Gender and Electoral Incentives: Evidence from Crisis Response*

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Abstract

While there is evidence of gender differences in leaders' behavior, less is known about what drives these gaps. This paper uncovers the role of electoral incentives. Using a close election RD design in Brazil, we first show that female mayors handled the COVID-19 crisis differently over the year 2020, which ended with new municipal elections. We find that having a female mayor led to more deaths per capita at the beginning of the pandemic – a period characterized by uncertainty about the severity of the threat – but to fewer deaths per capita later in the year – a period where this uncertainty was reduced. We provide additional evidence that female mayors were less likely to close non-essential businesses early on, and more likely to do so at the end, and that residents in female-led municipalities were more likely to stay at home in the weeks surrounding the election. We then show that these results can be rationalized by a simple political agency model where politicians seek re-election and where voters assess female and male politicians' actions differently. Consistent with this interpretation, we show that the gender differences we find are driven exclusively by mayors who were not term limited and thus allowed to run for re-election, and that the effects are stronger in municipalities with greater gender discrimination. Taken together, the results suggest that female and male leaders face different electoral incentives and adapt their policy decisions to voters' expectations.

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1 Introduction

A large literature documents gender differences in the behavior of elected officials, which are particularly robust in developing countries. This literature has shown that, relative to male leaders, female leaders are more likely to invest in certain public goods, such as education and health (e.g., Chattopadhyay and Duflo 2004; Clots-Figueras 2012), and are less prone to corruption (Brollo and Troiano, 2016). However, less is known about *why* female and male leaders make different choices once elected.

Gender differences in leaders' behavior could come from differences in policy preferences. An alternative explanation is that female and male leaders face different electoral incentives. Indeed, there is substantive evidence showing that voters are gender biased and tend to assess the performance of female leaders differently (e.g., Gagliarducci and Paserman 2012; Bertrand and Duflo 2017; Le Barbanchon and Sauvagnat 2022). In this context, female politicians seeking re-election might have incentives to behave differently. For instance, if female politicians expect more backlash (or less rewards) for a given policy decision, it will be strategically less beneficial for them to adopt it than for male politicians.

This paper provides new evidence on the drivers of gender differences in leaders' behavior by uncovering the role of electoral incentives. To do so, we study the response of local leaders to the COVID-19 crisis in Brazil. We investigate whether female and male mayors handled the crisis differently and to which extent their behaviors were driven by electoral incentives.

This setting offers several advantages. First, studying a crisis context enables us to focus on high-stake policies that are salient to voters and that we can directly link to outcomes. Second, Brazilian municipalities are federal entities, which implies that mayors could independently choose over which containment policies to adopt, in contrast with most countries where these decisions were taken at the national or regional level. Furthermore, Brazil has over 5,000 municipalities, which enables us to use a close election design to assess the causal impact of female leadership. Third, a municipal election was held in November 2020. Hence, from the start of the pandemic, mayors seeking re-election knew they would face their electorate in the near future. Fourth, Brazilian mayors face a two-term limit, meaning that only first-time mayors could run for re-election. This creates variation in electoral incentives across mayors that we exploit to study the underlying mechanisms.

In order to isolate the causal impact of female leadership, we use a Regression Discontinuity Design (RDD) and compare municipalities where a female candidate barely won against a male candidate in the 2016 election – the last one before the COVID-19 outbreak – to those where a male candidate barely won against a female candidate. We can thus compare municipalities that are similar in every aspect, except in the gender of their mayor. To provide support for the identification strategy, we show that municipalities are indeed balanced on a large set of socio-demographic and political characteristics at the threshold. Moreover, we show that barely elected female and male mayors are similar in terms of incumbency status, age, race, education, occupation, and political orientation. We are thus confident that our results capture a gender effect, rather than the impact of other observable characteristics of the mayor.[1] We explore female and male mayors' response to the crisis throughout the year 2020, corresponding to the last year of the their term.

We first measure the impact of female leadership on the number of COVID-19 deaths in the municipality. We find that, even though the gender of the mayor did not impact the time at which municipalities experienced their first COVID-19 fatality, the number of COVID-19 deaths followed a different trajectory over time in female-led compared to male-led municipalities. At the beginning of the first wave (April-May 2020), having a female mayor led to a 0.39 increase in the number of deaths per 10,000 inhabitants, corresponding to a three-fold increase compared to male-led municipalities. This effect disappeared as the country entered the peak of the first wave, with female- and male-led municipalities experiencing a similar number of deaths from June to October 2020. We find a large effect again at the end of the year, but in a markedly different direction. Between November 2020 and January 2021, female-led municipalities experienced one fewer death per 10,000 inhabitants, corresponding to a 41.1 percent decrease relative to male-led municipalities. Overall, these two contrasting effects translate into a negative but non-significant impact on the cumulative number of COVID-19 deaths as of January 31, 2021.

Given that female- and male-led municipalities differ only in the gender of their mayor, we interpret these results as reflecting differential responses to the crisis by female and male mayors. To provide further support for this interpretation, we next explore the impact of having a female mayor on containment policies and residents' isolation behavior.

Using data collected directly from laws and decrees issued by the municipalities, we find that female and male mayors differ primarily in their use of commerce restrictions. Consistent with the evolution in the number of deaths, we show that female mayors were less likely to close non-essential businesses at the beginning of the year, while they became more likely to do so towards the end. Commerce restrictions were in place 2.5 and 6.5 fewer days in female-led municipalities in March and April 2020, as female mayors started closing non-essential businesses 33 days later on average. In contrast, commerce restrictions were in place 7.3 and 7.5 more days in female-led municipalities in September and October 2020, respectively, corresponding to a two-fold increase relative to male-led municipalities.[2]

Additional evidence shows that residents in female-led municipalities were more likely to stay at home around election day. Using daily cellphone data, we find that the share of phone users who stayed at home remained the same in female- and male-led municipalities throughout the period of analysis, except in the last days of the electoral campaign and in the few days following the election results, when it was 10 to 20 percent higher in female-led municipalities. These results likely reflect a higher propensity of male mayors to organize in-person events around election day.[3]

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[1] We also show that our results are robust to controlling for municipality characteristics, mayors' characteristics other than gender, and to including state fixed effects.

[2] Assessing the causal impact of policies on COVID-19 deaths is beyond the scope of this paper, and mayors' actions likely go beyond the policies we are able to observe. We thus refrain from making a causal claim on the relationship between commerce restrictions and COVID-19 deaths. However, we do see these results as evidence that the effects we find on COVID-19 deaths reflects the fact that female and male mayors responded differently to the crisis over time.

[3] The fact that the share of residents staying at home remained the same over almost all the period is

Overall, our results suggest that female and male mayors handled the COVID-19 crisis differently: while female mayors were less likely to implement containment policies at the beginning of the pandemic, male mayors were more likely to relax containment efforts at the end of the year.

The second part of the paper uncovers the role of electoral incentives. We start by illustrating how electoral incentives can give rise to the observed patterns using a simple political agency model where voters are gender biased. In the model, voters care about a public good, and the politician, who cares about re-election, can implement policies that mitigate the incoming shock to the public good, but also generate a direct cost to voters.[4] Voters are gender biased, as they believe that containment policies will be less effective if implemented by a female politician, such that female politicians receive less credit for their actions. We analyze politicians' optimal policy choice under two scenarios corresponding to our two main periods of analysis. First, when voters believe that the shock will materialize with a low probability – as it was arguably the case during the first weeks of the pandemic in Brazil – they are less willing to accept containment policies and it is costly for politicians to close the economy. In this scenario, female politicians implement a lower level of policy than their male counterparts, as voters expect policies to be even more cost-ineffective when implemented by female politicians. Conversely, when voters believe that there is a significant threat to the public good – such as later in the year once the health consequences became more apparent – they are more willing to accept the disutility associated with the policy in order to preserve the public good. As voters believe that male politicians can achieve the same results with a lower level of policy than female politicians, male mayors are the ones implementing a lower policy level in this scenario.

We then investigate the role of electoral incentives empirically. Exploiting the two-term limit rule, we compare mayors who were elected for the first time in 2016 and thus allowed to run again in 2020, to incumbent mayors who could not run again. Consistent with electoral incentives explaining gender differences in leaders' behavior, we find that our effects are only driven by mayors who could run for re-election. Specifically, having a female mayor leads to more deaths at the beginning of the year only when she has electoral incentives, while having a male mayor leads to more deaths at the end of the year only when he has electoral incentives. Departing from the RD framework and using an OLS estimation, we also show that our results are stronger in more competitive elections, where mayors won with a small victory margin.

Lastly, we explore whether the data supports the fact that female and male mayors face different electoral incentives because voters assess their actions differently. Consistent with this interpretation, we find that our results are stronger in municipalities where we

consistent with female- and male-led municipalities differing primarily in their use of commerce restrictions. Closing non-essential businesses do not restrict mobility per se, as opposed curfews or lockdowns for instance. They nonetheless promote social distancing by preventing people from entering closed spaces.

[4] In our context, the public good captures health, and the policies represent any actions the politicians can take to contain the pandemic and reduce the number of COVID-19 deaths. However, the framework is general enough so that it can apply to other crisis contexts featuring policy solutions that can be unpopular and politically costly, such as fiscal policies aimed at curbing inflation, or environmental policies aimed at limiting global warming.

expect higher gender discrimination and thus voters' bias, as proxied by the gender wage gap in the local labor market. We also show that alternative interpretations of the results, such as gender differences in policy preferences or risk-aversion, are unlikely to account for the patterns we observe. Taken together, these results support the interpretation that gender-specific voters' expectations shaped female and male mayors' response to the crisis.

Our results have important implications for the way we interpret gender differences in leaders' behavior. They might not necessarily stem from differences in preferences but can be driven by electoral incentives. This makes gender differences in leaders' behavior particularly likely to materialize in competitive elections, in contexts with greater gender discrimination, and for policies salient to voters.

Contribution to the literature

Our paper contributes to three main strands of the literature, which study how the behavior of political leaders vary by gender, the prevalence of gender discrimination in politics, and how electoral incentives shape leaders' behavior. We add novel insights to each of these bodies of work and connect them by showing how the interaction of voters' bias and electoral incentives help explain gender differences in policy-making.

Along with the literature showing that leaders matter for economic outcomes (Jones and Olken, 2005; Besley et al., 2011; Yao and Zhang, 2015; Ottinger and Voigtlander, 2022), a large literature has emerged studying gender differences in the behavior of political leaders.[5] Studies in developing countries consistently find divergent policy choices by politician gender. In India and Brazil, researchers have shown that female politicians tend to invest more in infrastructure relevant to women's needs (Chattopadhyay and Duflo, 2004), spend more in education and health (Clots-Figueras, 2011, 2012; Bhalotra and Clots-Figueras, 2014; Funk and Philips, 2019), and be less likely to engage in corruption (Brollo and Troiano, 2016). The results are less conclusive in high-income countries. While female legislators are more likely to support bills related to family and children issues (Besley and Case, 2003; Lippmann, 2022), there is mixed evidence of gender differences in legislative efficiency (Anzia and Berry 2011; Volden et al. 2013; Battaglini et al. 2020), and several papers find no gender differences in public policies at the municipal level in the US, Spain or Italy (Ferreira and Gyourko, 2014; Bagues and Campa, 2021; Casarico et al., 2022).[6]

Only a few recent papers uncover causal effects of female leadership in crisis contexts. Dube and Harish (2020) find that European queens were historically more likely to be at war than kings, as unmarried queens were perceived as easier to attack, while married queens were better equipped to attack, splitting the work with their spouse. Using data from the Colombian armed internal conflict, Eslava (2021) shows that having a female mayor reduced the number of guerilla attacks, likely due to their better negotiation skills. In the context of the COVID-19 crisis, Bruce et al. (2022) find that female-led municipalities in

[5]See Hessami and da Fonseca 2020 for a review.

[6]Recent evidence from Italy suggests that those null effects can mask more subtle differences: Profeta and Woodhouse (2022) find that, while having a female mayor does not impact overall spending, it affects the timing of public expenditures, stressing the importance of investigating gender differences over time.

Brazil experienced a lower total number of deaths in 2020, consistent with the net negative cumulative effect we report.

Our study contributes to the literature on gender differences in leaders' behavior in two main ways. First, we provide causal evidence of gender differences in crisis response over time. We show that these differences can vary and even reverse as the crisis unfold. Second, and most importantly, we provide evidence on a new mechanism explaining why female leaders make different policy decisions. We show that our results can be explained by female and male leaders adapting their behavior in response to voters' gender biases. In doing so, we bridge the gap between the literature on female leadership discussed above and the literature on gender discrimination in politics.

A large body of work finds evidence of voters' bias against female candidates (e.g., Fréchette et al. 2008; De Paola et al. 2010; Eymeoud and Vertier 2020; Le Barbanchon and Sauvagnat 2022).[7] Voters also appear to be gender biased when they evaluate the actions of female leaders once in power. The "role incongruity" theory in the psychology literature posits that these biases arise because traits associated with leadership, such as strength and assertiveness, are perceived as inconsistent with the characteristics that society associates with women, making voters unlikely to perceive them as strong leaders (Eagly and Karau, 2002; Duflo, 2012; Bertrand and Duflo, 2017). Consistent with this theory, lab and on-the-field experiments show that female politicians are evaluated less favorably than male politicians, particularly on issues related to national security and military crises, but less so when they emphasize "feminine" issues, such as child care and education (Herrnson et al., 2003; Lawless, 2004; Beaman et al., 2009; Eggers et al., 2018). Using quasi-experimental evidence from Italy, Gagliarducci and Paserman (2012) show that female mayors are more likely to experience an early termination of their mandate in regions where people display less favorable attitudes towards working women. Similar gender biases in performance evaluation have been found in multiple contexts outside politics, including manufacturing and financial firms (Macchiavello et al., 2020; Egan et al., 2022), healthcare (Sarsons, 2017), and academia (Mengel et al., 2018; Ross et al., 2022).

If people are biased against women in leadership positions and tend to assess their actions differently, female and male leaders are likely to face different electoral incentives. Our results show that this mechanism can rationalize why female mayors responded differently to the crisis, building on the literature studying the impact of electoral incentives on leaders' behavior.

Political agency models (Barro, 1973; Ferejohn, 1986) posit that elections work as a disciplining device, creating incentives for leaders to align their decisions with voters' preferences. Researchers have found extensive empirical support for this theory by showing that politicians seeking re-election exert more efforts than term-limited ones (Besley and Case, 1995; List and Sturm, 2006; Sieg and Yoon, 2017; Aruoba et al., 2019; Fouirnaies

[7] An exception in the quasi-experimental literature is Broockman and Soltas (2020), who find evidence of discrimination based on race but not gender in the election of delegates in US Republican presidential primaries. Recent studies have also highlighted gender discrimination from political parties as a key driver of the low female representation in politics (Casas-Arce and Saiz, 2015; Fujiwara et al., 2021; Gonzalez-Eiras and Sanz, 2021).

and Hall, 2022).[8] In Brazil, Ferraz and Finan (2011) and de Janvry et al. (2012) find that having a non-term-limited mayor decreases resource misappropriation and increases the performance of a large conditional cash transfer program, respectively.

