more directed votes in elections (again in accordance to Menezes (2015) results).

Table 14: RDD-fuzzy regression results for blank or null votes. Election years: 2008, 2010 and 2012. Offices: president and mayors.

Year	Cutoff	Bw	Obs.	Coef.	SE	P.value
2008	20,000	4,250	471	-0.095	0.136	0.752
	40,000	11,989	282	0.000	0.003	0.565
	60,000	20,209	147	0.001	0.004	0.490
2010	20,000	4,098	461	0.004	0.004	0.182
	40,000	9,872	251	0.002	0.004	0.320
	60,000	18,868	152	0.000	0.001	0.877
2012	20,000	3,681	413	0.023	0.027	0.196
	40,000	14,408	394	-0.002	0.005	0.677
	60,000	13,801	107	0.034	0.170	0.822

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust nearest neighbor variance estimator (three minimum neighbors). Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014). Triangular kernel with quadratic local-polynomial. Results with controls listed in Table 10

In last presidential elections (2018), polarization was dramatic in Brazil. Left versus Right debate was at the center of the presidential run, with the last four times presidential winner party (the left wing Workers Party – PT) being the main target. Before that, the 2014 elections was one of the closest seen in Brazil, when Mrs. Rouseff defeated Mr. Neves (from central right Brazilian Social Democracy Party – PSDB) with only 51.64% of the valid votes in the second round. Internet may had an important role in this scenario, since, back in 2010, Mr. Lula da Silva, the first president of Workers Party, had 80% of presidency approval, the highest value ever recorded.[37]

[37] A news about these figures are available in: http://g1.globo.com/politica/noticia/2010/12/popularidade-de-lula-bate-recorde-e-chega-87-diz-ibope.html

Hence, a closer look at the relationship between broadband velocity and vote share of left parties since 2008 might shed light into this turnaround in Brazil. As pointed before, vote shares were classified as left, center or right based on Power & Zucco Jr (2012) party index.

Results suggests, once again, that there is no relationship between broadband internet speed and the vote share received by left wing parties in elections for president and mayors (Table 15). So, unlike results reported by previous studies (Jaber 2013; Falck *et al.* 2014; Gavazza *et al.* 2015; Campante *et al.* 2017), there is little evidence of important effects of internet on vote shares, at least when fixed broadband is considered.

Table 15: Fuzzy-RDD regression results for left wing parties vote share. Election years: 2008, 2010 and 2012. Offices: president and mayors.

Year	Cutoff	Bw	Obs.	Coef.	SE	P.value
2008	20,000	3,723	217	-0.269	2.040	0.940
	40,000	12,974	195	-0.009	0.034	0.919
	60,000	26,281	143	-0.001	0.004	0.809
2010	20,000	4,810	542	-0.003	0.011	0.820
	40,000	7,651	175	-0.025	0.319	0.800
	60,000	21,243	183	0.003	0.003	0.243
2012	20,000	3,693	237	-0.229	1.285	0.484
	40,000	12,756	212	-0.006	0.016	0.876
	60,000	15,286	87	-0.048	0.127	0.497

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust nearest neighbor variance estimator (three minimum neighbors). Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014). Triangular kernel with quadratic local-polynomial. Left wing parties: PSTU, PSOL, PC do B, PT, PSB and PCO. Results with controls listed in Table 10.

Despite results suggest no relationship between left wing parties and votes, some smaller parties, that face narrow campaign budgets, could use broadband internet to reach more people at lower costs. Table 16 presents the vote share of PSOL party for local legislators (*vereador*) and federal deputy (*deputado federal*), offices with more number of candidates[38]. PSOL (*Partido Socialismo e Liberdade*[39]) is a relatively recent left wing party, formed in 2004 with dissidents from PT, which makes an interesting case of study.

Results suggests a negative effect, for two out the three cutoffs, in 2010 national elections, but with a limited effect in terms of percentage of votes. Menezes (2015), reports positive

[38]Executive offices campaigns are more expensive and parties usually support each other to improve winning chances, forming blocks (*coligações*).

[39]Socialism and Liberty Party.

Table 16: RDD-fuzzy regression results for PSOL vote share. Election years: 2008, 2010 and 2012. Offices: local legislator and federal deputy.

