Internet, Social Media, and the Behavior of Politicians: Evidence from Facebook in Brazil*

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Abstract

Recent years have witnessed the remarkable diffusion of social media in tandem with the spread of mobile phones that are, in many places, the key tool for accessing those media. We ask whether this has affected the communication and responsiveness of politicians towards voters. Using data on the spread of the 3G mobile phone network in Brazil, and self-collected data on the universe of Facebook activities by federal legislators, we examine how legislators respond when municipalities that are part of their electoral base obtain access to the 3G technology. We find that politicians *increase* their online engagement with voters that gain 3G mobile access but *decrease* their offline engagement measured by speeches and earmarked transfers towards connected localities where they have a large pre-existing vote share. Our results suggests that instead of increasing responsiveness, social media may enable politicians to solidify their position with core supporters using communication strategies while shifting resources away towards localities that lack 3G internet access.

Keywords: Internet; Mobile Phones; Social Media; Accountability; Legislative Behavior; Elections.

JEL Codes: D72, H72, L86, L96.

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1 Introduction

The role of media in disclosing information, monitoring the actions of politicians, and making them accountable is widely seen as central to the proper functioning of democracies. The recent explosion of social media as another channel through which citizens can access news and information can thus be transformative for the responsiveness and accountability of politicians.[1] At the same time, however, the political impact of social media has been the object of increased skepticism as they offer opportunities to affect content and manipulate information in a way that can mislead voters.[2]

The possibility of direct communication between voters and politicians through social media might affect political responsiveness, which makes them substantially different from previously dominant media technologies. As a result, while there is a large literature that shows how traditional media can make politicians more accountable and responsive (Besley and Burgess, 2002; Strömberg, 2004b; Ferraz and Finan, 2008; Snyder and Strömberg, 2010; Strömberg, 2015), and a growing number of studies showing that social media can affect the political behavior of citizens (Falck, Gold and Heblich 2014; Campante, Durante and Sobbrio 2018; Enikolopov, Makarin and Petrova 2018; Manacorda and Tesei 2018; Guriev, Melnikov and Zhuravskaya 2019), we still know little about the impact of social media on the behavior of politicians.

This paper examines how politicians respond to the introduction of 3G internet across their electoral districts. We study the behavior of federal legislators in Brazil and their communication through Facebook as well as their legislative behavior through speeches and discretionary transfers. This is a particularly appealing context for a number of reasons. First, as we will discuss in greater detail, there is typically very little local media coverage of those legislators – a majority of voters does not even know who they voted for and, in the pre-existing media environment, had very limited access to information about what politicians do. legislators.

In contrast with more media-saturated environments in developed countries, where social media might crowd out other channels of accountability, one might expect here a significant impact of a new media technology that offers a cheap and effective avenue for interacting with and obtaining information about elected representatives.

Second, around the period of our study, Brazil went through a remarkable expansion in Facebook use – going from 4 million users in mid-2009 to about 30 million in mid-2011, and reaching 92 million by late 2014 – and the platform quickly acquired great

[1] Facebook alone reports 1.09 billion daily active users as of March 2016

[2] This is exemplified by the phenomenon of so-called "fake news" (Allcott and Gentzkow (2017);Allcott et al. (2019).

prominence in the political arena. Moreover, engagement with Facebook in the country occurs disproportionately via mobile phones, and the same period witnessed the expansion of the 3G mobile network that greatly enhanced the ability to access the Internet and social media in particular. Since this took place in staggered fashion across the Brazilian territory, we can compare the (online and offline) behavior of politicians towards a given municipality before and after it gets access to the 3G network, and relative to their behavior towards localities that remain without access.

Last but not least, the electoral system through which Brazilian legislators are chosen is also singularly well-suited for studying the issue. Votes are aggregated at the level of entire states, such that each legislator is elected with votes from multiple localities, and each locality gives votes to multiple elected legislators. This helps explain the aforementioned lack of engagement and accountability avenues, but, from the standpoint of our research design, it also offers additional variation that helps tease out the causal impact of 3G access. Specifically, consider a legislator (henceforth he/him, since the vast majority of Brazilian legislators are male) and two municipalities in his home state: one from which he obtained a substantial share of his votes and another where he got few votes. We can look at whether the politician increases his (online and offline) engagement with the former when it joins the 3G network, compared to his behavior when the other municipality joins, and also to the behavior of another politician from the same state, who competes over the same set of municipalities, but happens to have a different distribution of votes over that set.[3]

Our first key finding refer to the online behavior of politicians, which we study by scraping data from the public profile pages of all Facebook-active Brazilian deputies over the 2011-2014 legislature. We find that a politician's Facebook posts are more likely to mention the name of a specific municipality when it gets 3G access, but much more so when that municipality is part of his base of support (in the sense of providing a large share of his votes). We also find that voters interact more with those Facebook posts, as measured by likes, shares or comments and much more pronouncedly so for the municipalities in the base of support. This suggests that increased access to social media by constituents increases the incentives of politicians to interact with them.

While it seems natural to expect that increased access to social media by voters would increase their social media targeting by politicians, it is not obvious how this would translate into the offline realm. First of all, it could be the case that in an environment

[3]As we will discuss in greater detail, we implement this strategy by controlling for legislator-municipality, municipality-time and legislator-time fixed effects, and interacting the measure of 3G presence with the share of votes obtained by the legislator in the municipality. The fact that we have variation in 3G presence over time allows us to identify that coefficient.

with very low accountability to begin with, politicians would largely ignore voters' social media presence in whatever else they do. What is more, if there is any effect, it is unclear *ex ante* whether online and offline behavior would be complements or substitutes. On the one hand, legislators might be induced to do more in their legislative activity because of the enhanced ability to get that across to voters; by contrast, they could instead get away with doing even less, as the impact of any given level of legislative accomplishment on voters is increased by boasting about it on Facebook.

We investigate two margins of legislative activity. We first focus on congressional speeches. Those speeches are a significant part of the politicians' daily routines, where they express their opinions and support for various types of bills and propositions. We analyze the contents of the universe of speeches and find that legislators respond to the entry of a municipality into the 3G network by mentioning it *less* often – and once again, more strongly when it is part of his base of support. We interpret this as an immediate response to the entry of 3G: with easier Internet access by citizens, politicians need to make *less* use of speeches to reach their supporters, substituting away to online platforms.

We then turn to the choices made by legislators on allocating earmarked transfers by across municipalities. The analysis explores a unique feature of the Brazilian setting in which, on a yearly basis, congressmen propose amendments to the budgetary law (*Lei Orçamentária Anual*).[4] This pork-barrel spending is typically used by politicians to showcase improvements they bring to communities of their choice – roads, schools and health units are often funded in this way – such that proposed earmarked transfers tie the actions of a legislator to specific municipalities.

We find that politicians devote *fewer* resources in earmarked transfers to their core base of electoral support in response to the introduction of 3G. In other words, when 3G arrives to a municipality in the base of support of a legislator, he reacts by transferring resources to other municipalities in their base that are left without 3G access. Our evidence thus indicates that the associated diffusion of social media and mobile phones gives rise to a *substitution* between online and offline behavior: politicians react to Facebook entry, within their base of support, by simultaneously increasing their online presence, and reducing their offline activity.

We rationalize these results in the context of a simple model of "persuasion and pork-barrel" where politicians can choose to allocate communication efforts and transfers across different municipalities from which they get varying levels of support. We assume that (online) communication is especially effective in reaching core supporters within

[4]These amendments are strictly capped at the level of legislators, implying a strong opportunity cost of targeting the resources. See Firpo et al. (2015) and Finan and Mazzocco (2016) on determinants and effects of earmarked resources in Brazil.

those municipalities – after all, to be reachable via Facebook, one has to choose to follow the politician in the first place. In contrast, transfers benefit the municipality as whole, which makes them relatively more effective in attracting swing voters.

We interpret the arrival of 3G as representing a shock that makes communication more effective in a given locality, via Facebook. Politicians respond by increasing their effort along that dimension, and especially so if the municipality is more important to them. However, because all the politicians actively competing for that municipality do the same, the core supporters of each of them become more attached, thereby reducing the number of swing voters and making transfers to that municipality relatively less effective as a way of garnering additional votes. The politicians thus find it optimal to divert transfers to the municipalities that remain without 3G, compensating with additional support in the latter the loss of (swing) votes in 3G municipalities. Consistent with the model, we indeed find electoral losses in the subsequent election, within the politicians' electoral base, in municipalities that receive 3G (relative to those that do not), and that the response in terms of reducing transfers comes entirely from legislators with relatively safe seats, for whom presumably the attachment of core supporters would be strongest.

In sum, we find evidence that access to social media increases the responsiveness of politicians, but only in the online realm. This comes at the expense of offline responsiveness, suggesting that there are real costs for voters. Intuitively, politicians can use social media to increase the attachment of core supporters, thereby increasing their political "market power" against voters. While what we capture is a short-run response – eventually one would expect 3G and social media access to become universal – it is not hard to imagine that these changes might be persistent. In particular, one might speculate that the consolidation of core supporters persists over time, so that places that got earlier access to social media may end up with fewer swing voters even in the long run, and receive less offline attention as a result.

Our paper relates to a number of different strands of literature. We add to the burgeoning empirical literature looking at the political impact of social media or mobile phones (Tufekci and Wilson, 2012; Flaxman et al., 2013; Halberstam and Montagnes, 2015; Enikolopov et al., 2015; Manacorda and Tesei, 2016; Acemoglu et al., 2018). These contributions have focused mostly on the impact of social media on collective action and the flow of political information, while our focus is on the behavior of politicians. Similarly, the literature on the political impact of the Internet has mostly focused on voter turnout (Falck et al., 2014; Campante et al., 2018). Campante et al. (2018) also focus on the interplay between online and offline activities, but again on the side of citizens rather

than politicians.

More broadly, many have studied the political impact of the introduction of new media technologies (see for instance the survey by Prat and Strömberg, 2013). A big part of that literature focuses on the behavior of voters – in terms of participation (Strömberg, 2004a,b; Gentzkow et al., 2011) or the ability to impose accountability by voting out incumbents (Ferraz and Finan, 2008). More closely, others have studied the impact on the behavior of politicians, and the degree to which it responds to constituents. For instance, Snyder and Strömberg (2010) show that US legislators exert more effort, bring more resources to their districts, and are more likely to break ranks with their parties (presumably to side with the preferences of constituents) when they face greater media coverage induced by the congruence of political districts and newspaper markets. We extend this literature to the context of social media, and of a relatively unsaturated media environment in terms of political coverage, and show that the impact of this particular new media technology can actually go in the direction of reducing the (offline) responsiveness of politicians.

The remainder of the paper is organized as follows: Section 2 provides relevant background on the Brazilian context, regarding the expansion of Facebook and mobile phones, the political environment, along with the data sources used in our estimation. Section 3 describes our empirical strategy. Section 4 discusses the results. We rationalize the results with the model in Section 5. Section 6 concludes.

2 Background and Data

2.1 The rise of mobile Internet and Facebook in Brazil

Access to 3G mobile networks expanded considerably in Brazil between 2011 and 2014. The share of municipalities with mobile Internet coverage more than doubled throughout the period: it jumped from 30.0 to 66.8 in the span of just four years (Panel A of Table 1). This is equivalent to more than 2,000 municipalities gaining connection in this short spell. Coverage expanded throughout the Brazilian territory, as most regions of the country experienced vertiginous two-fold growth in the share of connected municipalities. For example, 42.1 percent of the municipalities in the richest and most populous southeast were connected at baseline; by the end of 2014, coverage had expanded markedly and reached 86 percent. But even remote municipalities in the Amazon were getting connected (Panel A of Figure 1). In terms of population, this expansion meant that, in four years, an additional 30 million people gained access to broadband mobile

Internet coverage.[5]

The rise in access to 3G technology was accompanied by an increase in the connectivity reported in household surveys. At the start of our sample period in 2011, 36.6 percent of the households used the Internet; in 2014, this number had increased to approximately 55 percent (Panel B of Table 1).[6] The most common method of Internet access was through mobile phones: 80.4 percent of the households reported in 2014 that at least one of its members was a mobile Internet user. These numbers are consistent with World Bank data on Internet connectivity: in 2014, Brazil had 134 mobile phone subscriptions per 100 inhabitants, and only 10.5 fixed broadband Internet subscriptions per 100 inhabitants.

Just as the expansion of 3G was taking place, Facebook entered the Brazilian market. Facebook registered the domain `facebook.com.br` in 2007, and the company effectively started operations in Brazil in 2008. It then went on to experience a very rapid expansion: from just over 4 million users as of mid-2009, it had almost 30 million two years later. By 2014, 92 million people (about 45% of the total population of the country) were reported to be monthly users. These numbers are shown in Panel C, across three data sources and surveys on Facebook use in Brazil conducted in different periods in time. Taking Panels B and C together, it shouldn't come as a surprise that, for the most part, social media access in Brazil takes place largely via mobile phones. In fact, out of those aforementioned 92 million Facebook users, no less than 77 million were accessing via mobile Internet.[7]

Finally, Facebook became by and large the dominant social network platform. To make this point, we use Google Trends data that allows us to compare the interest in several social media platforms over time. The index is based on the number of Google searches, normalized by the maximum number of search queries.[8] The number of Google searches for the terms "Facebook," "Twitter," and "Orkut," reveals, again, Facebook's steep rise in Brazil. While Orkut was the first social networking website with significant presence, it was in clear decline from 2011, eventually shutting down operations in 2014. Twitter was never a significant player over this period.

[5]The municipality-level data on mobile phone and 3G Internet coverage was obtained from the *Agência Nacional de Telecomunicações* (ANATEL), the public agency that regulates the private telecommunications sector in Brazil. This aggregate panel is available on the website of Teleco, a telecommunications consultancy firm, available at `http://www.teleco.com.br/3G_cobertura.asp`. It is retrieved using proprietary datasets from the ISPs, to which we could not obtain access. Population data from the Instituto Brasileiro de Geografia e Estatística (IBGE).

[6]Source: Pesquisa Nacional de Amostras de Domicílios (PNAD) survey.

[7]The rise of Facebook represented a large expansion in the reach of social media in Brazil. While the country had had a strong presence of another platform (Orkut), its number of users peaked under 30 million (Ibope Nielsen Online). This means that the growth of Facebook from 2011 represented a substantial net increase in the number of Brazilian social media users.

[8]Google Trends data does not reveal the normalization.

It soon became clear that Facebook was an important political arena, and this was clearly recognized by politicians themselves. Out of 513 politicians elected for the 2011-2014 legislature, 415 had created an active public official Facebook profile by the end of his or her term, and the vast majority of these were created after 2010.[9] To analyze how they use the platform, we scraped the universe of the Facebook profiles for its contents, message, and number of likes, shares and comments which we later use to proxy for online engagement. We obtained a database of 460,540 posts.

We show descriptive statistics of politician engagement on Facebook calculated over the distribution of yearly activity across users in Panel A of Table 2. In line with the idea that Facebook was being increasingly used to convey messages with political content, the average congressmen posted 24.5 messages in 2011; it increased almost twenty-fold to 484.2 messages in 2014. By then, the average politician posted more than once per day, every day.

The politicians' messages often carried contents that referred to municipalities of their states of origins, and about their legislative activities in Congress. To shed light on the nature and content of the posts, we devised a text processing algorithm that matches each of the 460,540 posts in our sample to the 5,545 Brazilian municipalities. In fact, our key outcome of interest when it comes to Facebook activity is the mentions to municipalities in the politicians' posts in a given year. This will allows us to analyze the online engagement at the level of legislator-municipality pairs, and its evolution over time, which is crucial for our empirical strategy.

The main challenge was that the straightforward procedure of just checking whether or not a given municipality name appeared on the post works very poorly. The reason is that a considerable number of municipalities have names that also have other meanings in Portuguese.[10] We tested the performance of our approach in a sub-sample, with the algorithm providing a correct match for 89.09% of the true mentions, and a false match for only 2.00% of the posts.

We obtain that, from the universe of posts, 36.7% or 168.98k cited at least one municipality. These are the posts that will constitute the core of our analysis, since they

[9]Most politicians who by the end of the term did not hold an active Facebook profile had retired from politics.

[10]This problem was particularly severe for municipalities with names of Catholic saints or of words and expressions that are commonly used in other contexts, such as "union" or "Brazilian." Put simply, we need to be able to figure that when a politician writes "Feliz Natal" ("Merry Christmas"), that is not a reference to the city of Natal. Thus, we manually classified the municipality names into "dubious", ie names that could appear in contexts other than mentioning the municipality, and "non-dubious". We identified 898 municipalities with dubious names. For this subset, we required that the municipality name was preceded by an expression that commonly precedes a place in a sentence, such as "municipality of", "mayor of" or "airport of". The algorithm is presented in more detail in Appendix Appendix B.

measure the engagement of the politician with the municipalities in their states of origin. Panel B of Figure 1 maps the incidence of the number of mentions to municipalities in 2011 and 2014 in a logarithmic scale. While Facebook is still sparsely used in 2011, few municipalities are mentioned. In contrast, virtually all municipalities were mentioned at least once in 2014. It is possible to note the geographical concentration of posts targeting municipalities that had 3G access in 2011. Panel B also displays the geographic variation: more populated municipalities, as expected, are more frequently mentioned than less-populous ones.

We also study how the access to the Internet affected the communication from citizens to the congressmen. It is much harder to measure this, as data from the individual citizens' Facebook profiles is typically private, in contrast with the politicians' public profiles. We thus use, as proxies for citizen communication, variables that count how many likes, shares, and comments the posts from politician i mentioning municipality m had in year t. Given the private nature of the information, we cannot know how many of these likes, shares or comments are actually coming from municipality m, but it stands to reason that there would be a positive relationship. In Panel A of Table 2, we similarly observe a remarkable increase in the interaction between Facebook users and those politicians.

The posts that cited at least one municipality jumped from an average of 4.44 in 2010 to 177.56 in 2014, per politician and year. The behavior of the politicians was also met with citizens' engagement online. Starting from negligible numbers in 2010, messages posted by politicians that cited at least one municipality were liked 17.21 million times, obtained 6.64 million shares and 1.56 million comments over the years up to 2014.

Yet, we dig further to show that the Facebook posts indeed carried political content. Within the 169.98k posts, keywords that are related to congressional activity were used as much as 146.13k times. These keywords are, in most part, jargon used by the politicians and Congress associated to the legislative activity or political support for various types of bills.[11] The contents of Facebook posts also contained information on other topics and public goods and services: keywords associated to education and health were mentioned 27.3k and 23.2k times, respectively. Finally, the database is consolidated at the level of the Congressman-year-municipality triplet, containing information on the number of posts and the sum of likes, shares and comments of the posts.

In short, from 2010 to 2014 Facebook use increased sharply, and it became widely adopted in the country, by politicians citizens alike. It became a mainstream channel for

[11]More specifically, we looked for the following keywords "amendment", "audience", "committee", "commission", "congress", "deputy", "law", "party", "plenary", "project", "proposition", "agenda (or *pauta* in Portuguese) ", "voting".

politicians to advertise themselves and their legislative activity, as well as to interact with the general public. Congressmen overwhelmingly adopted Facebook, posted messages with increasing frequency, and mentioned virtually all municipalities in Brazil.

2.2 The Brazilian legislature

Brazil has a bicameral federal legislature (National Congress), with a lower house (Chamber of Deputies) and an upper house (Federal Senate). The lower house has 513 federal deputies, which proportionally represent each of the 27 federal units (UF), namely 26 states plus the Federal District. The upper house has 81 senators, three for each UF. Senators are elected in statewide majoritarian elections, for eight-year terms, though terms overlap such that there are senators being elected every four years. Deputies are elected for four-year terms in an open-list proportional representation system, in which each state is a single, at-large, multimember district.[12] We study the behavior of members of the Chamber of Deputies elected in 2010 for the 2011-2014 (53rd) legislature.[13]

Voters can choose to vote for one candidate for *deputado* (which is what the vast majority of voters, up to 90 percent, actually do), or for a party label.[14] The allocation of seats in a given state is chosen proportionally to the share of votes obtained by a party or coalition, taking into account all the votes given to the party or coalition, and to individual candidates affiliated to it. The candidates who fill those seats will be the top vote-getters in the party ticket. Note also that there are no term limits, and parties are required to nominate willing incumbents in their slate of candidates. There is no minimum threshold for parties to enter into parliament, and as a result Brazil has an unusually large number of parties represented in the *Congresso* – 28 in our sample.

Generally speaking, the Brazilian combination of open-list proportional representa-

[12] A detailed analysis of the Brazilian legislative electoral system can be found in Ames (2002). Our description is based on that source.

[13] Elected congressmen may be permanently or temporarily replaced. A substitute can obtain a seat on a permanent basis – for instance, if a legislator resigns or is removed (which could arise from a verdict of electoral violations, or misbehavior in Congress as adjudicated by a congressional vote) – or temporarily – say, if a legislator is tapped by the President for a cabinet position. In the case of the lower house, the substitute will be the next best-voted party candidate in the previous election; in the case of the Senate, the substitute is picked beforehand by the senatorial candidates as part of their electoral ticket. We use the sample of elected politicians in the 2010 elections. Descriptive statistics are presented in Table A1 in the appendix: only 8.8% deputies are female, most (77.8%) are college-educated, on average obtained 114.9k votes in the 2010 elections, and spent R$ 3.24m in campaign costs (approximately US$ 1 million). We also present the descriptive statistics of the 52nd legislature, which was remarkably similar in terms of the demographic composition, but spend relatively less on campaign costs and, on average, were elected with fewer votes.

