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 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. At the same time, 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 and, some think, might threaten democracy.¹

A distinctive feature of social media is the possibility of direct communication between voters and politicians, which might affect politicians’ behavior differently than traditional media. In spite of widespread evidence that 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; Varjão, 2019) and that social media can affect the political behavior of citizens (Falck et al., 2014; Campante et al., 2018; Enikolopov et al., 2018; Manacorda and Tesei, 2019; Guriev et al., 2019), we still know little about the impact of social media on the behavior of politicians.

We examine the impact of social media on the responsiveness of politicians in the context of the rapid expansion of 3G mobile Internet in Brazil.² This took place concurrently with a remarkable dissemination of Facebook, which rapidly became the dominant social media platform in the country, and acquired commensurate prominence in Brazilian politics.³ In a low-information setting regarding politicians and what they do, this new media environment greatly enhanced the possibilities for interacting with and acquiring information about elected representatives – in contrast with the media-saturated environments of developed countries, where social media might crowd out other channels of accountability.

¹This is most clearly exemplified by the phenomenon of so-called “fake news” (Allcott and Gentzkow (2017); Allcott et al. (2019); Lazer and et al (2018)). For broader skeptical accounts, see for instance Vaidhyanthan (2018) or, for a media account, Madrigal (2017).

²3G technology is essential for the dissemination of access to social media for at least two reasons. First, access to social media occurs disproportionally via mobile phones – as of 2020, 78% of Facebook users worldwide access the website only via mobile phones (Statista 2020, available on https://www.statista.com/statistics/377808/distribution-of-facebook-users-by-device/) – and especially so in a context such as that of Brazil, where cellphones are much more widely disseminated than broadband access. Second, while the previous generation of wireless mobile technology already allowed for basic data transmission such as text messaging, it was only with 3G that cellphones became more effective tools for Internet access Woyke, 2018.

³Facebook went from 4 million users in Brazil, in mid-2009, to about 30 million in mid-2011, and reaching 92 million by late 2014. Between 2011 and 2014, the number of municipalities with 3G coverage more than doubled, going from 30% to about 67% – an expansion reaching about 30 million people.
We find that access to 3G Internet in a municipality is associated with greater online interaction between legislators for whom the locality is important, relative to other municipalities that remain off the network. This, however, comes at the expense of lower engagement offline: those legislators become less likely to mention the municipality in floor speeches, and crucially, bring fewer resources from discretionary transfers. 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.

Our empirical strategy leverages two features of the Brazilian setting. First, we take advantage of the staggered rollout of the 3G network in Brazilian municipalities. This allows us to adopt an event study design using within-municipality variation in 3G coverage. Second, we exploit a peculiarity of the Brazilian system to elect federal legislators to go beyond the standard differences-in-differences strategy: federal legislators compete for votes in all municipalities of a given state, and multiple legislators are elected in each state. This allows us to control for legislator-municipality fixed effects, thus alleviating concerns that unobserved factors could confound our results – say, if legislators were more likely to focus attention on strategically important locations, and also to facilitate access of those areas to the 3G network by lobbying mobile operators.

We present three main sets of findings. First, we show that politicians use social media extensively to communicate with their constituents, finely targeting different localities and covering policy-relevant topics. To study that, we scraped the universe of posts from all Facebook-active members of the Brazilian lower house (*Câmara dos Deputados*) over the 2011-2014 legislature from their public Facebook pages. We then developed and applied an algorithm that classified which municipalities, if any, each post mentioned, and combined that with a topic modeling algorithm to classify the content of the posts. The 513 legislators in our sample posted over 460,000 times between 2011-2014, receiving millions of likes, shares, and comments on their posts. Of those, almost 170,000 mentioned at least one municipality and virtually all municipalities in the country were mentioned at least once. We also find that a significant number of those posts have policy content, discussing issues such as education, health, or public projects.

Second, we show that politicians change their online behavior swiftly and intensely when a municipality is covered by the 3G network. Legislators increase mentions to those municipalities by 15.7% compared to uncovered municipalities. We also find that voters interact more with those Facebook posts, as measured by likes, shares, and comments. This suggests that increased access to social media by constituents indeed raises the
incentives of politicians to interact with them. Importantly, however, we find that these results are much more pronounced when considering municipalities that are part of the politicians’ base of support (in the sense of providing a large share of their votes). For a municipality in the top decile of electoral importance for the politician, 3G is associated with an increase of 60% in Facebook mentions and over 80% of comments, shares, and likes. From a theoretical perspective, it is not obvious that this should be the case, as one might expect politicians to target municipalities with the largest number of swing voters, rather than those where they are ex-ante more popular. This underscores the peculiarity of social media, in which politicians mostly reach voters that chose to follow them in the first place, and could plausibly have consequences for polarization, as social media disproportionately increase the politicians’ communication capacity with those core supporters.

For our third main set of results, we turn our attention to how the impact translates into the offline realm. Even though the increased communication has policy-relevant content, it is not obvious how it affects the incentives to use traditional political tools. In an environment with very low accountability such as in Brazil, social media communication could just be cheap talk, with politicians ignoring voters’ social media presence in whatever else they do. Moreover, even if there is any effect, it is unclear ex-ante whether online and offline behaviors 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; on the other hand, they could instead get away with doing even less, as the impact of any legislative accomplishment on votes could be increased by boasting about it on social media.

We study two margins of legislative activity. We first focus on congressional speeches, which are a significant part of the politicians’ daily routines, and in which they express their opinions and support for various types of bills and propositions (Moreira (2019); Moreira (2020)). 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 their 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 across municipalities. The analysis explores a unique feature of the Brazilian setting in which, on a yearly basis, the legislators propose amendments to the federal budget.4

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4These amendments are strictly capped at the level of legislators, implying a strong opportunity cost of
This pork-barrel spending is typically used by politicians to showcase improvements they bring to communities of their choice – roads, schools and healthcare 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, they react by transferring resources to other municipalities in their base that are left without 3G access.

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. Our key assumption is that (online) communication is especially effective in reaching core supporters within those municipalities, in line with the social media feature that, to be reachable by the politician, one has to choose to follow them 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 social media. Politicians respond by increasing their communication effort. Since social media are more effective at reaching core supporters, effort increases especially so in municipalities they are more popular. Since all other politicians do the same, the core supporters of each of them become more attached, thereby reducing the number of swing voters in a municipality with 3G. This makes transfers to these municipalities 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. Consistent with the model, we find electoral losses in the subsequent election, within the politicians’ electoral base, in municipalities that receive 3G (relative to those that do not). Furthermore, 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 stronger. Importantly, political competition is essential to generate this reduction in votes, since votes should increase even if communication and transfers happen to be substitutes for general technological reasons.