Year	Cutoff	Bw	Obs.	Coef.	SE	P.value
2008	20,000	13,955	66	-0.0016	0.0017	0.6262
	40,000	27,243	84	0.0000	0.0006	0.3531
	60,000	38,619	71	0.0009	0.0030	0.7607
2010	20,000	6,802	772	-0.0004	0.0002	0.0119
	40,000	13,581	358	0.0002	0.0002	0.0250
	60,000	20,984	179	-0.0001	0.0001	0.0789
2012	20,000	9,708	77	0.0029	0.0187	0.8564
	40,000	12,799	62	0.0003	0.0017	0.8727
	60,000	17,647	42	0.0010	0.0038	0.5404

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust nearest neighbor variance estimator (three minimum neighbors). Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014). Triangular kernel with quadratic local-polynomial. Results with controls listed in Table 10.

effects for small and third-placed parties, also for 2010 elections, which is, somewhat related with results found here, at least in significant results (not in magnitude or direction).

Another possible effect could be seen in votes for young candidates (under 30 years), who could take better advantage of broadband internet due to familiarity to new technologies. Table 17 presents the vote share of local legislators (*vereador*) and federal deputy, who also have more candidates running than for executive offices.

Results suggests no relationship between broadband internet speed and vote share for young candidates, in any year or cutoff, meaning that this technology seems have not helped in electoral performance of younger.

We now investigate two outcomes not related to ballots directly, but with candidates participation and budget. Table 18 present results for the first, only for 2008 and 2012 years, since in national elections candidates do not run representing cities or districts.

Table 17: RDD-fuzzy regression results for young candidates (under 30 years-old). Election years: 2008, 2010 and 2012. Offices: local legislator and federal deputy.

Year	Cutoff	Bw	Obs.	Coef.	SE	P.value
2008	20,000	4,621	506	-0.090	0.261	0.909
	40,000	13,638	333	0.004	0.006	0.180
	60,000	10,466	71	0.002	0.002	0.135
2010	20,000	3,147	368	0.009	0.014	0.288
	40,000	11,604	281	-0.002	0.012	0.752
	60,000	7,021	55	0.000	0.001	0.795
2012	20,000	4,319	474	-0.011	0.013	0.206
	40,000	4,806	102	-0.341	25.000	0.878
	60,000	12,816	102	0.013	0.050	1.000

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust nearest neighbor variance estimator (three minimum neighbors). Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014). Triangular kernel with quadratic local-polynomial. Results with controls listed in Table 10.

Table 18: RDD-fuzzy regression results for number of candidates. Election years: 2008, 2010 and 2012. Offices: local legislator and federal deputy.

Year	Cutoff	Bw	Obs.	Coef.	SE	P.value
2008	20,000	4,309	476	0.645	0.969	0.846
	40,000	11,976	282	-0.103	0.190	0.519
	60,000	28,290	262	0.006	0.032	0.758
2012	20,000	12,800	1,680	0.000	0.028	0.822
	40,000	6,637	143	0.166	0.513	0.661
	60,000	10,808	89	-0.079	0.169	0.828

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust nearest neighbor variance estimator (three minimum neighbors). Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014). Triangular kernel with quadratic local-polynomial. Results with controls listed in Table 10.

Like most of the outcomes so far, results suggests no relationship between broadband internet speed and the number of candidates running for local offices. The new possibility to reach voters seems not be sufficient to attract people to run in elections.

Regarding budget campaign, we look two outcomes: the amount used by a small party (PSOL) and by young candidates (Tables 19 and 20, respectively).

Table 19: RDD-fuzzy regression results for PSOL campaign budget Election years: 2008, 2010 and 2012

Year	Cutoff	Bw	Obs.	Coef.	SE	P.value
2008	20,000	19,155	58	0.053	0.266	0.725
	40,000	19,261	32	5.799	217.042	0.569
	60,000	28,808	26	0.037	0.199	0.941
2012	20,000	7,267	40	-0.032	0.337	0.929
	40,000	15,803	55	-0.056	0.074	0.206
	60,000	24,205	45	0.089	0.171	0.459

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust nearest neighbor variance estimator (three minimum neighbors). Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014). Triangular kernel with quadratic local-polynomial. Results with controls listed in Table 10.

Table 20: RDD-fuzzy regression results for young candidates (under 30 years-old) budget. Election years: 2008, 2010 and 2012

Year	Cutoff	Bw	Obs.	Coef.	SE	P.value
2008	20,000	4,739	524	-0.157	0.603	0.838
	40,000	16,976	477	0.003	0.003	0.072
	60,000	11,331	73	0.001	0.002	0.694
2012	20,000	4,892	539	-0.017	0.010	0.021
	40,000	5,467	118	0.048	0.200	0.609
	60,000	31,060	368	-0.004	0.002	0.000

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust nearest neighbor variance estimator (three minimum neighbors). Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014). Triangular kernel with quadratic local-polynomial. Results with controls listed in Table 10.