[14] Voting is compulsory for all citizens between ages 18 and 70, and optional for those between ages 16 and 18, or older than 70.

tion and large districts (namely, states) is seen as not conducive to the accountability of representatives on the part of voters (Ames, 2002). This is compounded by a sparse media environment, with very low newspaper penetration and an uneven presence of local radios and TV stations (Ferraz and Finan, 2008). As a result, most individual legislators receive very little media coverage, and depend on local and visible achievements to make him or herself known to the electorate.[15]

The fact that each state is a single multimember district for the Chamber of Deputies implies that each candidate vying for congressional office can get votes from anywhere in the entire state. What is more, the distribution of votes for each candidate tends to be highly heterogeneous. To show this, we gather municipality-level election data made available by the Tribunal Superior Eleitoral (TSE), the independent judicial institution that runs and oversees Brazilian elections. The main information we use is the votes each elected congressman had in each of the municipalities from his or her UF. We compute the vote share

$$\text{VoteShare}_{im} = \frac{\text{Votes of politician } i \text{ in municipality } m}{\text{Total votes of politician } i} \times 100 \quad (1)$$

which represents the importance that municipality m had in electing the congressman i. Some congressmen get elected from strong voting concentrated around a few municipalities; others are elected from a much more disperse base of support. This is potentially reflective of different electoral strategies and the type of engagement between politicians and electorate. In fact, Ames (1995b) describe the former as the "concentrated" types, characterized either by being a dominant force in a municipality – their electoral bailiwicks, for instance –, or by specializing in specific segments of the population that happen to be geographically clustered. In contrast, the "scattered" types are often candidates that appeal to segments of the society with state-wide representation, such as business owners, or are well-known figures themselves (celebrities, ex-footballers). This is clearly exemplified in Figure 2, mapping the vote shares of the top two vote-getters in the 2010 elections, from the state of São Paulo (Tiririca and Gabriel Chalita).

Once elected, the work of a legislator ranges from roll-call votes, public speeches, bill proposition, and to participation in special committees. Prior to the advent of Facebook, politicians primarily used congressional speeches to communicate their legislative

[15]In this context, voters typically have very low levels of knowledge regarding deputies. In fact, even though the vast majority does vote for individual candidates as opposed to party labels, polls consistently find that large numbers of voters do not even recall who they voted for in the previous elections – almost one in three, as soon as a mere twenty days after the election, going up to about one in two four years later. Source: `http://media.folha.uol.com.br/datafolha/2013/05/02/intvoto_depfederal_20092010.pdf`.

achievements to the voters. We thus obtained the database of the universe of speeches conducted in Congress.[16] We use the same algorithm to detect if municipalities are mentioned during those speeches. In Panel B of Table 2 we see that politicians, on average, make two speeches per month. We also use the number of speeches as an outcome variable in our subsequent analysis.

Most interestingly for our purposes, legislators also can propose amendments (*emendas parlamentares*, EPs) to the federal budget, with which they can earmark resources to specific projects in municipalities of their choice. These transfers are aimed at the provision of public goods and cannot exceed a ceiling.[17] Since actual lawmaking is, in practice, largely delegated to the Executive (Neto and Santos, 2003), this pork-barrel function is a major part of the typical legislator's work, a fact that has also been ascribed to the incentives put forth by the open-list electoral system (Ames, 1995a).[18] In our sample, as also shown in Panel B of Table 2, the average legislator distributed 5.4 EPs per year to 5.5 municipalities. Given that the average congressman has 253 municipalities in his constituency (i.e. UF), it is clear that politicians choose which localities will receive transfers very carefully.

In sum, the Brazilian context affords us an especially suitable setting in which to study how the combination of social media and mobile Internet access affects the behavior of politicians and how they respond to their constituents. First, there is a rapid diffusion of social media that occurs in the presence of substantial variation in Internet access. Second, it takes place from a baseline with relatively few and weak channels to hold politicians accountable and responsive. In addition, this occurs after mobile phones were already widely disseminated – if instead mobile phone coverage had entered simultaneously with mobile Internet and social media, we would not be able to determine whether any effects would have been driven by that combination, or by the introduction of mobile phones per se.

3 Empirical Strategy

We examine how politicians behave when voters in a given municipality get access to 3G mobile Internet. Our empirical strategy exploits two sources of variation. First, there was a staggered entry of 3G Internet across municipalities over time. So we can compare

[16] Source: Chamber of Deputies and Senate websites.

[17] The ceiling was approximately 4.2 million, 4.3 million, 4.2 million and 4.7 million US dollars for the 2011-14 period, respectively.

[18] "Many if not most deputies spend the bulk of their time arranging jobs and pork-barrel projects for their benefactors and constituents." (Ames, 1995b, pp. 407)

the behavior of politicians before and after citizens get access to 3G Internet. Second, we explore the fact that candidates compete for votes across their entire home state. This allows us to explore variation in their electoral base of support. We can thus compare the behavior of the politicians in their electoral strongholds against municipalities where he or she got few votes.

In a context such as the United States, where a single politician represents a congressional district, we could use a difference-in-differences strategy and estimate the following regression:

$$y_{mst} = \beta \cdot 3G_{mt} + \lambda_m + \delta_{st} + \epsilon_{mst}, \quad (2)$$

where y_{mt} is the behavior of congressperson m in year t, $3G_{mt}$ is an indicator that takes the value of 1 when there is 3G Internet in constituency m in year t, λ_m is a politician and congressional district fixed-effect that controls for fixed politician and locality characteristics, and δ_{st} is a state-by-year dummy that accounts for state shocks, and ϵ_{mst} is an error-term. The underlying assumption needed to identify the effect of 3G Internet is that places where 3G entered (and social media expanded) had a similar trends to places where 3G Internet did not enter. In Subsection 4.1, we use this specification to provide preliminary evidence of the effect of the introduction of the introduction of 3G at the municipality level.

The Brazilian context allows us to go further and separately control for legislator interacted with locality effects. This is important as the deputy-municipality fixed effects control for the confounding story that legislators lobby the mobile operators to bring 3G to their electoral turf. Because each state is a multi-member district where legislators are elected at-large, we can exploit the fact that any legislator has votes in localities with and without 3G Internet access and estimate the following regression:

$$y_{imst} = \beta \cdot 3G_{mt} + \lambda_{im} + \delta_{st} + \epsilon_{imst}, \quad (3)$$

where y_{ismt} is the behavior of congressperson i towards municipality m of state s at year t, $3G_{mt}$ is an indicator that takes the value of 1 when there is 3G Internet in constituency m in year t, λ_{im} is a politician-municipality pair fixed-effect that controls for fixed characteristic of politician and municipalities.

We can go one step further and take advantage of the three-dimensional structure to examine how politicians respond when municipalities in their electoral stronghold gain 3G access. This more flexible specification is important for two reasons. First, there is a large number of municipalities where legislators get very small vote share (close to

zero). Second, and more importantly, if we assume politicians care about their electoral prospects, we should expect them to focus their effort and resources on their electoral base of support. We thus explore the fact that there is substantial variation in the vote share of different politicians across different municipalities. We can employ a triple-difference empirical strategy where we compare the outcome of legislator i before and after the entry of 3G Internet across localities where they had a significant vote share with places where they had no votes. Because vote share is continuous, we use the following empirical specifications:

$$y_{imst} = \gamma \cdot 3G_{mt} \cdot \text{VoteShare}_{im} + \beta \cdot 3G_{mt} + \lambda_{im} + \delta_m + \phi_{it} + \epsilon_{ismt} \quad (4)$$

$$y_{imst} = \gamma \cdot 3G_{mt} \cdot \text{VoteShare}_{im} + \lambda_{im} + \delta_{mt} + \phi_{it} + \epsilon_{ismt} \quad (5)$$

where VoteShare_{im} is the vote share of legislator i in municipality m, defined in Equation (1). Because we are looking at the behavior of legislators in a given legislature VoteShare_{im} is fixed over time. In both specifications we control for politician-municipality and politician-time fixed effects (λ_{im} and ϕ_{it} respectively). The latter fixed effects account for non-linear trends in how different politicians behave over time, for example over the electoral cycles. In specification (4) we control for municipality fixed effects, and allow for the level effects of the introduction of 3G, which is captured by the β coefficient.

In our preferred specification (5), we control for municipality-time fixed effects δ_{mt}. This is important because 3G entry could correlate with municipal growth. Given that the entry of 3G also varies at municipality-time level, we exclude it from the specification. The coefficient γ measures how legislators behave in municipalities with and without 3G Internet comparing localities where they had a significant share of votes with places where they got little votes. In other words, we expect γ to be a key coefficient of interest.

Furthermore, specification (5) explores variation that comes from the same politician having different votes across municipalities within a given electoral district. That is, is *not* just relying on the roll-out of 3G coverage over time, but comparing the behavior of politicians *within* their electoral bases of support *given* the presence or not of 3G. To account for the fact that many politicians are elected in a given municipality, we cluster the standard errors at the level of both municipality and politician.

We make a final modifications to equation (5). We allow for non-linear effects in the politicians' vote share, which can be expected if he or she is pays core attention to their electoral strongholds. Our final specification is

$$y_{imst} = \sum_{\tau=3}^{10} \gamma_\tau \cdot 3G_{mt} \cdot \text{VoteShareDecile}_{im}^{\tau} + \lambda_{im} + \delta_{mt} + \phi_{it} + \epsilon_{imst} \quad (6)$$

where VoteShareDecile$_{im}^{\tau}$ is equal to one if the vote share is in the τ-th decile, and zero otherwise. We make use of this more flexible empirical specification in Subsection 4.2 where, again, our main coefficients of interest are the collection of γ_τ.

4 Results

4.1 Effects at the municipality level

In this section, we implement regressions at the municipality level to study how earmarked transfers, speeches and politicians' social media activity are affected by introduction of 3G Internet access.

We divide our sample into three groups: municipalities that gained 3G access before or on December 2011, municipalities that obtained 3G access between January 2012 and December 2014, and the ones that were connected thereafter.[19] Municipalities that get early access to 3G are different in a number of observable characteristics, as shown in Table 3: on average, they tend to be richer, larger and more urban. This is consistent with a profit-maximizer mobile phone companies that switches the 3G signal earlier where their consumer bases are likely to be located.

In this study, we use the municipalities that gained access after January 2015 as our control group. Identification of the treatment effects hinges on the fact that municipalities that gain and do gain 3G access between 2011 and 2014 would have followed trends parallel to the control group in the absence of treatment. To make this notion formal, and test for the parallel trends assumption, we run the following event-study-type specification

$$y_{mst} = \sum_{j=-2}^{2} \beta_j \cdot 3G_{m,t+j} + \lambda_m + \delta_{st} + \epsilon_{mt}, \tag{7}$$

where $3G_{m,t+j}$ is a variable that assumes 1 if municipality m gained 3G access at time $t+j$, and zero otherwise, excluding municipalities that had 3G prior to 2011. We interpret the null hypothesis $\beta_{-2} = \beta_{-1} = 0$ as evidence of the validity of parallel trends. In Figure A1 in the appendix, we plot the estimated coefficients $\hat{\beta}_j$, and show to be the case. These results point to the conclusion that municipalities that obtained 3G after 2015 are appropriate counterfactuals for those that gained access through treatment period. Thus, for the remainder of the paper, we use municipality that never gained 3G access up to

[19] Our primary data contains the month and year that 3G was made available. If that happened after July each year, we code the 3G entry to the following year.

2014 as the control group.

We initially run the differences-in-differences specification (3) to answer whether politicians change their online and offline behaviors when municipalities gain 3G Internet. We use the inverse hyperbolic sine transformation of the dependent variables to account for the excess mass at zero. As shown in Columns (i)-(iv) in Table 4, we measure strong positive impacts of 3G introduction on the interaction of politicians with votes on congressional speeches and the Facebook platform. In addition to politicians' citations, we are able to elicit the reactions to the posts, measured by the number of likes, shares, and comments. We see that 3G introduction increases by 15.7 percent the probability that the municipality is the subject of a politician post on Facebook. Moreover, all measures of public response increases: posts are liked 26.3 percent more, shared 21.0 percent more, and additional 25.5 percent comments are observed.

We then estimate the effect at the municipal level of the introduction of 3G on the margins of offline activity: speeches and earmarked transfers. We find that introduction of 3G is associated with municipalities being cited *less* often in Congress. We interpret this as evidence of substitution between online and offline activities. We also find negative (and insignificant) effects on the transfers targeting those municipalities. Yet, the results at the municipality level cannot reveal how politicians differentially target municipalities in their electoral base of support. For that, in the next subsection we explore tridimensional nature of the data at the politician-municipality-year triplet.

4.2 Politicians and municipalities: Facebook for pork

Online communication We start by testing whether the presence of 3G Internet affects the use of social media by politicians. We first estimate equation (5) with the full set of politician-municipality, municipality-time, and politician-time fixed effects. We show the corresponding results in Table 5.[20] Column (i) makes it immediately clear that politicians strongly react online to the presence of 3G in the municipalities that are electorally important to them. As a matter of fact, if for instance the politicians have two municipalities in their electoral base, both with 3G access, they mention the municipality 31.8 percent more for each percentage point increase in the electoral base of support. This happens because the politicians have near zero votes in most places, and the effect of 3G in these municipalities drives the results in this specification. Public engagement rises in tandem with politician behavior, as seen in Columns (ii)-(iv): likes, shares and comments that those posts obtained markedly increase.

[20]Results for specification (4) is in Table A2 in the appendix.

As introduced in Section 3, we allow for non-linear effects in the vote share. This can be expected if the politicians exert particular effort, or attention, to their electoral strongholds. So we implement the semi-parametric specification (6) which interacts 3G with the vote share decile. Results are shown in Figure 6. We again note that politicians are heavily increasing their communication, and disproportionally targeting municipalities in the 9th and 10th deciles. We also observe increase in Facebook activity for municipalities much lower in pecking order of importance to the politician: they noticeably increase the mentions to municipalities from the 5th or 6th vote share decile.

For short, politicians talked about the municipalities on Facebook. We now show that those posts carried political content. To do so, we trained a topic modelling algorithm to detect the contents of the messages that deputies were conveying in the platform. More specifically, we manually classified 2,000 posts into four topics: two related to the provision of public goods – health and education –, and two that measure direct parliamentary activity in the Congress – project and amendments. The latter category is particularly important to us, as transfers to municipalities are often implemented through amendments to the annual budget law. We then ran a penalized logistic regression to predict our manual classification, using the count of words mentioned in those posts as explanatory variables.[21] We then evaluated the out-of-the-sample performance of the algorithm, and found that 96% of the posts that mentioned amendments were correctly classified as such; conversely, 97% of the posts that did not mention amendments were classified as not related to that topic.[22] We then use the trained algorithm to automatically detect the topics in the remaining 168.98 thousand posts.

We replace the dependent variable in specification (6), so that y_{imst} now represents the inverse hyperbolic sine transformation of the number of posts in those specific topics. Results are shown in Panel A of Figure 4 and suggest that, in mentioning specific municipalities, deputies conveyed messages of political nature to the electorates. In Panel B, we confirm those findings with a simple specification where we count the number of times that those words were mentioned.[23]

At the same time, that politicians talked about policies on Facebook, public engagement also rose: the number of likes, shares, and comments that the overall number of posts for the politician-municipality increase with, again, effects being detected from the

[21] We also used combinations of two and three words. Prior to this step, we used the Portuguese dictionary to stem the words, and eliminated the ones which are unlikely to carry predictive power such as articles.

[22] The corresponding numbers for the other categories: health: 85% and 97%; education: 89% and 97%; project: 77% and 97%.

[23] Note that the we find stronger effects for "project". This is expected because the performance of text-modelling algorithm was lower for this category.

5th or 6th decile and much more pronounced at the vote-getter municipalities (Figure 3). Overall, this corroborates the findings from the linear specification (5). For short, online Facebook activity intensively increased.

Offline parliamentary activity. So far we have established that, on municipalities electorally important to a politician, 3G Internet entry is associated with congressmen using Facebook as a mean to increase their communication. Now, we try to understand whether or not Internet also affects *offline* parliamentary activity.

We first find that politicians reduce speeches which mentions the municipalities that are most relevant to them (Column (v) of Table 5), which suggests that there is a margin of substitution between online and offline communication strategies. In particular, we analyze the effect on the distribution of earmarked transfers to municipalities. In order to do so, we calculate the total value a congressmen distributed to each municipality per year and we use this information in a regression of the inverse hyperbolic sine transformation in the same fashion as before. Using the linear specification (5), we find that, on average, there is a negative and insignificant impact of 3G on the most electorally-important municipalities to the politicians (Column (vi)).

Not unlike the online behaviour of the politicians, we find that the effects on offline parliamentary activities are actually heavily non-linear. Using specification interacted with vote share deciles, shown in Figure 3, we find that politicians reduce the number of speeches that targeted municipalities in their core base of support. However, and most important to us, there is a pronounced, negative and significant effect of transfers for the municipalities in the electoral strongholds at the highest 9th and 10th deciles.

Whether proposing earmarked transfers translates into policy remains, so far, an open question. There are reasons to believe that just proposing pork-barrelling and earmarked transfers by itself signals the politicians type, particularly if Facebook can make those actions visible. Nevertheless, the actual provision of public policy ultimately depends on the delivery of the projects to the communities, which can further bolster the politicians' credentials with the electorate. Furthermore, the allocation of funds to execute the proposed transfers depends on a continuous bargaining process with the Executive branch, which traditionally traded parliamentary support for funds for pork (Ames, 2002). We thus track the earmarked transfers through the Federal budgeting process. We find that a smaller amount of proposed pork translates into less pork at the tail: indeed, less projects are authorized, exeecuted, and ultimately paid for (Panel A of Figure 5).

Finally, provide evidence on the specific types of project that lost funding. To do so, we use information on the destination ministry or government implementing body of the

earmarked resources. At the period, Brazil had 39 ministries or special secretaries with ministerial status.[24] So we aggregate spending into the five biggest spending categories: health, education, agriculture development and environment, industrial and urban development, and integration and defense.[25] In Panel B of Figure 5, we find that politicians reduced funding projects that are potentially highly visible to the local population (such as education and agriculture) in their electoral strongholds. Yet, we also observe no change in funding for health and even a slight increase in the 8th and 9th deciles. This is consistent with politicians reacting to preferences of the electorate. In fact, at that time, health topped the list of voters' preoccupations regarding the quality of public goods provided in the country: in national polls, nearly one in two voters said it was the most pressing social problem.[26]

Taken together, this suggests that politicians are shifting resources *away* from their core base of support, at the same time that they target those same municipalities *online* much more. This finding is divergent from a body of literature that points to increase in responsiveness of the government when traditional media is present because better-informed voters receive more favorable policies (Strömberg, 2001, 2004a,b; Besley and Burgess, 2002; Eisensee and Stromberg, 2007; Snyder and Strömberg, 2010). This suggests that the effects of the effectiveness of traditional media does not necessarily lends itself to effectiveness of social media. It also points to a margin of substitution between online and offline parliamentary activity: because politicians get much more exposure through Facebook, they can attempt to get away by doing less for municipalities that can see their posts, and shift the resources instead to non-3G precincts.

Electoral outcomes. We next evaluate this electoral strategy in the subsequent 2014 elections. We run specification (6) with vote shares in 2014 as outcome variable for the subsample of candidates that ran for reelection. Because we only observe the vote shares

[24]Source: `http://repositorio.ipea.gov.br/bitstream/11058/8094/1/BAPI_n12_Trajetoria.pdf`, accessed June 27, 2019.

[25]Spending categories were defined taking into consideration that Brazilian ministries often overlap mandates and have complementary portfolio of actions. Health – *Ministério da Saúde* (Health). Education – *Ministério da Educação* (Education), *Ministério da Cultura* (Culture), and *Ministério da Ciência e Tecnologia* (Science and Technology). Agriculture development and environment – *Ministério da Agricultura, Pecuária e Abastecimento* (Agriculture), *Ministério do Desenvolvimento Social e Combate à Fome* (Social Development), *Ministério do Desenvolvimento Agrário* (Rural Development), *Ministério do Meio Ambiente* (Environment), and *Ministério da Pesca e Aquicultura* (Fishing). Industrial and urban development – *Ministério do Desenvolvimento, Indústria e Comércio* (Industrial and Commercial Development), *Ministério dos Transportes* (Transportation), *Ministério de Minas e Energia* (Energy), *Ministério das Cidades* (Cities), *Ministério do Turismo* (Tourism), *Secretaria da Micro e Pequena Empresa* (Small Enterprises), and *Secretaria dos Portos* (Ports). Integration and defense – *Ministério da Defesa* (Defense) and *Ministério da Integração Nacional* (Integration).

[26]Education ranked fourth, after employment and drugs. Source: `http://www.ibopeinteligencia.com/noticias-e-pesquisas/educacao-e-3a-maior-preocupacao-do-pais/`, accessed June 27 2019.

in two years (the elections of 2010 and 2014), the specification is equivalent to the first-difference regression

$$\Delta \text{VoteShare}_{imst} = \sum_{\tau=3}^{10} \gamma_\tau \cdot 3G_{mt} \cdot \text{VoteShareDecile}_{im}^{\tau} + \lambda_i + \delta_m + \Delta\epsilon_{imst},$$

where Δ is the operator that takes the difference between 2014 and 2011. Thus, in this specification, we are explaining the gains or losses in vote shares between elections by the effect of introducing 3G network, relative to the overall number of votes. At this stage, our findings are suggestive owing to the fact that the decision to re-stand for office is potentially reflective of anticipated wins or losses, and correlated with the municipalities in which 3G starts service between 2011 and 2014. In Panel A of Figure 6, we see that significant vote shares are inflicted in politicians in their 9th and 10th-decile strongholds compared to municipalities where little or no votes where obtained in the previous election.