The effects of electoral incentives on the behavior of politicians are more pronounced in certain circumstances, in particular when voters are better aware of leaders' policy decisions and performance (Snyder and Strömberg, 2010; Ashworth, 2012). Crises tend to create such higher accountability environments. Indeed, there is ample evidence that leaders' responses in a crisis context matter for electoral outcomes, such as during the Ebola pandemic (e.g., Campante et al. 2021; Maffioli 2021), after natural disasters (e.g., Healy and Malhotra 2009; Bechtel and Hainmueller 2011), terrorist attacks (e.g., Getmansky and Zeitzoff 2014), or more recently, during the COVID-19 pandemic (e.g., Baccini et al. 2021; Giommoni and Loumeau 2022). Electoral incentives are also stronger close to elections. In the last year of their term, politicians have an incentive to implement short-term electorally-rewarding policies that might ignore long-term consequences, such as monetary expansions or tax reductions (see Alesina 1988; Drazen 2001; Alesina and Paradisi 2017; Aidt et al. 2020; and in Brazil Klein and Sakurai 2015; Orair et al. 2015), or less stringent containment policies at the beginning of the COVID-19 pandemic (Pulejo and Querubín, 2021).

Our study contributes to this literature by showing, in a setting where electoral incentives are likely to be strong – the response to a crisis during an election year – that while electoral incentives affect the behavior of both female and male leaders, female leaders adopt different electoral strategies when voters are likely to assess their actions differently.

The remainder of the paper is organized as follows. Section 2 presents our setting and the data, and Section 3 describes our sample and empirical strategy. We present the results showing that female mayors handled the COVID-19 crisis differently in Section 4, and uncover the role of electoral incentives in Section 5. Section 6 concludes.

2 Setting and data

2.1 Brazilian local governments and elections

Brazil is divided into 5,570 municipalities, the lowest subnational government tier in the country.[9] Municipal governments are in charge of providing public services of local interest, including water and sanitation, transportation, basic education, and – importantly for this paper – public health. Municipalities' expenditures represented 18.9 percent of total public spending in 2019. Their revenues come mainly from constitutionally-mandated inter-government transfers (56.7 percent of total municipal revenues in 2019), followed by local taxes and user fees (IBGE, 2020).

[8] In the Argentinian context where there is no term limit, Dal Bó and Rossi (2011) show that longer terms increase politicians' effort, as the positive effects of their actions are more likely to materialize before the next election.

[9] The first tier consists of 27 "federative units", made of 26 states and the Federal District. The Federal District does not contain any municipality; it is divided into administrative regions, including the capital Brasília, and is thus excluded from the analysis.

The constitution recognizes municipalities as "federal entities", which gives them the status of autonomous governments, with the ability to independently decide over local policies. At the onset of the COVID-19 pandemic, the national congress reaffirmed municipalities' power to implement containment policies (Law Nº 13.979). The Brazilian Supreme Court further ruled that the federal government could not overrule the policies implemented by local governments (decision ADPF 672).

Municipal governments have an executive branch (*prefeitura*) and a legislative branch (*câmara municipal*). The executive branch is presided by mayors who are elected by popular vote every 4 years. Voter registration and voting is mandatory for adults between the ages of 18 and 70. The electoral rule depends on the municipal population. Municipalities with fewer than 200,000 inhabitants elect their mayors through plurality rule – where the candidate with the most votes wins the election – while municipalities with 200,000 inhabitants or more use a two-round system. Mayors are subject to a strict two-term limit established by the 1988 constitution, meaning that an incumbent mayor cannot run for re-election. Local legislators are elected at the same time as mayors using an open-list proportional system. The legislature analyzes and revises the budget proposed by the mayor, who then decides how much to spend on the different items. The legislators can also propose bills, which can be contested by the mayor who ultimately retains the most influence over the implementation of laws and decrees.

Our empirical strategy relies on the results of the 2016 municipal election, the last election before the COVID-19 outbreak. The term of the mayors elected in 2016 ran from January 1, 2017 through December 31, 2020. The first round of the next local election took place on November 15, 2020,[10] and the new mayors took office on January 1, 2021. Our period of analysis focuses on the last year of the mayor's term, from February 2020 (first registered COVID-19 case in the country) through the end of January 2021.[11]

Female participation in the last two municipal elections was higher than in prior ones, but it remained small. The share of female mayoral candidates in the 2016 (2020) elections was 12.9 (13.5) percent , and only 11.5 (12.1) percent of the elected mayors were female. This represents a small improvement relative to 2000, when women represented 7.6 percent of mayoral candidates and 5.7 percent of elected mayors (TSE, 2021). This political participation gap is also observed in congressional elections: in 2020, the share of congresswomen in Brazil's parliament was 14.6 percent, less than half of the Latin American (32.8 percent) and OECD averages (31.5 percent) (The World Bank, 2021).[12]

[10]The 2020 municipal election was originally scheduled on October 4 and postponed to November 15 due to the COVID-19 health emergency. While basic safety protocols were put in place at the voting booth, the election took place in person as the previous ones. The electoral campaign lasted for 50 days – the usual length in Brazilian municipal elections – and ran up to the day before the election.

[11]We include the first month of the new municipal administration as COVID-19 deaths tend to materialize a few weeks after infection, implying that people who died from the disease in January likely became infected while the prior mayor was still in office.

[12]The gender gap in leadership positions in Brazil is not restricted to the political world. Among the 343 publicly listed companies in Brazil, only 14.2 percent of all board members are female (Teva Índices, 2021). Considering only the CEOs, the share of females is of 8 percent. This is similar to the 2020 Forture-500 share of female CEOs, which was 7.4 percent (Hinchliffe, 2021).

2.2 The COVID-19 pandemic in Brazil

The authorities announced the first confirmed COVID-19 case in Brazil on February 26, 2020, and the first confirmed death three weeks later, on March 17. The disease expanded exponentially across the country, and so did the death toll. The country registered 201 COVID-19 deaths by the end of March, reached 6,006 deaths by the end of April, and 29,367 by the end of May (Roser et al., 2020).

Our period of analysis includes the first wave of infections (February 2020 - October 2020), and the beginning of the second wave (November 2020 - January 2021). The first wave in Brazil was one of the deadliest worldwide (Appendix Figure A1). On June 10, Brazil's cumulative number of deaths overcame the number of deaths reported by the U.K., and the nation became the second country in the world with the most deaths attributed to COVID-19, behind the U.S. The second wave started in November and proved to be even deadlier than the first. By the end of the period of analysis, the daily number of deaths had reached similar levels as in the peak of the first wave, and the country had accumulated over 224,000 deaths in total.

The federal government responded by implementing social assistance programs and border restrictions, while largely refraining from imposing mobility and gathering restrictions within the country. Meanwhile, multiple states and municipal governments declared state of emergency and implemented containment policies such as school and commerce restrictions, along with public gathering restrictions. Only a small number of local governments decided to go further and implemented curfews and lockdowns. Section 4.2 and Appendix B3 provide more details about the implementation of containment policies across municipalities and over time.

The perception of the public about the severity of the threat and the need for containment policies evolved over the year 2020. According to surveys conducted by Ipsos, in March 2020, 56 percent of Brazilian respondents did not believe that social isolation would work, and, at the beginning of April, 85 percent expected things to return to normal by June. Instead, as the number of deaths started to increase, by the start of May, 68 percent of respondents did not want to return to the workplace, and by the end of May, 7 out of 10 Brazilians did not agree with reopening non-essential businesses (Ipsos, 2020).

2.3 Data

This section describes the main datasets used in the analysis. Appendix Table B1 provides the definition and source of each variable used in the paper.

COVID-19 deaths. Our main outcome, the number of COVID-19 deaths, comes from Brasil.io. This open data platform collects, cleans, and assembles the COVID-19 information provided by the state health secretaries, and makes it publicly available as a daily municipal-level panel (Justen, 2021). We focus on confirmed deaths rather than cases. Deaths are considered a more reliable measure of the spread of COVID-19 as well as of the spread of other diseases (Maugeri et al., 2020; O'Driscoll et al., 2021), as they are less likely to go unrecorded. We observe the daily number of COVID-19 deaths from the first registered death on March 17, 2020, until January 31, 2021. We performed quality checks to identify potential data errors and outliers and we only found unusual spikes in a few municipalities located in the state of Mato Grosso. We exclude municipalities part of this state – representing 3.3 percent of the sample – in one of our robustness check (Appendix D), as well as when presenting the raw data on the number of deaths in Section 3.1.

In addition, we validate our main results using data from the Brazilian System of Information and Epidemiological Surveillance of Respiratory Infections (SIVEP-Gripe). The Ministry of Health maintains a patient-level registry of deaths from Severe Acute Respiratory Infection (SARI), a broader category that includes deaths coming from COVID-19 as well as deaths coming from other diseases with similar symptoms. The registry contains data from both public and private hospitals. By looking at overall SARI deaths, we can test the robustness of our results to using a death measure that does not rely on COVID-19 testing and is less vulnerable to diagnostic missclassification. As shown in Appendix Figure B1 and Appendix D, both data sources are highly consistent during the period of analysis.[13]

Containment policies. We built a novel policy dataset based on publicly available municipal legislation documents, following the procedure of Chauvin et al. (2021). We accessed multiple online sources, including municipal websites and municipal official gazettes, and collected local laws, decrees, and other mandates issued by municipalities in response to the COVID-19 crisis. We then extracted the text of the legal documents, parsed their individual articles, and used them to construct a daily panel of indicator variables that denote whether a given policy was in place in the municipality on a given day. Finally, we validated the quality of the data against a testing dataset, built manually for a randomly chosen subset of municipalities. We consider 10 containment policies, which we defined according to the international policy data featured in the Oxford COVID-19 Government Response Tracker (Wade et al., 2022): commerce restrictions (closing non-essential businesses), gathering, transport, travel, and workplace restrictions, events cancellations, school closures, curfews, lockdowns and face mask mandates. We were able to collect those data for 48.3 percent of our sample over the period from March 1 to October 31, 2020. Four of these policies (gathering restrictions, school closures, events cancellations, and face masks mandates) were implemented by the vast majority of municipalities and sustained for most of the period of study (Appendix Tables B2 and B3), providing little variation to identify the effects of interest. We thus focus on the remaining six policies in our analysis.

Isolation index. To study residents' isolation behavior, we use the "Social Isolation Index" produced by the private firm InLoco (2021). This index is built using anonymized data from over 60 million cellphones and it indicates the share of active phone users who stayed within 450 meters of their residence in a given municipality on a given day. During

[13] As discussed in more detail in Chauvin (2021), the study of COVID-19 at the municipal level makes it challenging to compute the number of deaths using alternative measures. Estimating excess deaths relative to prior years for a given month, for instance, requires historical mortality data with enough variation in each month to accurately predict the number of deaths that would be expected without the pandemic. This is only feasible for a small number of highly populated municipalities. Likewise, data from seroprevalence surveys to infer infection rates from the presence of antibodies are only available for a restricted subset of municipalities.

the pandemic, the company made a daily municipal-level panel available to researchers. To protect users' privacy, the data are not available on days where the number of active users in the municipality was below a given threshold. Furthermore, the number of municipalities included in the sample gradually decreased over the second half of 2020, reflecting a change in the company's business priorities. For consistency, we focus on a balanced panel of municipalities for which we have data for every day over our period of analysis, from February 26, 2020 to January 31, 2021, corresponding to 29 percent of our sample.

Electoral data. Municipal electoral data come from the Brazilian elections authority (*Tribunal Superior Eleitoral*, TSE). We performed several data-quality checks using alternative sources such as press articles and municipal official gazettes. For each candidate in each municipality, we know her gender, incumbency status, age, race, education level, occupation, party affiliation, and the number of votes they received. We further attribute to each candidate an ideology score capturing the ideological inclination of their political party following Power and Rodrigues-Silveira (2019).

Municipalities' characteristics. We use a large set of municipal socio-demographic characteristics to test the validity of our identification strategy and the robustness of our results to the inclusion of controls. Most of these baseline variables are constructed directly from the microdata of the 2010 demographic census (the last one before the 2016 elections). One exception is our measure of density -– the total population living within 1 km of the average inhabitant of the city – which we compute using 2015 data from the Global Human Settlement Layer (Schiavina et al., 2019) following De la Roca and Puga (2017)'s method. We made sure to include variables that have been shown to predict the geographic variation in COVID-19 deaths, such as population, density, the share of residents above 65 years old, proximity to internationally-connected airports, the number of nursing home residents, or household income (Chauvin, 2021).[14]

3 Empirical strategy

3.1 Sample and descriptive statistics

To estimate the causal impact of female leadership, we use a Regression Discontinuity Design (RDD) and compare municipalities where a female candidate barely won against a male candidate, to municipalities where a male candidate barely won against a female candidate. We thus restrict our sample to Brazilian municipalities where the top two contenders in the 2016 election were one female and one male candidates, accounting for 22.4 percent of all Brazilian municipalities.[15]

[14]The 2010 municipal population is also used to normalize the number of deaths, so that our main outcome is the number of COVID-19 deaths per 10,000 inhabitants. Between 2010 and our period of analysis, five new municipalities were created from seven parent municipalities. Out of these twelve redistricted municipalities, only one qualified to be part of our sample. We removed it to ensure time-consistent geographies throughout our analysis.

[15]In some municipalities, the original election was cancelled and a supplementary election took place later on. In these cases, we ignore the results of the ordinary election and consider the top two candidates in the

We further exclude municipalities for which their COVID-19 outcomes cannot be directly linked to their local government's actions. More precisely, we exclude the 18.6 percent municipalities that are part of a commuting zone (*arranjos populacionais*), as defined by the Brazilian institute of Geography and Statistics (IBGE, 2016). A commuting zone is made of a group of municipalities which are linked through commuting flows and that often coordinate on urban services such as transport. Hence, the number of COVID-19 deaths in a municipality part of a commuting zone is tightly linked to the spread of the virus inside the commuting zone and to the policy choices of its neighbors.

Our final sample consists of 981 municipalities. As shown in Figure 1, they are evenly spread out across all Brazilian states, and there is no clear geographical patterns between municipalities where a female candidate was elected (in blue) and municipalities where a male candidate was elected (in red).

Table 1 presents some descriptive statistics on our sample.[16] The first panel includes socio-demographic characteristics from the 2010 census. The second panel includes political characteristics based on the first round of the 2016 municipal election for turnout and the number of candidates,[17] and based on the first round of the 2018 presidential election for the vote share of the elected president at the municipal level. Municipalities in our sample had 13,928 inhabitants on average in 2010, the average monthly median household income per capita was 319 reais (56.2 US dollars at the contemporary exchange rate), and 2.6 candidates ran in the 2016 elections on average. While municipalities in our sample are on average smaller and less dense than the average Brazilian municipality, still 60 percent of the residents in our sample live in urban areas. Moreover, the average municipality in our sample is very similar in all the other socio-demographic and political characteristics to the average Brazilian municipality (Appendix Table A2).