For the PSOL party, there is no relationship between broadband internet speed and budget, while for young candidates results are mix: slightly significant and positive for just one cutoff in 2008 (40,000) and actually negative in 2012 for the first and last cutoffs. If any conclusion could be taken is that broadband internet velocity are related with lower young candidates budgets in 2012 elections. The only parallel in literature we can make about this

outcome is regarding party donating in US elections, where Jaber (2013) reports a positive impact for Democratic Party.

5.1 Further investigation

In the previous section, due to RDD design, each regression was run considering the multiple cutoff structure. Another way to estimate results is with parametric regressions, using the distance of the running variable to the cutoff and adjusting it by a polynomial. We look to parametric regressions considering two specifications: linear and quadratic. This choice follows Gelman & Imbens (2019), to avoid possible noisy estimates, eventual sensitivity to the degree of the polynomial and problems with the confidence intervals.

The results are presented in Table 21, with all outcomes and the three elections years and cutoffs. The lack of relationship between broadband internet and turnout, blank and null votes, left wing vote share, number of candidates, PSOL vote share and budget, and young candidates vote share and budget remains. Significant results are sparse and, some times, with inverted signs when linear specification is switched to quadratic.

Table 21: Parametric Fuzzy-RDD regression for all outcomes. Election years: 2008, 2010 and 2012

Year	Model	Cutoff	Obs.	Coef.	SE	P.value	Outcome
2008	Linear	20,000	3,356	0.001	0.001	0.196	Turnout
	Quadratic	20,000	3,356	0.002	0.010	0.862	
	Linear	40,000	3,356	0.001	0.000	0.011	
	Quadratic	40,000	3,356	-0.001	0.001	0.222	
	Linear	60,000	3,356	0.002	0.001	0.023	
	Quadratic	60,000	3,356	-0.001	0.001	0.061	
2010	Linear	20,000	3,427	0.001	0.001	0.089	Turnout
	Quadratic	20,000	3,427	0.000	0.001	0.876	
	Linear	40,000	3,427	0.000	0.000	0.010	
	Quadratic	40,000	3,427	-0.002	0.001	0.147	
	Linear	60,000	3,427	0.002	0.000	0.000	
	Quadratic	60,000	3,427	0.000	0.001	0.977	
2012	Linear	20,000	3,428	0.001	0.001	0.329	Turnout
	Quadratic	20,000	3,428	0.000	0.001	0.579	
	Linear	40,000	3,428	0.000	0.000	0.203	
	Quadratic	40,000	3,428	-0.002	0.001	0.132	
	Linear	60,000	3,428	0.001	0.000	0.001	
	Quadratic	60,000	3,428	0.000	0.000	0.944	

Table 21: Parametric Fuzzy-RDD regression for all outcomes. Election years: 2008, 2010 and 2012 *(continued)*

Year	Model	Cutoff	Obs.	Coef.	SE	P.value	Outcome
2008	Linear	20,000	3,356	0.001	0.001	0.154	Blank or Null votes
	Quadratic	20,000	3,356	0.018	0.067	0.788	
	Linear	40,000	3,356	-0.002	0.000	0.000	
	Quadratic	40,000	3,356	0.001	0.000	0.001	
	Linear	60,000	3,356	-0.002	0.002	0.267	
	Quadratic	60,000	3,356	0.001	0.002	0.590	
2010	Linear	20,000	3,427	0.000	0.000	0.690	Blank or Null votes
	Quadratic	20,000	3,427	0.002	0.001	0.068	
	Linear	40,000	3,427	0.000	0.000	0.381	
	Quadratic	40,000	3,427	0.000	0.000	0.159	
	Linear	60,000	3,427	0.000	0.000	0.784	
	Quadratic	60,000	3,427	0.001	0.000	0.009	
2012	Linear	20,000	3,428	0.002	0.001	0.052	Blank or Null votes
	Quadratic	20,000	3,428	0.007	0.004	0.047	
	Linear	40,000	3,428	0.001	0.000	0.006	
	Quadratic	40,000	3,428	0.002	0.001	0.217	
	Linear	60,000	3,428	-0.001	0.001	0.491	
	Quadratic	60,000	3,428	-0.002	0.001	0.182	
2008	Linear	20,000	1,530	0.012	0.002	0.000	Left wing vote share
	Quadratic	20,000	1,530	0.115	0.458	0.803	
	Linear	40,000	1,530	-0.003	0.001	0.000	
	Quadratic	40,000	1,530	-0.015	0.004	0.000	
	Linear	60,000	1,530	-0.005	0.003	0.085	
	Quadratic	60,000	1,530	-0.012	0.008	0.145	
2010	Linear	20,000	3,427	0.001	0.001	0.575	Left wing vote share
	Quadratic	20,000	3,427	-0.002	0.004	0.610	
	Linear	40,000	3,427	0.001	0.001	0.586	
	Quadratic	40,000	3,427	0.001	0.001	0.288	
	Linear	60,000	3,427	0.000	0.001	0.960	
	Quadratic	60,000	3,427	0.001	0.001	0.319	
2012	Linear	20,000	1,738	-0.002	0.002	0.302	Left wing vote share
	Quadratic	20,000	1,738	-0.011	0.012	0.371	
	Linear	40,000	1,738	-0.001	0.002	0.480	
	Quadratic	40,000	1,738	-0.004	0.002	0.058	
	Linear	60,000	1,738	-0.002	0.002	0.261	
	Quadratic	60,000	1,738	-0.005	0.001	0.000	