The specification above does not answer what are the level effects of 3G introduction on votings because the outcome variables are relative to the total votes that candidates obtained in the elections. We run a final specification with the inverse hyperbolic sine of votes as dependent variable. Because we are interested in the level effect of 3G introduction, which varies at the municipality-year level, we remove the corresponding fixed effect. We find that 3G had, on average, a positive effect on votes, but this effect is heavily decreasing with vote shares.[27]

The following stylized facts emerge for the analysis in this section: (i) politicians make strong use of Facebook to mention the municipalities in their base of support, with much more pronounce effects at their strongholds. Their behavior is met with increasing response and citizens' engagement with the posts; (ii) perhaps surprisingly, they reduce *offline* activity, measured by the number of speeches conferred in Congress and, particularly in shifting earmarked transfers away from the municipalities that are electorally most important to them. This is suggestive of a substitution between online and offline activity; and, finally, (iii) they lose electoral grip in the subsequent 2014 elections. In the next section we propose mechanisms that rationalize these effects.

[27]Yet in the spirit of providing suggestive evidence, we assess if Facebook was itself a relevant factor in bolstering the politicians' electoral prospects in 2014. To do so, we interact the 3G-by-vote share decile variable with the use of Facebook specifically during the 2014 electoral campaign. We construct a binary variable that indicates if municipality m was mentioned by politician i leading to the election that was held in October 5, 2014. We do not find evidence that targeting Facebook messages to the electoral strongholds attenuated the electoral losses in the strongholds. See Figure A2 in the appendix.

Robustness. We conduct a number of exercises to confirm the robustness of the results above. Main results are unchanged in all tests. First, we restrict to the sample of politicians with Facebook profile opened during or prior to 2011 to account for the endogenous timing of opening a profile (Figure 7). We show that 3G indeed predicts opening a Facebook profile in a panel of politicians by year, but does not predict subsequent Facebook activity (Table 6). Second, we also set Facebook activity to zero when a profile was not open, as in the previous specifications it was coding as missing (Figure 8). Third, we weight the regressions for the population to show that the results are not driven by small and less-relevant municipalities which could possibly be at the fringe of 3G expansion (Figure 9). The main results are not driven by municipalities above or below median population (Figure 10). Fourth, we exclude municipalities in years that they had not obtained 3G, but were neighbour to those that had access to the technology. We do so to avoid the potential that 3G signals were also being captured by geographically close municipalities. We defined as neighbouring municipality the ones for which the closest distance at any two points in their polygons is smaller than 50km, which is the maximum coverage of 3G antennas. We also exclude municipalities that are within the same "population arrangement", as defined by the Brazilian statistical bureau (IBGE). It captures the surrounding conurbated municipalities characterized by, for example, commuting patterns (Figure 11). Fifth, we show that the effects are contemporaneous to the introduction of 3G in an specification with lead treatment effects (Figure 12).

We also tested if particular types of politicians were driving the results. We do not find any evidence that younger or more educated politicians made more use of Facebook, nor that their reaction offline was any different (Figures 13 and 14). We also looked if the behaviour of politicians with dispersed base of support was different from those with strong voting in few municipalities. To this effect, we calculated the normalized Herfindahl-Hirschman index for a objective measures voting concentration.[28] We define as "concentrated"types the politicians for whom the index is above median, and label the remaining as "dispersed types". Again, as we show in Figure 15, we do not find any significant difference.

Finally, we test if the local media interacted with the use of online platform and transfers. To do so, we obtain data on the municipalities that had community radio or TV station prior to our sample period.[29] As discussed above, previous papers showed that responsiveness of the government was magnified by the presence of local media

[28]More specifically, the Herfindahl-Hirschman is $HH_i = \sum_{m=1}^{M_i} \text{VoteShare}_{im}$ where M_i is the number of municipalities in i's state of origin. The normalized score is $HH_i^* = \frac{HH - 1/M_i}{1 - 1/M_i} \in [0,1]$ where 0 is uniform voting in all municipalities, and 1 is total concentration.

[29]Source: Perfil dos Municípios Brasileiros 2009 (IBGE)

(Strömberg, 2004b; Snyder and Strömberg, 2010). We no not find evidence that local media changed politicians' responsiveness in our setting (Figure 16).

5 A Simple Model of Facebook and Pork

Our key results establish that the expansion of Internet access in a municipality, via its entry into the the 3G network, leads to an increase in the online engagement of politicians for whom that municipality is an important part of their electoral base. This, however, is matched by a decrease in the politicians' offline engagement, and particularly their inclination to transfer earmarked resources to the municipality. In order to make sense of these patterns, we now lay out a stylized model of political competition in which politicians strategically use both communication and transfers as means to secure votes, and in which we can study their response to the arrival of Facebook.

5.1 Model Setup

Consider two politicians, $p \in \{a, b\}$, who compete for votes in an election in the municipalities $m \in \{1, 2, ..., n\}$ of a given state. The politicians have two potential instruments to affect voters in a given municipality: communication, $c_m^p \in \mathbb{R}_+$, and earmarked transfers, t_m^p. As for voters, in each municipality there is a continuum of voters of mass 1, indexed by i, each of whom is characterized by an ideological distance from each candidate, $r_{im}^p \sim U[0, 1]$ (i.e., uniformly distributed on the unit interval). Each politician has a given level of overall popularity in each municipality, μ_m^p. We label municipalities such that they are ordered by the popularity of politician a ($\mu_{m'}^a \geq \mu_{m''}^a$ for $m' < m''$), who will be the focus of our comparative statics.

We make three simplifying assumptions, which are not needed for obtaining the key insights, but help sharpen the focus of the analysis. First, we impose symmetry in terms of ideology ($r_{im}^b = 1 - r_{im}^a$) and popularity ($\mu_{m'}^b \leq \mu_{m''}^b$ for $m' < m''$). Second, we model transfers as a binary variable $t_m^p \in \{0, 1\}$, subject to a unitary budget constraint, i.e., $\sum_m t_m^p \leq 1$, implying that the politician can only transfer to one municipality.[30] Finally, we assume that only politician a is currently in office, hence with the option of making transfers – in other words, we will set $t_m^b = 0$ for all m.[31]

[30] This is meant to capture, in simple fashion, the tight budget that individual politicians have, as illustrated by the fact that, in our data, they target few municipalities (an average of five), relative to the total number of municipalities in each state.

[31] In the Online Appendix, we present a model in which both politicians can make transfers, and show that the key insights carry over, though the complexity of possible strategic interactions between transfers

The key assumption is in the difference between transfers and communication: we posit that the latter is only effective at reaching voters who already have a substantial idiosyncratic preference for the politician. This captures the idea that it is only voters who are more aligned with a politician who will choose to follow him on Facebook or, more generally, to pay attention to what he says. Formally, we define the "core set" of p in municipality m as $\mathcal{I}_m^p = \{i : \mu_m^p - r_{im}^p \geq 0\}$, which we take to be the set of individuals in m who are sufficiently close to p that his communication efforts exert influence over them. We will refer to them as politician p's "core supporters."[32]

Formally, we model voter i's behavior as follows: she computes the utility from voting on each candidate, and if the highest utility is greater than the opportunity cost of voting, she casts a vote for the corresponding politician, while abstaining otherwise. The utility from voting for candidate p, given (c_m^p, t_m^p), is given by:

$$U_{im}^p \equiv U_m^p(c, t, r_i) = \alpha t_m^p + I_{im}^p \cdot c_m^p + \mu_m^p - r_{im}^p \tag{8}$$

where $I_{im}^p = \mathbb{1}_{\left[i \in \mathcal{I}_m^p\right]}$, i.e. an indicator of whether voter i is in the core set of politician p in municipality m. We model the opportunity cost of voting as a random variable $\varepsilon_{im} \sim U[0, d]$, independent of r_i.[33] In sum, i votes for p iff $U_{im}^p \geq \max\{U_{im}^a, U_{im}^b, \varepsilon_{im}\}$.

Taking into account the expected behavior of voters, politicians will choose the optimal levels of the policy tools to maximize:

$$W^p = \sum_m \left[v_m^p - \frac{\gamma_m}{2}\left(c_m^p\right)^2\right] \tag{9}$$

where v_m^p is the share of m's population voting for p, and the cost of communication is a quadratic function parameterized by γ_m. This maximization is subject to the budget constraint on the allocation of transfers.

We further assume:

H1. $1 > \mu_m^a + \mu_m^b > 1 - \alpha > \max\{\mu_m^a, \mu_m^b\} > 0$

The first part of H1, $\mu_m^a + \mu_m^b < 1$, is the most crucial. It implies that the core sets of both politicians are non-overlapping. This removes the strategic interaction between the communication decisions of the two politicians, and lets us focus on the interplay between transfers and communication. It also implies that there exists a mass of unattached voters in the center of the ideological spectrum who will abstain with probability one in the

from different politicians substantially complicates the analysis.

[32]More generally, we could model an influence function $h_P(r_i, c)$, such that r, c are super-modular. Under a few additional functional form restrictions on h, we conjecture all results would still hold.

[33]Note that even though $\varepsilon \perp r$, a voter who is ideologically closer to p has a higher likelihood of voting for p.

absence of transfers, which simplifies the analysis by reducing the number of cases to be considered without qualitatively affecting the results. The other conditions in H1 help to rule out corner solutions in our model.

In addition, to focus on interior solutions, we also impose the following conditions on the distribution of the opportunity cost of voting:

H2. (i) $d > \gamma^{-1} \cdot \frac{3\mu_m^b - (1-\alpha-\mu_m^a)}{2\left(\mu_m^a + \mu_m^b - (1-\alpha)\right)}$, (ii) $d > \gamma^{-1} \cdot \frac{\mu_m^p}{d-\alpha-\mu_m^p}$, (iii) $d > \gamma^{-1} \cdot \frac{3}{4}$

Parts (i) and (ii) guarantee that there is competition for politician b's core supporters and that no voter votes with probability 1. Part (iii) ensures that the problem of politician b is concave.

5.2 Main Results

We solve the model in two steps: first, we characterize the optimal communication strategy taking transfers as given, and then solve for the optimal transfers taking into account the communication strategy. (The details of the derivation are left to the Appendix, for the sake of brevity.) Our key comparative statics exercise will be a reduction in γ_m, the cost of communication, which we interpret as being the upshot of the entry of municipality m into the 3G network. In other words, the arrival of Facebook to a municipality makes communication to that municipality more effective.

The first key result, characterizing the optimal communications strategy for given transfers, is as follows:

Proposition 1. *Assume H1-H2 hold and t_m^a is fixed for all m. Then, there exists a unique equilibrium which has the following comparative statics: (i) c_m^p is increasing in μ_m^p: a politician's communication efforts towards a municipality are increasing in his popularity in the municipality; (ii) c_m^p is decreasing in γ_m: communication effort is decreasing in the cost of communication; and (iii) the effect of γ on communication is increasing in the politician's popularity, μ_m^p.*

This proposition is rather intuitive: first, politicians will tend to focus their communication efforts in places where they are more popular. This is because their popularity translates into a larger set of core voters, who are reachable by those efforts. Second, a reduction in the cost of communication implies increased communication efforts.[34] This means that a municipality's entry into the 3G network will increase those efforts towards

[34]Note that H1 is important for this result. If the core sets of the two politicians are overlapping, then communication becomes a strategic substitute across politicians, which makes the comparative statics ambiguous. Intuitively, while a reduction in the cost of communication has the direct impact of increasing a politician's efforts, that increase triggers an incentive for other politicians to reduce their effort, which pushes the equilibrium comparative statics in the opposite direction.

that municipality. The third part of the proposition then establishes that the impact of such entry will tend to be stronger in places where the politician has a bigger set of core voters.

We can then characterize the equilibrium with transfers and the comparative statics in response to the arrival of 3G Internet, as follows:

Proposition 2. *Assume H1-H2 hold, and $\gamma_m = \gamma$. Then: (i) $t_1^a = 1$: politician a will transfer to municipality 1; (ii) If the cost of communication at municipality 1, γ_1, decreases enough, then politician a switches the transfer to municipality 2; and (iii) If the change in γ_1 is small, but enough to trigger the change in transfer, v_1^a may fall, whereas v_2^a will increase.*

This proposition states that, if the costs of communication are the same in the different municipalities, the politician will, intuitively enough, choose to direct his transfers to the municipality that is most important to him. However, if communication targeted to that municipality becomes relatively more effective, he may choose to direct resources *away* from it, to the benefit of other municipalities where he is still popular (even if less so). He is willing to do that even at the cost of losing votes in the former, in exchange for obtaining additional votes in the latter.

5.3 Interpretation

Propositions 1 and 2 provides a foundation for interpreting our key empirical findings. When a municipality joins the 3G network, thereby increasing the effectiveness of communication, politicians respond by increasing their communication efforts towards that municipality. In our context, this means more Facebook posts targeted at the municipality, and more so when the municipality is more important for him, which is exactly what we find in the data. In contrast with this increased online engagement, Proposition 2 shows that he may shift transfers away from the municipality, and towards other municipalities that are also important for him, but which have not experienced the increased effectiveness in communication – namely, those that remain without 3G Internet – again consistent with our findings.

The intuition behind Proposition 2 is as follows: as both politicians increase their communication with the municipality where that communication became more effective (as per Proposition 1), it follows from (8) that the core supporters of each politician will become more attached to them. This means that politician *a* will have a weakened ability to swing his competitor's core voters away by using transfers. As a result, he has an increased incentive to shift his transfers towards another municipality that is important to him, but where communication remains less effective, and therefore more

voters are persuadable. The result of the shift in transfers is an increase in a's votes in the latter municipality, while he may even lose votes in the municipality that joined the 3G network.

Our model thus showcases a mechanism through which online and offline engagement are substitutes, even in the absence of any technological feature inducing that substitutability. Instead, it is the key feature that transfers are less targeted to core supporters than communication efforts that leads to that pattern: online engagement increases the attachment of core supporters, thus making transfers relatively less effective as a way of garnering additional votes. While it would be possible for there to be technologically-induced substitution – say, if by amplifying the extent to which people learned about the politician's offline efforts, online engagement would render the latter less necessary – it seems hard to square off such a mechanism with the fact that the politician actually loses votes, relatively speaking, in the places that join the 3G network.

More broadly, our model underscores the point that the expansion of the Internet (and of social media in particular) need not increase the offline responsiveness of politicians. This is because politicians – unlike what was the case with previous media technologies – are also content providers, which means that they can avail themselves of the new technology to increase the attachment of their core supporters. In doing so, they increase their "market power" with respect to competitors and voters, which induces them to switch their offline efforts to places where the ability to reach swing voters with transfers remains relatively high.

A final note on interpretation, beyond the specific scope oft he model, has to do with the patterns we would expect to develop over time. To the extent that 3G access (and more broadly, access to social media) would increase towards universalization, there could be a reversal in which places that gained access first would lose transfers initially, only to eventually regain them as communication becomes more effective in the other municipalities. While this is possible, any feature leading to the persistence of the effects of transfers – for instance, if transfers can increase the politician's general popularity in the target municipality over time – would push in the opposite direction.

5.4 Additional Evidence

Our model attributes the reduction in transfers in response to the arrival of Facebook via 3G Internet to the politicians' enhanced ability to increase the attachment of their core supporters. In that spirit, we can study whether the response we find in the data is indeed driven by politicians who are more likely to rely on core supporters, corresponding to

higher levels of the μ^p parameters.

To get at that, we construct a measure of seat safety by recomputing the rank of candidates in their states of origin. We consider that elected deputies who were at or below the lowest quartile of the list have relatively unsafe seats, and were therefore less able to rely on a core set of supporters. In Figure 17, we show evidence that those vulnerable legislators respond to 3G entry by making greater use of Facebook, but they do not reduce mentions in congressional speeches, or, more importantly, transfers to the municipalities in their electoral base of support.

This is further corroborated, at least in part, with an additional indirect measure of political competition: politicians who are not the only members of their party elected in their home states are more likely to face competition – in this case, given the Brazilian open-list system, from within their own party. Likewise, we find that they also do not reduce congressional speeches, nor transfers (Figure 18). However, we do not find evidence that they use online communication more often than their peers.

On a separate note, we can also consider heterogeneity in the degree to which the arrival of 3G represents a reduction in communication costs. Specifically, we take into account the fact that, before the advent of online communication, mayors supplied a local platform through which candidates vying for a seat at the national Congress could disseminate their political positions and achievements. As such, we posit that this created significant disadvantages in communicating with local voters for politicians who were not in the party coalition of the local mayor, as the latter would be less willing to advance the interests of someone from a competing political party.[35] This would imply that the reduction in communication costs entailed by the arrival of 3G would be more significant in that case. Consistent with that, we find that politicians used Facebook more often to target municipalities in which the mayor was in a *different* coalition of parties, as shown in Figure 19.

6 Conclusion

We have examined the response of Brazilian legislators to the spread of social media in the country via 3G mobile phone networks. We find that politicians respond to the arrival of 3G to a municipality within their base of support by increasing their social media interactions with that municipality. They write more Facebook posts mentioning

[35]Mayoral elections do not coincide with elections for the Congress. They are held every four years, in between national mandates. Thus, mayors elected in 2008 were in power during the 2010 national elections, with few exceptions.

the municipality, and these posts get more comments, shares, and likes from their followers. Far from indicating greater overall responsiveness, however, we instead see this increased online interaction countered by decreased effort directed at the municipality when it comes to offline behavior. Politicians bring fewer resources to the municipalities that received 3G access, and mention them less often in congressional floor speeches. We show that this reduced offline effort is rationalized by a model in which the more effective communication technology brought by social media allows politicians to increase the attachment of their core supporters, allowing them to switch transfers to other municipalities, which end up with a relatively larger presence of swing voters. In short, social media does not seem to increase the responsiveness of politicians, because they allow them to increase their "market power" relative to voters as a group.

These results underscore the fact that social media are a fundamentally different kind of media technology, because they are not simply tools for the spread of news and information. Instead, their low barriers to entry allow politicians to become content providers, and that in turn changes the optimal mix of forms of engagement between politicians and voters. To the extent that actual resources are valuable, and more so than online engagement per se, this can actually be costly from the standpoint of voters.

Of course, our setting does not allow us to consider many important factors. For instance, it is not possible to make a clear welfare assessment, especially since we do not have a good way of measuring the social welfare impact of the local public goods financed via transfers. By the same token, what we observe is a relatively short-run response, as social media access via 3G spreads across the country, although we have argued that it is not hard to imagine circumstances under which the short-run variation ends up persisting over time. Last but not least, it is evidently possible that what we have found in the Brazilian context may be different elsewhere, even though we have also argued that there would be reason to believe, *prima facie*, that the positive impact of social media on accountability and responsiveness would have been particularly likely in that context, with its relative paucity of pre-existing sources of information.

With those caveats in mind, our evidence provides additional reasons to be skeptical of positive effects of social media on political accountability, even leaving aside concerns with "fake news" or misinformation that have become widespread in recent years. Social media can empower politicians relative to voters, and make them overall less responsive as a result.

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Tables and Figures

Table 1: The rise and adoption of mobile Internet and Facebook in Brazil

	2011	2012	2013	2014
Panel A. Rollout of 3G coverage				
% municipalities with 3G	.300	.539	.616	.668
% municipalities with 3G, north	.232	.354	.398	.444
% municipalities with 3G, northeast	.216	.369	.491	.564
% municipalities with 3G, centerwest	.281	.419	.454	.493
% municipalities with 3G, southeast	.421	.751	.815	.860
% municipalities with 3G, south	.287	.613	.668	.704
Panel B. Internet adoption				
% households with Internet use	.366	.403	.480	.549
% households with mobile Internet use	–	–	.536	.804
Broadband Internet subscriptions per 100 inhabitants	7.17	8.98	9.53	10.55
Mobile subscriptions per 100 inhabitants	100.1	118.0	123.8	133.9
Panel C. Facebook adoption				
% use Facebook (*Latinobarometer*)	.135	–	.428	–
% use Facebook (*Ibope Nielsen Online*)	.228	.243	–	–
% use Facebook (*Facebook*)	–	–	–	.450
Panel D. Google Trends interest index for Facebook, Orkut and Twitter				
Facebook	20.96	65.09	85.85	67.79
Orkut	22.06	14.91	2.67	1.00
Twitter	5.79	3.74	2.21	1.42

Notes: Panel A: "% municipalities with 3G" refers to the share of municipalities with 3G access in Brazil across regions (*Source:* TELECO). Panel B: "% households with (mobile) Internet use" is the share of households that report using (mobile) Internet (*Source:* Pesquisa Nacional por Amostra de Domicílios, PNAD). Broadbrand Internet (mobile) subscriptions per 100 inhabitants (*Source:* World Bank). Panel C: "% use Facebook" is the share of Facebook users in the population (*Sources:* Latinobarometer, Ibope Nielsen Online survey and Facebook, available at `https://www.facebook.com/business/news/BR-45-da-populacao-brasileira-acessa-o-Facebook-pelo-menos-uma-vez-ao-mes`, accessed Jan 30th 2019). Panel D: Google Trends index for searches for Facebook, Orkut and Twitter in Brazil from 2011 and 2014. Numbers of Google searches are normalized with respect to the largest valued observed over time and across all series (*Source:* Google Trends).