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 targeting the resources. See Ames (1995a), Firpo et al. (2015) and Finan and Mazzocco (2016) on determinants and effects of earmarked resources in Brazil.
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., 2016; 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 (Snyder and Strömberg, 2010; Gavazza et al., 2019). 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, and describes our data sources and key variables. Section 3 describes our empirical strategy. Section 4 discusses the results. We rationalize the results with the model in Section 5, where we also discuss additional evidence. Section 6 concludes.
2 Background and Data

2.1 The expansion of 3G Internet in Brazil

Mobile internet was launched in Brazil in 2005, but until 2007 it had limited penetration with a small number of firms using their existing mobile phone concessions to implement the third generation of wireless mobile telecommunications (3G) transmission in 850 MHz frequencies. Because only 20 percent of households in Brazil had access to the internet from a home-based computer, there was a large demand for the 3G internet expansion. In the end of 2007 Brazil’s Telecom regulator (Anatel) designed a spectrum auction where 11 service areas were auctioned out. To promote regional competition, Anatel awarded four blocks of spectrum in each lot. Another auction took place in 2010 for Band H and the remaining personal mobile service radio frequencies for 3G use.

Because some regions were more economically attractive than others, Anatel introduced several contractual obligations for the winning firms. First, companies that obtained a block of spectrum to serve the richest parts of Brazil also had to serve a poor and unconnected region. For example, a company that won an auction to serve the metropolitan region of São Paulo (Brazil’s richest region) also had to acquire and serve the Amazon region. Second, Brazil’s Telecom regulator introduced targets for the expansion of the 3G network to 2,740 municipalities that were out of the 3G Internet network. First, all capitals and cities above 100,000 inhabitants needed to have full coverage of 3G Internet (80% of urban area) by May 2013. Second, all municipalities with populations between 30,000 and 100,000 needed to be connected to 3G Internet by June 2016 and 70% of those needed to be connected by May 2013. Finally, for smaller municipalities with a population of 30,000 people and below, companies were required to connect 20% of municipalities by May 2013, 75% by June 2016 and all needed to be connected by December 2019.

Telecom companies got a concession for a given area, but they were given a choice over which municipalities to connect over time. After the auctions and the identity of winners was disclosed, Anatel asked each Telecom company to select a list of municipalities they wanted to connect. Because there were multiple companies serving a given area, the choice was made in sequential order where each firm chose 5% of mun-

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53G refers to the third generation of wireless mobile telecommunications technology, which greatly increased the capabilities of mobile data transfer.


7A municipality being connected was defined as at least 80% of the urban area of the main district having a 3G signal.

8This original list was published in 2008 and appended with the last 3G spectrum auction in 2010.
nicipalities taking turns until no municipality in the pre-selected list by Anatel was left. After this procedure, Anatel signed a concession agreement with each Telecom company containing specific municipalities and dates that 3G Internet connections needed to be completed. Because the expansion was dictated by commercial interests of large companies and strict rules based on population brackets set by the regulatory agency, politicians had a limited ability to influence the choices made by Telecom firms regarding the cities that received 3G. Thus in our empirical analysis, we use the staggered entry of 3G internet as the main source of variation.

We obtained data on whether a municipality was connected to 3G Internet by month and year from Teleco, a telecommunications consultancy firm in Brazil. They built the dataset from information they collect directly from Telecom companies. The dataset includes, for each municipality, the month and year of the first 3G Internet connection and the month and year that other Telecom companies entered the municipality. For our analysis, we consider that a municipality had 3G Internet at year \( t \) whenever 3G started operating by June of \( t \). If 3G started at \( t \) but after July, we consider that 3G enters the municipality at \( t + 1 \).

Telecom companies complied with Anatel and starting in 2008 expanded the number of municipalities covered by mobile Internet. The expansion was considerable over the period of our analysis. Between 2011 and 2014 the coverage more than doubled going from 30 to 67% of municipalities connected to 3G Internet as shown in Table 1. This is equivalent to more than 2,000 municipalities connected to Mobile Internet in this short spell. In terms of population, this expansion meant that, in four years, 30 million people gained access to broadband mobile Internet coverage. While we do not have municipality-level data on 3G accesses, in Figure X we show the trend in 3G access between 2008 and 2014. The figure shows a great expansion of access to 3G networks during our study period.

The rise in access to 3G technology was accompanied by an increase in the connectivity reported in the PNAD household survey. In Panel B of Table 1 we show that, at the start of our sample period in 2011, 36.6 percent of the households used the Internet and in 2014 this share increased to 55 percent. 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.

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10Note that, although firms needed to connect a pre-specified list of municipalities, they could speed up the process and connect localities before the due date.

11See https://www.teleco.com.br
per 100 inhabitants, and only 10.5 fixed broadband Internet subscriptions per 100 inhabitants. Moreover, the market share of smartphones, essential for using social media apps in cell phones, also soared during this period. While in 2011 13.6% of cellphone sales were smartphones, in 2014 this share increased to 77.5% according to Teleco.\footnote{See Teleco’s website.}

### 2.2 The entry of Facebook and the rise of social media in political communication

As the expansion of 3G Internet took 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 experienced a very rapid expansion from just over 4 million users as of mid-2009 to 92 million users in 2014 (about 45% of the total population of the country). The availability of 3G Internet was crucial for this expansion as the access to Social Media in Brazil takes place largely via mobile phones. In fact, out of those aforementioned 92 million Facebook users, no less than 77 million accessed via mobile Internet.

Facebook became by and large the dominant social network platform in Brazil. In Table 1 Panel C we show data from Facebook use based on LatinBarometer. It shows an increase in the percentage of individuals that use facebook from 13% in 2011 to 43% in 2013. Complementary data from Ibope Nielsen and Facebook show a similar trend. We can also use data from Google Trends to compare the interest in several social media platforms over time.\footnote{The index is based on the number of Google searches, normalized by the maximum number of search queries.} The number of Google searches for the terms “Facebook,” “Twitter,” and “Orkut,” are displayed in Panel D and reveal Facebook’s steep rise. While Orkut was the first social networking website with significant presence, it was in clear decline when Facebook started and eventually shut down operations in 2014. Twitter, a popular social media platform in the U.S., was not a widespread social media in Brazil during our study period.

In the early 2010s it was clear to many politicians that Facebook would become an important source of political information and the adoption of Facebook as a communication device spread quickly. Out of 513 Federal Deputies elected for the 2011-2014 legislature, 415 had created an active public official Facebook profile by the end of his or her term. In Table 2 we show that 17% of Federal Deputies had a facebook account in the first year of their legislative term in 2011 while by the end of the term in 2014 80% had a Facebook account.
In order to study the online communication of legislators, we scraped the universe of their Facebook profiles for their content, messages, and number of likes, shares, and comments. We obtained a database of 460,540 posts from the 415 active public official Facebook profiles. 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 politicians increasingly used Facebook over time, the average legislator posted 24.5 messages in 2011; it increased almost twenty-fold to 484.2 messages in 2014.

Our key outcome of interest that captures online activity is the number of times per year a politician mentions a municipalities in their posts. This 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 for this task is that a considerable number of municipalities have names that also have other meanings in Portuguese. For example, whenever a politician said the word Natal, it could either mean the municipality with that name or a reference to Christmas (the word Natal means "Christmas" in Portuguese). To deal with that, we devised a text processing algorithm that matches each of the 460,540 posts in our sample to the 5,545 Brazilian municipalities. We tested the performance of our approach in a sub-sample, with the algorithm providing a correct match for 89% of the true mentions, and a false match for only 2% of the posts.