Table 21: Parametric Fuzzy-RDD regression for all outcomes. Election years: 2008, 2010 and 2012 *(continued)*

Year	Model	Cutoff	Obs.	Coef.	SE	P.value	Outcome
2008	Linear	20,000	3,356	0.007	0.006	0.185	N. cand.
	Quadratic	20,000	3,356	0.022	0.152	0.883	
	Linear	40,000	3,356	-0.007	0.011	0.539	
	Quadratic	40,000	3,356	-0.017	0.006	0.004	
	Linear	60,000	3,356	-0.003	0.002	0.149	
	Quadratic	60,000	3,356	0.010	0.012	0.401	
2012	Linear	20,000	3,427	0.010	0.008	0.224	N. cand.
	Quadratic	20,000	3,427	0.033	0.048	0.489	
	Linear	40,000	3,427	-0.008	0.010	0.466	
	Quadratic	40,000	3,427	-0.006	0.014	0.658	
	Linear	60,000	3,427	-0.018	0.010	0.070	
	Quadratic	60,000	3,427	-0.014	0.009	0.101	
2008	Linear	20,000	128	0.000	0.001	0.370	PSOL vote share
	Quadratic	20,000	128	0.002	0.001	0.225	
	Linear	40,000	128	0.001	0.001	0.089	
	Quadratic	40,000	128	0.000	0.000	0.038	
	Linear	60,000	128	0.002	0.005	0.652	
	Quadratic	60,000	128	0.000	0.004	0.915	
2010	Linear	20,000	2,815	0.000	0.000	0.266	PSOL vote share
	Quadratic	20,000	2,815	0.000	0.000	0.002	
	Linear	40,000	2,815	0.000	0.000	0.719	
	Quadratic	40,000	2,815	0.000	0.000	0.003	
	Linear	60,000	2,815	0.000	0.000	0.765	
	Quadratic	60,000	2,815	0.000	0.000	0.629	
2012	Linear	20,000	211	-0.001	0.001	0.363	PSOL vote share
	Quadratic	20,000	211	-0.003	0.009	0.708	
	Linear	40,000	211	0.000	0.000	0.018	
	Quadratic	40,000	211	0.000	0.000	0.770	
	Linear	60,000	211	0.000	0.000	0.024	
	Quadratic	60,000	211	0.000	0.000	0.410	
2008	Linear	20,000	89	0.245	0.350	0.484	PSOL budget
	Quadratic	20,000	89	-0.430	1.099	0.696	
	Linear	40,000	89	-0.007	0.036	0.855	
	Quadratic	40,000	89	-0.049	0.019	0.010	
	Linear	60,000	89	0.082	0.109	0.450	
	Quadratic	60,000	89	0.162	0.109	0.137	

Table 21: Parametric Fuzzy-RDD regression for all outcomes. Election years: 2008, 2010 and 2012 *(continued)*