Table 2: Politicians' online and offline behavior

	2011	2012	2013	2014	2011-2014 total, per pol.	2011-2014 total, all pol.
Panel A. Politicians' online behavior						
% open FB profiles	.173	.406	.657	.809	–	–
Posts	24.48 (37.01)	143.85 (303.52)	245.24 (492.93)	484.17 (1,004)	897.74 (1,517)	460.54k
Posts (*citing any municipality*)	4.44 (17.74)	44.85 (117.67)	102.55 (212.67)	177.56 (266.71)	329.1 (523.85)	168.98k
Likes (*from above*)	26.57 (98.21)	819.37 (3,022.8)	3,307.7 (9,159.6)	29,398.7 (146.31k)	33,465.4 (151.98k)	17.21m
Shares (*from above*)	4.15 (16.94)	296.57 (1,010.2)	1,107.5 (2,971.3)	11,617.2 (143.52k)	12,937.7 (144.47k)	6.64m
Comments (*from above*)	7.52 (30.42)	146.60 (530.63)	367.40 (1,083.2)	2,513.1 (20,906.2)	3,034.6 (21,284.8)	1.56m
Panel B. Politicians' offline behavior						
Speeches	24.06 (42.69)	20.38 (44.22)	26.09 (60.24)	17.74 (45.16)	87.91 (179.26)	45.28k
Transfers	5.68 (7.76)	4.95 (7.33)	4.81 (8.08)	6.56 (7.85)	21.81 (24.23)	11.28k
Transfers (R$)	R$ 5.54m (R$ 5.74m)	R$ 5.35m (R$ 6.04m)	R$ 4.12m (R$ 5.52m)	R$ 6.73m (R$ 6.49m)	R$ 21.74m (R$ 20.42m)	R$ 11.21b
Number of targeted municipalities	6.32 (8.02)	5.34 (7.58)	5.52 (8.50)	6.99 (7.74)	9.47 (10.39)	3504.4

Notes: Panel A: "% open FB profiles" is the share of politicians per year that had opened their Facebook profiles. We defined a Facebook profile open from the moment of the first post. "Posts" are the number of posts on Facebook by politician. "Posts (*citing any municipality*)" is the subset of Facebook posts in which at least one Brazilian municipality was cited. "Likes", "shares" and "comments" are number of likes, shares and comments that those posts obtained. Panel B: "Transfers" is the average number of earmarked transfers proposed by politicians, per year. "Transfers (R$)" is the average value of earmarked transfers in Brazilian Reais, at the time of proposal. "Number of targeted municipalities" is the number of municipalities that were targeted through earmarked transfers by the politician in a given year. "Speeches" is the total number of speeches delivered in Congress that cited at least one municipality. Standard errors are calculated across politicians. Along the columns, "2011-2014, total, per pol." is accumulated values per politician across the 2011-2014 time period. It equal to the sum of for the 2011-2014 period, except for the "number of targeted municipalities" since the politician might repeatedly target them over time. "2011-2014, total all pol." is the number across all politicians, in all time periods. Standard errors in parenthesis. *Sources:* Facebook data from politicians' public Facebook profiles; transfers and value of transfers obtained from Brazilian Senate's database of amendments to the *Lei Orçamentária Anual*; speeches from Congress' database.

Table 3: Descriptive statistics of municipalities by date of 3G connection

		3G connection year		
	All	$\leq$ 2011	[2012, 2014]	$\geq$ 2015
Income per capita	R$ 493.80	R$ 621.42	R$ 491.32	R$ 389.67
	(243.34)	(272.41)	(218.10)	(189.65)
Years of schooling	9.46	9.56	9.56	9.27
	(1.09)	(.866)	(1.11)	(1.22)
Gini index	.494	.498	.484	.504
	(.066)	(.058)	(.068)	(.068)
Population	34,316	93,617	13,929	8,696
	(203,274)	(379,155)	(12,911)	(7,663)
% urban population	.638	.779	.624	.537
	(.220)	(.197)	(.207)	(.191)
% poor	.232	.162	.219	.306
	(.179)	(.151)	(.178)	(.175)
% electricity	.972	.988	.976	.954
	(.060)	(.033)	(.052)	(.079)
Area	1.525	1.592	1.024	2.064
	(5.612)	(6.022)	(3.028)	(7.308)
Turnout in 2010	.806	.816	.804	.802
	(.060)	(.049)	(.060)	(.067)
Municipalities	5,556	1,542	2,178	1,836

Notes: Descriptive statistics of the municipalities in the sample. "Full sample" refers to the all Brazilian municipalities; "$\leq$ 2011" is the subsample of municipalities that gained 3G access before January 2012; "[2012, 2014]" refers to the municipalities gained access between January 2012 and December 2014, thus during the period of analysis; "$\geq$ 2015 " gained access on or after January 2015 and constitute the control group. "Income per capita" at the municipality level, in Brazilian Reais. "Years of schooling", "Gini index" and "Population" refer to the average number of years of schooling, Gini inequality index, and population in the municipalities. "% Urban population", "% poor", "% electricity" refer to the share of urban population, poor (defined as below poverty levels) and with household access to electricity. Area of the municipalities in thousands of square kilometers. Standard errors in parenthesis. *Source:* IBGE 2010 census.

Table 4: Municipality-level regressions

	(i) Posts	(ii) Likes	(iii) Shares	(iv) Comments	(v) Speeches	(vi) Transfers
Panel A. Extensive margin, binary dependent variable						
3G	.005	.013	.028***	.040***	-.024*	-.007
	(.013)	(.012)	(.012)	(.012)	(.015)	(.014)
Mean of dep. var.	.535	.521	.467	.433	.348	.189
Panel B. Intensive and extensive margins, IHS of dependent variable						
3G	.157***	.263***	.210***	.255***	-.040**	-.151
	(.027)	(.060)	(.041)	(.049)	(.020)	(.176)
Mean of dep. var.	3.19	294.9	161.7	30.34	.846	R$ 99,756
Observations	16,056	16,056	16,056	16,056	16,056	16,056
Treated	2,178	2,178	2,178	2,178	2,178	2,178
Control	1,836	1,836	1,836	1,836	1,836	1,836

Notes: Panel regressions at the municipality by year levels, explained by presence of 3G dummy variable, with municipality and state-year fixed effects. In Panel A, dependent variable is binary. In column *(i)*, it is equal to one if a given municipality was cited at least once in Facebook in a given year. Dependent variables in columns *(ii)*, *(iii)* and *(iv)* are equal to one if those posts obtained at least one like, share or comment, respectively. Dependent variable in column *(v)* is equal to one if the municipality was cited at least once on Congressional speeches. Column *(vi)* is equal to one the given municipality was targeted by transfers, and zero otherwise. "Mean of dep. var." refers to the mean of the dependent variable, averaged across the 2011-2014 period. In Panel B, dependent variables are the inverse hyperbolic sine transformation of the number of earmarked transfers proposed to the municipality in a given year, speeches delivered in the Congress and Facebook posts that mentioned the municipality, likes, shares and comments that those posts obtained. "Mean of dep. var." refers to the raw numbers, without the inverse hyperbolic sine transformation, and averaged across the 2011-2014 period. Transfers in Brazilian Reais. Clustered standard errors at the municipality level.

Table 5: Municipality-politician level regressions

	(i) Posts	(ii) Likes	(iii) Shares	(iv) Comments	(v) Speeches	(vi) Transfers
Panel A. Extensive margin, binary dependent variable						
3G×Vote Share	.130***	.149***	.147***	.159***	-.0061*	-.0056*
	(.024)	(.024)	(.022)	(.023)	(.003)	(.0038)
Mean of dep. var.	.094	.091	.080	.067	.020	.010
Panel B. Intensive and extensive margins, IHS of dependent variable						
3G×Vote Share	.318***	1.063***	.471***	.698***	-.013**	-.069
	(.057)	(.127)	(.070)	(.079)	(.005)	(.053)
Mean of dep. var.	.229	21.19	2.18	11.62	.033	3,844.2
Observations	203,107	203,107	203,107	203,107	412,254	412,254

Notes: Panel regressions at the municipality-politician by year levels, explained by presence of 3G dummy variable, and interaction with vote shares of the candidates in the municipalities. Specifications contains municipality-time, municipality-politician and politician-time fixed effects. In Panel A, dependent variable is binary. In column *(i)*, it is equal to one if a given municipality was cited by a politician at least once in Facebook in a given year. Dependent variables in columns *(ii)*, *(iii)* and *(iv)* are equal to one if those posts obtained at least one like, share or comment, respectively. Dependent variable in column *(v)* is equal to one if the municipality was cited by a politician at least once on Congressional speeches in a given year. Column *(vi)* is equal to one the given municipality was targeted by transfers, and zero otherwise. "Mean of dep. var." refers to the mean of the dependent variable, averaged across the 2011-2014 period. In Panel B, dependent variables are the inverse hyperbolic sine transformation of the number of earmarked transfers proposed to the municipality by a politician in a given year, speeches delivered in the Congress and Facebook posts that mentioned the municipality, likes, shares and comments that those posts obtained. "Mean of dep. var." refers to the raw numbers, without the inverse hyperbolic sine transformation, and averaged across the 2011-2014 period. Numbers are relative to the municipalities from the politicians' state of origin. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

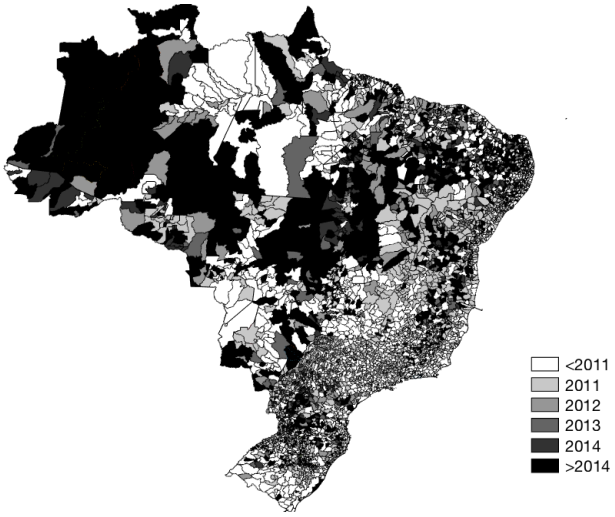
Table 6: Politician-level regressions

	(i) FB Open	(ii) Posts	(iii) Likes	(iv) Shares	(v) Comments	(vi) Speeches	(vii) Transfers
Panel A. Extensive margin, binary dependent variable							
Vote share with 3G	.576*	.473	.431	.328	.340	.326	.075
	(.333)	(.341)	(.345)	(.352)	(.351)	(.264)	(.261)
Mean of dep. var.	.641	.628	.627	.620	.616	.815	.808
Panel B. Intensive and extensive margins, IHS of dependent variable							
Vote share with 3G	–	.708	-.819	-1.481	-1.253	.452	1.720
	–	(1.680)	(2.590)	(2.273)	(1.977)	(.813)	(4.021)
Mean of dep. var.	–	109.9	11.67k	4.61k	1.04k	24.68	R$ 5.67m
Observations	1,329	1,329	1,329	1,329	1,329	1,329	1,329

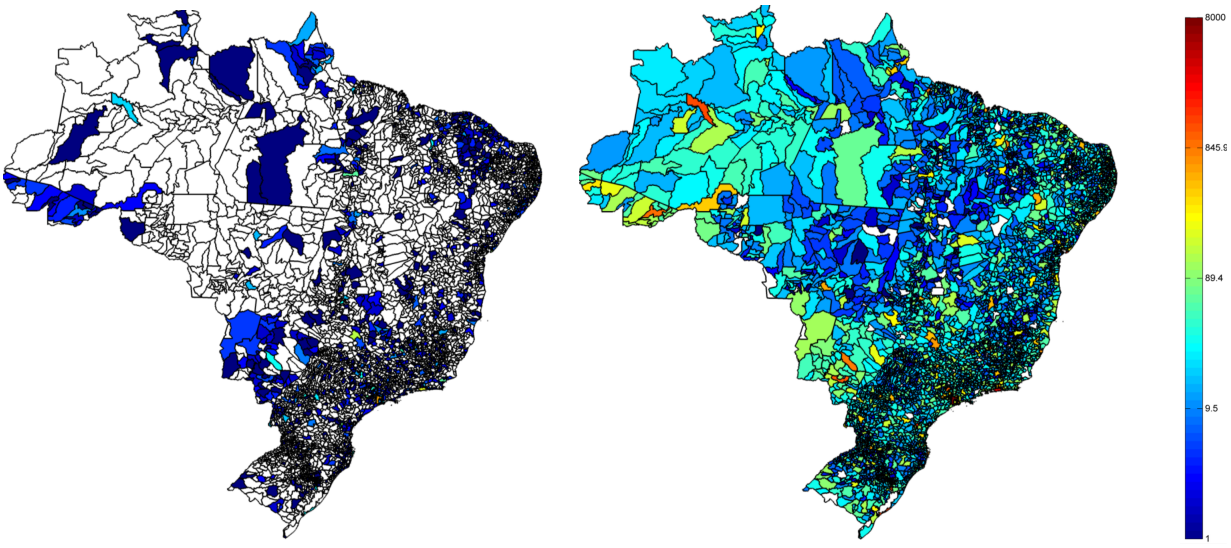
Notes: Panel regressions at the politician by year levels, explained by the share of municipalities with 3G weighted by the politicians' vote share, with politician and state-year fixed effects. In Panel A, dependent variable is binary. In column *(i)*, it is equal to one if the politician had an active Facebook profile, defined by having posted at least once in the year. In column *(ii)* it is equal to one if a given municipality was cited at least once in Facebook in a given year. Dependent variables in columns *(iii)*, *(iv)* and *(v)* are equal to one if those posts obtained at least one like, share or comment, respectively. Dependent variable in column *(vi)* is equal to one if the municipality was cited at least once on Congressional speeches. Column *(vii)* is equal to one the given municipality was targeted by transfers, and zero otherwise. "Mean of dep. var." refers to the mean of the dependent variable, averaged across the 2011-2014 period. In Panel B, dependent variables are the inverse hyperbolic sine transformation of the number of earmarked transfers proposed to the municipality in a given year, speeches delivered in the Congress and Facebook posts that mentioned the municipality, likes, shares and comments that those posts obtained. "Mean of dep. var." refers to the raw numbers, without the inverse hyperbolic sine transformation, and averaged across the 2011-2014 period. Transfers in Brazilian Reais. Clustered standard errors at the politician level.

Figure 1: 3G rollout and Facebook

Panel A. 3G rollout

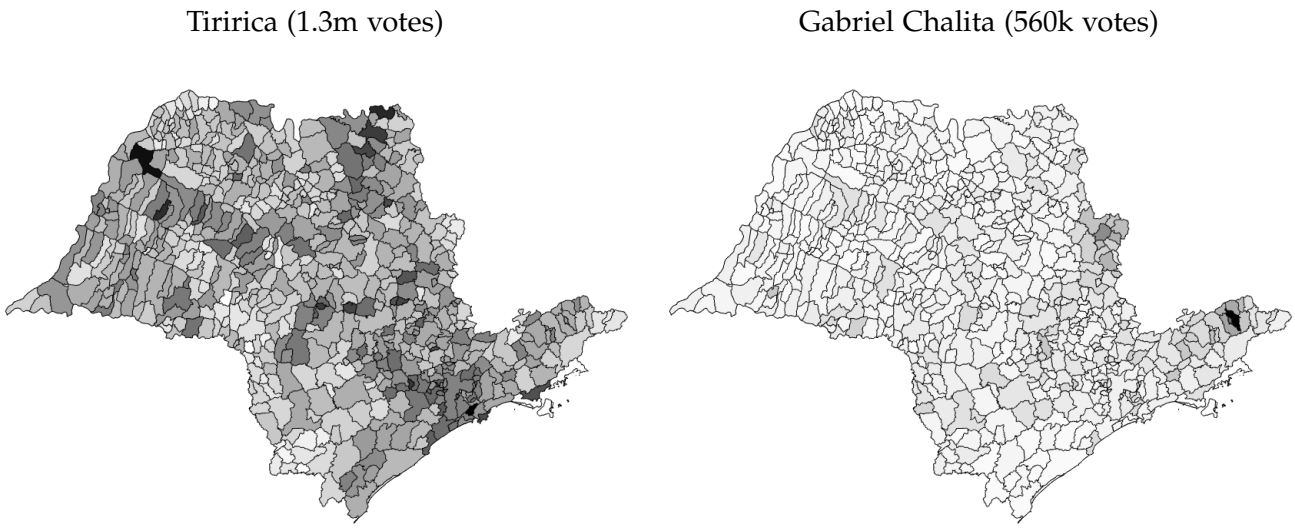


Panel B. Mention to municipalities on Facebook



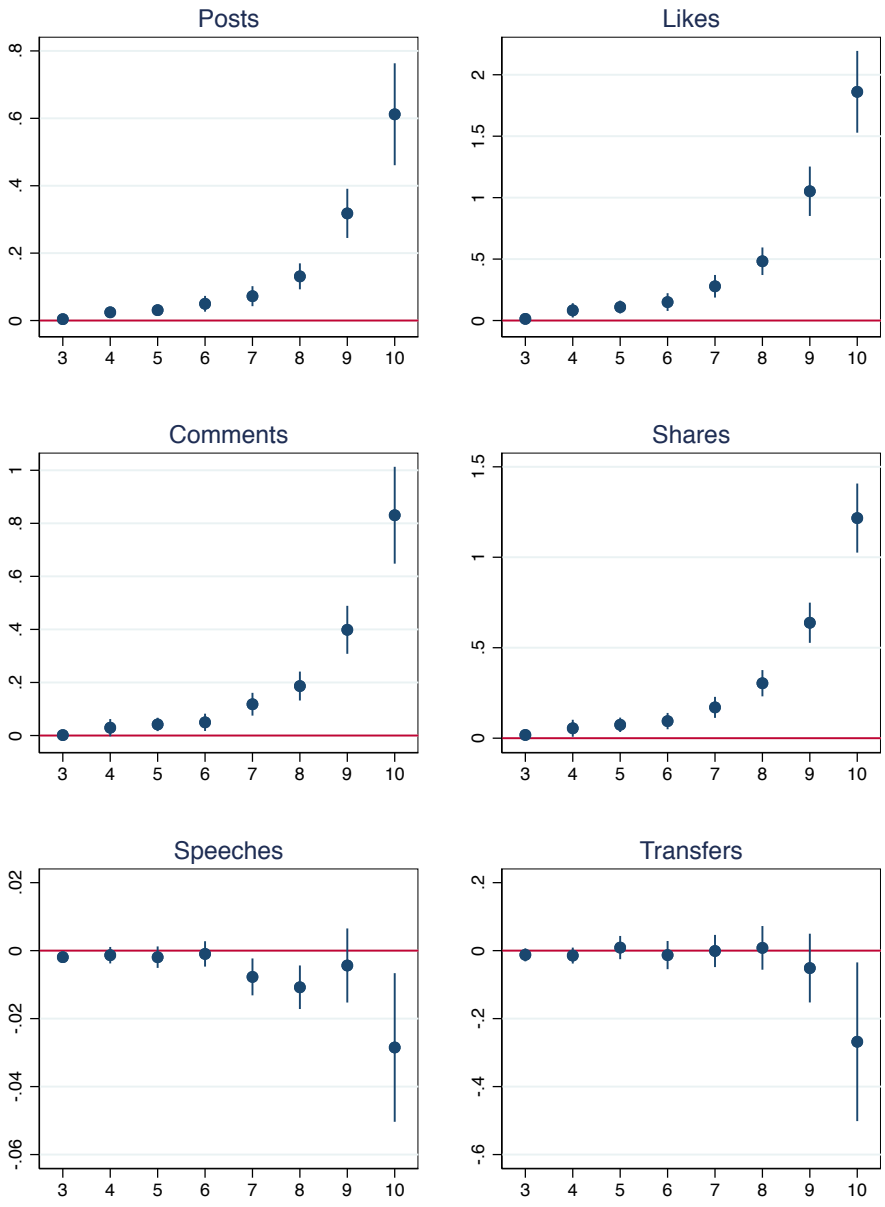
Notes: Panel A: Roll-out of 3G coverage across municipalities in Brazil prior to 2011, after 2014 and for the intermediary years. *Source:* Teleco. Panel B: Number of times in 2011 and 2014 that municipalities are mentioned on Facebook, computed over the posts of all elected politicians in the log scale.

Figure 2: Vote share of the two best-voted politicians from São Paulo state



Notes: Vote shares per municipality of the two best-voted politicians from the state of São Paulo: Tiririca (1.3m votes) and Gabriel Chalita (560k votes). Vote shares are computed as the votes for the candidate in a municipality divided by the candidate's total number of votes. Light colors represent low vote shares. Black colors represent the highest vote share for each candidate. *Source:* Tribunal Superior Eleitoral (TSE).