We find that 36.7% of posts (just under 169,000) mention at least one municipality. These are the posts that constitute the core of our analysis as they 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. In 2011 Facebook is sparsely used and few municipalities are mentioned. In contrast, virtually all municipalities were mentioned at least once in 2014. We can also observe in the Figure the geographical concentration of facebook posts in municipalities that had 3G access in 2011.

Importantly, Facebook posts carry political content. Among the posts that mention a municipality, keywords that are related to congressional activity were used in as many as 146,000. 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. 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 B.

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15 More specifically, we looked for the following keywords “amendment”, “audience”, “committee”,...
contents of Facebook posts also contained information on other topics and public goods and services: keywords associated with education and healthcare were mentioned 27.3 and 23.2 thousand times, respectively. Finally, the database is consolidated at the level of the politician-year-municipality triplet, containing information on the number of posts, as well as the sum of likes, shares and comments on the posts.

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 are typically private, in contrast with the politicians’ public profiles. We proxy citizen communication with the number of likes, shares, and comments on the posts made by politicians. Given the private nature of the information, we cannot know how many of these likes, shares, and comments are actually coming from citizens in a specific municipality, but we use these measures as proxies for citizen engagement with a politician that represents the municipality. In Panel A of Table 2, we observe a remarkable increase in the interaction between Facebook users and legislators over time.

In sum, between 2011 and 2014 Facebook use increased sharply, becoming widely adopted in Brazil by politicians and citizens alike. It became a mainstream channel for politicians to advertise themselves and their legislative activity, as well as to interact with the general public. 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.

### 2.3 The Brazilian congress

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 (deputados federais) that represent each of the 26 states plus the Federal District. Federal Deputies, who are the focus of our analysis, are elected under an open-list proportional representation multimember district system. They have a four-year term and can run for reelection without any term-limit.\textsuperscript{16}

Voters can choose to vote for one candidate or for a party label. Political parties can
\textsuperscript{16}See Ames (2002) for a detailed analysis of Brazil’s legislative electoral system.
form coalitions and the allocation of seats in a given state is chosen proportionally to the share of votes obtained by a party or a coalition. The candidates who fill those seats will be the top vote-getters in the party (or coalition) ticket. 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.

Generally speaking, the Brazilian combination of open-list proportional representation and large districts is seen as one of the main causes of poor accountability (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 themselves known to the electorate. In this context, voters typically have very low levels of knowledge regarding federal deputies. 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 any municipality across the entire state. What is more, as we will show later, the distribution of votes for each candidate tends to be highly heterogeneous.

Once elected, the work of a legislator ranges from roll-call votes, public speeches, bill proposition, and participation in special committees. Prior to the advent of Facebook, politicians primarily used congressional speeches to communicate their legislative achievements to the voters. Most interestingly for our purposes, legislators also can propose amendments (emendas parlamentares, EPs) to the federal budget and 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. 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 and “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)

Legislative Activity  We look at two dimensions of legislative activity, floor speeches and budget amendments (emendas parlamentares, EPs), which we can tie to specific municipalities. For the former, we obtained the database of the universe of speeches made in Congress, which is available on the Chamber of Deputies website. We use the same

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17 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.

18 The ceiling varied between 4.2 to 4.7 million US dollars for the 2011-14 period.
algorithm from our Facebook analysis 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.

As for the budget amendments, we obtain the original list of amendments from the government Open Data portal: https://dados.gov.br/dataset/emendas-parlamentares. The dataset contains, for every amendment, the legislator responsible for it, the state and municipality targeted, the Ministry in charge, a text description of the project and the monetary value. From this information we use the amendments that are proposed by individual legislators and are targeted at municipalities (some amendments are proposed for whole states). We use the information of the municipality to match with the 3G internet dataset. In Panel B of Table 2 we show summary statistics of the amendments. The average legislator proposed 5.4 amendments per year to 5.5 municipalities. Given that the average congressman has 253 municipalities in his constituency (state), it is clear that politicians choose which localities will receive transfers very carefully.

**Electoral Support**  In our empirical analysis we explore heterogeneity on politician’s response to the entry of 3G Internet based on the vote share obtained across municipalities in the previous election. To capture the geographical variation in electoral support for each legislator, we gather municipality-level election data made available by Brazil’s Electoral Court (Tribunal Superior Eleitoral). We gathered data on the total valid votes obtained by each elected legislator in each municipality. We then compute the vote share:

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\text{VoteShare}_{im} = \frac{\text{Votes of politician } i \text{ in municipality } m}{\text{Total votes of politician } i} \times 100,
\]

which represents the importance of municipality \(m\) for legislator \(i\). Some deputies get their votes from a few concentrated municipalities while others are elected from a much more dispersed 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 where we show the map of vote shares for the top two legislators elected in the state of São Paulo.
in 2010 (Tiririca and Gabriel Chalita).

3 Empirical Strategy

Our goal is to examine the causal effect of citizens getting access to 3G Internet on the behavior of politicians. For that, our empirical strategy exploits two sources of variation. First, there was a staggered entry of 3G across municipalities over time, which allows us to compare the behavior of politicians before and after citizens get access to 3G. Second, we explore the fact that candidates compete for votes across their entire home state, which allows us to compare the change in the behavior of politicians across different municipalities as some of them get access to the 3G network.

In a context such as the United States, where a single politician represents a congressional district, we could use a two-way fixed-effect model 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 congressman $m$ in year $t$, $3G_{mt}$ is an indicator of whether there is 3G Internet in constituency $m$ in year $t$, $\lambda_m$ is a politician and congressional district fixed-effect that controls for unobserved time-invariant politician and locality characteristics, $\delta_{st}$ is a state-by-year indicator that controls flexibly for unobserved state trends, and $\epsilon_{mst}$ is an error term. The coefficient of interest is $\beta$, which captures the causal effect of 3G under the identifying assumption that the behavior of politicians across municipalities with and without 3G access are on parallel trends prior to the entry of 3G.

Our context allows us to go further and separately control for legislator interacted with municipality fixed effects. This is important as the legislator-municipality fixed effects control for the possibility that legislators lobby the mobile operators to bring 3G to their electoral turf. We can add this fixed effect because each state is a multi-member district in which multiple legislators compete for votes. Moreover, we observe 3G entry and political behavior at the municipality level, allowing us to observe the behavior of multiple legislators in municipalities with and without 3G access. Formally, we can estimate the regression

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

This equation has two differences in comparison to equation 2. First, the unit of obser-
vation is now the triple legislator \( i \), municipality \( m \), and year \( t \). We observe all pairs of politicians and municipalities in their constituents (i.e., state). Second, we add politician-municipality pair fixed-effect \( \lambda_{im} \). Again, the coefficient of interest is \( \beta \).