Our sample is also representative of the evolution of COVID-19 in Brazil. Appendix Figure B2 plots the number of COVID-19 deaths over time separately for our sample of analysis and for all Brazilian municipalities and shows that the two samples experienced a similar number of deaths per capita throughout the period of analysis. The same is true when looking at the share of phone users staying at home over time (Appendix Figure B4). Finally, Appendix Table B2 presents the share of municipalities that implemented a given containment policy at least once during the period of analysis, separately for our sample and for a representative 10 percent random sample of municipalities obtained from Chauvin et al. (2021). As in the random sample of municipalities (first two columns), around 90 to 95 percent of municipalities in our sample implemented school closures,

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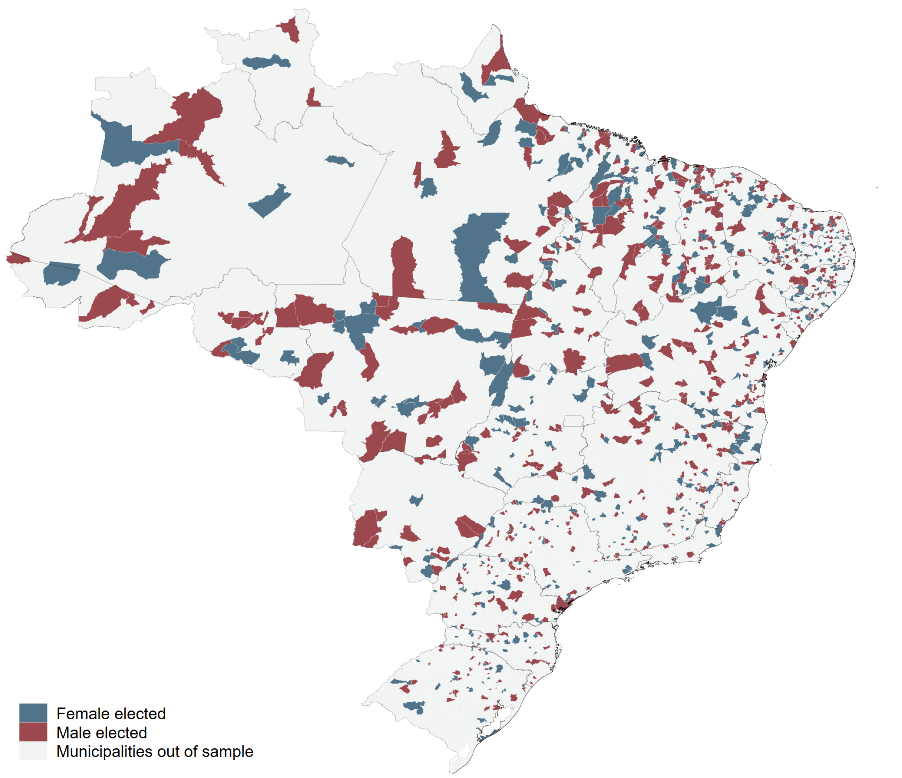
supplementary one. This concerns 25 municipalities in our sample and our results are robust to excluding them (see Appendix D). We further identified 39 municipalities where no supplementary election took place but where the votes of one of the original top two candidates were invalidated by the electoral justice due to irregularities, such as having registered their candidacy after the official deadline. We remove those elections, as the candidates that were eventually assigned the first and second place were not the ones who received the most votes. Finally, we exclude one municipality whose supplementary election took place in March 2020, implying that two different mayors served during the COVID-19 crisis.

[16] Appendix Table A1 presents the same statistics separately for municipalities where a female candidate was elected and municipalities where a male candidate was elected.

[17] All municipalities in our sample are below 200,000 inhabitants and thus had single-round elections.

gathering restrictions, events cancellation and made face masks mandatory. In the analysis, we will focus on the remaining six policies for which we have enough variation across municipalities: commerce restrictions, curfew, lockdown, transport restrictions, travel restrictions, and workplace restrictions.

Figure 1: Municipalities in the analysis sample by gender of the election winner



Notes: This figure plots the geographical distribution of municipalities part of our sample of analysis. Municipalities in blue correspond to municipalities where a female candidate was elected in 2016 whereas municipalities in red correspond to municipalities where a male candidate was elected.

Table 1: Descriptive statistics

	Mean	Sd	Min	Max	N
Panel A	*Socio-demographic characteristics*				
Population	**13,928**	12,724	1,037	91,311	981
Density	**119.5**	186.3	0.0	3,467.9	981
Average persons per room	**0.704**	0.243	0.435	4.282	981
Commuting time	**21.57**	4.57	9.03	44.59	981
Share of population $\geq$65 years old	**0.083**	0.023	0.022	0.179	981
Nursing home residents per 10k pop	**3.742**	11.488	0.000	209.939	981
Area	**1,765**	5477	27	84,568	981
Distance to São Paulo	**1,448**	739	49	3,441	981
Km to closest airport connecting to hot spots	**301.3**	214.6	23.1	1,556.9	981
Median household income p/c	**319.3**	143.9	80.0	836.5	981
Informality rate	**0.169**	0.055	0.036	0.418	981
Unemployment rate	**0.044**	0.021	0.000	0.173	981
College graduate employment share	**0.067**	0.030	0.005	0.192	981
Black and mixed population share	**0.591**	0.214	0.019	0.933	981
Panel B	*Political characteristics*				
Turnout	**0.855**	0.059	0.673	0.980	981
Number of candidates	**2.642**	0.920	2.000	9.000	981
Elected president's vote share	**0.318**	0.186	0.025	0.808	981

Notes: The sample includes only municipalities outside of any "arranjos populacionais", where one man and one woman were the two front runners in the 2016 election. Socio-demographic variables come from the 2010 census, except for the density that is defined as the total population living within 10 km of the average inhabitant of the municipality and which is computed using the 2015 data from the Global Human Settlement Layer. The political variables are computed using the results of the first round of the 2016 municipal election, except for the last, which uses data from the first round of the 2018 presidential election.

3.2 Specification

We define the running variable X as the victory margin of the female candidate (the difference between her vote share and the vote share of the male candidate), and the treatment variable T as an indicator equal to 1 if the winner is a woman ($X \geqslant 0$) and 0 if the winner is a man ($X < 0$). We assess the impact of having a female mayor using the following specification:

$$Y_i = \alpha_i + \tau T_i + \beta_1 X_i + \beta_2 X_i T_i + \mu_i \tag{1}$$

where i indexes municipalities.

In the robustness tests, we augment this specification in two main ways. First, we add controls for municipality socio-demographic characteristics and for winners' characteristics (other than gender). Second, we include state fixed effects to make sure that our results are not affected by state-level politics. All robustness tests are reported in Appendix D.

We use a nonparametric estimation method, which amounts to fitting two linear regressions on each side of the threshold (Imbens and Lemieux, 2008; Calonico et al., 2014). We follow Calonico et al. (2014)'s estimation procedure that provides robust confidence intervals, and we use the data-driven MSERD bandwidths developed by Calonico et al. (2019). We also show the robustness of the main results to using a second order polynomial and a wide range of different bandwidths. Finally, we follow Calonico et al. (2017) when presenting the RD results graphically: we focus on observations in the estimation bandwidths and we use a linear fit and a triangular kernel, so that the polynomial fit represents the RD point estimator.

As shown in Appendix Table A3, municipalities close to the threshold are very similar to the average municipality in the full sample, in terms of both socio-demographic and political characteristics.[18]

3.3 Validity of the design

3.3.1 Density and balance tests

The identification assumption is that all municipalities' characteristics change continuously at the discontinuity, so that the only discrete shift is the change in the mayor's gender. This assumption can be violated if candidates are able to sort themselves across the threshold, which would require them to be able to predict and manipulate their vote share with extreme precision.

We perform several tests to bring support for the identification strategy. First, we test for a jump in the density of the running variable using both McCrary (2008)'s and Cattaneo et al. (2018)'s method. As shown in Appendix Figures A2 and A3, the victory margin of the female candidate is smooth at the discontinuity.

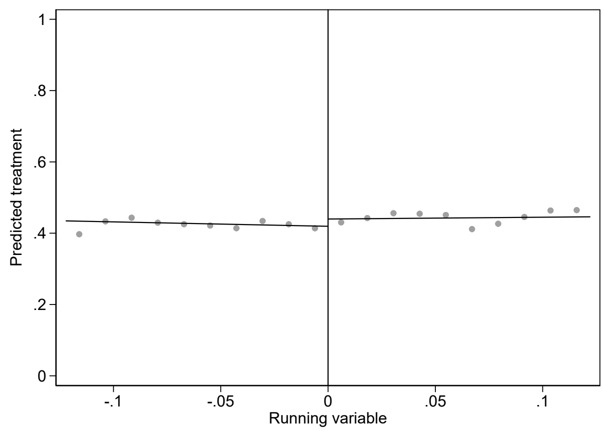
Second, we test for the balance of municipalities' characteristics at the threshold using a general balance test, following Anagol and Fujiwara (2016). We regress the treatment variable on all 17 baseline variables presented in Table 1, predict the treatment status of each municipality using the regression coefficients, and test for a jump in the predicted value at the discontinuity. As shown in Figure 2 and Appendix Table A4, there is no significant jump at the threshold and the point estimate is small and not significant.

We also test for a jump in each of the baseline characteristics taken individually (see Appendix C). Only one variable out of 17 is significant at the 10 percent level. Consistent with Figure 1, municipalities close to the threshold are balanced based on their distance to São Paulo or to the nearest airport, confirming the absence of geographic sorting. They are also balanced on key variables shown to predict the spread of COVID-19, such as density or the share of residents above 65 years old. Turning to political variables, female- and male-led municipalities at the threshold had the same average number of candidates and turnout rate in 2016, and their residents were equally likely to vote for the elected president in the last presidential election before COVID-19.

[18] For the descriptive statistics, we define municipalities close to the threshold as municipalities where the victory margin is smaller than 4 percentage points. Instead, the estimation bandwidths used in the analysis vary with the outcomes, as they are data-driven.

Taken together, these results suggest that there is no sorting at the discontinuity. Furthermore, we show that the main results are robust in magnitude and statistical significance to controlling for the whole set of covariates as well as to the inclusion of state fixed effects (Appendix D).

Figure 2: General balance test



Notes: This figure is constructed by restricting the support to observations in the estimation bandwidths and by setting the fit to match the local polynomial point estimator (polynomial order 1 and triangular kernel). Dots represent the local averages of the treatment variable (indicator equal to one if the female candidate won in 2016) predicted by a set of 17 municipal characteristics. Averages are calculated within evenly-spaced bins of the running variable. The running variable is the margin of victory of the female candidate in the 2016 election (percentage point difference between the vote share of the female and the male candidates). Positive values denote that the female candidate won the election, and negative values that the male candidate prevailed.

3.3.2 Gender vs. other characteristics of the winner

The use of an RDD ensures that the gender of the mayor is as good as randomly assigned across municipalities at the threshold. However, it does not ensure that our results can be interpreted as a gender effect if gender is correlated with other characteristics of the winner. For instance, if female candidates are systematically more likely to be from a left-wing party, our results might be capturing the impact of political ideology instead of gender.

We explore the role of the following characteristics of the winner: incumbency status, age, race, education, occupation, and political orientation. We measure political orientation using an ideological score that summarizes the position of the candidate's political party on a left-right axis, following Power and Rodrigues-Silveira (2019). We also consider indicator variables for the two parties that gathered the most votes during the 2016 elections (PMDB and PSDB, the main center and center-right party respectively), as well as for the historical left-wing party (PT).

Looking first at the characteristics of all 2016 candidates, we see that female candidates are very similar to the average male candidate, in terms of age, race, incumbency status, and political orientations (Appendix Table A5). However, they are more likely to have completed higher education compared to male candidates (72.4 vs. 49.3 percent, on average), which is consistent with positive selection of female candidates and with the presence of gender discrimination in politics (e.g., Baltrunaite et al. 2014; Besley et al. 2017).

Ultimately, we are interested in whether female candidates barely winning against male candidates are similar to male candidates barely winning against female candidates. To formally assess whether our effects could be driven by observable characteristics other than gender, we take as outcomes the characteristics of the winner and test for a jump at the threshold. As shown in Table 2 and Appendix Figure C2, no coefficient is significant.

In particular, female mayors at the threshold are not more likely to be the incumbent, to work in the health sector or to be a business owner, and they have a similar ideological position as male mayors. While most point estimates are small in magnitude, the point estimate on education suggests that closely-elected female mayors might be more likely to have completed higher education, even though the effect is not significant (p-value of 0.30). We further show that controlling for all winners' characteristics described above leaves the results unchanged (Appendix D). All in all, we are confident that our results can be interpreted as a gender effect, rather than coming from political experience, age, race, education, occupation, or ideology.

Table 2: Balance test: characteristics of the winner of the election

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Outcome	Incumbent	Age	White	Higher	Occupation				Ideology	PMDB	PSDB	PT
				Education	Politics	Public	Health	Business	Score			
Treatment	-0.040	-0.814	0.132	0.155	-0.021	0.029	-0.049	0.025	0.081	0.021	0.031	0.019
	(0.077)	(1.929)	(0.075)	(0.100)	(0.075)	(0.060)	(0.048)	(0.053)	(0.056)	(0.062)	(0.048)	(0.034)
R. p-value	0.591	0.822	0.123	0.299	0.736	0.734	0.461	0.644	0.246	0.889	0.481	0.563
Observations	604	573	592	482	565	527	630	617	728	565	593	516
Polyn. order	1	1	1	1	1	1	1	1	1	1	1	1
Bandwidth	0.141	0.131	0.138	0.107	0.130	0.122	0.147	0.144	0.191	0.130	0.138	0.119
Mean	0.260	48.972	0.644	0.445	0.212	0.112	0.121	0.102	0.206	0.154	0.053	0.022

Notes: In column 1 (resp. 3, 4, 5, 6, 7, 8, 10, 11, 12), the outcome is an indicator variable equal to 1 if the winner of the 2016 election is the incumbent (resp. self-declares as white, has completed higher education, works in politics, the public sector, in the health sector, or is a business owner, runs under the PMDB, PSDB or PT party label). In column 2, the outcome is the age of the 2016 winner at the time of the first round. In column 9, the outcome is an ideological score based on the party of the candidate and ranging from -1 (most to the left) to 1 (most to the right). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

4 Main results

4.1 Impact of having a female mayor on COVID-19 deaths

We start by looking at the impact of having a female mayor on the timing of the first reported COVID-19 death. We take as outcome the number of days between the last day of 2019 – when the first case of COVID-19 was reported worldwide – and the first death attributed to the disease in the municipality. As shown in Appendix Table A6 and Figure A4, the coefficient is close to zero and non-significant.

Given that having a female mayor did not affect the timing at which municipalities started to experience fatalities, we can use the same time frame to study the evolution of COVID-19 deaths in female- and male-led municipalities. We look at the impact on the total number of deaths in the four main periods characterizing the evolution of COVID-19 in Brazil (see Appendix Figure B2): beginning of the first wave (April-May 2020), peak of the first wave (June-August 2020), end of the first wave (September-October 2020), and beginning of the second wave (November 2020-January 2021).[19] We normalize the number of deaths by the 2010 population and multiply by 10,000 so that the outcome measures the total number of deaths in the municipality per 10,000 inhabitants.

Table 3: Impact on COVID-19 deaths by periods

	(1)	(2)	(3)	(4)
Outcome	# COVID-19 deaths per 10,000 inhabitants			
	Period 1	Period 2	Period 3	Period 4
Treatment	0.391**	-0.057	-0.192	-0.999**
	(0.176)	(0.511)	(0.281)	(0.405)
Robust p-value	0.035	0.846	0.466	0.016
Observations	578	498	677	513
Polyn. order	1	1	1	1
Bandwidth	0.133	0.113	0.163	0.118
Mean, left of threshold	0.203	2.580	1.380	2.432

Notes: Each column takes as outcome the total number of deaths per 10,000 inhabitants (using the 2010 population) during the period of interest. Period 1 (resp. 2, 3, and 4) corresponds to April-May 2020 (resp. June-August 2020, September-October 2020, and November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

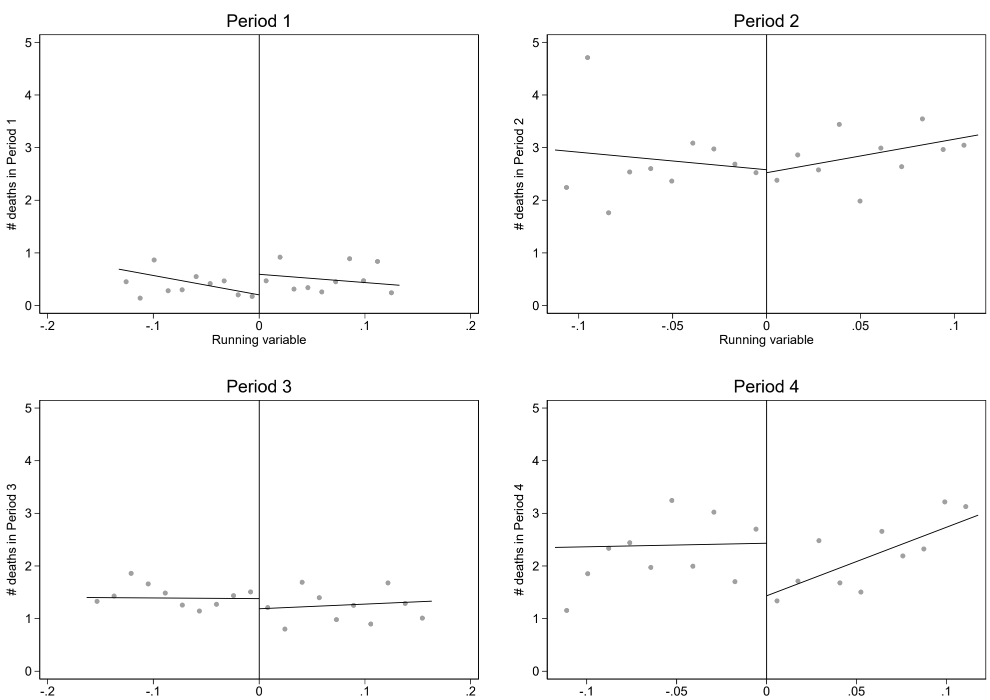
Table 3 shows that, on average, having a female mayor led to a 0.39 increase in the number of deaths per 10,000 inhabitants in the first period, a coefficient significant at the

[19] We start in April as no death occurred in municipalities part of our sample in March (a total of only 201 COVID-19 deaths occurred across the country during this month).