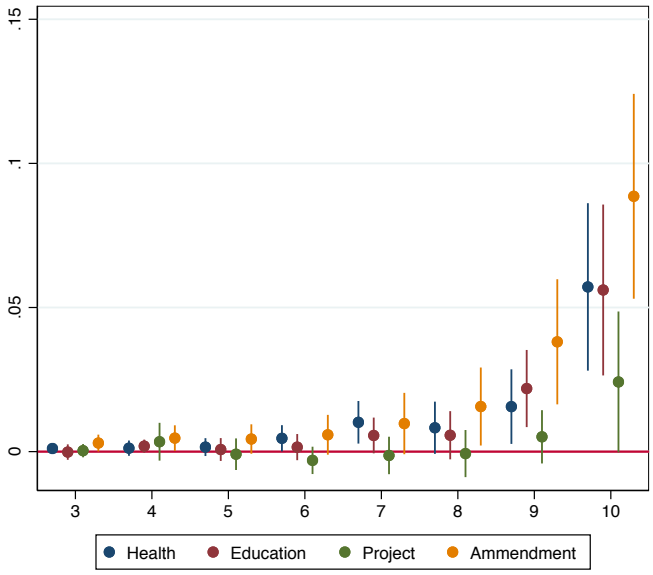
Figure 3: Effect of 3G entry on online and offline behaviour



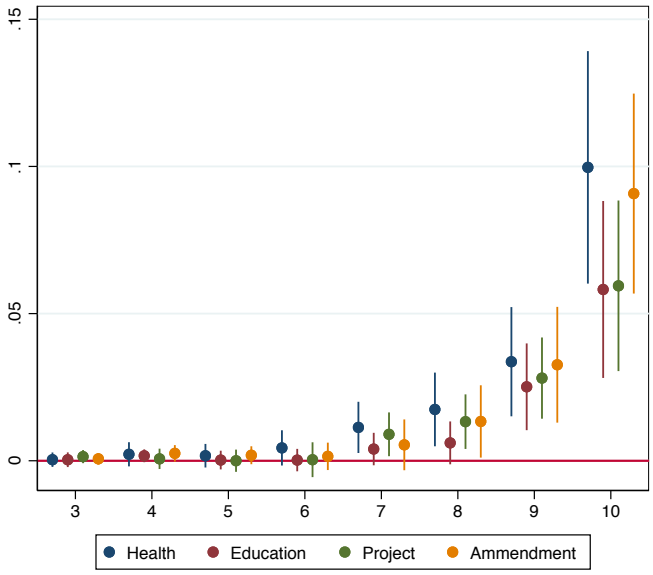
Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable (treatment) interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. Point estimates in circles, and the corresponding 95% confidence intervals in bars. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 4: Language use in Facebook by the politicians

Panel A. Topic modelling



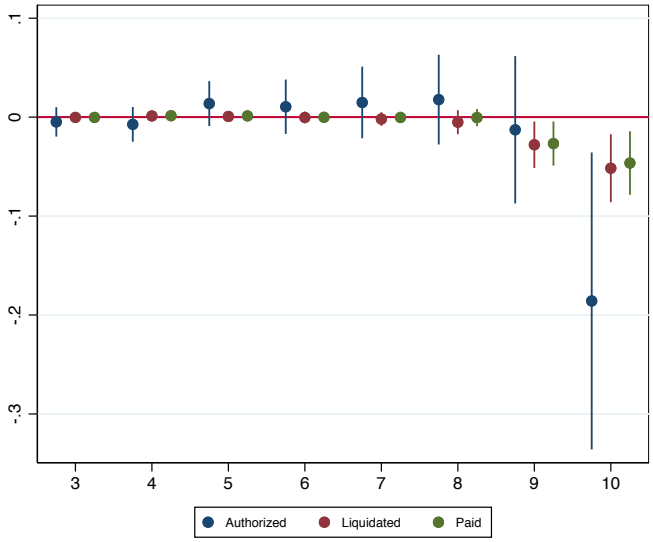
Panel B. Keywords mentioned on Facebook



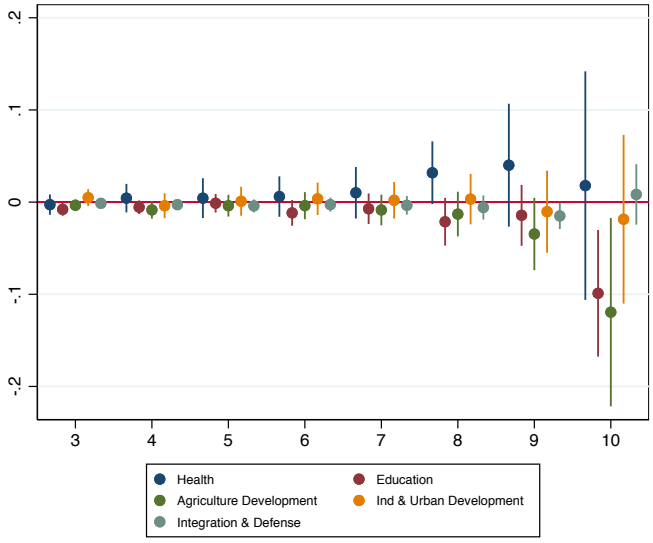
Notes: Panel regressions at the municipality-politician by year levels. In Panel A, dependent variable is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year a and topic, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. In Panel B, the dependent variable is the inverse hyperbolic sine transformation of the count of the keywords "health", "education","project"and "amendment". Point estimates in circles, and the corresponding 95% confidence intervals in bars. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. Two-way clustered standard errors at the municipality and politician levels.

Figure 5: Public goods

Panel A. Transfers through various stages of the budgeting process



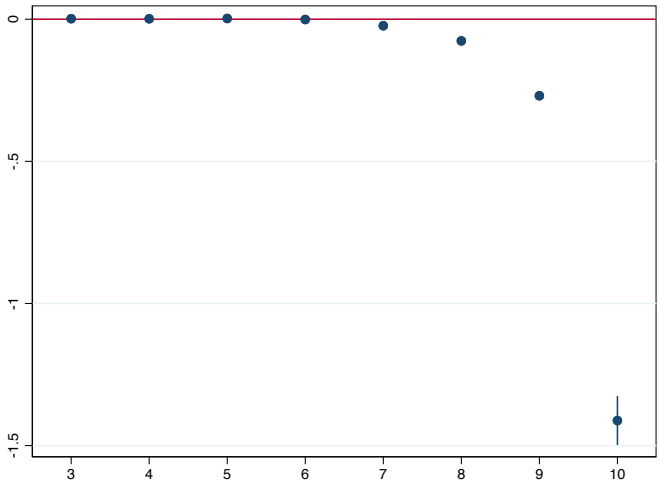
Panel B. Destination of funds



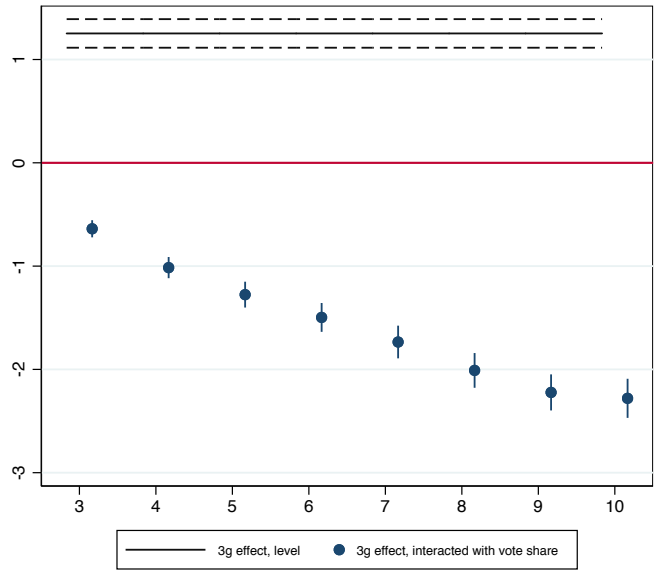
Notes: Panel regressions at the municipality-politician by year levels. In Panel A, dependent variable is the inverse hyperbolic sine transformation of transfers through the authorization, liquidation and payment budgeting process, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. In Panel B, the outcome variable is the transfers for specific budget lines. Spending is aggregated into the five biggest spending categories: health, education, agriculture development and environment, industrial and urban development, and integration and defense. This is accomplished by aggregating the volume of transfers to ministries in the following way: Health – *Ministério da Saúde* (Health). Education – *Ministério da Educação* (Education), *Ministério da Cultura* (Culture), and *Ministério da Ciência e Tecnologia* (Science and Technology). Agriculture development and environment – *Ministério da Agricultura, Pecuária e Abastecimento* (Agriculture), *Ministério do Desenvolvimento Social e Combate à Fome* (Social Development), *Ministério do Desenvolvimento Agrário* (Rural Development), *Ministério do Meio Ambiente* (Environment), and *Ministério da Pesca e Aquicultura* (Fishing). Industrial and urban development – *Ministério do Desenvolvimento, Indústria e Comércio* (Industrial and Commercial Development), *Ministério dos Transportes* (Transportation), *Ministério de Minas e Energia* (Energy), *Ministério das Cidades* (Cities), *Ministério do Turismo* (Tourism), *Secretaria da Micro e Pequena Empresa* (Small Enterprises), and *Secretaria dos Portos* (Ports). Integration and defense – *Ministério da Defesa* (Defense) and *Ministério da Integração Nacional* (Integration). Transfers in Brazilian Reais. Point estimates in circles, and the corresponding 95% confidence intervals in bars. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. Two-way clustered standard errors at the municipality and politician levels.

Figure 6: Effect of 3G on 2014 electoral outcomes

Panel A. Vote share in 2010 and 2014 elections



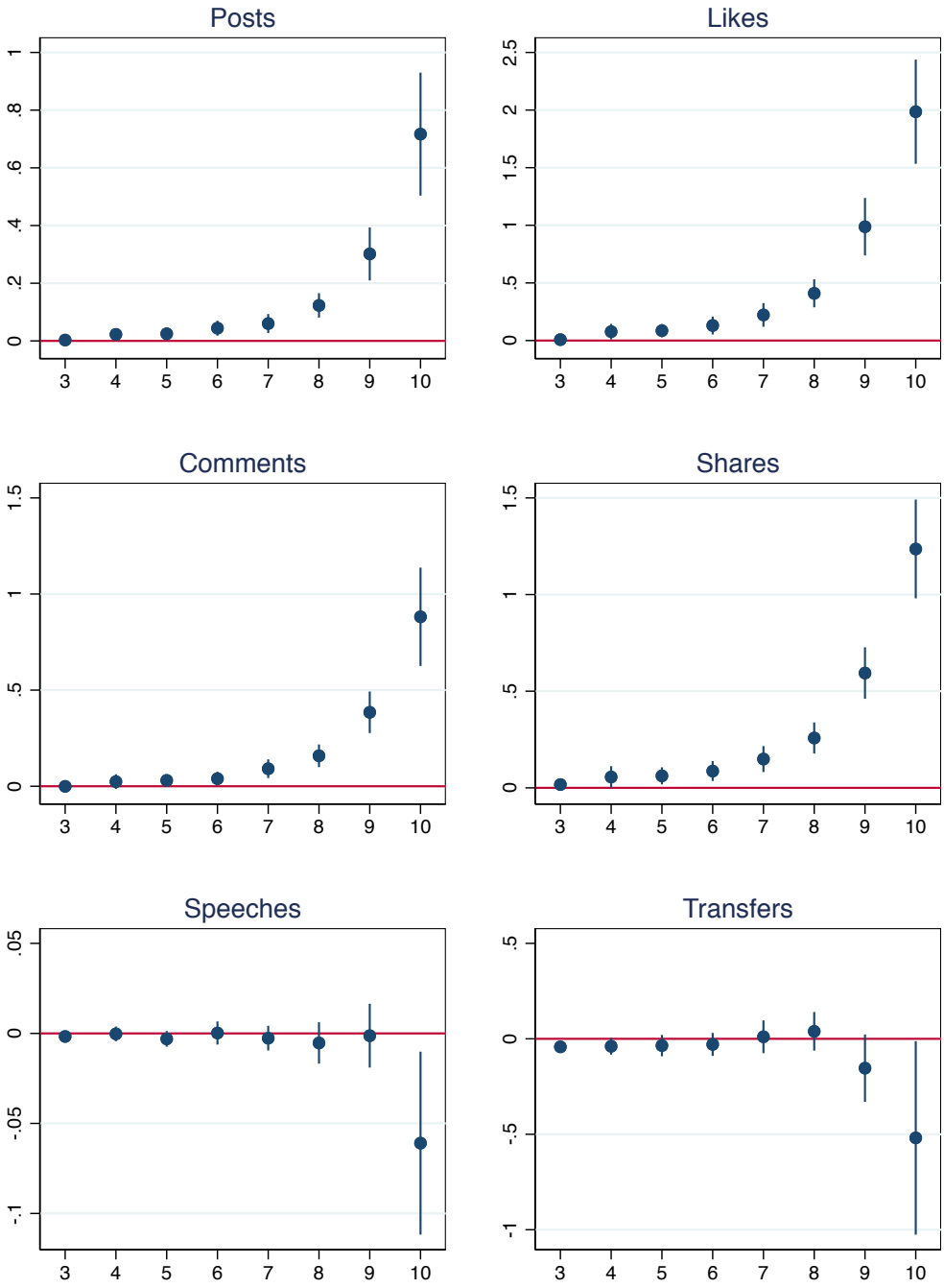
Panel B. Votes (levels) in 2010 and 2014 elections



Notes: Panel A: Panel regressions at the municipality-politician by year level for the politicians of the 53rd legislature that ran for reelection in 2014. Dependent variable is the *share* of votes that candidates obtained in the 2010 and 2014 elections, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. Point estimates in circles, and the corresponding 95% confidence intervals in bars. Specification includes municipality-time, municipality-politician and politician-time fixed effects. Two-way clustered standard errors at the municipality and politician levels. Panel B: Dependent variable is the inverse hyperbolic sine transformation of the level votes of the Congressman, explained by the 3G treatment dummy (solid line, with dashes representing the 95% confidence level) and 3G interacted with vote share deciles (along the horizontal axis). Specification includes municipality-politician and politician-time fixed effects. Two-way clustered standard errors at the municipality and politician levels.

Figure 7: Effect of 3G entry on online and offline behaviour

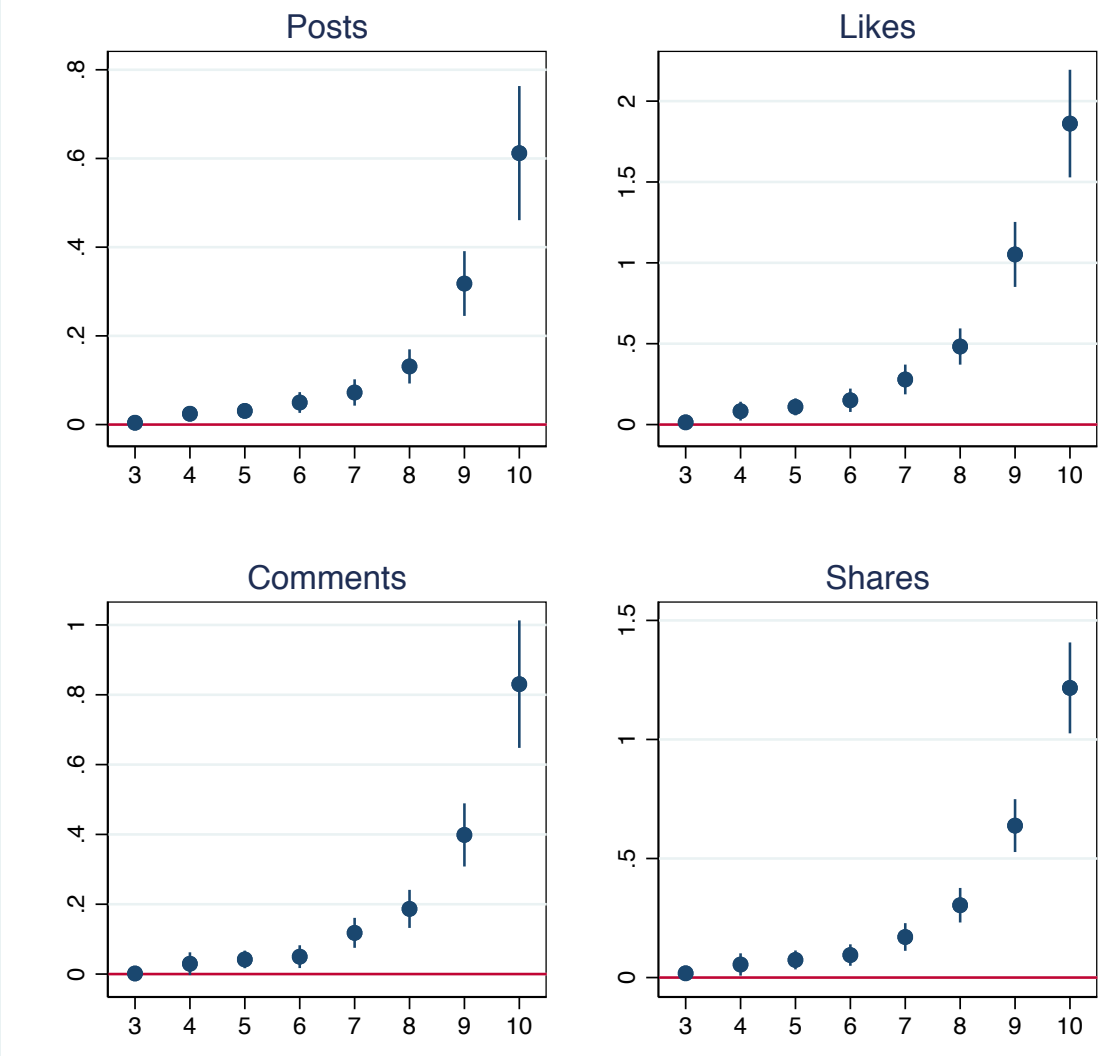
Panel only with politicians who opened their Facebook profile during or prior to 2011



Notes: Panel regressions at the municipality-politician by year levels. Sample restricted to politicians who opened their Facebook profiles during or prior to 2011. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable (treatment) interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. Point estimates in circles, and the corresponding 95% confidence intervals in bars. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 8: Effect of 3G entry on online behaviour

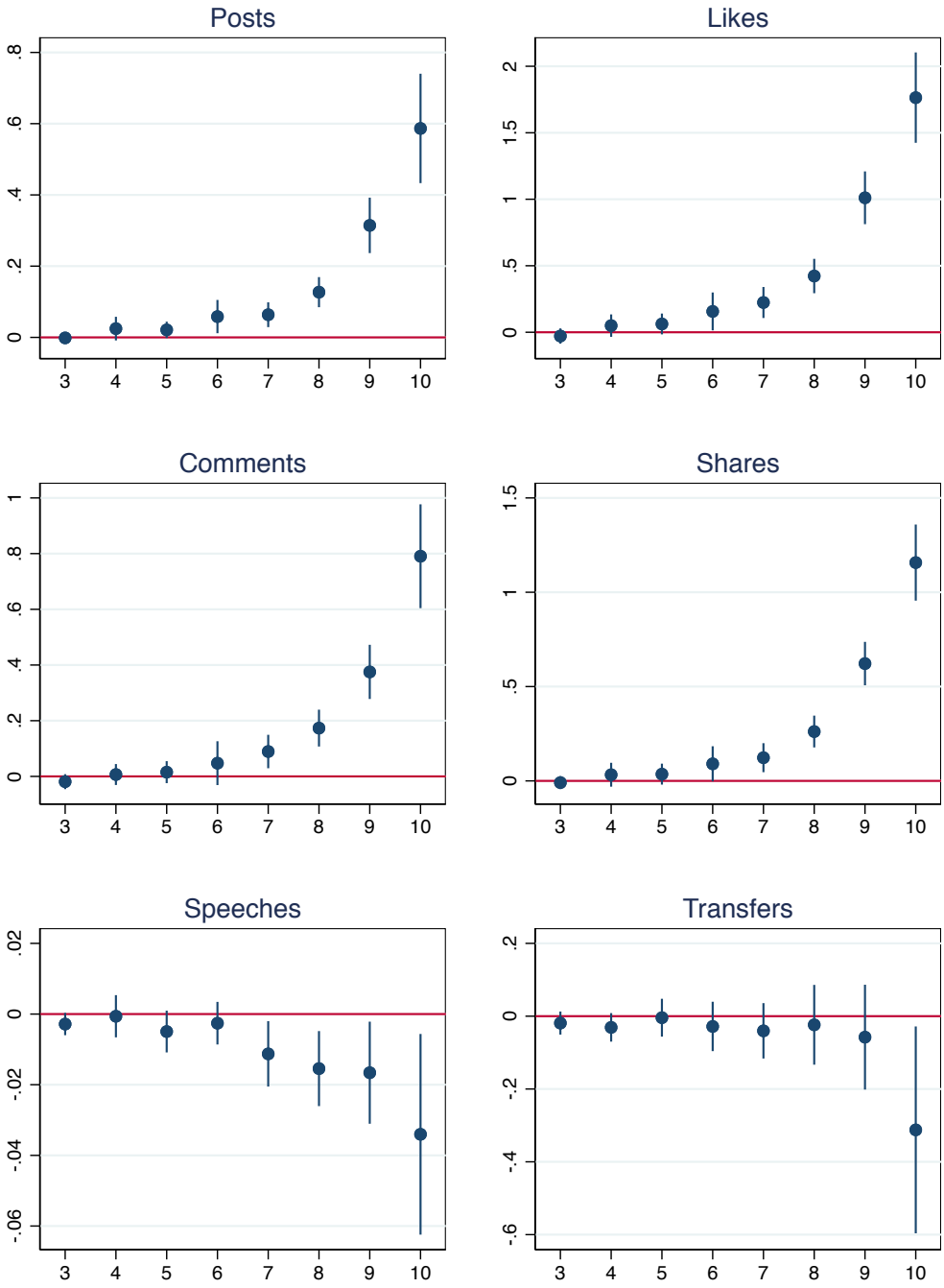
Municipality-politician level regressions, setting Facebook activity to zero if profile was not open



Notes: Panel regressions at the municipality-politician by year levels. Facebook measures set to zero whenever profile was not open. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable (treatment) interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. Point estimates in circles, and the corresponding 95% confidence intervals in bars. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. Two-way clustered standard errors at the municipality and politician levels.