There are two potential issues with this specification. First, most politicians receive a meaningful number of votes from a handful of municipalities in their state. As such, the marginal impact of 3G on a municipality where a politician has little in the way of electoral incentives should be very close to zero. This is especially true for earmarked transfers, since the total number of transfers each politician can make are an order of magnitude smaller than the number of municipalities in their state. Second, as is the case for any application of difference-in-differences, our identification strategy will be invalid in the presence of a time-varying omitted variable correlated with 3G entry. This would be the case, for example, if mobile operators enter first and politicians give more attention to municipalities with growing population or income. Although we show in Section 4 that trends are parallel between municipalities receiving 3G at different moments, this could still be an issue.

We deal with both issues by leveraging the three-dimensional structure of our data. Specifically, we exploit the fact that there is substantial variation in the vote share of politicians across different municipalities. This allows us to employ a triple-difference strategy in which we compare the outcome of legislator \( i \) before and after the entry of 3G Internet across localities where they had different levels of electoral support in the previous election.

We estimate the following regression:

\[
y_{imst} = \gamma \cdot 3G_{mt} \cdot VoteShare_{im} + \lambda_{im} + \delta_{mt} + \phi_{it} + \epsilon_{ismt}
\]  

(4)

where \( VoteShare_{im} \) is the vote share of legislator \( i \) in municipality \( m \), defined in Equation (1). For ease of interpretation, we demean the variable \( VoteShare \). This specification allows us to control for politician-municipality and politician-time fixed effects (\( \lambda_{im} \) and \( \phi_{it} \) respectively). The latter fixed effects account for non-linear trends in politicians’ behavior, for example over the electoral cycles. We also control for municipality-time fixed effects \( \delta_{mt} \), which helps addressing the concern that 3G entry could correlate with time-varying unobservable variables in the municipality level.

The coefficient of interest in equation 4 is \( \gamma \), which captures the difference between the causal effect of 3G entry in municipalities where the politicians had more votes and the causal effect in municipalities where they had fewer votes. This coefficient allows us to compare the response of politicians across municipalities with and without 3G access,
conditional on how important those municipalities are for their electoral prospects.

That said, there is no reason to impose that the impact of that electoral importance on the effect of 3G Internet on the behavior of politicians will vary linearly with that electoral importance, as measured by the vote share. For instance, we might expect that politicians will pay special attention to their electoral strongholds. We thus make a final modification to equation (4), to allow for non-linear effects, leading to our final specification:

\[
y_{inst} = \sum_{\tau=3}^{10} \gamma_\tau \cdot 3G_{mt} \cdot \text{VoteShareDecile}^\tau_{im} + \lambda_{im} + \delta_{mt} + \phi_{it} + \epsilon_{inst}
\] (5)

where VoteShareDecile$^\tau_{im}$ is equal to one if the vote share is in the $\tau$-th decile, and zero otherwise. In this specification, the main coefficients of interest are the parameters $\gamma_\tau$.

All our dependent variables include a large number of zeroes. To deal with that, unless otherwise stated, we apply the inverse hyperbolic sine transformation (IHS) to the dependent variable.\(^{19}\) Finally, the standard errors in specification 2 is clustered in the municipality level, while specifications 3-5 are two-way clustered at the municipality and politician levels (Cameron et al., 2011).

\section*{4 Results}

\subsection*{4.1 Do Politicians Respond to 3G Access in Municipalities?}

\textbf{Municipality Event-Study Estimates}

We begin by estimating regressions at the municipality level, to examine whether the introduction of 3G Internet affects politicians’ social media activity, speeches, and earmarked transfers. These initial regressions are useful to assess the validity of our DD research design.

In the context of our “natural experiment” of interest, we have three groups of municipalities: those that gained access to 3G Internet before 2011, those that obtained 3G access between 2011 and 2014 (our period of interest), and the ones that remained unconnected as of 2014.\(^{20}\) The middle group is “treated” during our period of analysis, but

\footnote{The IHS transformation is very similar to log away from zero, but has the advantage of being defined when the dependent variable has value zero. All our results are robust to using $\log(1 + x)$ transformation instead.}

\footnote{Our primary data contains the month and year that 3G was made available. If that happened after July, we code the 3G entry to the following year.}
It is clear that the other two represent very different comparison groups in terms of the potential impact of 3G access. What is more, in Table 3, which presents characteristics of municipalities in these distinct groups, we see that municipalities that get early access to 3G are different in a number of observable characteristics, compared to those that get connected during our study period (2011-2014) and afterwards. They are, on average, richer, larger and more urban, consistent with telecom companies expanding 3G Internet according to a profit-maximizing objective and targeting first larger and richer localities.

The identification of the 3G effects hinges on the assumption that municipalities that gain 3G access between 2011 and 2014 would have, in the absence of connection, followed trends similar to those in municipalities in the comparison group. To test for the implicit parallel-trend assumption we adapt (2) in order to run the following event-study-type specification:

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

(6)

where 3G_{m,t+j} is a variable that takes the value of 1 if municipality m gained 3G access at time t + j, and zero otherwise, excluding municipalities that had 3G prior to 2011.

In Figure 3, we plot the estimates from the event-study model in equation (6) for two different samples: (i) the “treatment” group of municipalities that gain 3G access during the 2011-2014 period compared to municipalities that remained unconnected as of 2014; and (ii) the same “treatment” group compared to municipalities that had been previously connected. As is clear from the figure, jurisdictions that were connected to 3G internet prior to 2011 follow a different trend in terms of Facebook posts, and also in terms of targeted transfers. Based on the differences in characteristics and in pre-trends, we proceed to use as the control group the localities that remained without access to 3G internet until after the 2011-2014 legislature.

In Figure 4, we plot the estimated coefficients from the event-study model using six different dependent variables. The first four plots measure the Facebook engagement of politicians and the response from their followers. The last two plots use speeches and targeted transfers as measures of politicians’ offline behavior.

The results show a quick and meaningful increase in Facebook activities by politicians and users after a municipality receives 3G Internet. One year after municipalities get 3G Internet, the number of Facebook posts made by politicians referring to the municipality increases by approximately 10 percent, reaching close to a 30 percent increase in two years. This pattern is similar when we measure the number of likes, comments, and shares on these posts.
The last two plots in Figure A11 show a strikingly different story for politicians’ offline behavior. When municipalities get 3G Internet access, they receive fewer citations in speeches made in Congress by the legislators (4% less in the year of adoption and 9% 2 years later). Moreover, although noisy, we also find no evidence that municipalities getting access to 3G Internet receive more transfers from politicians.\footnote{We show in Table AXXX the difference-in-differences estimates (equation 2), which aggregate the dynamic treatment effects into a single estimate. We find that municipalities that get connected to 3G Internet have an 17-percent increase in the number of Facebook mentions by legislators, accompanied by a 4-percent decline in the number of citations in speeches, as well an imprecise estimate for targeted transfers.}

**Exploiting the Variation across Politicians and Municipalities**

The evidence above is consistent with a substitution pattern between politicians’ online and offline activities. However, this specification fails to capture heterogeneity in politician’s behavior in different municipalities. This is especially problematic in the case of earmarked transfers. Since politicians only send transfers to a fraction of all possible municipalities – politicians target on average five out of hundreds of potential municipalities –, most municipalities are infra-marginal for receiving a transfer and should have zero treatment effect of receiving 3G. This should reduce any effect of 3G on transfers for the relevant municipalities, i.e., those that could conceivably be affect by 3G entry. To deal with this issue, we move to the triple-difference model described by equation 4, in which we interact the 3G entry dummy with the legislator’s vote share in the municipality.