5 percent level. This represents a three-fold increase compared to the average number of deaths in male-led municipalities at the threshold. Conversely, we find that female-led municipalities experienced one fewer deaths per 10,000 inhabitants in the last period, on average. This effect is significant at the 5 percent level and corresponds to a 41.1 percent decrease compared to male-led municipalities. We find no effect during the second and third periods, corresponding to the middle and end of the first wave. The coefficients are not significant and the point estimates are much smaller, both in absolute terms and compared to the means.

Figure 3 plots the number of deaths against the running variable for each period separately. Consistent with the formal estimation, we see an upward jump at the threshold at the beginning of the first wave, a downward jump at the end of the period of analysis, and no significant jumps for the other two periods.

Figure 3: Impact on COVID-19 deaths by period

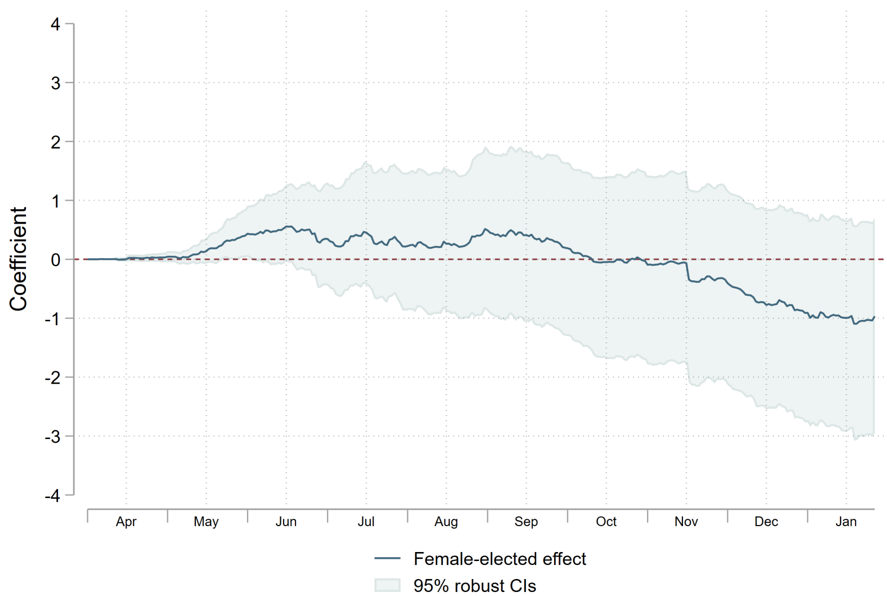


Notes: Each graph is constructed by restricting the support to observations in the estimation bandwidths and by setting the fit to match the local polynomial point estimator (polynomial order 1 and triangular kernel). Dots represent the local averages of the total number COVID-19 deaths per 10,000 inhabitants in the municipality during the period of interest. Averages are calculated within evenly-spaced bins of the running variable. The running variable is the margin of victory of the female candidate in the 2016 election (percentage point difference between the vote share of the female and the male candidates). Positive values denote that the female candidate won the election, and negative values that the male candidate prevailed.

Appendix Table A7 and Appendix Figure A5 further assess the impact month by month. We find that the positive impact in the first period is mainly driven by a larger number of deaths in female-led municipalities in May 2020, while the negative impact in the last period is driven by a lower number of deaths in female-led municipalities in November and December 2020.

Finally, we look at how these effects translate into the evolution of the number of cumulative deaths. Figure 4 shows the estimated impact of having a female mayor on the total number of deaths up to a given date, for each day from April 1 to January 31. Consistent with female-led municipalities experiencing more deaths at the beginning, the point estimates on the cumulative number of deaths is positive and significant from May to June. It remains positive but not significant up to October, when it becomes close to zero. Next, in line with female-led municipalities experiencing fewer deaths at the end of the year, the point estimates become negative starting in November.[20]

Figure 4: Impact on the cumulative number of COVID-19 deaths day by day



Notes: This figure plots the RD estimates obtained by taking as outcome the cumulative number of Covid-19 deaths per 10,000 inhabitants, for each day from April 1st to January 31st, 2020.

Looking at the overall number of deaths over the whole period, we find that having a female mayor reduced the cumulative number of deaths by 0.97 as of January 31st 2021

[20]While a higher mortality rate at the beginning could mechanically lead to a lower number of deaths later on (as the population affected develop immunity and a fraction of the most vulnerable residents is no longer alive), such mechanical effect is unlikely to explain the impact in period 4. Indeed, while the impact in period 1 is large in relative terms, it represents a low number of total deaths. The virus was still at low levels, making it implausible that female-led municipalities became more likely to reach "herd immunity" early in the pandemic. Moreover, such mechanisms would also have led to fewer deaths during the peak of the first wave, contrasting with the null effects we find in periods 2 and 3. Finally, the impact in period 4 is much larger than in period 1 (an increase of 0.39 compared to a decrease of one, Table 3) and the point estimate on the cumulative number of deaths becomes negative in the late period (Figure 4), showing that the later impact more than compensated the earlier one.

(14.4 percent), on average, but the coefficient is not statistically significant (Appendix Table A8 and Appendix Figure A6).

The impact of female leadership on COVID-19 deaths is robust in both magnitude and significance to the inclusion of municipal baseline characteristics, mayors' characteristics other than gender, and state fixed effects. They are also robust to the exclusion of unusual observations (Mato Grosso state and supplementary elections), and to specification choices (use of a second polynomial order and different bandwidths). In addition, the same patterns are found if we use as outcome the overall number of SARI deaths (as described in Section 2.3). Appendix D describes the robustness tests in more details and presents the corresponding tables and figures.

Female- and male-led municipalities experienced a different evolution in the number of COVID-19 deaths. As municipalities on either side of the threshold have the same characteristics and only differ in the gender of their mayor, these results suggest that female and male mayors handled the crisis differently. To provide further support for this interpretation, we now investigate the impact of female leadership on containment policies and residents' isolation behavior.

4.2 Impact on policies and isolation

4.2.1 Impact of having a female mayor on containment policies

As discussed in Section 2.3, we consider six policies for which we have enough variation across municipalities: commerce restrictions (closing non-essential businesses), workplace, travel, and public transport restrictions, curfews, and lockdowns.

We first look at the impact of having a female mayor on the adoption of a given policy by calendar month, from March to October 2020 — the period for which policy data are available. For each policy and month, we define our dependent variable as the total number of days in which the policy was in place in the municipality.

Table 4 presents the results for commerce restrictions. We find that female mayors were significantly less likely to close commerce at the beginning of the pandemic. On average, non-essential businesses were closed 2.5 and 6.5 fewer days in female-led municipalities in March and April, respectively, relative to an average of 3.2 and 10.6 days in male-led municipalities at the threshold. Both coefficients are significant at the 5 percent level. As shown in Appendix Table A9, these effects are driven by the fact that female mayors started closing non-essential businesses 33 days later on average, an effect that is significant at the 5 percent level (column 1). Given that closing commerce was one of the first policies to be implemented in response to the crisis, this implies that female mayors were more likely to delay the implementation of any containment policy (column 7, p-value 0.11).[21]

In contrast, we find that female mayors became significantly more likely than male mayors to close commerce later in the year. On average, non-essential businesses were

[21]Contrary to commerce closure, more drastic policies, such as curfews and lockdowns, were implemented later in 2020 and only by a small fraction of municipalities (Appendix Figure B3). No municipality in our sample implemented a lockdown before May, and curfews and lockdowns were implemented in less than five percent of the municipalities in our sample at any point during the period of analysis.

closed 7.3 and 7.5 more days in female-led municipalities in September and October, respectively. These effects represent a two-fold increase relative to male-led municipalities, and they are both significant at the 10 percent level. Given that the average number of days with commerce restrictions in male-led municipalities started decreasing in July 2020, these effects are likely driven by male mayors being more likely to lift commerce restrictions at the end of the year.

Table 4: Impact of having a female mayor on commerce restrictions by month

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Number of days with commerce restrictions in place							
	03/20	04/20	05/20	06/20	07/20	08/20	09/20	10/20
Treatment	-2.495**	-6.507**	-1.720	0.743	2.565	4.033	7.254*	7.541*
	(0.977)	(2.837)	(4.042)	(4.070)	(4.048)	(3.856)	(4.338)	(4.298)
Robust p-value	0.018	0.037	0.893	0.684	0.364	0.197	0.067	0.056
Observations	243	250	242	232	222	234	232	232
Polyn. order	1	1	1	1	1	1	1	1
Bandwidth	0.107	0.112	0.106	0.099	0.094	0.101	0.099	0.099
Mean, left of threshold	3.182	10.624	10.437	11.017	10.856	8.822	7.862	6.582

Notes: The sample is restricted to municipalities for which data on policies are available. The outcome is the number of days during which the policy was in place, separately for each month. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Appendix Figure A7 shows this pattern visually. While we see a large downward jump in March and April, the discontinuity gradually disappears in subsequent months, before turning into large upward jumps in September and October.

We do not find significant effects when turning to the other five policies (Appendix Tables A10 to A14). We observe similar patterns for workplace restrictions – with negative effects at the beginning of the pandemic that turn into positive effects over time – but these results are noisier, and not statistically significant. Female mayors also appeared more likely to implement curfews, and less likely to impose travel restrictions and lockdowns throughout the period of analysis, but the coefficients are imprecisely estimated and none of them are statistically significant.

Appendix Figure A8 summarizes these results by plotting the RD estimate day by day for each policy. Overall, female- and male-led municipalities differed mainly in their use of commerce restrictions. This could be explained by the fact that commerce closure is the policy that exhibits the most variation in the timing and extent to which mayors decided to use it. Other policies such as curfews and lockdowns were more extreme and thus adopted only by a small fraction of municipalities, making variation across municipalities difficult to detect (Appendix Figure B3).

The results are robust to exploiting within-state variation only, through the inclusion of state-fixed effects (Appendix Table A15). This shows that the effects we find are not driven by female and male mayors being subject to different state policies, but can be attributed to their own policy choices.

The timing of the policy results aligns well with the evolution of the number of COVID-19 deaths: female mayors were less likely to close commerce in March and April, and female-led municipalities experienced more deaths in May; they became more likely to close commerce in September and October, and their municipalities experienced fewer deaths in November and December. However, we refrain from making a causal claim on the relationship between commerce restrictions and COVID-19 deaths, since we only partially observe the mayors' actions, and formally assessing the causal impact of policies on COVID-19 deaths is beyond the scope of this paper. Still, we see these results as evidence that the effects we find on COVID-19 deaths reflects the fact that female and male mayors responded differently to the crisis over time.

4.2.2 Impact of having a female mayor on residents' isolation behavior

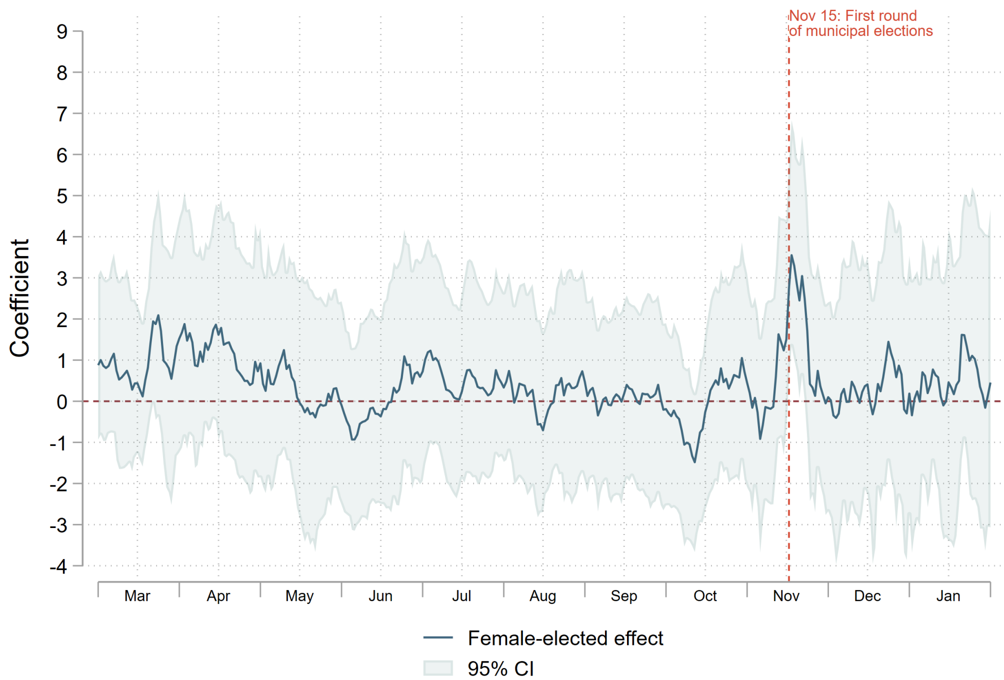
Finally, we measure the impact of having a female mayor on residents' isolation behavior, using InLoco's "isolation index". This index is defined as the share of phone users in the municipality who stayed at home on a given day. Figure 5 shows daily RD estimates of the effect from February 25, 2020 to January 31, 2021.

For most of the period of study, we find no statistically significant female-mayor effect on residents' isolation behavior. The point estimates are positive in the first few weeks of the pandemic, but the effects are imprecisely estimated and not significant. In the following months – from May through October – they remain close to zero. This non-significant impact on isolation is consistent with the fact that female and male mayors differ mainly in their use of commerce restrictions. Indeed, closing non-essential businesses do not restrict mobility per se; they mainly reduce the risk of contamination by preventing people from entering closed spaces (Goolsbee and Syverson, 2021).

In sharp contrast with the null effects found over most of the period of interest, Figure 5 shows a large, positive, and statistically significant effect of having a female mayor on the share of residents staying at home around the day of the election. In other words, residents in male-led municipalities were significantly more likely to go out around election day. Appendix Table A16 zooms in this period, providing separate estimates for each day around Sunday November 15. We find that the positive effect is driven by the two days prior to the election (columns 4 and 5) – Friday and Saturday, the last two days in which campaigning was legally allowed – and by a few days in the week immediately after the election. On those days, the impact represents an increase of 10 to 20 percent in the share of residents staying at home in female-led municipalities, compared to male-led municipalities.[22]

[22]Note that the null effect on election day (column 6, Appendix Table A16) is consistent with voting being mandatory in Brazilian municipal elections.