Year	Model	Cutoff	Obs.	Coef.	SE	P.value	Outcome
2012	Linear	20,000	149	-0.006	0.021	0.776	
	Quadratic	20,000	149	-0.016	0.117	0.894	
	Linear	40,000	149	-0.046	0.007	0.000	PSOL
	Quadratic	40,000	149	-0.141	0.033	0.000	budget
	Linear	60,000	149	0.029	0.016	0.079	
	Quadratic	60,000	149	0.044	0.039	0.265	
2008	Linear	20,000	3,237	0.002	0.002	0.258	
	Quadratic	20,000	3,237	0.014	0.038	0.720	
	Linear	40,000	3,237	0.001	0.001	0.104	Young
	Quadratic	40,000	3,237	0.001	0.002	0.489	votes
	Linear	60,000	3,237	-0.001	0.001	0.525	
	Quadratic	60,000	3,237	-0.002	0.001	0.006	
2010	Linear	20,000	3,413	0.001	0.001	0.139	
	Quadratic	20,000	3,413	0.001	0.004	0.800	
	Linear	40,000	3,413	0.000	0.000	0.419	Young
	Quadratic	40,000	3,413	-0.001	0.000	0.012	votes
	Linear	60,000	3,413	-0.001	0.000	0.004	
	Quadratic	60,000	3,413	-0.002	0.000	0.000	
2012	Linear	20,000	3,369	-0.001	0.001	0.098	
	Quadratic	20,000	3,369	-0.008	0.006	0.172	
	Linear	40,000	3,369	-0.001	0.001	0.390	Young
	Quadratic	40,000	3,369	-0.001	0.002	0.699	votes
	Linear	60,000	3,369	0.000	0.000	0.090	
	Quadratic	60,000	3,369	-0.001	0.001	0.322	
2008	Linear	20,000	3,237	0.001	0.003	0.828	
	Quadratic	20,000	3,237	0.015	0.060	0.800	
	Linear	40,000	3,237	0.001	0.001	0.100	Young
	Quadratic	40,000	3,237	0.002	0.002	0.305	budget
	Linear	60,000	3,237	0.000	0.001	0.961	
	Quadratic	60,000	3,237	-0.001	0.002	0.641	
2012	Linear	20,000	3,369	-0.002	0.000	0.000	
	Quadratic	20,000	3,369	-0.011	0.009	0.230	
	Linear	40,000	3,369	0.000	0.000	0.441	Young
	Quadratic	40,000	3,369	0.000	0.001	0.866	budget
	Linear	60,000	3,369	-0.001	0.000	0.167	
	Quadratic	60,000	3,369	-0.002	0.001	0.026	

Table 21: Parametric Fuzzy-RDD regression for all outcomes. Election years: 2008, 2010 and 2012 *(continued)*

Year	Model	Cutoff	Obs.	Coef.	SE	P.value	Outcome

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust variance estimator.
Left wing parties: PSTU, PSOL, PC do B, PT, PSB and PCO.
Results with controls listed in Table 10.

The only result we could point out as relatively consistent is the negative relationship between the internet velocity and left wing vote share, for local elections (2008 and 2010) and for the 40,000 cutoff. But, being too specific, it is hard to support this results as consistent, specially taking into considerations the results in previous section.

A possible limitation of RDD models is the bandwidth choice, which could influence results. It is possible that a narrower or wider bandwidth give different results, since fewer or more observations will be part of regressions (a trade off between "randomness" and "precision"). Considering this possibility, Table 22 presents only significant results using also half or double bandwidths of those used in the previous section.

Table 22: Significant Fuzzy-RDD regression with half or double bandwidths for all outcomes. Election years: 2008, 2010 and 2012

Year	Cutoff	Model	Obs.	Coef.	SE	P.value	Outcome
2008	60,000	Double-Bw	423	0.000	0.001	0.010	Turnout
2010	60,000	Half-Bw	88	0.002	0.004	0.099	Turnout
	60,000	Double-Bw	1,214	0.001	0.001	0.000	
2008	20,000	Double-Bw	549	0.013	0.010	0.001	Blank or Null votes
2010	20,000	Half-Bw	242	0.006	0.008	0.081	Blank or Null votes
2012	20,000	Double-Bw	519	0.002	0.002	0.000	Blank or Null votes
	40,000	Half-Bw	103	-0.013	0.037	0.087	
	60,000	Double-Bw	195	-0.006	0.005	0.002	
2008	40,000	Double-Bw	1,092	0.023	0.043	0.058	Left wing vote share
2012	20,000	Half-Bw	191	0.351	0.804	0.029	Left wing vote share
	60,000	Half-Bw	65	-0.022	0.021	0.051	
2008	20,000	Double-Bw	1,031	-0.103	0.097	0.000	N. cand.
2010	20,000	Double-Bw	1,687	0.000	0.000	0.000	PSOL vote share
	60,000	Double-Bw	848	0.000	0.000	0.008	

Table 22: Significant Fuzzy-RDD regression with half or double bandwidths for all outcomes. Election years: 2008, 2010 and 2012 *(continued)*

Year	Cutoff	Model	Obs.	Coef.	SE	P.value	Outcome
2008	20,000	Double-Bw	1,097	0.006	0.014	0.099	Young votes
	60,000	Double-Bw	153	0.000	0.002	0.004	
2012	20,000	Half-Bw	226	0.004	0.056	0.078	
	20,000	Double-Bw	1,031	-0.006	0.004	0.028	Young votes
	60,000	Double-Bw	248	-0.004	0.005	0.029	
2008	20,000	Double-Bw	1,127	0.010	0.020	0.070	Young budget
	40,000	Double-Bw	2,098	0.032	0.136	0.075	
2012	20,000	Double-Bw	1,242	-0.008	0.003	0.000	Young budget
	60,000	Double-Bw	3,359	-0.001	0.000	0.000	

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust variance estimator.
Left wing parties: PSTU, PSOL, PC do B, PT, PSB and PCO.
Results with controls listed in Table 10.