In Table 5, we show results from estimating equation (4).\footnote{Note that because we control for a full set of fixed-effects, the coefficient on 3G alone is not identified, and we focus our interest on the interaction between the availability of 3G Internet and the vote-share of politicians across municipalities, $3G \times Voteshare$.} Column (1) shows that the entry of 3G Internet increased the number of posts made by politicians citing the newly connected municipality, and this effect is larger in places where the politician had a larger vote-share. For a sense of magnitudes, an increase of one standard-deviation in the vote share of politicians, relative to the mean, increases the number of posts in a municipality with 3G Internet by 37 percent. Followers react with a significant increase in the number of likes, shares and comments to politicians’ posts. These effects, shown in columns (2)-(4), are significantly larger for localities where the politician had a large vote share in the previous election. Together, these results imply that politicians indeed communicate more through social media with voters in localities that are connected to 3G Internet, and particularly so in their political strongholds.

We examine in columns (5) and (6) of Table 5 how the entry of 3G internet affects the number of congressional speeches mentioning and targeted transfers to a given munic-
ipality. Municipalities that are 1 standard deviation above the average politicians’ vote share have 30% less chance of ever being mentioned in a speech in any given year. Similarly, these cities are also 56% less likely to receive at least one transfer and receive on average 6.9% less resources, although the latter estimate is not significant at conventional levels. Together with the results in the municipality-level, we conclude that these municipalities are likely to have received less political attention using traditional political tools such as Congressional speeches and directed transfers.

The specification above already captures part of the heterogeneity in politicians’ behavior across municipalities. However, as we noted above, variables such as congressional speeches and transfers, that have high a mass at zero, will likely have non-linear treatment effects based on the municipality’s importance to the politician. To allow for these non-linear effects we estimate the semi-parametric specification from Equation (5), which interacts the 3G indicator with the vote share decile. We show the results for all six dependent variables in Figure ?? where each dot represents the $\gamma$ coefficient for a given decile with the respective 95% confidence interval in bars.

The first four figures show that access to 3G Internet increases the posts made by politicians, as well as likes, comments and share by Facebook users. These effects are consistent with our previous results and are stronger for the top two deciles of vote share, suggesting non-linear treatment effects based on the electoral importance of a municipality. The bottom two figures show the effects for offline behavior measured by speeches and transfers to municipalities. We find that in the top decile – that is, that represent a large share of the votes obtained by the politician in question – they reduce both the mentions of a municipality in speeches, and the transfers directed to these municipalities.

In sum, the entry of 3G into a municipality induces politicians for whom that municipality is important to interact more with it online, but also to redirect their offline efforts away from them, and towards the municipalities in their base of support that remain outside of the 3G network. In other words, we find a pattern of substitution in which 3G access induces an increase in online interaction at the expense of offline interaction, relative to important municipalities without 3G.

4.2 Looking at the Issues

What do Politicians talk about on Facebook?

We have shown that politicians are more likely to mention municipalities on their Facebook feeds when these municipalities get connected to 3G internet, especially those that
are politically important to them. But do these mentions contain any politically relevant message? To answer this question we trained a topic modeling algorithm to detect the contents of the Facebook messages. 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 – projects and amendments. The latter category is particularly important because, as we have mentioned, transfers to municipalities are typically 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. We use the trained algorithm to automatically detect the topics in the remaining 169,000 posts.\footnote{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. 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.}

We use the posts classified by topic to estimate a series of semi-parametric regressions as the ones specified by Equation (5), but replacing the dependent variable with the number of posts where politician $i$ cites municipality $j$ for a given topic (e.g. education). We show the results in Figure 6, panel A, where each color represents a different topic. The results suggest that politicians indeed used their Facebook pages to convey messages related to policy and legislative policy-making. As 3G Internet enters a municipality, politicians increase the mentions to that municipality in topics related to education, health, amendments, and projects. Again, this increase is particularly manifest in the politicians political strongholds as measured by share of votes in the previous election.

In sum, we find that politicians talk about substantive policy issues on Facebook, as well as about their legislative activity, when they increase online communication upon the arrival of 3G Internet.

\textbf{What transfers do Politicians shift around?}

In Figure 6, Panel B, we present results from the same specification, but use earmarked transfers separated by topic as a dependent variable. To do so, we use information on the Ministry or Government agency that implemented the earmarked transfer (i.e. Ministry of Education). We aggregate spending into the five biggest spending categories: health, education, agriculture development and environment, industrial and urban development, and integration and defense.\footnote{Brazil had 39 ministries or special secretaries with ministerial status.} We find that politicians react to the entry of 3G Internet by shifting around the type of resources targetted to municipalities. In top
deciles, politicians shift earmarked transfers of Agriculture and Education projects towards localities where they have a high vote-share but 3G Internet is absent while health and urbanization are kept intact.

**Traditional and online social media**

Taken together, the results from this section suggest that politicians are shifting resources away from their core base of support, at the same time that they are targeting 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 effectiveness that traditional media often has on increasing politicians’ accountability does not necessarily have external validity to online social media. It also points to a margin of substitution between online and offline parliamentary activity: because politicians get much more exposure on Facebook, they can attempt to get away by doing less for municipalities that can see their posts, shifting resources instead to municipalities that do not have 3G Internet.

Given this contrast with the impact of more traditional media, it is worth considering how these pre-existing media sources, which are differentially present across Brazilian municipalities, may interact with the arrival of 3G Internet in affecting the response of politicians. In Figure 6, we estimate the effects of 3G Internet by deciles of vote, splitting the sample between municipalities with and without the presence of local mass media (radio and TV). For ease of comparison we plot the coefficients from both samples in the same graph. While the effects of 3G Internet are slightly larger in localities without a local media, we cannot reject that the effects are the same between the two types of municipalities. Thus it seems that the change in the behavior of politicians driven by the arrival of 3G Internet is not dependent of pre-existing media outlets.

**4.3 Robustness**

We also conduct a number of exercises to confirm the robustness of our findings. Results are shown in Table 9. For comparison, we first show in Panel A the main results for the politician-municipality regressions. These results input a missing value for the variables that describe Facebook activity if a politician did not have an open Facebook account in that period. This decision makes the panel unbalanced and we might worry that part of
the effect of 3G Internet entry comes from politicians’ response by opening a Facebook account. To make our panel balanced, in Panel B we account for the fact that not all politicians had a Facebook account throughout the period, and use a zero instead of a missing value for Posts, Likes, Shares and Comments. The point estimates reported in columns (1)-(4) are smaller but remain highly significant.