Figure 5: Daily RD estimates of the impact of having a female mayor on the isolation index (7-day moving average)



Notes: This figure plots the estimated daily coefficients of the effect of having a female mayor on the 7-day moving average of the isolation index, which measures the share of phone users staying at home on a given day. The moving averages are centred in the current day, so that for each day it measures the impact on the average share of phone users staying at home over the last three days, the current day, and the next three days. We restrict the sample to a balanced panel of municipalities, excluding those with missing values between Feb-25-2020 and Jan-31-2021.

These results could come from male mayors being more likely to organize in-person events during the 2020 electoral campaign and following the election results. Indeed, given that electoral authorities banned the use of mass messaging on social media during the 2020 election period, candidates had incentives to use in-person events instead, despite the social distancing regulations in place. Local media reported multiple breaches of sanitary protocols, in particular large in-person gatherings violating the social distancing recommendations (Tarouco, 2021).[23]

Together with the impact on commerce closure, these results suggest that male mayors were more likely to open-up their municipalities at the end of the year compared to female mayors.

[23] Anecdotal evidence include large in-person campaign events in the week leading to the election, as well of victory-celebrating parties, parades, and concerts in the week after the election.

5 Mechanisms: The role of electoral incentives

Overall, our results show that female and male mayors responded differently to the crisis: while female mayors were less likely to undertake containment efforts at the onset of the pandemic, male mayors were more likely to relax containment efforts at the end of the year.

We now explore the role of electoral incentives in explaining these gender differences. Municipal elections were held in November 2020, meaning that, since the start of the pandemic, mayors planning to run for re-election knew they would face their voters in the near future and likely be re-elected or voted out based on their response to the crisis. In Section 5.1, we first outline a simple political agency model that shows how our results can arise from the optimal choice of re-election-seeking politicians if voters are gender-biased. Section 5.2 then provides empirical evidence that supports the mechanisms featured in the model over alternative interpretations.

5.1 A simple model of political agency with voter bias

Public good

Society is a representative democracy composed by a mass one of voters and one politician. Voters derive utility from the consumption of a public good g, which, in our application, denotes health. In normal times, the amount of public good available to voters is fully predictable and is given by $\overline{g}$.

Society faces an emerging shock that threatens to reduce the public good according to $g = \overline{g}\ \exp(-\psi)$, where ψ represents the severity of the shock, and $\psi > 0$, such that $g < \overline{g}$.

The politician has access to a policy instrument, $0 \leq P \leq 1$, which can mitigate the impact of the shock. In our application, this represents any action the mayor can take to contain the spread of the virus and reduce the number of COVID-19 deaths.

The amount of the public good that will be available after the shock depends both on the severity of the shock ψ and policy intensity P, according to the following production function:

$$g = \overline{g}\ \exp(-\psi\ \exp(-\lambda P)\,) \tag{2}$$

where $\lambda \geq 1$ is a parameter that captures the effectiveness of the politician's actions at mitigating the effects of the shock.[24]

[24] We arrive to this formulation by assuming that the public good is produced according to $g = \overline{g} - \overline{g}\, f_1(\psi_m)$, and that $\psi_m = \psi\,(1 - f_2(P))$, where ψ_m represents the severity of the shock that remains after the implementation of the policy. We then define the shock's damage function as $f_1(\psi_m) = 1 - exp(-\psi_m)$, and the policy abatement function as $f_2(P) = 1 - exp(-\lambda P)$. Combining these expressions into the production function and simplifying yields equation 2. Similar specifications have been previously used in a long-standing plague control literature studying the optimal use of pesticides (e.g., Talpaz and Borosh 1974; Lichtenberg and Zilberman 1986; Hall and Moffitt 2002).

Voters' utility

Voters observe the policy level enacted by the politician. They draw utility from the amount of public good that they believe will be available after the shock, and direct disutility from the policy, according to:

$$U = \tilde{g} \exp(-P) \tag{3}$$

where $\tilde{g}$ is the anticipated public good level.

Equation 3 reflects the trade-off of containment policies: on the one hand, containment policies increase voters' utility by preserving the public good; on the other, they impose a direct cost on voters by closing the economy and limiting freedom. Moreover, the disutility caused by the policy enters equation 3 multiplying $\tilde{g}$, such that the larger the anticipated level of public good, the more disutility the policy generates. This captures voters' higher willingness to accept containment policies if the shock is (perceived as) more severe. This is in line with recent survey evidence across 15 countries showing that the willingness to sacrifice civil liberties increases with the perception of health insecurity (Alsan et al., 2021).

While the model is motivated by the COVID-19 pandemic context, it is general enough to shed light on the behavior of politicians in other crisis contexts involving policy interventions that can be costly to voters and thus potentially unpopular, such as fiscal austerity policies or environmental policies.

Voters' beliefs

Voters anticipate the level of public good that will result from the shock based on the observed level of policy and on two subjective beliefs, such that $\tilde{g}$ can differ from g in equation 3.[25]

First, voters hold a gender-biased belief about policy effectiveness. Specifically, voters believe that the policy will be less effective if it is implemented by a female politician than if it is implemented by a male politician ($\lambda_f < \lambda_m$). In other words, we assume that female politicians get less credit for their actions. This in line with evidence showing that voters assess female political leaders less favorably than their male counterparts (e.g., Bertrand and Duflo 2017), and of gender-biased performance evaluation in other contexts (e.g., Sarsons 2017; Mengel et al. 2018; Macchiavello et al. 2020; Egan et al. 2022; Ross et al. 2022).

Second, voters believe that the shock will happen with probability $0 \leq p \leq 1$. Only when $p = 1$ do voters believe that the full potential of the shock (ψ) will materialize.[26] Indeed, opinion surveys suggest that many Brazilian respondents were skeptic about the gravity of the threat at the beginning of the pandemic, when the exposure to COVID-19 deaths was low, and that this perception shifted as the first wave progressed (Ipsos, 2020). We will thus consider the behavior of politicians for different levels of p.

[25]Several recent papers in political economy also consider agents who make decisions based on potentially misspecified subjective models (Esponda and Pouzo, 2016), including papers studying the consequences of competing political narratives (Eliaz and Spiegler, 2020), or the recurrence of populism (Levy et al., 2022).

[26]The probability p could also be interpreted as the share of the electorate that believes that the shock will take place and have a severe public health impact.

Under these assumptions, we obtain the following voters' utility:

$$U = \overline{g}\ \exp(-p\ \psi\ \exp(-\lambda_s P)\ )\ \exp(-P) \tag{4}$$

where $s = \{m, f\}$ indexes the politician's gender, with m denoting male politicians and f female politicians.

Elections and Optimal policy

We assume that the politician seeks to maximize their re-election probability, which is an unobserved positive function of voters' utility. They thus optimize their re-election chances by choosing the policy level that maximizes voters' utility (equation 4).[27] This yields the following optimal policy level:

$$P_s^* = \frac{1}{\lambda_s} \log(\lambda_s p \psi) \tag{5}$$

We are interested in how the optimal policy P_s^* varies with voters' gender-biased beliefs about policy effectiveness (λ_s) and with voters' beliefs about the severity of the threat (p). Both are interrelated, as shown by the interaction of these two terms in equation 5.

Figure 6 plots the optimal policy level as a function of voters' beliefs about the effectiveness of the policy at two different levels of p. Recall that the model assumes that voters attribute a lower level of policy effectiveness to female politicians. For instance, they may assume that $\lambda_f = 2$ and $\lambda_m = 4$. When voters believe that the probability p of a shock is small (left graph), the level of optimal policy P_s^* is increasing in λ_s over much of the support of λ_s, meaning that a female politician would implement a lower level of policy than a male politician. In contrast, when voters believe that the probability p of a shock is large (right graph), the level of optimal policy P_s^* is decreasing with λ_s over much of the support of λ_s, meaning that a female politician would choose a higher level of policy.

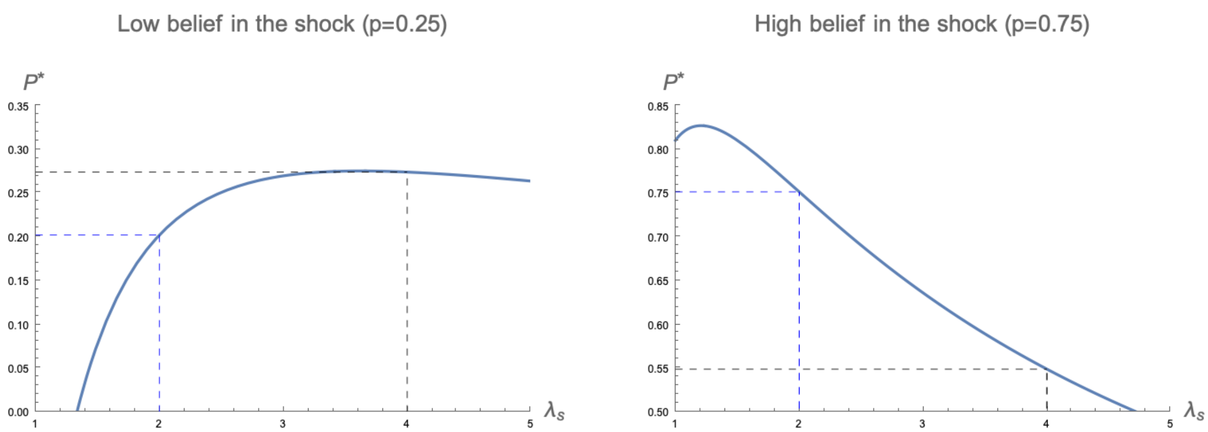
Intuitively, when voters believe that the threat to the public good is low – as at the beginning of the pandemic in Brazil – the marginal cost to voters of an additional unit of policy is high. This makes it very costly for politicians to close the economy, and even more costly for female mayors, as voters perceive them as less effective, and thus expect their policies to be even more cost-ineffective than those enacted by male leaders. In this context, the optimal policy – the point at which the marginal benefit of the policy to voters just outweighs the marginal cost – is low, and even lower if the mayor is a woman (as illustrated by Appendix Figure E1).

In contrast, when voters believe that there is a significant threat – such as after the consequences of the first wave materialized – they are more willing to bear the disutility

[27]Specifically, we assume that voters will re-elect the politician if their utility (which is a function of the politician's policy choice) is higher than their reservation utility. We assume that politicians know voters' preferences and beliefs, but do not observe the reservation utility that voters' have in crisis times. Their best strategy is to choose the policy that delivers the maximum utility possible given the severity of the shock and voters' beliefs.

associated to the policies in order to preserve the public good.[28] In this case, the marginal cost of the policy to voters is lower. Policies are tolerated up to the point where the anticipated level of public good is deemed high enough such that the marginal benefit no longer justifies the marginal cost. Because male mayors are perceived as more effective, they need to implement a lower level of policy than female mayors to reach this point (Appendix Figure E2).

Figure 6: Optimal policy (P^*) as a function of voters' beliefs about policy effectiveness (λ_s) at different levels of beliefs in the likelihood of the shock (p)



Notes: The figure plots the optimal level of policy chosen by the politician as a function of voters' beliefs about the effectiveness of containment policies under two scenarios: one in which voters believe that the shock will happen with a low probability ($p = 0.25$) and one in which voters believe it will happen with a high probability ($p = 0.75$), normalizing the pre-crisis amount of the public good to $\tilde{g} = 1$ and assuming a shock of magnitude $\psi = 3$.

5.2 Empirical evidence

5.2.1 Gender differences and electoral incentives

If, as in the model, our results are driven by the fact that female and male mayors faced different electoral incentives, we should see that the effects are concentrated among electorally-motivated mayors. We consider two measures of electoral incentives to test this prediction. First, we exploit the two-term limit rule and compare mayors who could run for re-election to those who could not. Second, we depart from the RD framework to test whether our results vary with the winning vote margin and thus the competitiveness of the election.

[28] As discussed in Section 2, the support for containment policies increased during the first wave in Brazil, consistent with people willingness to sacrifice civil liberties increasing with the perception of health insecurity (Alsan et al., 2021).

Term limits

In Brazil, mayors can hold office for two consecutive terms only, meaning that mayors re-elected in 2016 could not run again in the 2020 election. We can thus compare incumbent mayors in 2016 (term-limited) to first-time elected mayors in 2016 (not term-limited). As stressed by Ferraz et al. (2012), being term limited is a particularly strong indicator of electoral incentives in this context. Indeed, given the absence of incumbency advantage in Brazilian municipal elections (Anagol and Fujiwara, 2016), first-time mayors cannot take re-election for granted. Moreover, only a very small fraction of term-limited mayors return to office – either at the municipal level after a one-term hiatus or in higher-level offices – making them unlikely to be motivated by future political career concerns.

We consider three sub-samples depending on the incumbency status of the two front runners in the 2016 election: (1) neither of the two front runners ran as incumbent in 2016, so that the treatment captures the impact of having a non-term-limited female mayor vs. a non-term-limited male mayor (i.e., both can run for re-election); (2) only the male candidate ran as incumbent, so that the treatment captures the impact of having a non-term-limited female mayor vs. a term-limited male mayor (i.e., only the female mayor can run for re-election); and (3) only the female candidate ran as incumbent, so that the treatment captures the impact of having a term-limited female mayor vs. a non-term-limited male mayor (i.e., only the male mayor can run for re-elecion). As shown in Appendix Table A17, municipalities have similar characteristics across the three sub-samples.

We replicate our main analysis on COVID-19 deaths in each sub-sample separately. We start with the first period, when female-led municipalities experienced significantly more COVID-19 deaths than male-led municipalities. Table 5 shows that the estimate remains large and positive only in elections where female mayors faced electoral incentives (columns 2 and 3). When both mayors can run for re-election, the impact is virtually the same as for the full sample, although not significant (p-value 0.13, column 2). When the female mayor can run for re-election while the male mayor cannot, the point estimate is large and significant at the 5 percent level (column 3). In contrast, the effect disappears when the female mayor cannot run for re-election: it is small, negative, and far from significant (p-value 0.59, column 4).

We next turn to the last period, when female-led municipalities experienced significantly fewer COVID-19 deaths than male-led municipalities. As shown in Table 6, the negative impact on deaths is exclusively driven by municipalities where the male mayor faced electoral incentives (columns 2 and 4). When both male and female mayors can run for re-election, the impact is significant at the 5 percent level and higher in magnitude than in the full sample (column 2). When only the male mayor can run for re-election, the impact is similar as in the full sample and almost significant (p-value 0.11, column 4). In contrast, when the male mayor cannot run for re-election, the point estimate is close to zero and far from significant (p-value 0.69, column 3).