Once again significant results are sparse, for some years, outcome, cutoffs and bandwidths, putting in check any solid relationship between broadband internet speed and election outcomes.

5.1.1 Pooled regressions

The cumulative RDD regression design, although considers all the heterogeneity that multiple cutoffs offers, reduces the sample size, specially in the 40,000 and 60,000 cutoffs. We now look for pooled regressions, in order to verify if combined samples (and, hence, more observations) support results presented in the previous sections. All cutoffs are considered, and samples are divided by the mean value between the cutoffs (population up to 30,000 for the first, between 30,001 and 50,000 for the second and 50,001 and above for the third). Results for all outcomes are presented in Table 23.

Results suggest a negative effect for turnout in 2010 and positive effects for blank or null votes in 2008 and 2010. Regarding left wing vote share, a positive effect in 2008 is reverted to negative in 2012. PSOL vote share is no longer significant, while its budget is. In 2008, we see a negative effect to number of candidates, reverting to positive in 2012. Finally, for younger candidates, we observe no effects on votes, but a significant effects on budget: positive in 2008 reverted to negative in 2012.

Putting all these results together (the cumulative RDD, the parametric RDD and the

Table 23: RDD-fuzzy pooled regressions for all outcomes. Election years: 2008, 2010 and 2012

Year	Bw	Obs.	Coef.	SE	P.value	Outcome
2008	3,435	476	0.001	0.008	0.786	Turnout
2010	3,559	510	-0.009	0.007	0.068	
2012	4,379	605	0.013	0.010	0.121	
2008	3,727	506	0.051	0.010	0.000	Blank or Null votes
2010	4,770	676	0.008	0.005	0.063	
2012	3,513	499	0.008	0.019	0.531	
2008	3,672	275	0.102	0.033	0.001	Left wing vote share
2010	4,784	676	-0.002	0.021	0.869	
2012	2,246	188	-0.096	0.027	0.000	
2008	2,281	315	-0.636	0.117	0.000	N. cand.
2012	3,614	509	0.200	0.127	0.053	
2008	3,684	28	-0.003	0.011	0.801	PSOL vote share
2010	7,764	1,131	-0.001	0.001	0.113	
2012	3,915	65	-0.002	0.005	0.257	
2008	4,311	27	1.496	0.522	0.003	PSOL budget
2012	3,138	40	2.840	0.519	0.000	
2008	3,476	477	0.039	0.029	0.102	Young votes
2010	4,650	655	-0.009	0.009	0.318	
2012	7,498	1,116	-0.016	0.027	0.600	
2008	3,894	517	0.053	0.029	0.031	Young budget
2012	5,954	867	-0.022	0.012	0.085	

Obs: Standard Errors (SE) are clustered by regions, with heteroskedasticity-robust nearest neighbor variance estimator (three minimum neighbors). Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014). Triangular kernel with quadratic local-polynomial. Results with controls listed in Table 10.

pooled RDD), it is hard to conclude that the Backhaul program, and, hence, broadband internet velocity, made a significant difference in 2008, 2010 and 2012 elections in terms of turnout, percentage of blank or null votes, left wing vote share, PSOL vote share, young candidates vote share and PSOL and young candidates budget. Although only the first round and four offices were analyzed, it is not likely to see a different results in other scenarios (second rounds and other offices). The lack of consistency across specification, years and cutoffs put in check the significant results observed in some regressions.

6 Discussion and conclusions

Relationship between broadband velocity and elections outcome did not seems be relevant in Brazil, at least when fixed broadband are considered, neither for local or national elections between 2008 and 2012. Despite our robust identification strategy, we did not find strong relationship between broadband velocity, measured by the jumps of internet speed in the Backhaul program roll out, and election outcomes. These results are in line with some finds reported by Menezes (2015) (turnout and blank and null votes), but differs from others (vote shares).

Our results are also different from those reported in some part of the literature, mostly concentrated in European countries and USA (Jaber 2013; Falck *et al.* 2014; Gavazza *et al.* 2015; Campante *et al.* 2017), which could indicate that the background may be important in this kind of analysis. First of all, vote is mandatory in Brazil, which is not necessarily true in other countries. Second, the political system in Brazil is presidentialist, in a federation republic, which means that people may behavior differently than in a parliamentarian system. Third, national congress deputies and local assemblies are elected by proportional vote, while senators are elected by majority vote, situation that may differ across countries. A fourth source of variation in political background regards to the difference between unitary and federal systems, that sets different rules to be played in the "political game".