Up to now we have considered that all municipalities are homogeneous, but some localities are much larger than the others. Because deputies get elected based on total votes, not vote shares, they might respond differentially to more populous jurisdictions. In Panel C we account for this by estimating the triple-difference specification weighing each observation by the population of the municipality. The results shown in columns (1)-(6) are qualitatively similar from our main specification in Panel A. Finally in Panel D we account for the fact that 3G Internet coverage does not stop at the administrative border between municipalities, by excluding from the sample municipalities in years when they had not obtained 3G, but neighboring municipalities already had access to the technology.\textsuperscript{25} Despite a smaller number of observations, results are qualitatively similar from our baseline specification in Panel A.

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 \( m \in \{1, 2, \ldots, n\} \) of a given state. The politicians have two potential instruments

\textsuperscript{25}We defined as neighboring 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).
to affect voters in a given municipality: communication, $c^p_m \in \mathbb{R}_+$, and earmarked transfers, $t^p_m$. 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, $r^p_{im} \sim U[0,1]$ (i.e., uniformly distributed on the unit interval). Each politician has a given level of overall popularity in each municipality, $\mu^p_m$. We label municipalities such that they are ordered by the popularity of politician $a$ ($\mu^a_{m'} \geq \mu^a_{m''}$ 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 ($r^b_{im} = 1 - r^a_{im}$) and popularity ($\mu^b_{m'} \leq \mu^b_{m''}$ for $m' < m''$). Second, we model transfers as a binary variable $t^p_m \in \{0, 1\}$, subject to a unitary budget constraint, i.e., $\sum_m t^p_m \leq 1$, implying that the politician can only transfer to one municipality.\footnote{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.} Finally, we assume that only politician $a$ is currently in office, hence with the option of making transfers – in other words, we will set $t^b_m = 0$ for all $m$.\footnote{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 from different politicians substantially complicates the analysis.}

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 $I^p_m = \{i : \mu^p_m - r^p_{im} \geq 0\}$, 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.”\footnote{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.}

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 $(c^p_m, t^p_m)$, is given by:

$$U^p_{im} \equiv U^p_m(c, t, r_i) = \alpha t^p_m + I^p_{im} \cdot c^p_m + \mu^p_m - r^p_{im}$$

where $I^p_{im} = \mathbb{1}_{[i \in I^p_m]}$, 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
ε_{im} \sim U[0,d]$, independent of $r_i$. In sum, $i$ votes for $p$ iff $U_{im}^p \geq \max \{ U_{im}^a, U_{im}^b, \epsilon_{im} \}$.

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

$$W^p = \sum_m \left[ v^p_m - \frac{\gamma_m}{2} (c^p_m)^2 \right]$$

(8)

where $v^p_m$ is the share of $m$’s population voting for $p$, and the cost of communication is a quadratic function parameterized by $\gamma_m$. This maximization is subject to the budget constraint on the allocation of transfers.

We further assume:

**H1.** $1 > \mu^a_m + \mu^b_m > 1 - \alpha > \max \{\mu^a_m, \mu^b_m\} > 0$

The first part of H1, $\mu^a_m + \mu^b_m < 1$, 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 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) $d > \gamma^{-1} \cdot \frac{3\mu^b_m - (1 - \alpha - \mu^a_m)}{2 (\mu^a_m + \mu^b_m - (1 - \alpha))}$, (ii) $d > \gamma^{-1} \cdot \frac{\mu^b_m}{d - \alpha - \mu^a_m}$, (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 $\gamma_m$, 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

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29Note that even though $\epsilon \perp r$, a voter who is ideologically closer to $p$ has a higher likelihood of voting for $p$. 

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 \( t^a_m \) is fixed for all \( m \). Then, there exists a unique equilibrium which has the following comparative statics: (i) \( c^p_m \) is increasing in \( \mu^p_m \): a politician’s communication efforts towards a municipality are increasing in his popularity in the municipality; (ii) \( c^p_m \) is decreasing in \( \gamma_m \): communication effort is decreasing in the cost of communication; and (iii) the effect of \( \gamma \) on communication is increasing in the politician’s popularity, \( \mu^p_m \).

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. This means that a municipality’s entry into the 3G network will increase those efforts towards 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) \( t^a_1 = 1 \): politician \( a \) will transfer to municipality 1; (ii) If the cost of communication at municipality 1, \( \gamma_1 \), decreases enough, then politician \( a \) switches the transfer to municipality 2; and (iii) If the change in \( \gamma_1 \) is small, but enough to trigger the change in transfer, \( v^a_1 \) may fall, whereas \( v^a_2 \) 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.

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

Propositions 1 and 2 provide 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 (7) 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 of the 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 \( \mu_p \) 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 8, 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 9). 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.\textsuperscript{31} 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 10.

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 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

\textsuperscript{31}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.
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.
References


Woyke, E. (2018). China is racing ahead in 5g. here’s what that means.
# Tables and Figures

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

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A. Rollout of 3G coverage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% municipalities with 3G</td>
<td>.300</td>
<td>.539</td>
<td>.616</td>
<td>.668</td>
</tr>
<tr>
<td>% municipalities with 3G, north</td>
<td>.232</td>
<td>.354</td>
<td>.398</td>
<td>.444</td>
</tr>
<tr>
<td>% municipalities with 3G, northeast</td>
<td>.216</td>
<td>.369</td>
<td>.491</td>
<td>.564</td>
</tr>
<tr>
<td>% municipalities with 3G, centerwest</td>
<td>.281</td>
<td>.419</td>
<td>.454</td>
<td>.493</td>
</tr>
<tr>
<td>% municipalities with 3G, southeast</td>
<td>.421</td>
<td>.751</td>
<td>.815</td>
<td>.860</td>
</tr>
<tr>
<td>% municipalities with 3G, south</td>
<td>.287</td>
<td>.613</td>
<td>.668</td>
<td>.704</td>
</tr>
</tbody>
</table>

| **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). Broadband 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-a-e, 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

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

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

<table>
<thead>
<tr>
<th></th>
<th>3G connection year</th>
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</thead>
<tbody>
<tr>
<td>Income per capita R$</td>
<td>493.80</td>
</tr>
<tr>
<td>(243.34)</td>
<td>(272.41)</td>
</tr>
<tr>
<td>Years of schooling</td>
<td>9.46</td>
</tr>
<tr>
<td>(1.09)</td>
<td>(.866)</td>
</tr>
<tr>
<td>Gini index</td>
<td>.494</td>
</tr>
<tr>
<td>(.066)</td>
<td>(.058)</td>
</tr>
<tr>
<td>Population</td>
<td>34,316</td>
</tr>
<tr>
<td>(203,274)</td>
<td>(379,155)</td>
</tr>
<tr>
<td>% urban population</td>
<td>.638</td>
</tr>
<tr>
<td>(.220)</td>
<td>(.197)</td>
</tr>
<tr>
<td>% poor</td>
<td>.232</td>
</tr>
<tr>
<td>(.179)</td>
<td>(.151)</td>
</tr>
<tr>
<td>% electricity</td>
<td>.972</td>
</tr>
<tr>
<td>(.060)</td>
<td>(.033)</td>
</tr>
<tr>
<td>Area</td>
<td>1.525</td>
</tr>
<tr>
<td>(5.612)</td>
<td>(6.022)</td>
</tr>
<tr>
<td>Turnout in 2010</td>
<td>.806</td>
</tr>
<tr>
<td>(.060)</td>
<td>(.049)</td>
</tr>
<tr>
<td>Municipalities</td>
<td>5,556</td>
</tr>
</tbody>
</table>