Table 5: Impact on COVID-19 deaths in period 1, by term limit status

Outcome	(1)	(2)	(3)	(4)
	Number of Covid-19 deaths in Period 1			
	Full sample	Both can run	Female can run Male cannot	Male can run Female cannot
Treatment	0.391**	0.387	0.919**	-0.154
	(0.176)	(0.271)	(0.347)	(0.290)
Robust p-value	0.035	0.133	0.014	0.592
Observations	578	282	140	116
Polyn. order	1	1	1	1
Bandwidth	0.133	0.129	0.126	0.110
Mean	0.203	0.157	0.127	0.305

Notes: In column 2, the sample is restricted to elections where neither of the two front runners ran as incumbent. In column 3 (resp. 4), the sample is restricted to elections where only the male (resp. female) candidate ran as incumbent. The outcome is the total number of deaths per 10,000 inhabitants (using the 2010 population) during the first period (April-May 2020). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table 6: Impact on COVID-19 deaths in period 4, by term limit status

Outcome	(1)	(2)	(3)	(4)
	Number of Covid-19 deaths in Period 4			
	Full sample	Both can run	Female can run Male cannot	Male can run Female cannot
Treatment	-0.999**	-1.743**	-0.176	-1.228
	(0.405)	(0.671)	(0.609)	(0.750)
Robust p-value	0.016	0.011	0.690	0.108
Observations	513	257	171	142
Polyn. order	1	1	1	1
Bandwidth	0.118	0.115	0.149	0.142
Mean	2.432	3.044	1.872	2.425

Notes: In column 2, the sample is restricted to elections where neither of the two front runners ran as incumbent. In column 3 (resp. 4), the sample is restricted to elections where only the male (resp. female) candidate ran as incumbent. The outcome is the total number of deaths per 10,000 inhabitants (using the 2010 population) during the last period (November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

These results are consistent with the model intuition and with female and male mayors adopting different electoral strategies: while electoral incentives push female mayors to undertake less containment efforts than male mayors at the beginning of the year when the crisis is more uncertain, electoral incentives instead push male mayors to undertake less containment efforts than female mayors at the end of the year when the uncertainty about the severity of the crisis is reduced.

One concern could be that term-limited and non-term-limited mayors do not differ only in the fact that they face more or less electoral incentives. Indeed, second-term mayors have been re-elected, implying that they have more experience in office, and that they may have higher abilities (if higher-ability candidates are more likely to get re-elected). This is, however, unlikely to explain the patterns we observe. First, the COVID-19 crisis started in the last year of the mayors' term, meaning that first-time mayors already had accumulated experience during three years. Second, when focusing on first-term mayors, we do not see that the effects are systematically weaker for college-educated, older mayors, or mayors who served as municipal legislators during the last term, suggesting that less able or less experienced mayors are not driving the results (Appendix Tables A18 to A20).[29] Third, as shown in the next section, we also find that our results are driven by more competitive elections, a proxy for electoral incentives that does not rely on term limits.

Election competitiveness

By construction, the RDD focuses on mayors who won by a small margin in 2016 and who are thus likely to face more competition in the next election than mayors who secured a large victory margin. If electoral incentives are driving our results, we would expect the effects to be larger for the former.

To test this prediction, we run an OLS estimation where we regress our main COVID-19-death outcomes on the treatment variable (having a female mayor) and where we further include an interaction term between the victory margin and the treatment variable. We also include the victory margin in the regression and control for all municipality characteristics displayed in Table 1 as well as all winner characteristics displayed in Table 2. While the causal interpretation of the effects is more challenging, this analysis allows us to see how the impact evolves as the victory margin of the mayor increases. Table 7 presents the results for the number of deaths in the first period (Panel A) and in the last period (Panel B).

[29] First-time mayors could have served as municipal legislators during the last term. Elections for municipal legislators happen at the same time as for mayors and they are elected by the same voters. While the subsample becomes very small, Appendix Table A20 shows that the coefficients are not smaller in magnitude for mayors who served as legislators during the 2012-2016 term.

Table 7: OLS estimates of the impact of having a female mayor on COVID-19 deaths

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome	# COVID-19 deaths per 10,000 inhabitants					
	Panel A: Period 1					
VM	All VMs		≤ 10pp		≤ 5pp	
Treatment	0.005	0.071	0.168	0.361**	0.267*	0.699***
	(0.060)	(0.089)	(0.105)	(0.174)	(0.137)	(0.226)
T*VM		-0.549		-4.023		-17.728***
		(0.394)		(3.049)		(6.768)
Obs.	981	981	548	548	252	252
Mean	0.402	0.402	0.886	0.886	0.832	0.832
	Panel B: Period 4					
VM	All VMs		≤ 10pp		≤ 5pp	
Treatment	-0.026	-0.093	-0.279	-0.955**	-0.643*	-0.961*
	(0.174)	(0.237)	(0.241)	0.428	(0.331)	0.559
T*VM		0.694		15.502**		12.653
		(1.279)		(7.421)		(17.835)
Obs.	981	981	548	548	252	252
Mean	2.412	2.412	2.391	2.391	2.288	2.288

Notes: The outcome is the total number of deaths per 10,000 inhabitants (using the 2010 population) during the first period (April-May 2020) in Panel A and during the last period (November 2020-January 2021) in Panel B. Columns 1 and 2 include all observations, while columns 3 and 4 (resp. 5 and 6) include only elections won by a victory margin smaller than 10 (resp. 5) percentage points in 2016. All regressions include the victory margin (VM) and control for municipality and winner characteristics (listed in Table 1 and 2, respectively). Robust standard errors are in parentheses. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities.

For both periods, the impact goes in the same direction as in the main RD analysis (Table 3). In the full sample, the point estimates are small and non significant (column 1). The effects become large and significant when we restrict the sample to more competitive elections, with a victory margin smaller than 10 or 5 percentage points (columns 3 and 5, respectively). More interestingly, in all regressions, the coefficient of the interaction term is negative in period 1 and positive in period 4 (columns 2, 4 and 6). Focusing on elections won by a vote margin smaller than 10 percentage points, we see that the estimates associated to the treatment are very close to the ones obtained with the RDD (0.36 for period 1 and -0.96 for period 4, column 4). This is reassuring, as these effects can be interpreted as the impact of having a female mayor when the vote margin is zero, which corresponds to the impact at the discontinuity estimated with the RDD. The coefficient of the interaction term further shows that the magnitude of the effect decreases as the victory margin increases, and disappears if we go from a 0 to a 10 percentage points victory margin.[30]

These results show that the impact is larger in more competitive races, where mayors face higher electoral incentives. They also suggest that, when gender differences in policy-making are due to female and male leaders facing different electoral incentives, the effects captured by close election designs are likely to dissipate in uncontested races.

5.2.2 Gender differences and voters' gender bias

The model assumes that female and male mayors face different electoral incentives because voters assess their actions differently. We test this assumption by running heterogeneity analyses based on the degree of gender discrimination in the municipality. Indeed, if the empirical results stem from voters' gender bias, we would expect the impact to be larger in municipalities with greater gender discrimination.

Table 8: Impact on COVID-19 deaths, by municipality's gender wage gap

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome	Number of Covid-19 deaths - Mayor can run					
	Full sample		Above median		Below median	
Periods	1	4	1	4	1	4
Treatment	0.548**	-1.250**	0.693**	-2.141**	0.306	-0.111
	(0.224)	(0.523)	(0.291)	(0.853)	(0.316)	(0.560)
Robust p-value	0.014	0.019	0.011	0.011	0.432	0.925
Observations	387	375	206	171	207	180
Polyn. order	1	1	1	1	1	1
Bandwidth	0.120	0.111	0.130	0.095	0.126	0.106
Mean	0.197	2.722	0.110	3.515	0.347	1.582

Notes: The sample includes only elections where the mayor is not term limited and can run for re-election. Columns 3 and 4 (resp. 5 and 6) further restrict the sample to municipalities where the gender wage gap is above (resp. below) the median. In columns 1, 3 and 5 (resp. 2, 4 and 6), the outcome is the number of COVID-19 deaths per 10,000 inhabitants (using the 2010 population) in period 1 (resp. period 4). Period 1 (resp. 4) corresponds to April-May 2020 (resp. November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

In order to proxy for the extent of gender discrimination and thus voters' gender bias at the municipal level, we follow Le Barbanchon and Sauvagnat (2022) and use the gender

[30]To see that, we divide the point estimate of the interaction term by 10 (third line) and add it to the point estimate of the treatment effect (first line) in column 4.

wage gap. Specifically, we consider all workers living in a given municipality and we compute the gap in the wages received by female and male workers, after accounting for age, education and occupation. Table 8 focuses on municipalities where the mayor can run for re-election, which drive our effects (Section 5.2.1).[31] Columns 3 to 6 show that the positive impact on COVID-19 deaths in period 1 and the negative effect in period 4 are much larger in municipalities above the gender wage gap median. In this sub-sample (as in the full sample), the coefficients are significant at the 5 percent level, whereas the coefficient are not significant in municipalities below the median. We obtain similar patterns if we consider the gender gap in labor force participation as an alternative proxy for gender discrimination (Appendix Table A21).

5.2.3 Alternative mechanisms

The evidence presented above is consistent with our main results being driven by electoral incentives and gender bias. We now discuss alternative interpretations for our findings.

First, gender differences in COVID-19 responses could come from gender differences in policy preferences. Specifically, we could have expected female leaders to prioritize public health and adopt more containment policies, in line with evidence showing that female politicians tend to invest more in health (Bhalotra and Clots-Figueras, 2014; Funk and Philips, 2019), and that women in the population took the COVID-19 risk more seriously (Vincenzo et al., 2020). While this interpretation could rationalize the later effect, it does not explain why female mayors delayed their crisis response at the beginning of the pandemic. Moreover, it would not account for the fact that gender differences materialize only when mayors face electoral incentives.[32]

Our results are also unlikely to be driven by female candidates being elected by different groups of voters with different preferences. To account for our findings, voters' preferences would have needed to change over time, and in opposite directions for voters supporting female versus male candidates. Furthermore, the population composition of female- and male-led municipalities is balanced at the threshold (Section 3.3) and voting is mandatory in Brazil, meaning that barely-elected female and male mayors faced the same electorate.

Alternatively, the effects could be driven by gender differences in risk aversion (Eckel and Grossman, 2008; Croson and Gneezy, 2009). This could have led female mayors to be more likely to wait and learn, behaving more cautiously at the beginning of the pandemic and reverting course over time as the uncertainty over the severity of the shock dissipated. However, if this was the main mechanism behind our results, the same time-varying patterns should hold regardless of whether the mayors faced electoral incentives or not.

Gender differences in risk aversion could still account for our results if we assume that female mayors are more adverse to the risk of losing the election. This would have led them to adopt the least electorally risky moves, which could have been delaying containment

[31]Note that this sample restriction does not create selection issues, as closely elected female and male mayors were as likely to run as incumbent and thus as likely to be term-limited (Table 2).

[32]The same reasoning holds if we instead expect female mayors to prioritize leaving the economy open: this would only rationalize the earlier effect but not the later, and would not account for the effects being driven by electoral incentives.

efforts at the beginning, and upholding containment efforts towards the end of the first wave. Several pieces of evidence go against this interpretation. First, we show in Section 5.2.2 that the effects are driven by municipalities with greater gender discrimination. This supports the hypothesis that female mayors acted in response to voters' bias rather than driven by a higher intrinsic risk aversion that is independent from voters' assessment.[33] Second, some evidence suggests that gender differences in risk aversion found in the overall population tend to dissipate with the education level, as well as for people working as managers or entrepreneurs, which are considered as more risk-taking careers (Croson and Gneezy, 2009). The fact that our results are not driven by lower-educated mayors (Appendix Table A18) and that we study individuals who self-selected into a highly competitive environment makes risk aversion unlikely to be the main driver of our results. Finally, more risk aversion towards losing re-election would lead female mayors to take the actions most aligned with voters' preferences and, absent voters' discrimination, should help them secure a higher vote share in the next election. Instead, we do not find gender differences in the probability to run, get re-elected, or in their vote share in the 2020 election (Appendix Table A22), consistent with male and female mayors optimizing their policy choices based on voters' gender-specific expectations.

6 Conclusion

This paper provides new evidence on the mechanisms explaining gender differences in leaders' behavior.

Using a regression discontinuity design in Brazilian municipal elections, we first show that female mayors handled the COVID-19 crisis differently over time. We find that having a female mayor led to more deaths at the beginning of the pandemic – a three-fold increase in May 2020 compared to the average male-led municipality – while it led to fewer deaths at the end of the year, corresponding to a 41.1 percent reduction in November-December.

Consistent with mayors' decisions driving those effects, we show that female mayors were less likely to impose commerce restrictions early – in February-March – while they became more likely to do so later – in September-October. Further evidence suggest that a lower share of residents stayed at home in male-led municipalities around election day. Hence, while female mayors were more likely to delay containment efforts at the beginning, male mayors were more likely to relax containment efforts at the end of the year.

We then show that the gender differences we observe are due to the fact that female and male mayors faced different electoral incentives. Their behavior can be rationalized by a simple political agency model where politicians seek re-election and where voters assess the performance of female and male politicians differently, leading them to adopt different policies. Consistent with electoral incentives and voters' bias explaining the behavior of

[33]The results presented in the paper suggest that gender differences in crisis response come as a response to voters' gender bias. This interpretation relates to several studies that find that gender differences in risk aversion come from women expecting negative consequences from not conforming to gender stereotypes, suggesting that gender norms could also be the ultimate driver of gender differences in risk aversion (Larkin and Pines, 2003; Kawakami et al., 2007; Carr and Steele, 2010).

mayors, we find that our results are driven exclusively by non-term-limited mayors who can run for re-election, that the effects are stronger in more competitive races, and larger in municipalities where gender discrimination is more prevalent.

These results suggest that gender differences in leaders' behavior do not necessarily stem from gender differences in policy preferences. Instead, they can be driven by leaders' incentives to adapt their policy choices to voters' gender-biased expectations.

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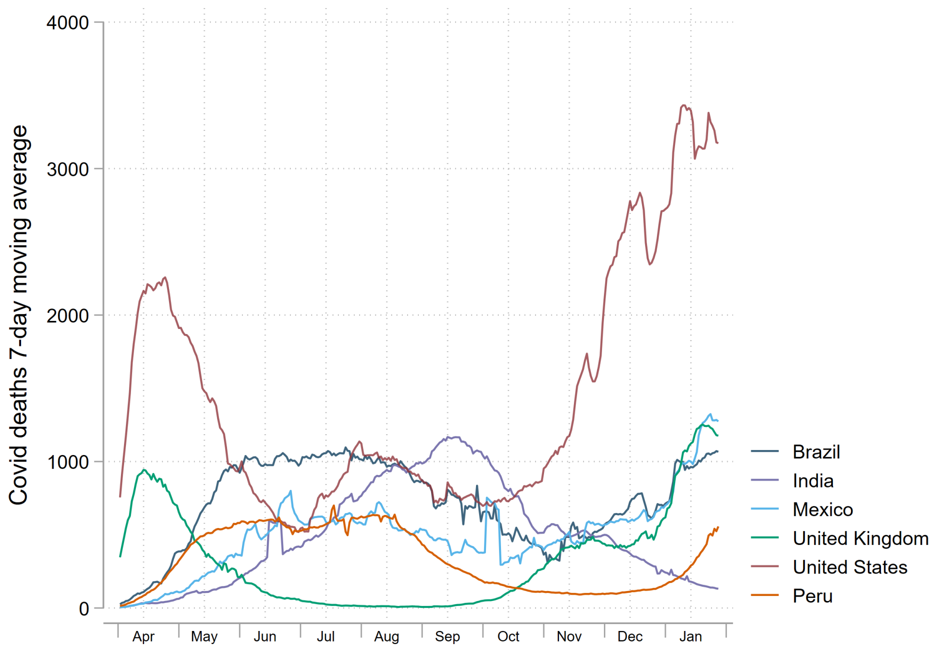
Appendix

Table of Contents

A Additional figures and tables

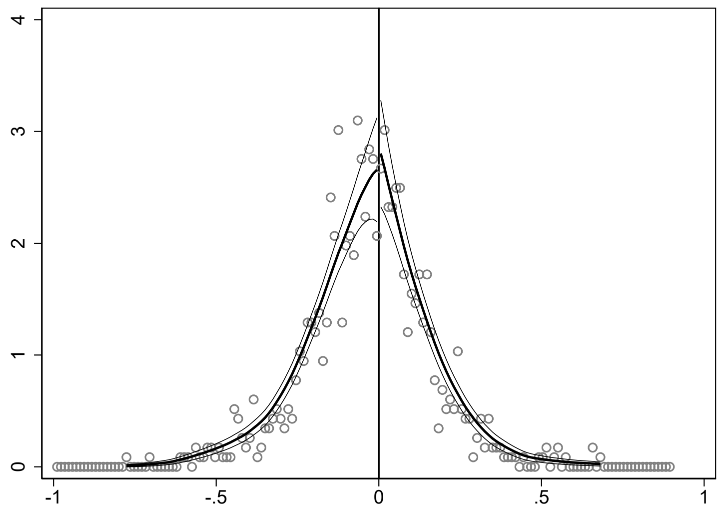
A1 Additional figures

Figure A1: Daily number of COVID-19 deaths in Brazil and in the other five countries with the highest mortality (7-day moving average)



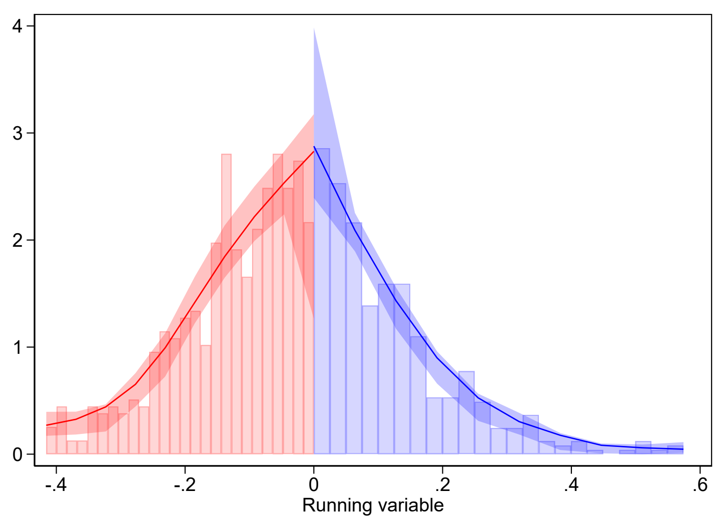
Notes: This figure includes the six countries with the highest number of confirmed COVID-19 deaths in the world as of January 31, 2021. It shows the number of confirmed COVID-19 deaths, smoothed using a 7-day moving average centered in the current day. Data from Our World in Data, accessed on June 23, 2021.