Figure 9: Effect of 3G entry on online and offline behaviour

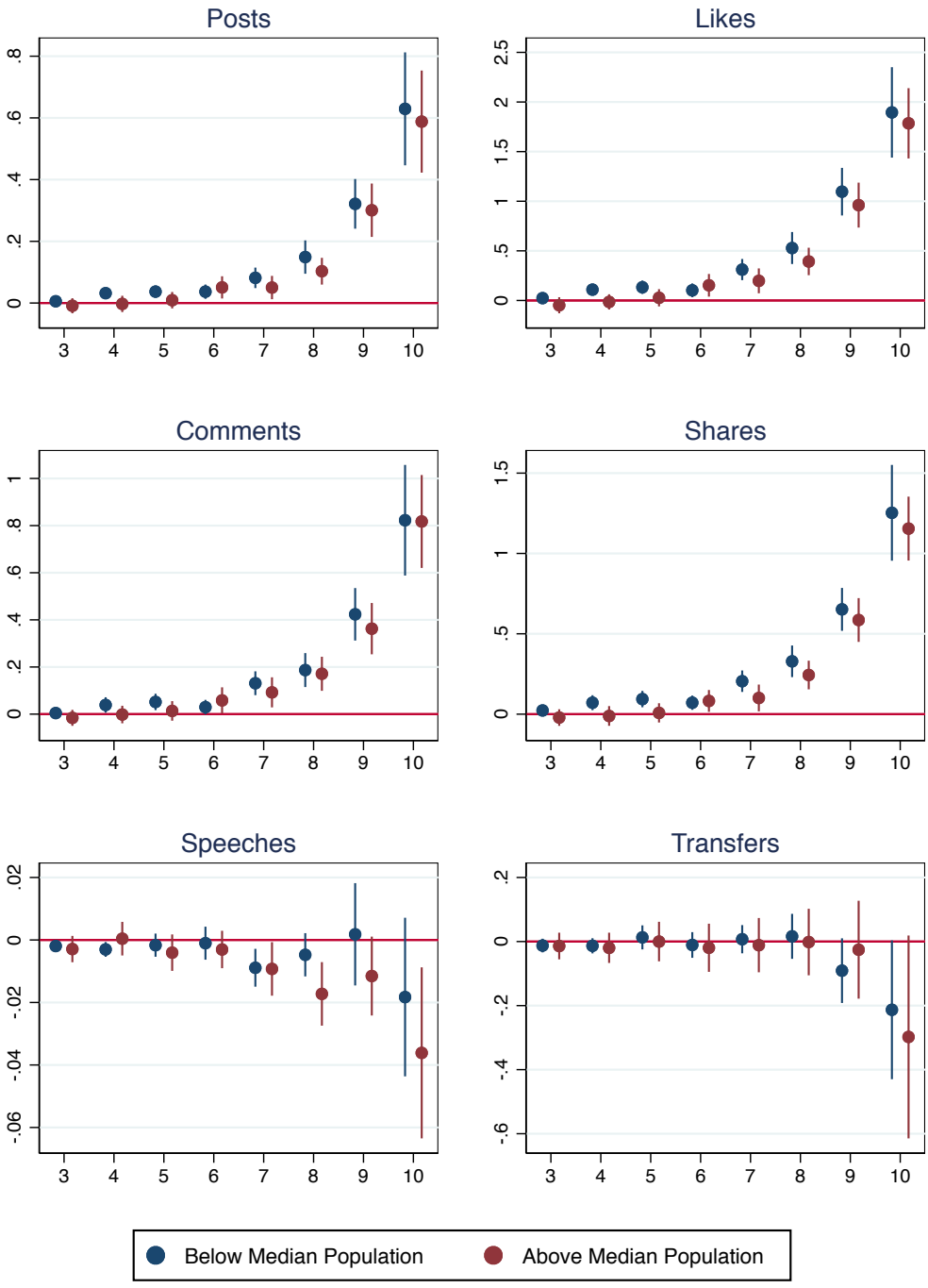
Municipality-politician level regressions, weighted by population



Notes: Panel regressions at the municipality-politician by year levels. Regressions weighted by the municipalities' population. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable (treatment) interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. Point estimates in circles, and the corresponding 95% confidence intervals in bars. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 10: Effect of 3G entry on online and offline behaviour

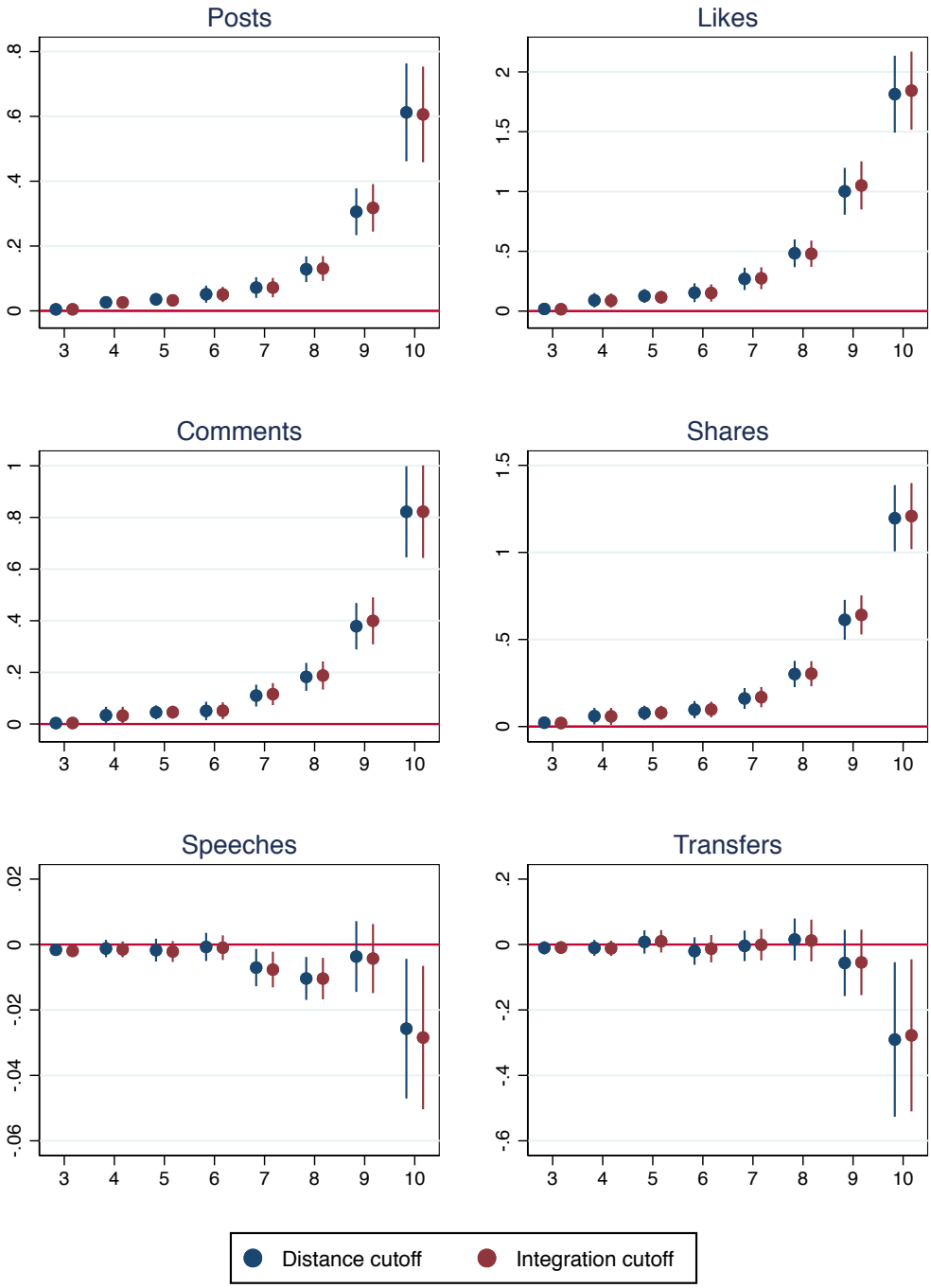
Heterogeneous effects by population



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. The figure plots the coefficients of the interaction below (blue) and above median population (red), and the corresponding 95% confidence interval. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 11: Effect of 3G entry on online and offline behaviour

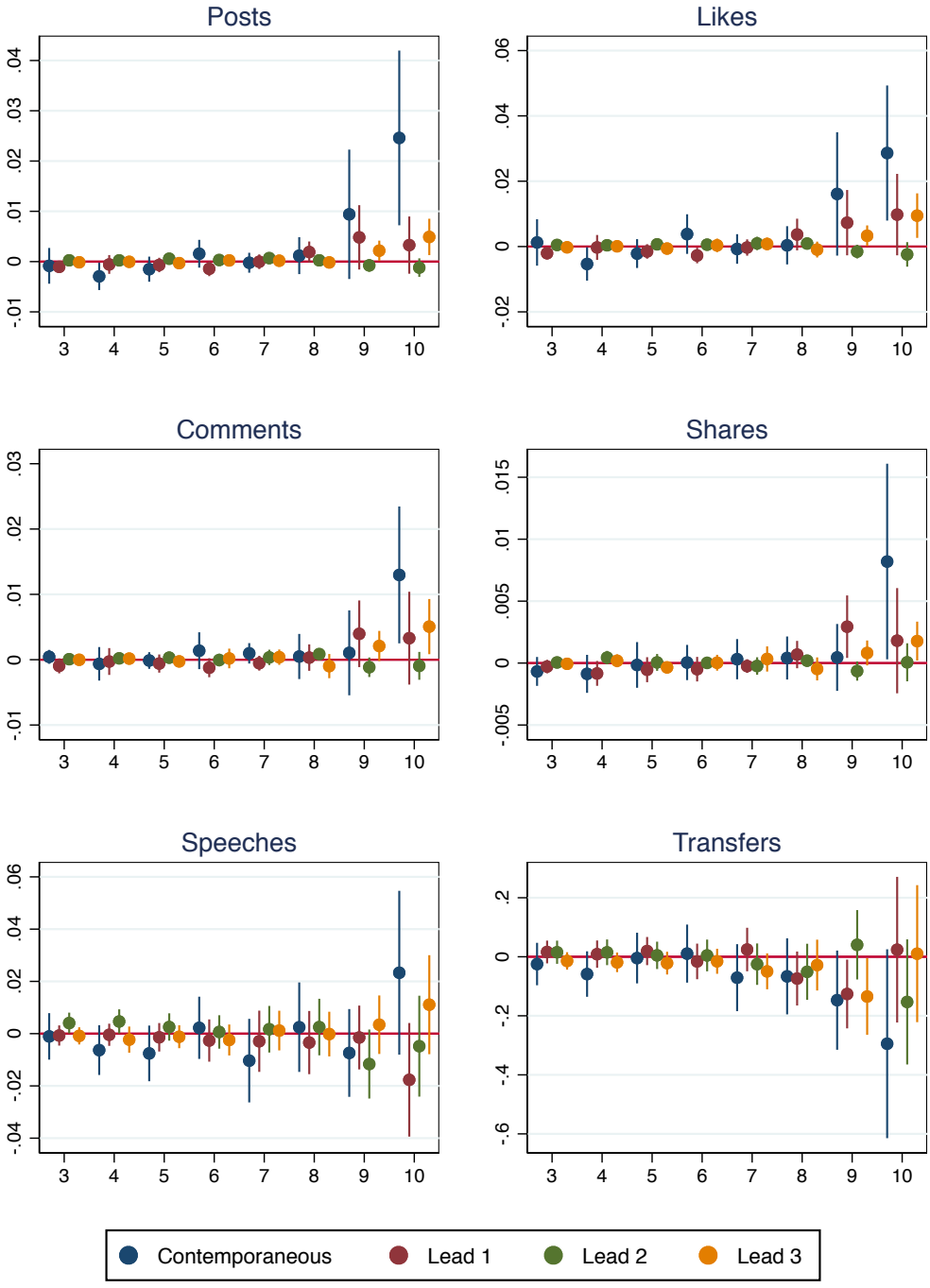
Excluding municipalities neighbouring to those that obtained 3G access



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable (treatment) interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. The coefficients labelled as "distance cutoff"are computed excluding the municipalities in years without 3G access that are at a 50km or less from municipalities that had obtained 3G at that time. "Integration cutoff"refers to the specifications that exclude conurbated municipalities, and obtained from IBGE (`https://biblioteca.ibge.gov.br/visualizacao/livros/liv99700.pdf`, accessed June 24, 2019). Point estimates in circles, and the corresponding 95% confidence intervals in bars. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 12: Effect of 3G entry on online and offline behaviour

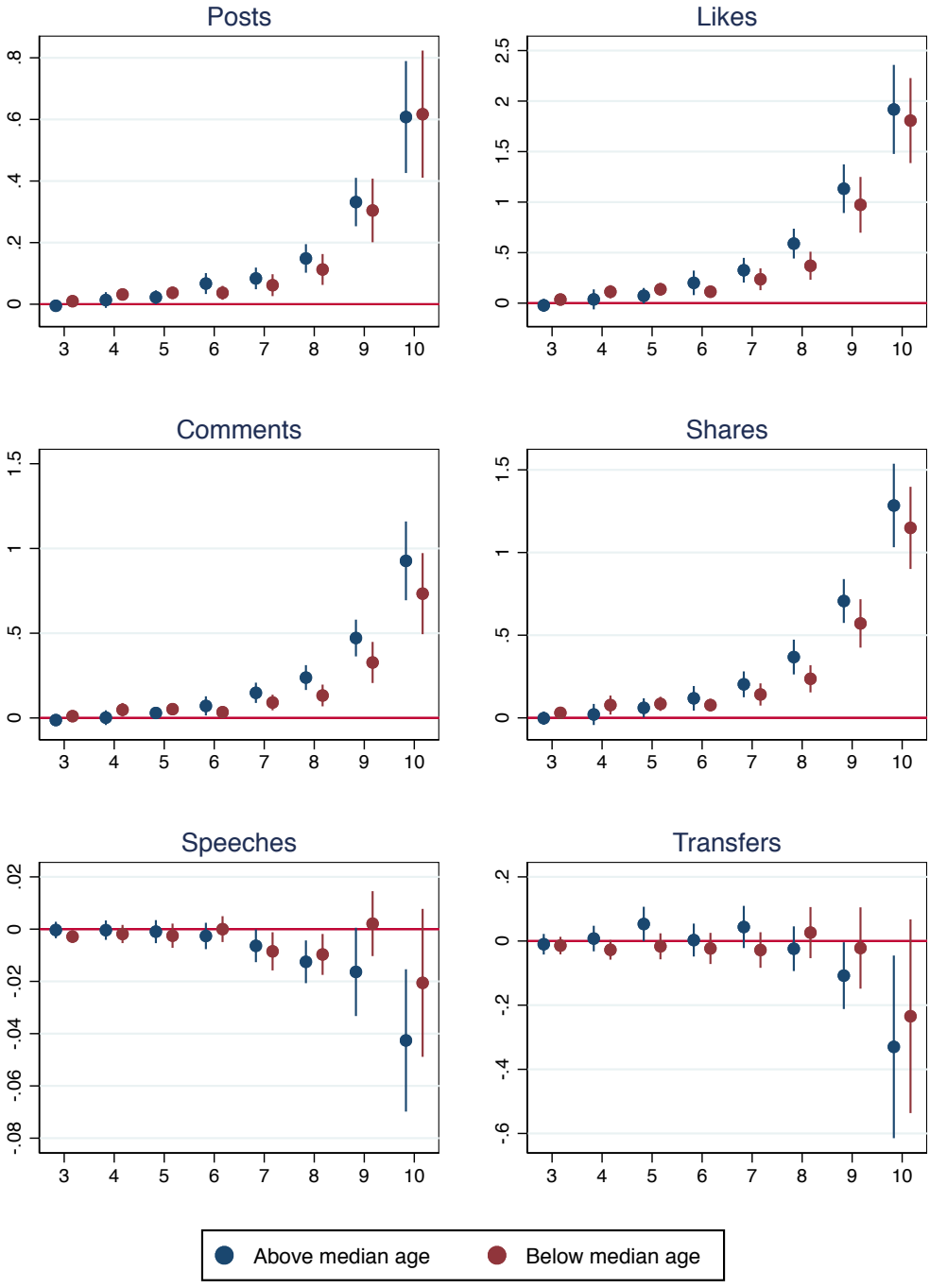
Contemporaneous and leads effects



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable (treatment) interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. Regressions include contemporaneous and three leads of the 3G introduction. Point estimates in circles, and the corresponding 95% confidence intervals in bars. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels. The *p*-values of joint significance of the lead effects across all deciles / only 9th and 10th deciles are: Posts, .120/.156; Likes, .243/.136; Comments, .174/.180; Shares, .311/.296; Speeches, .265/136; Transfers, .011/.007. Two-way clustered standard errors at the municipality and politician levels.

Figure 13: Effect of 3G entry on online and offline behaviour

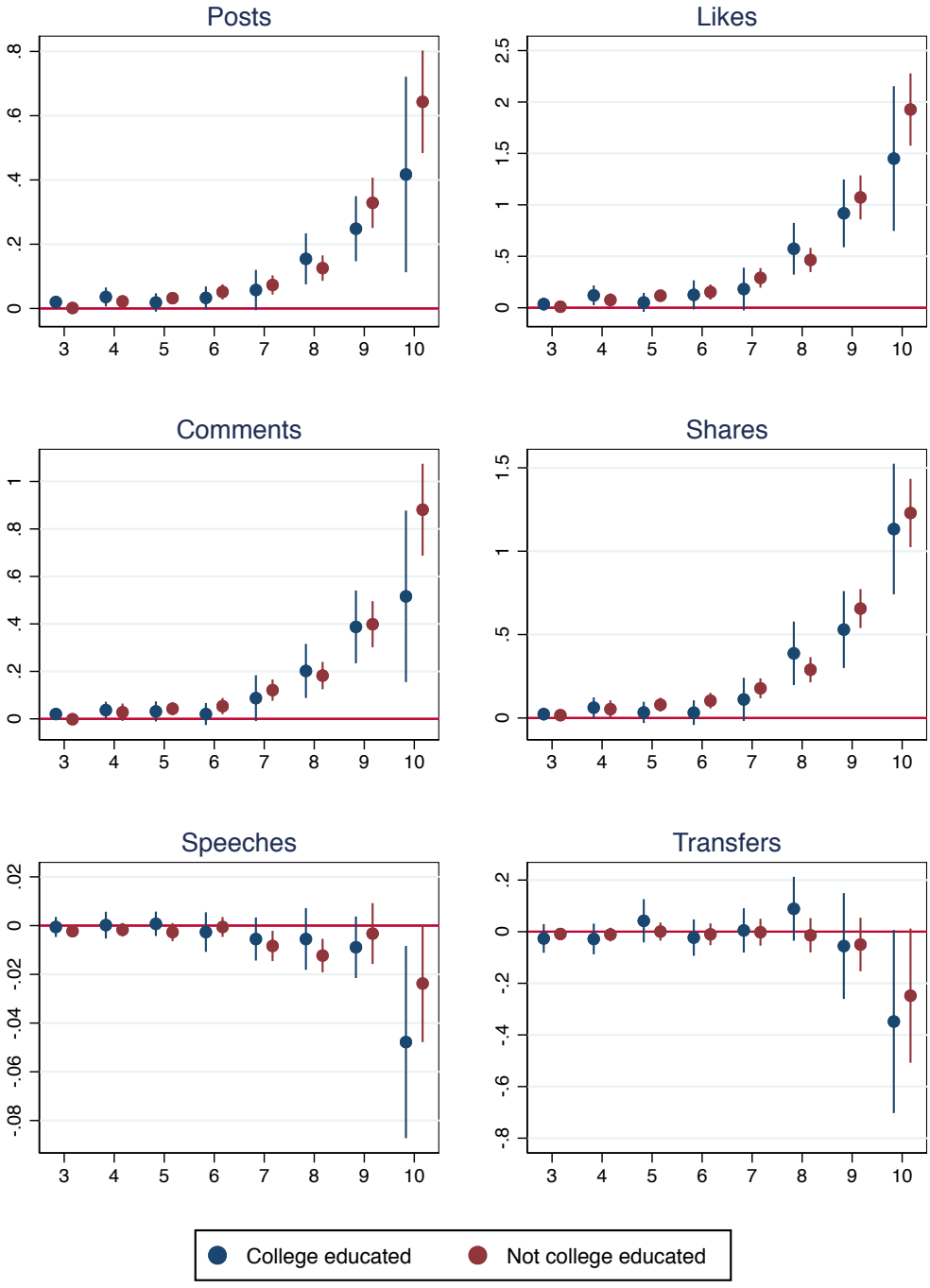
Heterogeneous effects by politicians' age



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. The figure plots the coefficients of the interaction above (blue) and below median politicians' age (red), and the corresponding 95% confidence interval. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 14: Effect of 3G entry on online and offline behaviour