Aside the political background, the internet usage is not fully controlled in our analysis. Installing the internet infrastructure in a municipality does not mean that all population will have access to the technology. Figure 1 shows that less than a third of Brazilian population had access to the internet in 2008, rising to 46.5% in 2012. Despite the lower costs internet provide in electoral campaign, less than half of population could be reached until 2012, even a less portion in poorer cities. So, it might be the case that internet velocity had a limited room to change reality and the sparse significant results found is not sufficient to trace a pattern yet.

Also, it was not possible to addressed the qualification of internet usage in our analysis. First of all, social networks have grown in Brazil after 2010. WhatsApp, one of the most popular social network in Brazil today, was created only in 2009, the very same year internet campaign was regulated. Is it possible that, today, mobile broadband and social medias usage in smartphones are more important for communication and mobilization than older social medias and connection made at home, through desktop or laptop computers and by fixed land lines. Unfortunately, the roll out of 3G and 4G technology implementation, at

municipality level, is unavailable. There is only data at Direct Dialling codes (DDDs)[40] areas, which makes impossible to determine when the technology begun to operate in every city[41].

Nonetheless, our paper contributes to bring into discussion that internet and political outcomes should be viewed in a wider perspective, meaning that some relationship may be circumstantial to idiosyncrasies of the countries or the technology. Also, further investigation, like the role of the new social medias and mobile broadband, are necessary to shed light in this discussion, even because internet and social medias are still evolving.

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[40]The DDD codes are numbers that divides Brazil in 67 areas.

[41]We contacted the Regulation Agency of Telecommunication – Anatel – requesting mobile internet implementation at municipality level. Unfortunately, there is no such data available.

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Appendix

Table 24: First stage of Fuzzy-RDD regressions for all outcomes

Year	Cutoff	Outcome	(Intercept)	Tr	Xl	Xr	F.stat
2008	20,000	Blank or Null votes	-4.407	-1.414	0.001**	0.001	13.09***
		Left wing vote share	3.071	-2.095	0.001*	0.000	5.83***
		N. cand.	-4.140	-1.380	0.001**	0.001	13.25***
		PSOL budget	-17.673	-2.821	0.000	0.000	1.35
		PSOL vote share	-10.418	-4.467	0.000	0.001**	2.42***
		Turnout	-8.690	-1.710	0.002**	0.001	11.10***
		Young budget	-3.631	-1.049	0.001***	0.001*	14.47***
		Young votes	-3.965	-1.131	0.001***	0.001*	13.96***
2008	40,000	Blank or Null votes	16.382	4.026	0.000*	0.000	10.70***
		Left wing vote share	15.618	-0.761	0.001*	0.000	7.45***
		N. cand.	16.405	4.025	0.000*	0.000	10.70***
		PSOL budget	-242.491*	24.409*	-0.001	0.001	3.51**
		PSOL vote share	-75.356	-9.385	0.001	0.002***	5.76***
		Turnout	17.322	3.934	0.001*	0.000	10.03***
		Young budget	4.718	5.284**	0.000	0.000	18.23***
		Young votes	9.598	5.335**	0.000*	0.000	13.65***
2008	60,000	Blank or Null votes	142.193**	16.646**	0.000	-0.001	9.43***
		Left wing vote share	103.102	20.470**	0.001	-0.001*	7.92***
		N. cand.	89.264**	15.927***	0.000	-0.001	16.31***
		PSOL budget	171.406	-34.691	0.002	-0.001	1.92
		PSOL vote share	-27.075	23.145**	0.001	-0.001**	3.68***
		Turnout	171.414**	17.917**	0.000	-0.001	8.34***
		Young budget	244.117**	25.441**	-0.001	-0.003	4.72***
		Young votes	249.056**	27.166**	-0.002	-0.003	4.74***
2008	Pooled	Blank or Null votes	1.800	3.883***	0.000	0.000	59.68***
		Left wing vote share	3.057	3.004**	0.000	0.000**	27.44***
		N. cand.	20.586***	3.626***	0.000***	0.000*	59.84***
		PSOL budget	-48.025	11.061*	-0.001	-0.001	2.95***
		PSOL vote share	7.967	13.170**	-0.001	-0.001	3.73***
		Turnout	34.252***	1.207	0.000	0.000*	38.57***
		Young budget	1.751	3.356***	0.000**	0.000**	56.94***
		Young votes	1.846	3.214***	0.000**	0.000**	57.08***
2010	20,000	Blank or Null votes	-7.007	2.495***	0.001***	0.001***	23.79***
		Left wing vote share	-6.890	2.892***	0.001***	0.001***	29.57***
		PSOL vote share	-8.461**	3.591***	0.001***	0.001***	46.85***
		Turnout	-6.873	2.970***	0.001***	0.001***	30.33***
		Young votes	-7.555	1.891**	0.002***	0.001**	17.33***