Figure A2: McCrary (2008)'s density test



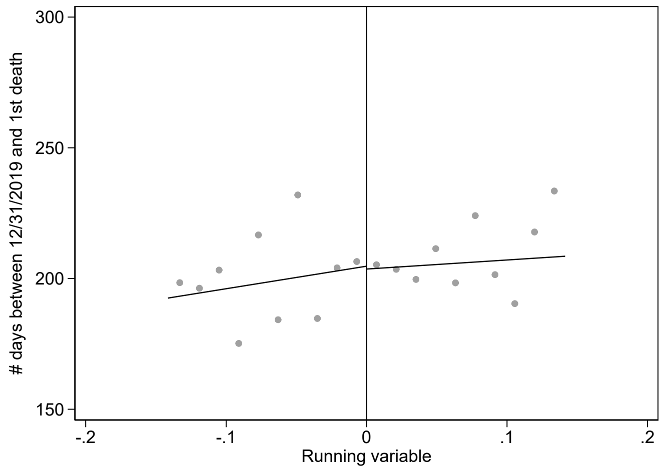
Notes: This Figure tests for a jump in the density of the running variable (the victory margin of the female candidate) at the threshold using the method developed by McCrary (2008). The solid line represents the density of the running variable. Thin lines represent the confidence intervals.

Figure A3: Cattaneo et al. (2018)'s density test



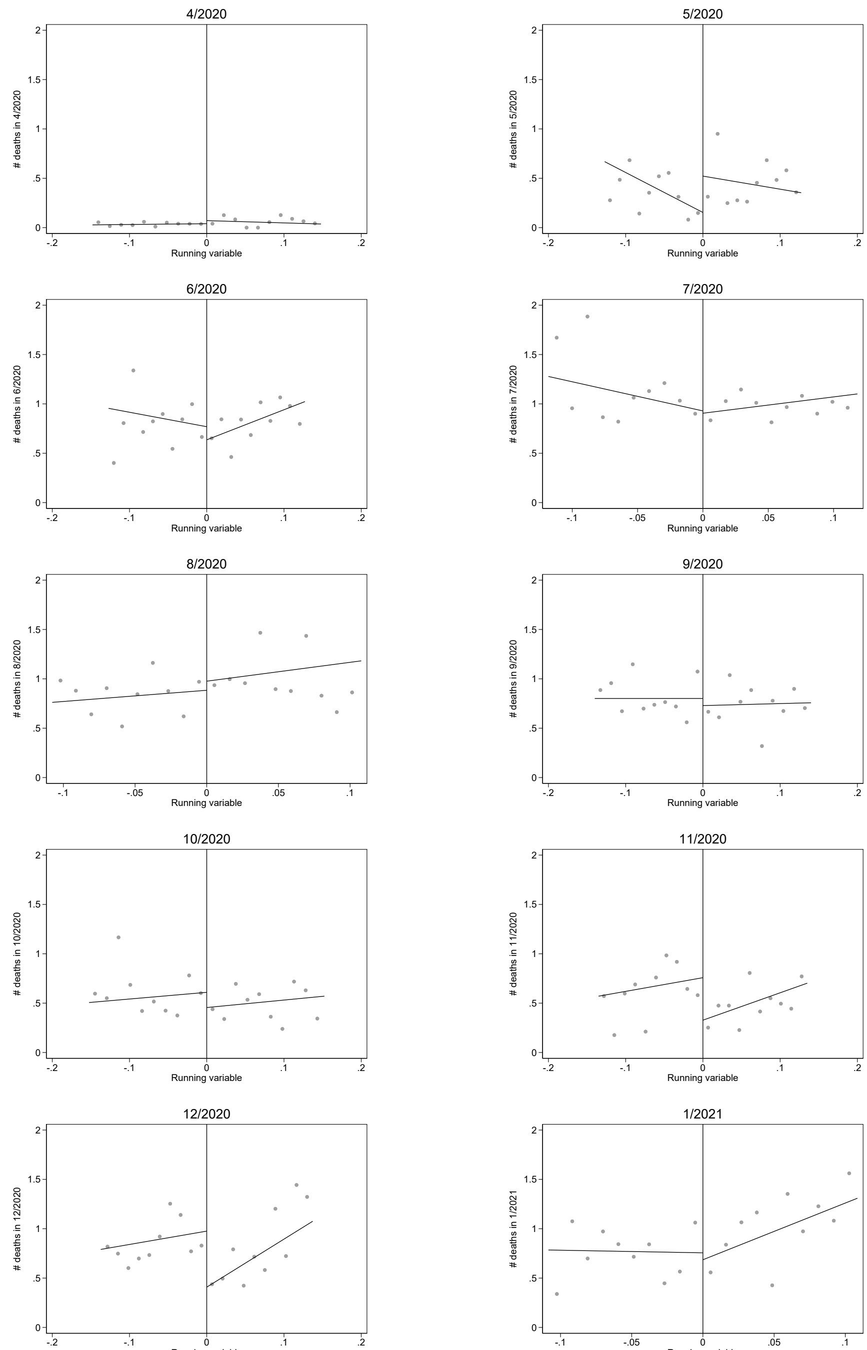
Notes: This Figure tests for a jump in the density of the running variable (the victory margin of the female candidate) at the threshold using the method developed by Cattaneo et al. (2018). The solid line represents the density of the running variable. Thin lines represent the confidence intervals. The p-value associated with the density test is 0.19.

Figure A4: Impact of having a female mayor on the timing of the first COVID-19 death



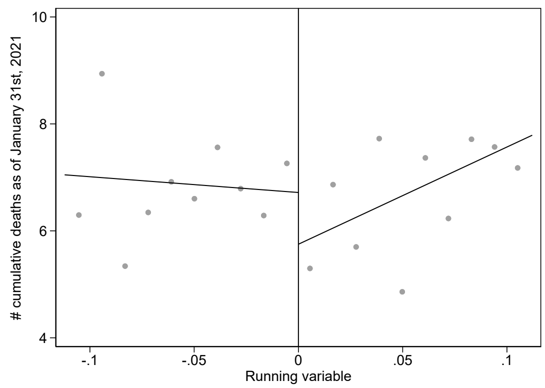
Notes: This figure is constructed by restricting the support to observations in the estimation bandwidths and by setting the fit to match the local polynomial point estimator (polynomial order 1 and triangular kernel). Dots represent the local averages of the number of days between 12/31/2019 and the first reported COVID-19 death. Averages are calculated within evenly-spaced bins of the running variable. The running variable is the margin of victory of the female candidate in the 2016 election (percentage point difference between the vote share of the female and the male candidates). Positive values denote that the female candidate won the election, and negative values that the male candidate prevailed.

Figure A5: Impact of having a female mayor on COVID-19 deaths by month



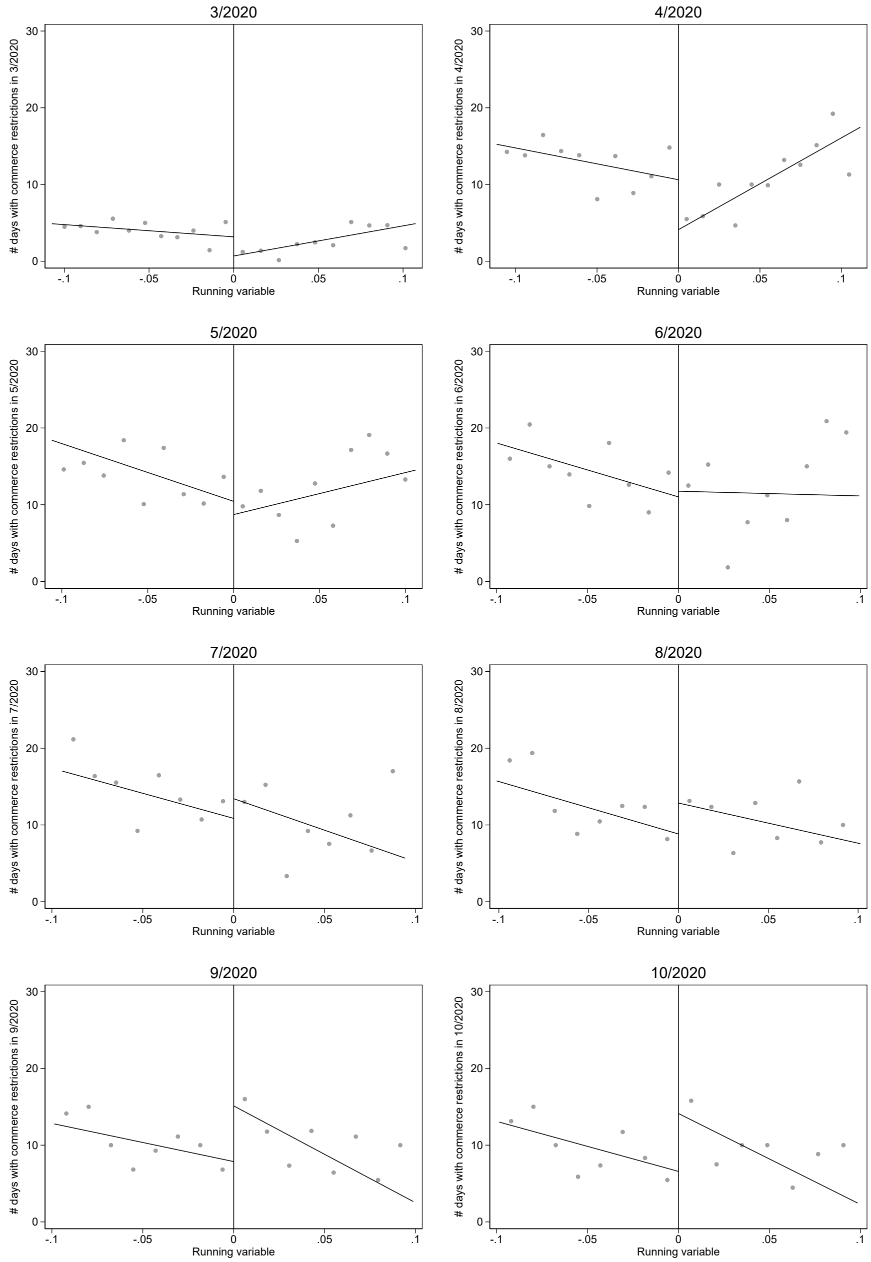
Notes: Each graph is constructed by restricting the support to observations in the estimation bandwidths and by setting the fit to match the local polynomial point estimator (polynomial order 1 and triangular kernel). Dots represent the local averages of the total number COVID-19 deaths per 10,000 inhabitants in the municipality during the month of interest. Averages are calculated within evenly-spaced bins of the running variable. The running variable is the margin of victory of the female candidate in the 2016 election (percentage point difference between the vote share of the female and the male candidates). Positive values denote that the female candidate won the election, and negative values that the male candidate prevailed.

Figure A6: Impact on the cumulative number of COVID-19 deaths as of January 31st, 2021



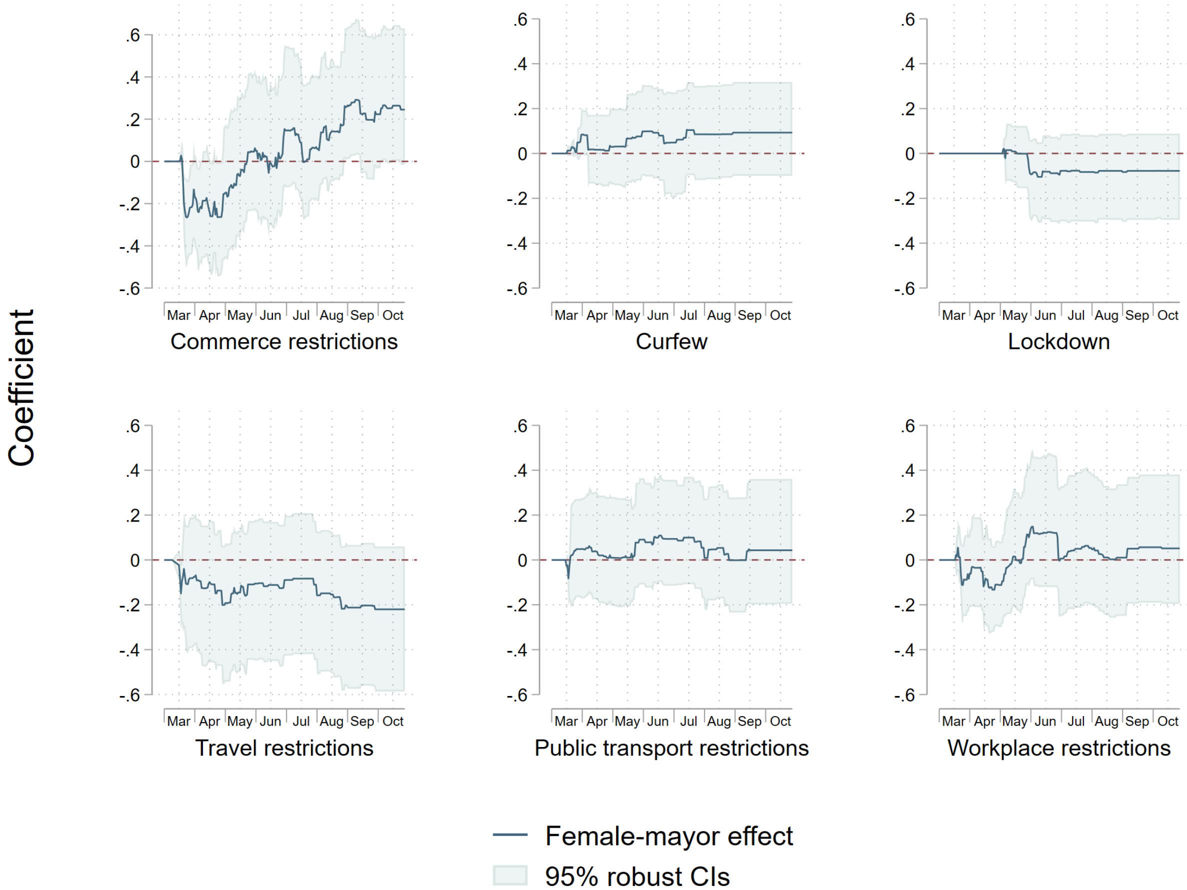
Notes: This figure is constructed by restricting the support to observations in the estimation bandwidths and by setting the fit to match the local polynomial point estimator (polynomial order 1 and triangular kernel). Dots represent the local averages of the cumulative number COVID-19 deaths per 10,000 inhabitants in the municipality as of January 31st, 2021. Averages are calculated within evenly-spaced bins of the running variable. The running variable is the margin of victory of the female candidate in the 2016 election (percentage point difference between the vote share of the female and the male candidates). Positive values denote that the female candidate won the election, and negative values that the male candidate prevailed.