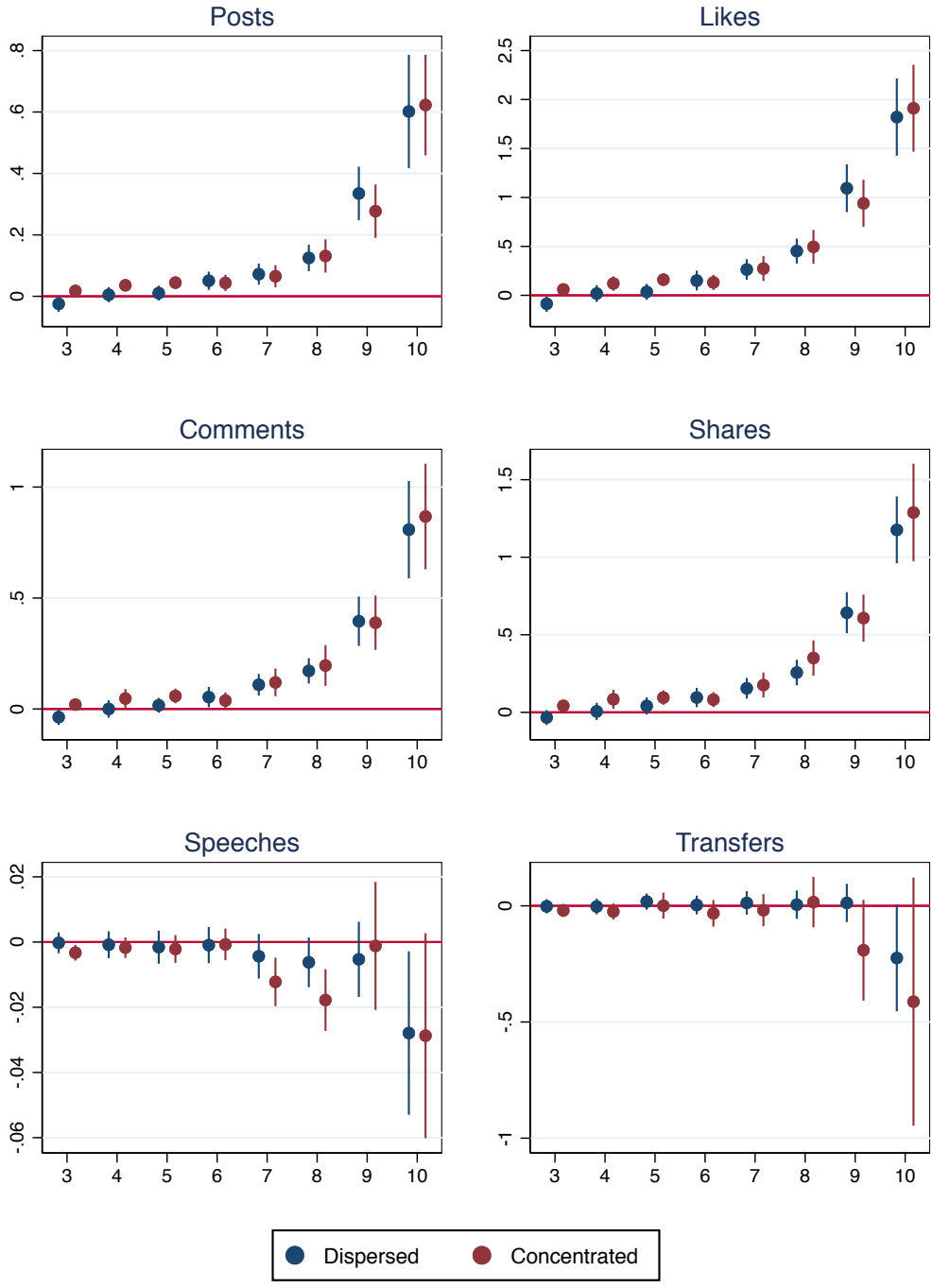
Heterogeneous effects by politicians' education



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. The figure plots the coefficients of the interaction with (blue) and without college education (red), and the corresponding 95% confidence interval. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 15: Effect of 3G entry on online and offline behaviour

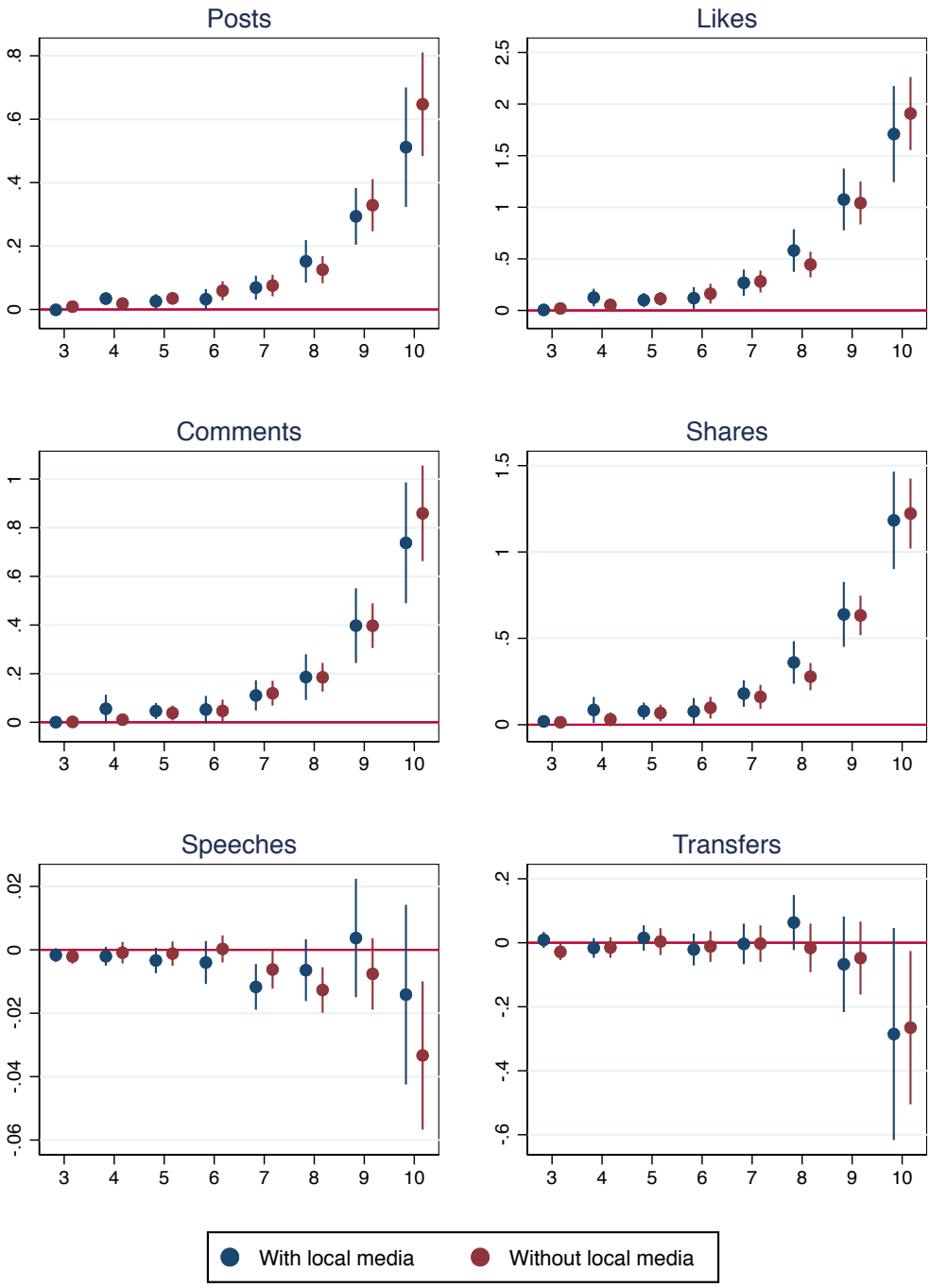
Politicians with concentrated and dispersed voting patterns in the 2010 elections



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile) in the 2010 elections. The figure plots the coefficients of the interaction if politician got elected with has concentrated votes in few municipalities (blue) versus dispersed among many municipalities (red), and the corresponding 95% confidence interval. This is accomplished by calculating the Herfindahl-Hirschmann index and associating congressman above median as "concentrated"types, and below median to "dispersed"types. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 16: Effect of 3G entry on online and offline behaviour

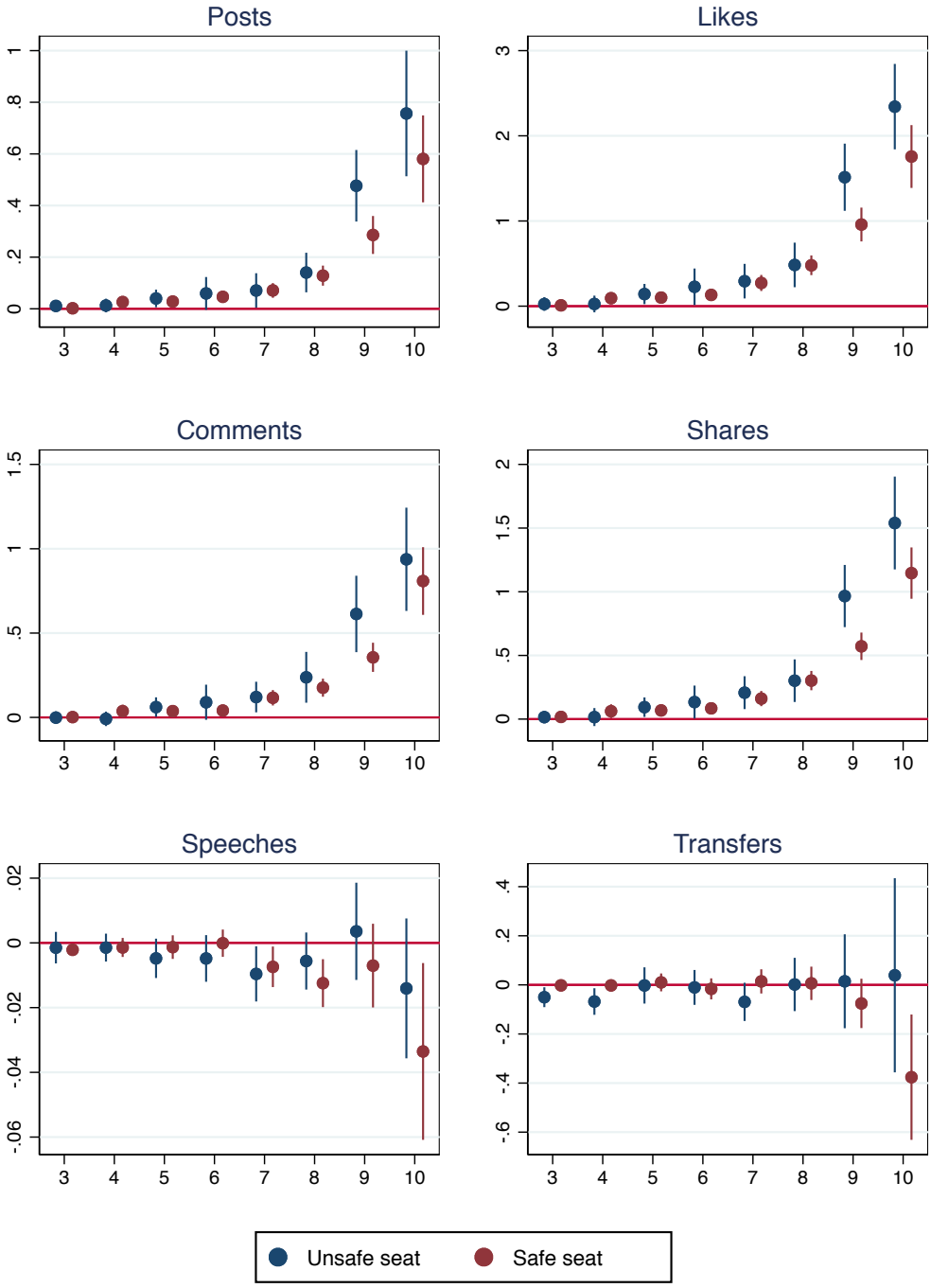
Heterogeneous effects by presence of local media



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile) in the 2010 elections. The figure plots the coefficients of the interaction with (blue) and without presence local media (red), and the corresponding 95% confidence interval. Presence of local media is defined as municipality having AM, FM or community radio, or TV station. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 17: Effect of 3G entry on online and offline behaviour

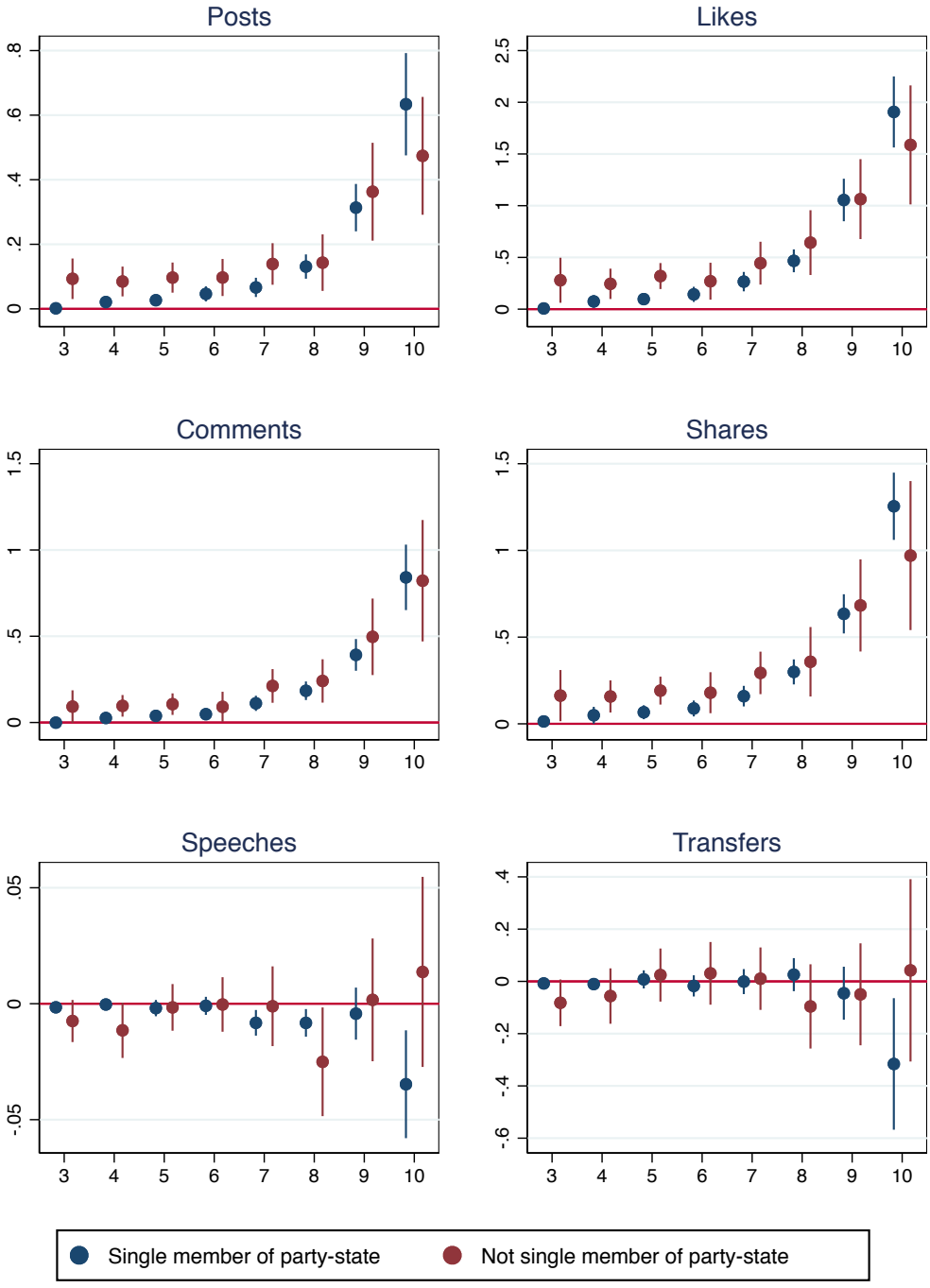
Margin of victory



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. The figure plots the coefficients of the interaction if Congressman won by below (blue) or above (red) median margin of victory, and the corresponding 95% confidence interval. Margin of victory are defined as the politicians' total number of votes divided by the electoral coefficient in their states of origin. The electoral coefficient is the number of votes required to obtain a seat in Congress. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 18: Effect of 3G entry on online and offline behaviour

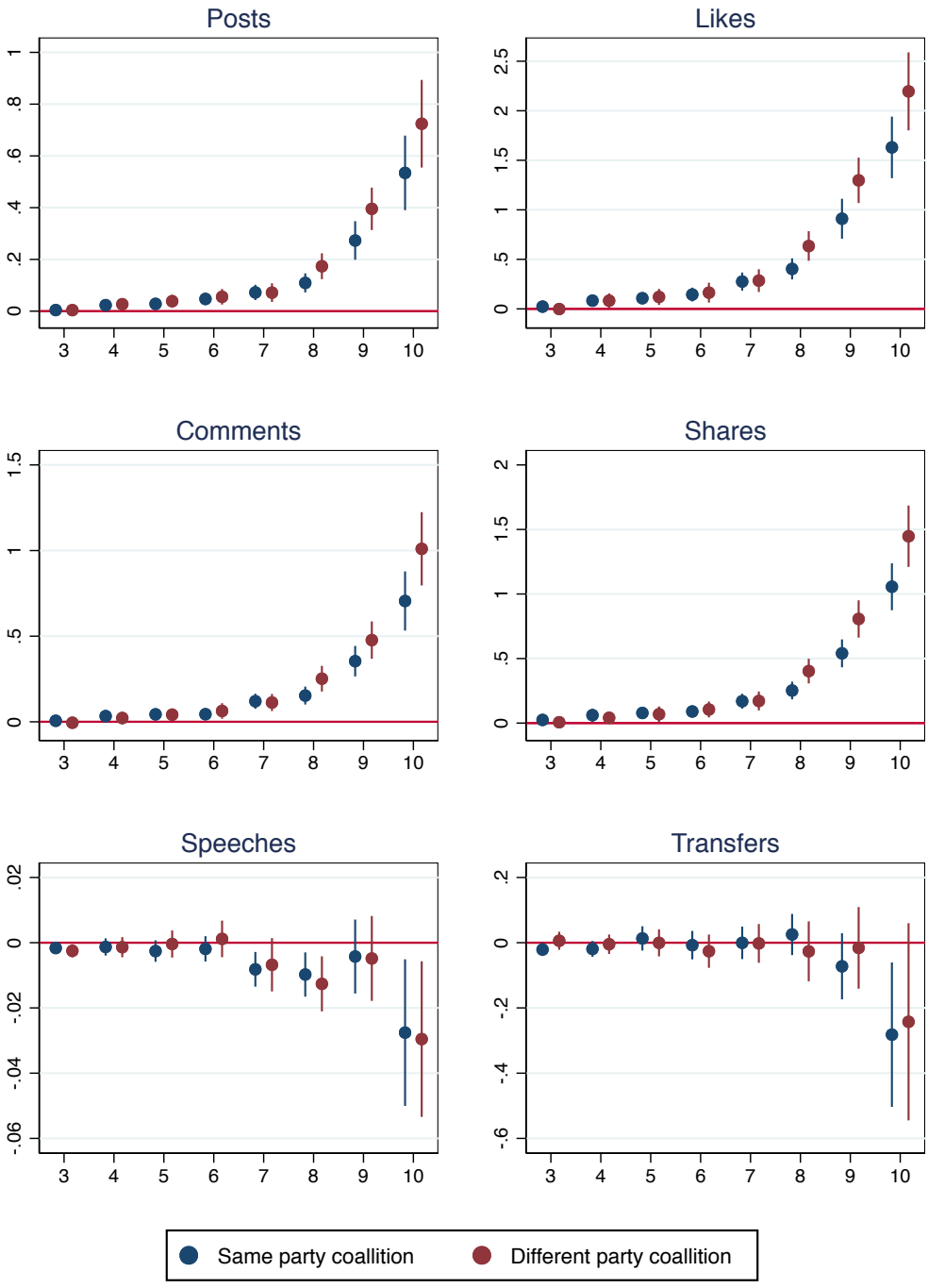
Single member of party-state



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. The figure plots the coefficients of the interaction if Congressman is single member of party-state (blue) and if he or she is not (red), and the corresponding 95% confidence interval. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure 19: Effect of 3G entry on online and offline behaviour

Party coallition similarity between Congressman and mayor



Notes: Panel regressions at the municipality-politician by year levels. In the top-left figure, the dependent variables is the inverse hyperbolic sine transformation of the number of politicians' posts mentioning a municipality in a given year, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. The figure plots the coefficients of the interaction if Congressman and mayor are affiliated to the same coallition of parties (blue) and if they are not (red), and the corresponding 95% confidence interval. All specifications includes municipality-time, municipality-politician and politician-time fixed effects. The figures labelled as "likes", "comments", and "shares" use the inverse hyperbolic sine transformation of the number of likes, comments and shares that those posts obtained. "Speeches" refers to the inverse hyperbolic sine transformation of the number of politicians' speeches in Congress mentioning a municipality in a given year. Finally, "transfers" refers to the inverse hyperbolic sine transformation of the value of the earmarked transfers proposed by the politicians. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Appendix A Tables and Figures

Table A1: Descriptive statistics: elected deputies

	53rd legislature	52nd and 53rd legislatures
% female	.088	.089
% college	.778	.786
% north	.127	.125
% northeast	.294	.300
% centerwest	.064	.060
% southeast	.349	.348
% south	.150	.147
Campaign exp. in 2010	R$ 3.24m (R$ 1.87m)	R$ 2.91m (R$ 1.81m)
Votes in 2010	114.86k (86.89k)	86.21k (85.80k)
Number of deputies	513	744