Notes: Descriptive statistics of the municipalities in the sample. “Full sample” refers to the all Brazilian municipalities; “≤ 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; “≥ 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

<table>
<thead>
<tr>
<th></th>
<th>(i)</th>
<th>(ii)</th>
<th>(iii)</th>
<th>(iv)</th>
<th>(v)</th>
<th>(vi)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Posts</td>
<td>Likes</td>
<td>Shares</td>
<td>Comments</td>
<td>Speeches</td>
<td>Transfers</td>
</tr>
<tr>
<td>3G</td>
<td>.005</td>
<td>.013</td>
<td>.028***</td>
<td>.040***</td>
<td>-.024*</td>
<td>-.007</td>
</tr>
<tr>
<td></td>
<td>(.013)</td>
<td>(.012)</td>
<td>(.012)</td>
<td>(.012)</td>
<td>(.015)</td>
<td>(.014)</td>
</tr>
<tr>
<td>Mean of dep. var.</td>
<td>.535</td>
<td>.521</td>
<td>.467</td>
<td>.433</td>
<td>.348</td>
<td>.189</td>
</tr>
</tbody>
</table>

Panel A. Extensive margin, binary dependent variable

<table>
<thead>
<tr>
<th></th>
<th>Posts</th>
<th>Likes</th>
<th>Shares</th>
<th>Comments</th>
<th>Speeches</th>
<th>Transfers</th>
</tr>
</thead>
<tbody>
<tr>
<td>3G</td>
<td>.157***</td>
<td>.263***</td>
<td>.210***</td>
<td>.255***</td>
<td>-.040**</td>
<td>-.151</td>
</tr>
<tr>
<td></td>
<td>(.027)</td>
<td>(.060)</td>
<td>(.041)</td>
<td>(.049)</td>
<td>(.020)</td>
<td>(.176)</td>
</tr>
<tr>
<td>Mean of dep. var.</td>
<td>3.19</td>
<td>294.9</td>
<td>161.7</td>
<td>30.34</td>
<td>.846</td>
<td>R$ 99,756</td>
</tr>
<tr>
<td>Observations</td>
<td>16,056</td>
<td>16,056</td>
<td>16,056</td>
<td>16,056</td>
<td>16,056</td>
<td>16,056</td>
</tr>
<tr>
<td>Treated</td>
<td>2,178</td>
<td>2,178</td>
<td>2,178</td>
<td>2,178</td>
<td>2,178</td>
<td>2,178</td>
</tr>
<tr>
<td>Control</td>
<td>1,836</td>
<td>1,836</td>
<td>1,836</td>
<td>1,836</td>
<td>1,836</td>
<td>1,836</td>
</tr>
</tbody>
</table>

Panel B. Intensive and extensive margins, IHS of dependent variable

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

<table>
<thead>
<tr>
<th>(i) Posts</th>
<th>(ii) Likes</th>
<th>(iii) Shares</th>
<th>(iv) Comments</th>
<th>(v) Speeches</th>
<th>(vi) Transfers</th>
</tr>
</thead>
<tbody>
<tr>
<td>3G × Vote Share</td>
<td>.130***</td>
<td>.149***</td>
<td>.147***</td>
<td>.159***</td>
<td>-.0061*</td>
</tr>
<tr>
<td>Mean of dep. var.</td>
<td>.094</td>
<td>.091</td>
<td>.080</td>
<td>.067</td>
<td>.020</td>
</tr>
</tbody>
</table>

Panel A. Extensive margin, binary dependent variable

| 3G × Vote Share | .318*** | 1.063*** | .471*** | .698*** | -.013** | -.069 |
| 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 |

Panel B. Intensive and extensive margins, IHS of dependent variable

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 if 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 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

Tiririca (1.3m votes)  Gabriel Chalita (560k votes)

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: Pre-intervention trends for different groups of municipalities

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 4: 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.
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 6: Topics cited in Facebook by the politicians and types of transfers

Panel A. Topic modelling

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 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 7: 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 8: 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 9: 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 10: Effect of 3G entry on online and offline behaviour

Party coalition 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 coalition 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
Figure A1: 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 A2: 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.
Table A1: Descriptive statistics: elected deputies

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

Notes: Descriptive statistics of the sample of elected deputies of the 53rd legislature (2011-14) and 52nd 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).
Figure A3: 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 A4: 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.
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 A6: 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 A7: 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 A8: 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 A9: 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 A10: 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.
Table A2: Municipality-politician level regressions

<table>
<thead>
<tr>
<th>(i)</th>
<th>(ii)</th>
<th>(iii)</th>
<th>(iv)</th>
<th>(v)</th>
<th>(vi)</th>
<th>(vii)</th>
<th>(viii)</th>
<th>(ix)</th>
<th>(x)</th>
<th>(xi)</th>
<th>(xii)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posts</td>
<td>Likes</td>
<td>Shares</td>
<td>Comments</td>
<td>Speeches</td>
<td>Transfers</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### Panel A. Extensive margin, binary dependent variable

<table>
<thead>
<tr>
<th>3G</th>
<th>0.002</th>
<th>0.015***</th>
<th>0.003</th>
<th>0.018***</th>
<th>0.004</th>
<th>0.021***</th>
<th>0.005*</th>
<th>0.020***</th>
<th>-0.003**</th>
<th>-0.003***</th>
<th>-0.001</th>
<th>-0.002*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3G × Vote Share</th>
<th>0.100***</th>
<th>0.109***</th>
<th>0.127***</th>
<th>0.109***</th>
<th>-0.007**</th>
<th>-0.005</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.018)</td>
<td>(0.019)</td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td></td>
</tr>
</tbody>
</table>

| Mean of dep. var. | 0.094 | 0.091 | 0.091 | 0.080 | 0.080 | 0.067 | 0.067 | 0.020 | 0.020 | 0.010 | 0.010 |