Table 24: First stage of Fuzzy-RDD regressions for all outcomes *(continued)*

Year	Cutoff	Outcome	(Intercept)	Tr	Xl	Xr	F.stat
2010	40,000	Blank or Null votes	-71.169***	3.481**	0.001***	0.001**	15.22***
		Left wing vote share	-82.716***	1.954	0.001**	0.002***	11.55***
		PSOL vote share	-59.078***	5.131***	0.001***	0.001**	21.05***
		Turnout	-63.840***	4.361**	0.001***	0.001**	17.97***
		Young votes	-65.281***	4.164**	0.001***	0.001**	16.65***
2010	60,000	Blank or Null votes	-68.369	19.281***	0.001**	0.000	10.36***
		Left wing vote share	-55.390	18.911***	0.001**	0.000	12.87***
		PSOL vote share	-57.071	18.786***	0.001**	0.000	11.99***
		Turnout	-48.205	18.167***	0.001***	0.000	14.43***
		Young votes	-128.045**	6.629	0.010***	-0.003	8.07***
2010	Pooled	Blank or Null votes	22.296***	0.938	0.000	0.000	52.48***
		Left wing vote share	18.773***	1.647**	0.000	0.000	65.08***
		PSOL vote share	-0.946	3.991***	0.000***	0.001***	60.34***
		Turnout	19.819***	1.500**	0.000	0.000	59.57***
		Young votes	-9.476**	3.015***	0.000**	0.001***	67.44***
2012	20,000	Blank or Null votes	-5.575	1.615**	0.002***	0.001**	21.47***
		Left wing vote share	-8.703	0.960	0.002***	0.001**	10.85***
		N. cand.	-4.608**	4.804***	0.000***	0.000***	117.72***
		PSOL budget	-48.958**	2.497	0.001**	0.001*	6.44***
		PSOL vote share	-22.785*	3.957**	0.001**	0.000	8.29***
		Turnout	-5.077**	4.444***	0.000***	0.000***	91.36***
		Young budget	-5.402	2.168***	0.001***	0.001**	31.88***
		Young votes	-5.876	1.793**	0.001***	0.001**	26.52***
2012	40,000	Blank or Null votes	-44.942***	5.117***	0.001***	0.000**	25.09***
		Left wing vote share	-40.295***	3.609**	0.001***	0.001**	15.00***
		N. cand.	-60.061***	0.091	0.002***	0.001*	9.24***
		PSOL budget	-84.435**	5.518	0.001**	0.000	7.08***
		PSOL vote share	-40.603	5.733*	0.001**	0.000	6.59***
		Turnout	-60.151***	0.070	0.002***	0.001*	9.24***
		Young budget	-60.978**	-1.447	0.003***	0.001	7.73***
		Young votes	-64.062**	-3.238	0.004***	0.001	6.96***

Table 24: First stage of Fuzzy-RDD regressions for all outcomes *(continued)*

Year	Cutoff	Outcome	(Intercept)	Tr	Xl	Xr	F.stat
2012	60,000	Blank or Null votes	-79.639	-2.756	0.002**	0.003**	7.81***
		Left wing vote share	-82.973	1.088	0.002**	0.002**	5.81***
		N. cand.	-77.764	-7.264	0.002**	0.004**	6.23***
		PSOL budget	-135.674*	11.076*	0.001	0.002**	11.04***
		PSOL vote share	-174.023*	11.344	0.001	0.001	6.41***
		Turnout	-78.936	-6.264	0.002**	0.004**	6.79***
		Young budget	-33.465*	15.215***	0.001***	0.000	32.02***
		Young votes	-78.819	-4.944	0.002**	0.004**	7.44***
2012	Pooled	Blank or Null votes	-5.428**	3.752***	0.000***	0.001***	78.94***
		Left wing vote share	17.203**	2.108**	0.000***	0.001***	46.51***
		N. cand.	20.621***	1.988**	0.000**	0.000**	70.85***
		PSOL budget	-38.712	5.558	-0.001	0.001***	6.71***
		PSOL vote share	-7.134	1.610	0.000	0.002***	8.41***
		Turnout	31.327***	0.075	0.000	0.000**	46.55***
		Young budget	-6.665**	2.338***	0.000***	0.001***	69.19***
		Young votes	-6.475**	2.268***	0.000***	0.001***	70.24***

Obs: Standard Errors (SE) are clustered by regions. Optimal bandwidth (Bw) selection by Mean Square Error following Calonico, Cattaneo and Titiunik (2014).

Triangular kernel with quadratic local-polynomial.

Turnout for the first round.

Results with controls listed in Table 10