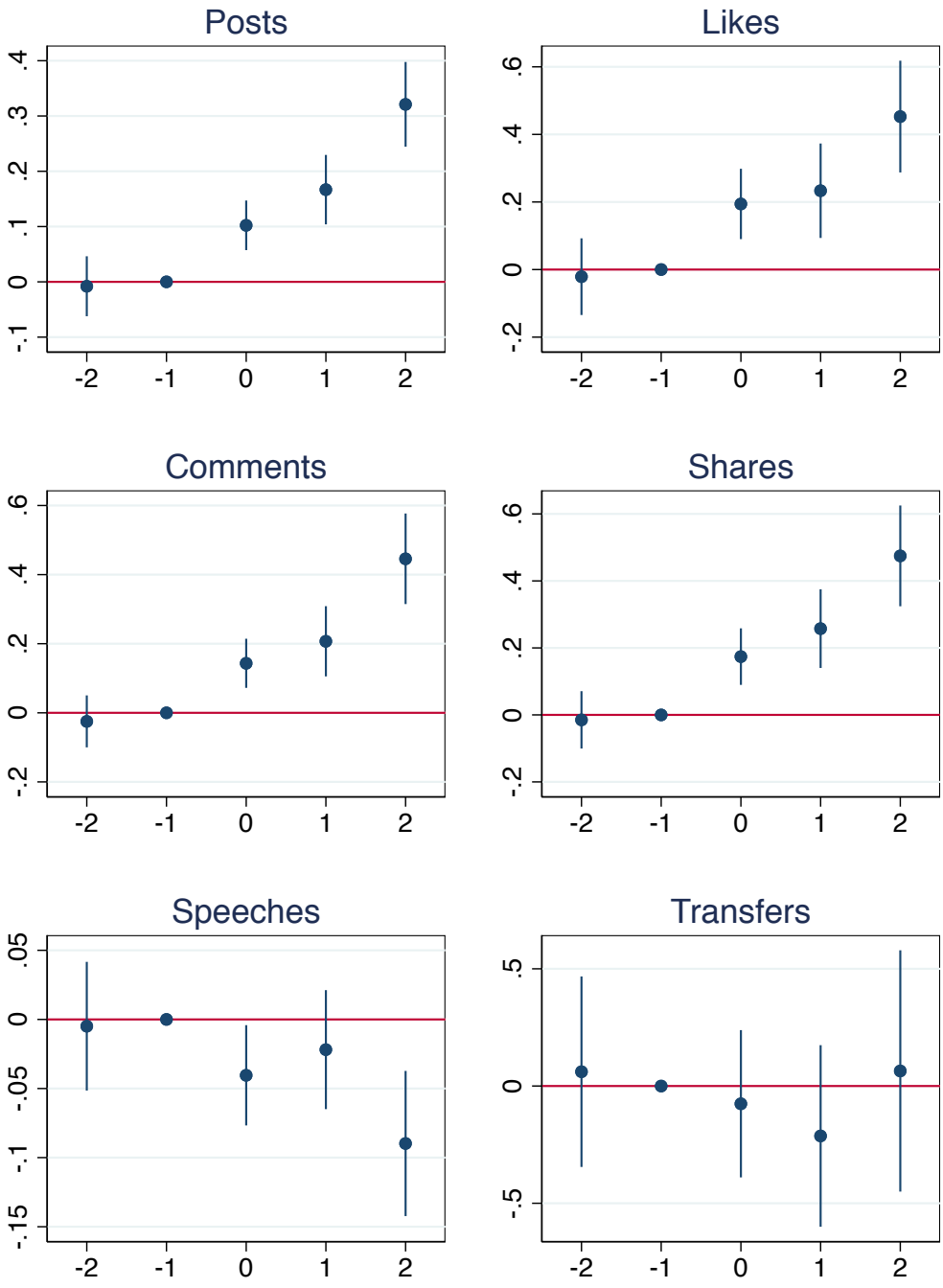
Notes: Descriptive statistics of the sample of elected deputies of the 53rd legislature (2011-14) and 52rd and 53th legislatures (2009-14). "% Female" refers to the proportion of female deputies. "% College" refers to the proportion of deputies who completed college or university education. "% North", "% northeast", "% centerwest", "% southeast", "% south" refers to region of the deputies' constituencies. "Campaign Expenditures" in Brazilian Reais (R$). "Votes" are the total number of votes obtained by the deputy in the 2010 elections. Standard errors in parenthesis. *Source:* Tribunal Eleitoral Superior (TSE).

Table A2: Municipality-politician level regressions

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)
	Posts		Likes		Shares		Comments		Speeches		Transfers	
Panel A. Extensive margin, binary dependent variable												
3G	.002	.015***	.003	.018***	.004	.021***	.005*	.020***	-.003**	-.003***	-.001	-.002*
	(.003)	(.004)	(.004)	(.004)	(.003)	(.004)	(.003)	(.004)	(.001)	(.001)	(.001)	(.001)
3G×Vote Share		.100***		.109***		.127***		.109***		-.007**		-.005
		(.018)		(.019)		(.018)		(.018)		(.003)		(.004)
Mean of dep. var.	.094	.094	.091	.091	.080	.080	.067	.067	.020	.020	.010	.010
Panel B. Intensive and extensive margins, IHS of dependent variable												
3G	.008	.043***	.025	.138***	.015	.092***	.015*	.069***	-.002*	-.004**	-.015	-.022*
	(.005)	(.009)	(.017)	(.023)	(.011)	(.015)	(.008)	(.012)	(.001)	(.002)	(.010)	(.013)
3G×Vote Share		.262***		.836***		.576***		.399		-.014***		-.063
		(.045)		(.109)		(.071)		(.059)		(.005)		(.050)
Mean of dep. var.	.229	.229	21.19	21.19	2.18	2.18	11.62	11.62	.033	.033	3,844.2	3,844.2
Observations	203,107	203,107	203,107	203,107	203,107	203,107	203,107	203,107	412,254	412,254	412,254	412,254

Notes: Panel regressions at the municipality-politician by year levels, explained by presence of 3G dummy variable, and interaction with vote shares of the candidates in the municipalities. Specifications contains municipality, municipality-politician and politician-time fixed effects. In Panel A, dependent variable is binary. In columns *(i)* and *(ii)*, it is equal to one if a given municipality was cited by a politician at least once in Facebook in a given year. Dependent variables in columns *(iii)* to *(viii)* are equal to one if those posts obtained at least one like, share or comment, respectively. Dependent variable in column *(ix)* and *(x)* is equal to one if the municipality was cited by a politician at least once on Congressional speeches in a given year. Column *(xi)* and *(xii)* is equal to one the given municipality was targeted by transfers, and zero otherwise. "Mean of dep. var." refers to the mean of the dependent variable, averaged across the 2011-2014 period. In Panel B, dependent variables are the inverse hyperbolic sine transformation of the number of earmarked transfers proposed to the municipality by a politician in a given year, speeches delivered in the Congress and Facebook posts that mentioned the municipality, likes, shares and comments that those posts obtained. "Mean of dep. var." refers to the raw numbers, without the inverse hyperbolic sine transformation, and averaged across the 2011-2014 period. Numbers are relative to the municipalities from the politicians' state of origin. Transfers in Brazilian Reais. Two-way clustered standard errors at the municipality and politician levels.

Figure A1: Pre-intervention trends on online and offline behaviour

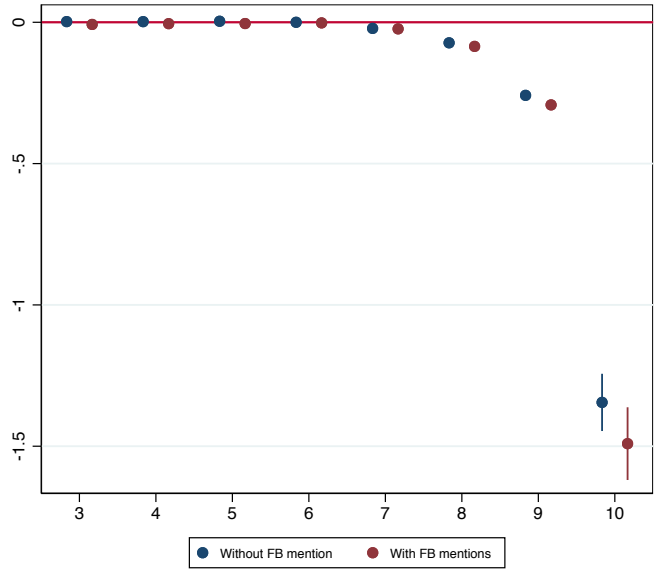


Notes: Coefficient plots for pre-trends specifications. Regressions of the dependent variable on leads and lags of 3G introduction at the municipality and year levels, with municipality and year-state fixed effects. Dependent variables are the inverse hyperbolic sine transformation of the number of posts citing the municipality, likes, shares and comments those posts obtained, congressional speeches citing those municipalities, and number of transfers targeting them. Clustered standard errors at the municipality level.

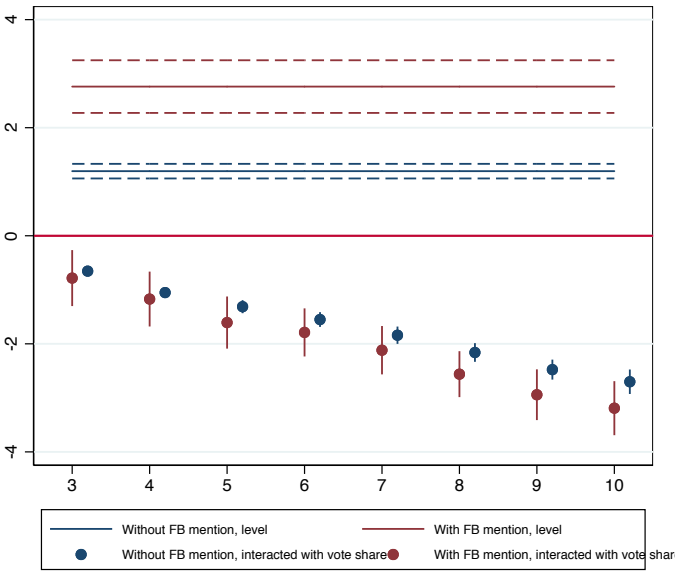
Figure A2: Effect of 3G on 2014 electoral outcomes

Interacted with Facebook use during the 2014 elections

Panel A. Vote share in 2010 and 2014 elections



Panel B. Votes (levels) in 2010 and 2014 elections



Notes: Panel A: Panel regressions at the municipality-politician by year level for the politicians of the 53rd legislature that ran for reelection in 2014. Dependent variable is the *share* of votes that candidates obtained in the 2010 and 2014 elections, explained by presence of 3G dummy variable interacted with the importance of the municipality for the politician (vote shares decile, along the horizontal axis) in the 2010 elections. Coefficients are interacted with the dummy variable which is equal to 1 if the politician cited the municipality in 2014 ("with FB mentions") and zero otherwise ("Without FB mentions"). Point estimates in circles, and the corresponding 95% confidence intervals in bars. Specification includes municipality-time, municipality-politician and politician-time fixed effects. Two-way clustered standard errors at the municipality and politician levels. Panel B: Dependent variable is the inverse hyperbolic sine transformation of the level votes of the Congressman, explained by the 3G treatment dummy (solid line, with dashes representing the 95% confidence level) and 3G interacted with vote share deciles (along the horizontal axis). Specification includes municipality-politician and politician-time fixed effects. Two-way clustered standard errors at the municipality and politician levels.

Appendix B Algorithm to detect citations to municipalities in posts

The algorithm works following the steps:

1. Find municipalities names contained in the post string

> Example: "Congresswoman Iara Bernardi (PT) meets the mayors of Capela do Alto, Iperó, Cedral, Cunha and Arocoiaba da Serra to assess the impact of the mining industry in Ipanema National Forest."
>
> Matched municipalities: Capela (SE), Capela (AL), Capela do Alto (SP), Iperó (SP), Cedral (MA), Cedral (SP), Cunha (SP), Arocoiaba da Serra (SP), Ipanema (MG).

2. Disconsider strings contained in longer strings which were also previously matched;

> Drop matches: Capela (SE), Capela (AL).

3. Duplicate names are kept only if cities belong to the Congressman's state of origin.

> Drop matches: Iara Bernardi was elected in São Paulo (SP), so drop Cedral (MA).

4. Citations to dubious names are kept if immediately preceded by term indicating a municipality

> Example: "Congresswoman Iara Bernardi (PT) meets the mayors of Capela do Alto, Iperó, Cedral, Cunha and Arocoiaba da Serra to assess the impact of the mining industry in Ipanema National Forest."
>
> "Cunha" and "Ipanema" were classified as dubious names. The list in which "Cunha" is contained is preceded by "mayors of", which is not true for "Ipanema". Final matched municipalities: Capela do Alto (SP), Iperó (SP), Cedral (SP), Cunha (SP), Arocoiaba da Serra (SP).

On a sampled evaluation of the performance of the algorithm on 250 posts, 89.09% of the true mentions were identified, and only 2.00% of the posts contained one or more false matches.

Table A3: Performance of the matching algorithm

Number of true mentions in post	Frequency	Correctly classified true mentions	Posts with false matches
0	62.80%	–	1.91%
1	28.40%	87.32%	2.82%
2	6.40%	86.67%	0.00%
3	1.60%	91.67%	0.00%
4 or more	0.80%	92.31%	0.00%
any	100.00%	88.89%	0.00%

Appendix C Model

Proof of Main Propositions

Proposition 1

When transfers are taken as given, the problem for each municipality is independent. We drop the municipality subscript, m, for convenience thereafter. We will also allow for both politicians to have transfers as this will be helpful for extensions of the model. We solve the model from politician a perspective, noting the solution is analogous for politician b.

Let $D_i^p(t^a, t^b) = \mathbb{1}_{\left[U^a(c^a,t^a,r_i)>U^b(c^b,t^b,1-r_i)\right]} \cdot \mathbb{1}_{[U^a(c^a,t^a,r_i)>0]}$ be the crossing point for politician a. This function measures whether politician a has a shot of receiving the vote of voter i. Also, let $X(t^a, t^b) = \sup\left\{i : D_i^a(t^a, t^b) = 1\right\}$

The expected voting of politician a conditional on transfers (t_a, t_b) is given by by

$$\begin{aligned} v^a(c^a, t^a, t^b) &= d^{-1} \int_0^1 D_i^a(t^a, t^b) \cdot \Pr.\left(U^a(c^a, t^a, r_i) > \varepsilon_i\right) dr_i \\ &= d^{-1} \int_0^1 D_i^a(t^a, t^b) \cdot U^a(c^a, t^a, r_i) dr_i \end{aligned}$$

where the second line assumes no voter votes for a with probability 1, which is guaranteed by H2(ii). The problem for politician a is given by

$$W(c^a, t^a, t^b) = v^a(c^a, t^a, t^b) - \frac{\gamma}{2} \cdot (c^a)^2 \tag{10}$$

We solve the problem for each combination of t^a and t^b.

Case 1. Assume that $t^b = 0$.

Note that $v^a(c^a, 1, 0) = v^a(c^a, 0, 0) + d^{-1}\alpha X(1, 0)$, so politician a's problem becomes

$$W(c^a, t^a, 0) = v^a(c^a, 0, 0) + d^{-1}\alpha X(1, 0) \cdot t^a - \frac{\gamma}{2} \cdot (c^a)^2$$

Because of H1, $X(1, 0) > X(0, 0) = \mu^a$ which implies that $\nabla_c X(1, 0) = 0$. So the FOC of the problem above is given by

$$\gamma c^a = d^{-1} \int_0^1 D_i^a(t^a, t^b) \cdot \nabla_c U^a(c^a, 0, r_i) dr_i$$

or

$$c^a = \frac{\mu^a}{d\gamma} \tag{11}$$

Case 2. $t^a = t^b = 1$. In that case, note that

$$\begin{aligned} &U^b(c^b, 0, r_i^b) < U^a(c^a, 0, r_i^a) && \iff \\ &U^b(c^b, 0, r_i^b) + \alpha < U^a(c^a, 0, r_i^a) + \alpha && \iff \\ &U^b(c^b, 1, r_i^b) < U^a(c^a, 1, r_i^a) \end{aligned}$$

Again H1 guarantees that the first expression is true, implying that Case 2 is equivalent to Case 1, and the optimal communication in this case is also given by (11).

Case 3. The potentially more complicated case is when $t^a = 0 < 1 = t^b$. In that case, it is possible that $U_i^b > U_i^a$ for some $i \in \mathcal{I}^a$. Hypothesis H1 and H2(i) guarantee this will be the case.

The utility of the voters in the influence zone $\mathcal{I}_1$ cross at $X(0,1)$, i.e.

$$U_i^a = U_i^b \iff \mu^a - X(0,1) + c^a = \mu^b + \alpha - 1 + X(0,1)$$

solving for $X(0,1)$ yields

$$X(0,1) = \frac{1}{2}\left(c^a + \mu^a - \mu^b - \alpha + 1\right) \tag{12}$$

because we assume the crossing of utilities happens inside the influence zone of 1, $X(0,1) < \mu^a$. Thus, problem (10) becomes

$$W(c^a, 0, 1) = d^{-1} \int_0^{X(0,1)} (c^a + \mu^a - r_i)\, dr_i - \frac{\gamma}{2} \cdot (c^a)^2 \tag{13}$$

The first order condition of this problem is given by

$$0 = \nabla W = d^{-1} X(0,1) + d^{-1} \nabla_{c^a} X(0,1) \cdot (c^a + \mu^a - X(0,1)) - \gamma c^a$$

which solves to

$$c^a(0,1) = \frac{3\mu^a - \mu^b - \alpha + 1}{4d\gamma - 3} \tag{14}$$

As for the comparative statics, items (i) and (ii) from Proposition 1 are straightforward given equilibrium communication (11) and (14). Item (iii) is proven by noticing that the equilibrium communication in cases (11) and (14) is sub-modular in μ^p (politician's p own popularity) and communication cost γ. Because $c(.)$ is twice differentiable, it suffices to notice that $\dfrac{\partial^2 c}{\partial \mu^p \partial \gamma} < 0$.

Proposition 2

.

Assume that $\gamma_m = \gamma \ \forall m$. First, we prove that politician a transfers to μ_1^a, i.e., the municipality where he is most popular. Politician a will transfer to the municipality m^* such that

$$m^* = \arg\max_m \{v_m^a(1) - v_m^a(0)\}$$

where $v_m^a(t) = v_m^a(c^{a*}, t, 0)$, and $c^{a*} = \arg\max_c W_m^a(c^a, 1, 0) = \arg\max_c W_m^a(c^a, 0, 0)$. Let also $W_m^a(t, 0) = \max_c W_m^a(c^a, t, 0)$.

Claim. $v_m^a(1) - v_m^a(0)$ is increasing in m.

Let $x(1) = x(1, 0)$ and $x(0) = x(0, 0)$. Then

$$v_m^a(1) - v_m^a(0) = \int_{x(0)}^{x(1)} (\alpha + \mu^a - r)dr + \alpha x(0) \tag{15}$$

Taking the derivative with respect to μ_a:

$$\begin{aligned} d \cdot \nabla_{\mu_a}(v_m^a(1) - v_m^a(0)) &= \int_{x(0)}^{x(1)} 1dr + \nabla_{\mu_a} X(1)(\alpha + \mu^a - X(1)) - \nabla_{\mu_a} X(0)(\alpha + \mu^a - X(0)) + \alpha \nabla_{\mu_a} X(0) \\ &= X(1) - X(0) + \nabla_{\mu_a} X(1)(\alpha + \mu^a - X(1)) > 0 \end{aligned}$$

since $X(1) - X(0) > 0$ and $\alpha + \mu^a - X(1) \geq 0$ is the utility of a voter who is indifferent between politician a and politician b inside of politician's b core zone, implying non-negative utility.

Taking now the derivative of refdv with respect to μ_b yields

$$d \cdot \nabla_{\mu_b}(v_m^a(1) - v_m^a(0)) = \nabla_{\mu_b} X(1)(\alpha + \mu^a - X(1)) < 0$$

Thus, for $\gamma_m = \gamma$, the claim above is proved. QED

Remark 1. We solved everything for v, rather than w, because communication of a in equilibrium is independent of t_m^a when $t_m^b = 0$.

Now to prove item 2 of Proposition 2, we just need to show that

$$\nabla_{\gamma_m}(v_m^a(1) - v_m^a(0)) > 0$$

We have

$$\begin{aligned} d\nabla_{\gamma_m}(v_m^a(1) - v_m^a(0)) &= \nabla_\gamma X(1)(\alpha + \mu^a - X(1)) \\ &= -\frac{1}{2}\nabla_\gamma c^b(1, 0) > 0 \end{aligned}$$

Thus, a decrease in γ_m reduces the marginal value transferring to municipality m.

If $\mu_1^a = \mu_2^a$ and $\mu_1^b = \mu_2^b$, any increase in γ_1 leads a to switch the transfer from municipality 1 to 2. Following that rationale, this will also happen for a discrete change in γ if $\mu_1^p = \mu_2^p + \varepsilon$. $\varepsilon \to 0$.

Because the effect of switching the transfer is discrete, if the change in γ_1 leading to the transfer switch is small enough, v_1^a will fall and v_2^b will increase. QED

Remark 2. Our results are valid when $\gamma_m = \gamma + \varepsilon_m$ for $\varepsilon_m \to 0 \; \forall m$, because $\mu_m^a c - \gamma/2c^2$ is a continuous function on c.

Alternative Model: Politician b also makes transfers

To establish that our key results also hold in a model in which we do not restrict to one of the politicians the ability to make transfers, we consider a version of the baseline model in which we allow positive transfers by politician b. To keep things simple, we restrict the model to $n = 4$ municipalities, with $\mu_{a1} \geq \mu_{a2} > \mu_{a3} \geq \mu_{a4}$ and $\mu_{b1} \leq \mu_{b2} < \mu_{b3} \leq \mu_{b4}$.