### Panel B. Intensive and extensive margins, IHS of dependent variable

<table>
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<tr>
<th>3G</th>
<th>0.008</th>
<th>0.043***</th>
<th>0.025</th>
<th>0.138***</th>
<th>0.015</th>
<th>0.092***</th>
<th>0.015*</th>
<th>0.069***</th>
<th>-0.002*</th>
<th>-0.004**</th>
<th>-0.015</th>
<th>-0.022*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.005)</td>
<td>(0.009)</td>
<td>(0.017)</td>
<td>(0.023)</td>
<td>(0.011)</td>
<td>(0.015)</td>
<td>(0.008)</td>
<td>(0.012)</td>
<td>(0.001)</td>
<td>(0.002)</td>
<td>(0.010)</td>
<td>(0.013)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3G × Vote Share</th>
<th>0.262***</th>
<th>0.836***</th>
<th>0.576***</th>
<th>0.399</th>
<th>-0.014***</th>
<th>-0.063</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.045)</td>
<td>(0.109)</td>
<td>(0.071)</td>
<td>(0.059)</td>
<td>(0.005)</td>
<td>(0.050)</td>
<td></td>
</tr>
</tbody>
</table>

| Mean of dep. var. | 0.229 | 0.229 | 21.19 | 21.19 | 2.18 | 2.18 | 11.62 | 11.62 | 0.033 | 0.033 | 3,844.2 | 3,844.2 |

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 A11: 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 A12: Effect of 3G on 2014 electoral outcomes interacted with Facebook use during the 2014 elections

Panel A. Vote share 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. Votes (levels) in 2010 and 2014 elections

Notes: 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>
<thead>
<tr>
<th>Number of true mentions in post</th>
<th>Frequency</th>
<th>Correctly classified true mentions</th>
<th>Posts with false matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>62.80%</td>
<td>–</td>
<td>1.91%</td>
</tr>
<tr>
<td>1</td>
<td>28.40%</td>
<td>87.32%</td>
<td>2.82%</td>
</tr>
<tr>
<td>2</td>
<td>6.40%</td>
<td>86.67%</td>
<td>0.00%</td>
</tr>
<tr>
<td>3</td>
<td>1.60%</td>
<td>91.67%</td>
<td>0.00%</td>
</tr>
<tr>
<td>4 or more</td>
<td>0.80%</td>
<td>92.31%</td>
<td>0.00%</td>
</tr>
<tr>
<td>any</td>
<td>100.00%</td>
<td>88.89%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>
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 \( D_i^{a}(t^a, t^b) = \mathbb{1}[U^a(c^a, t^a, r_i) > U^b(c^b, t^b, 1 - r_i)] \cdot \mathbb{1}[U^a(c^a, t^a, r_i) > 0] \) 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 \( X(t^a, t^b) = \sup \{ i : D_i^{a}(t^a, t^b) = 1 \} \)

The expected voting of politician a conditional on transfers \((t^a, t^b)\) is given by

\[
\nu^a(c^a, t^a, t^b) = d^{-1} \int_0^1 D_i^{a}(t^a, t^b) \cdot \Pr. (U^a(c^a, t^a, r_i) > \epsilon_i) \, dr_i \]
\[
= d^{-1} \int_0^1 D_i^{a}(t^a, t^b) \cdot U^a(c^a, t^a, r_i) \, dr_i
\]

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

\[
W(c^a, t^a, t^b) = \nu^a(c^a, t^a, t^b) - \gamma \cdot \frac{\nu^a}{2} \cdot (c^a)^2
\]

(9)

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

Case 1. Assume that \( t^b = 0 \).

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

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

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

\[
c^a = \frac{\mu^a}{d \gamma}
\]

(10)
Case 2. \( t^a = t^b = 1 \). In that case, note that

\[
\begin{align*}
U^b(c^b, 0, r^b_i) &< U^a(c^a, 0, r^a_i) \iff \\
U^b(c^b, 0, r^b_i) + \alpha &< U^a(c^a, 0, r^a_i) + \alpha \iff \\
U^b(c^b, 1, r^b_i) &< U^a(c^a, 1, r^a_i)
\end{align*}
\]

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 (10).

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

The utility of the voters in the influence zone \( I^a \) cross at \( X(0,1) \), i.e.

\[
U^a_i = U^b_i \iff \mu^a - X(0,1) + c^a = \mu^b + \alpha - 1 + X(0,1)
\]
solving for \( X(0,1) \) yields

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

because we assume the crossing of utilities happens inside the influence zone of 1, \( X(0,1) < \mu^a \). Thus, problem (9) becomes

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

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

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

As for the comparative statics, items (i) and (ii) from Proposition 1 are straightforward given equilibrium communication (10) and (13). Item (iii) is proven by noticing that the equilibrium communication in cases (10) and (13) is sub-modular in \( \mu^p \) (politician’s own popularity) and communication cost \( \gamma \). Because \( c(.) \) is twice differentiable, it suffices to notice that

\[
\frac{\partial^2 c}{\partial \mu^p \partial \gamma} < 0.
\]
Proposition 2

Assume that $\gamma_m = \gamma \forall m$. First, we prove that politician $a$ transfers to $\mu^a_1$, i.e., the municipality where he is most popular. Politician $a$ will transfer to the municipality $m^*$ such that

$$m^* = \arg \max_m \{v^a_m(1) - v^a_m(0)\}$$

where $v^a_m(t) = v^a_m(c^a*, t, 0)$, and $c^a* = \arg \max_c W^a_m(c^a, 1, 0) = \arg \max_c W^a_m(c^a, 0, 0)$. Let also $W^a_m(t, 0) = \max_c W^a_m(c^a, t, 0)$.

Claim. $v^a_m(1) - v^a_m(0)$ is increasing in $m$.

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

$$v^a_m(1) - v^a_m(0) = \int_{x(0)}^{x(1)} (\alpha + \mu^a - r)dr + \alpha x(0)$$

(14)

Taking the derivative with respect to $\mu^a$:

$$d \cdot \nabla_{\mu^a} (v^a_m(1) - v^a_m(0)) = \int_{x(0)}^{x(1)} \left(1dr + \nabla_{\mu^a} X(1)(\alpha + \mu^a - X(1)) - \nabla_{\mu^a} X(0)(\alpha + \mu^a - X(0)) + \alpha \nabla_{\mu^a} X(0)\right)$$

$$= X(1) - X(0) + \nabla_{\mu^a} X(1)(\alpha + \mu^a - X(1)) > 0$$

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 $\mu^b$ yields

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

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 $t^a_m$ when $t^b_m = 0$.

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

$$\nabla_{\gamma_m} (v^a_m(1) - v^a_m(0)) > 0$$

We have

$$d \nabla_{\gamma_m} (v^a_m(1) - v^a_m(0)) = \nabla_{\gamma} X(1)(\alpha + \mu^a - X(1))$$

$$= \frac{1}{2} \nabla_{\gamma} c^b(1, 0) > 0$$
Thus, a decrease in $\gamma_m$ 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 $\gamma_1$ leads $a$ to switch the transfer from municipality 1 to 2. Following that rationale, this will also happen for a discrete change in $\gamma$ if $\mu_1^p = \mu_2^p + \varepsilon$. $\varepsilon \to 0$.

Because the effect of switching the transfer is discrete, if the change in $\gamma_1$ 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 $\mu_m c - \gamma / 2c^2$ 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 $\mu_{a1} \geq \mu_{a2} \geq \mu_{a3} \geq \mu_{a4}$ and $\mu_{b1} \leq \mu_{b2} < \mu_{b3} \leq \mu_{b4}$. 