Figure A7: Impact of having a female mayor on commerce restrictions by month



Notes: The sample is restricted to municipalities for which data on policies are available. Each graph is constructed by restricting the support to observations in the estimation bandwidths and by setting the fit to match the local polynomial point estimator (polynomial order 1 and triangular kernel). Dots represent the local averages of the number of days the policy was implemented in the municipality during the month of interest. Averages are calculated within evenly-spaced bins of the running variable. The running variable is the margin of victory of the female candidate in the 2016 election (percentage point difference between the vote share of the female and the male candidates). Positive values denote that the female candidate won the election, and negative values that the male candidate prevailed.

Figure A8: Impact of having a female mayor on policies: Daily estimates



Notes: The sample is restricted to municipalities for which data on policies are available. This figure plots the estimated daily coefficients of the effect of having a female mayor on an indicator equal to 1 if the policy was implemented on that day.

A2 Additional tables

Table A1: Descriptive statistics by gender of the mayor

	Female (N=422)		Male (N=559)	
	Mean	Sd	**Mean**	Sd
Panel A	*Socio-demographic characteristics*			
Population	**13,879**	13,124	**13,965**	12,425
Density	**118.2**	219.0	**120.5**	157.3
Average persons per room	**0.698**	0.216	**0.708**	0.262
Commuting time	**21.60**	4.60	**21.54**	4.54
Share of population $\geq$ 65 years old	**0.083**	0.022	**0.082**	0.024
Nursing home residents per 10k pop	**3.128**	8.829	**4.206**	13.132
Area	**1,689**	5,830	**1,823**	5,199
Distance to São Paulo	**1,453**	740	**1,444**	739
Km to closest airport connecting to hot spots	**289.0**	198.3	**310.5**	225.9
Median household income p/c	**318.3**	138.4	**320.0**	148.1
Informality rate	**0.169**	0.054	**0.169**	0.055
Unemployment rate	**0.044**	0.022	**0.043**	0.021
College graduate employment share	**0.064**	0.029	**0.069**	0.030
Black and mixed population share	**0.590**	0.214	**0.592**	0.215
Panel B	*Political characteristics*			
Turnout	**0.858**	0.060	**0.853**	0.059
Number of candidates	**2.685**	0.969	**2.610**	0.881
Elected president's vote share	**0.316**	0.178	**0.320**	0.191

Notes: The sample includes only municipalities part of our sample of analysis. The first (resp. last) two columns include only municipalities where a female (resp. male) candidate won the 2016 election. Socio-demographic variables come from the 2010 census, except for the density that is defined as the total population living within 10 km of the average inhabitant of the municipality and which is computed using the 2015 data from the Global Human Settlement Layer. The political variables are computed using the results of the first round of the 2016 municipal election, except for the last, which uses data from the first round of the 2018 presidential election. All variables are defined in Appendix Table B1.

Table A2: Descriptive statistics: Comparison with the average Brazilian municipality

	All (N=5,556)		Sample (N=981)	
	Mean	Sd	**Mean**	Sd
Panel A	*Socio-demographic characteristics*			
Population	**33,706**	199,763	**13,928**	12,724
Density	**501.2**	1667.8	**119.5**	186.3
Average persons per room	**0.664**	0.213	**0.704**	0.243
Commuting time	**22.23**	5.98	**21.57**	4.57
Share of population $\geq$ 65 years old	**0.084**	0.025	**0.083**	0.023
Nursing home residents per 10k pop	**5.876**	12.832	**3.742**	11.488
Area	**1,525**	5,645	**1,765**	5477
Distance to São Paulo	**1,168**	754	**1,448**	739
Km to closest airport connecting to hot spots	**272.7**	205.6	**301.3**	214.6
Median household income p/c	**388.3**	165.6	**319.3**	143.9
Informality rate	**0.158**	0.055	**0.169**	0.055
Unemployment rate	**0.043**	0.022	**0.044**	0.021
College graduate employment share	**0.076**	0.036	**0.067**	0.030
Black and mixed population share	**0.516**	0.237	**0.591**	0.214
Panel B	*Political characteristics*			
Turnout	**0.855**	0.060	**0.855**	0.059
Number of candidates	**2.748**	1.170	**2.642**	0.920
Elected president's vote share	**0.387**	0.190	**0.318**	0.186

Notes: The sample includes either all Brazilian municipalities (first two columns), or only municipalities part of our sample of analysis (last two columns). In columns 1 and 2, we exclude 12 municipalities that experienced a redistricting between 2010 (census year) and today, as well as two municipalities that do not hold municipal elections (Brasília and Fernando de Noronha). Socio-demographic variables come from the 2010 census, except for the density that is defined as the total population living within 10 km of the average inhabitant of the municipality and which is computed using the 2015 data from the Global Human Settlement Layer. The political variables are computed using the results of the first round of the 2016 municipal election, except for the last, which uses data from the first round of the 2018 presidential election. The area, distance to São Paulo and number of kilometers to the closest airport are missing for 5 municipalities in the full sample. All variables are defined in Appendix Table B1.

Table A3: Descriptive statistics: Municipalities close to the threshold

	Full sample (N=981)		Close (N=202)	
	Mean	Sd	**Mean**	Sd
Panel A	*Socio-demographic characteristics*			
Population	**13,928**	12,724	**13,880**	11,254
Density	**119.5**	186.3	**109.7**	117.9
Average persons per room	**0.704**	0.243	**0.708**	0.209
Commuting time	**21.57**	4.57	**21.59**	4.70
Share of population $\geq$ 65 years old	**0.083**	0.023	**0.081**	0.023
Nursing home residents per 10k pop	**3.742**	11.488	**3.215**	7.650
Area	**1,765**	5,477	**1,682**	4,634
Distance to São Paulo	**1,448**	739	**1,492**	730
Km to closest airport connecting to hot spots	**301.3**	214.6	**294.3**	202.7
Median household income p/c	**319.3**	143.9	**314.4**	148.4
Informality rate	**0.169**	0.055	**0.167**	0.057
Unemployment rate	**0.044**	0.021	**0.044**	0.023
College graduate employment share	**0.067**	0.030	**0.066**	0.031
Black and mixed population share	**0.591**	0.214	**0.586**	0.225
Panel B	*Political characteristics*			
Turnout	**0.855**	0.059	**0.858**	0.057
Number of candidates	**2.642**	0.920	**2.733**	1.092
Elected president's vote share	**0.318**	0.186	**0.307**	0.193

Notes: The sample includes either all municipalities in our analysis sample (first two columns), or only municipalities close to the discontinuity, defined as municipalities where the victory margin is lower than 4 percentage points (last two columns). Socio-demographic variables come from the 2010 census, except for the density that is defined as the total population living within 1 km of the average inhabitant of the municipality and which is computed using the 2015 data from the Global Human Settlement Layer. The political variables are computed using the results of the first round of the 2016 municipal election, except for the last, which uses data from the first round of the 2018 presidential election. All variables are defined in Appendix Table B1.

Table A4: General balance test

Outcome	(1) Predicted treatment
Treatment	0.020
	(0.011)
Robust p-value	0.129
Observations	527
Polyn. order	1
Bandwidth	0.122
Mean, left of threshold	0.419

Notes: The outcome is the treatment variable predicted by a set of 17 municipal characteristics, as described in Section 3.3. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A5: Descriptive statistics: 2016 Candidates

Panel A	*All candidates (N=16,179)*							
	Female candidates (N=2,105)				Male candidates (N=13,960)			
	mean	sd	min	max	**mean**	sd	min	max
Incumbency	**0.167**	0.373	0	1	**0.178**	0.383	0	1
Age	**47.7**	10.3	20	90	**49.0**	10.8	20	89
White	**0.675**	0.469	0	1	**0.667**	0.471	0	1
Tertiary education	**0.726**	0.446	0	1	**0.494**	0.500	0	1
Occ.: Politics	**0.183**	0.387	0	1	**0.187**	0.390	0	1
Occ.: Public	**0.135**	0.341	0	1	**0.089**	0.284	0	1
Occ.: Health	**0.097**	0.297	0	1	**0.068**	0.252	0	1
Occ.: Business Owner	**0.082**	0.275	0	1	**0.146**	0.353	0	1
Ideological score	**0.187**	0.436	-0.843	0.760	**0.192**	0.427	-0.843	0.760
PMDB	**0.147**	0.354	0	1	**0.141**	0.348	0	1
PSDB	**0.100**	0.300	0	1	**0.107**	0.309	0	1
PT	**0.066**	0.248	0	1	**0.060**	0.238	0	1
Wins	**0.313**	0.464	0	1	**0.360**	0.480	0	1
Panel B	*Winners (N=5,568)*							
	Female candidates (N=626)				Male candidates (N=4,942)			
	mean	sd	min	max	**mean**	sd	min	max
Incumbency	**0.225**	0.418	0	1	**0.239**	0.427	0	1
Age	**47.3**	10.2	21	82	**48.9**	10.8	21	88
White	**0.709**	0.454	0	1	**0.702**	0.457	0	1
Tertiary education	**0.717**	0.451	0	1	**0.500**	0.500	0	1
Occ.: Politics	**0.195**	0.396	0	1	**0.206**	0.405	0	1
Occ.: Public	**0.150**	0.358	0	1	**0.083**	0.276	0	1
Occ.: Health	**0.105**	0.307	0	1	**0.077**	0.266	0	1
Occ.: Business Owner	**0.101**	0.301	0	1	**0.157**	0.364	0	1
Ideological score	**0.278**	0.365	-0.686	0.760	**0.273**	0.369	-0.843	0.760
PMDB	**0.195**	0.396	0	1	**0.183**	0.386	0	1
PSDB	**0.126**	0.332	0	1	**0.146**	0.353	0	1
PT	**0.048**	0.214	0	1	**0.045**	0.206	0	1

Notes: The sample includes all Brazilian municipalities (except Brasília and Fernando de Noronha that do not hold municipal elections). The level of observation is the candidate, considering only "effective" candidates (candidates who did not withdraw their candidacy and who were not disqualified for irregularities before the election). In panel A, we consider all candidates running in the first round (considering candidates running in both supplementary and ordinary elections), whereas in panel B we consider only the ultimate winner (the winner of the supplementary election if one took place). The age of the candidate (resp. education level) is missing for 12 (resp. 5) candidates. All variables are defined in Appendix Table B1.

Table A6: Impact of having a female mayor on the timing of the first COVID-19 death

	(1)
Outcome	Date of the first death
Treatment	-1.087
	(13.171)
Robust p-value	0.955
Observations	594
Polyn. order	1
Bandwidth	0.141
Mean, left of threshold	204.720

Notes: The outcome is the the number of days between 12/31/2019 and the first reported COVID-19 death. It is missing for 20 municipalities in which no death occurred up to May 9, 2021 (day at which the data were generated). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A7: Impact of having a female mayor on monthly COVID-19 deaths

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Outcome	Number of COVID-19 deaths per 10,000 inhabitants									
	04/20	05/20	06/20	07/20	08/20	09/20	10/20	11/20	12/20	01/21
Treatment	0.031	0.368**	-0.133	-0.023	0.092	-0.072	-0.154	-0.431**	-0.568**	-0.070
	(0.037)	(0.174)	(0.256)	(0.232)	(0.288)	(0.192)	(0.191)	(0.187)	(0.219)	(0.266)
R. p-value	0.520	0.040	0.665	0.970	0.973	0.754	0.391	0.027	0.018	0.644
Obs.	632	547	546	514	484	603	651	585	591	488
Polyn.	1	1	1	1	1	1	1	1	1	1
Bandwidth	0.148	0.127	0.127	0.118	0.108	0.140	0.152	0.135	0.137	0.108
Mean	0.040	0.154	0.769	0.929	0.884	0.801	0.610	0.758	0.976	0.756

Notes: Each column takes as outcome the total number of deaths per 10,000 inhabitants (using the 2010 population) during the month of interest. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A8: Impact on the cumulative number of COVID-19 deaths as of January 31st, 2021

	(1)
Outcome	Cumulative number of COVID-19 deaths as of 01/31/2021
Treatment	-0.967
	(0.789)
Robust p-value	0.229
Observations	497
Polyn. order	1
Bandwidth	0.112
Mean, left of threshold	6.717

Notes: The outcome is the cumulative number of deaths per 10,000 inhabitants (using the 2010 population) as of January 31st, 2021. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A9: Impact of having a female mayor on the timing of policies adoption

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome	Date at which the policy was first implemented						
	commerce	workplace	travel	transport	curfew	lockdown	any
Treatment	33.046**	20.190	-4.328	6.118	-23.749	-0.116	16.428
	(13.323)	(23.206)	(15.448)	(30.494)	(32.900)	(18.986)	(9.196)
Robust p-value	0.013	0.538	0.745	0.833	0.568	0.862	0.106
Observations	174	85	127	83	27	24	271
Polyn. order	1	1	1	1	1	1	1
Bandwidth	0.127	0.129	0.137	0.141	0.114	0.140	0.157
Mean, left of threshold	101.548	115.570	107.515	113.924	140.019	141.196	97.620

Notes: The sample varies by policies as, for each policy, it is restricted to municipalities that implemented the policy at some point during the period of analysis. The outcome is the number of days between December 31, 2019 and the first day in which the municipality implemented the corresponding policy (columns 1 through 6) or any of the six policies considered (column 7). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A10: Impact of having a female mayor on workplace restrictions by month

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Number of days with workplace restrictions in place							
	03/20	04/20	05/20	06/20	07/20	08/20	09/20	10/20
Treatment	-0.680	-2.179	-0.233	3.674	1.344	0.694	1.476	1.843
	(0.847)	(2.508)	(3.202)	(3.908)	(3.898)	(3.788)	(3.744)	(3.798)
Robust p-value	0.614	0.579	0.834	0.241	0.576	0.692	0.549	0.487
Observations	256	269	256	227	249	255	250	249
Polyn. order	1	1	1	1	1	1	1	1
Bandwidth	0.119	0.127	0.118	0.096	0.110	0.116	0.113	0.111
Mean, left of threshold	1.398	4.925	5.616	4.742	6.216	6.730	6.918	7.020

Notes: The sample is restricted to municipalities for which data on policies are available. The outcome is the number of days during which the policy was in place, separately for each month. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A11: Impact of having a female mayor on travel restrictions by month

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Number of days with travel restrictions in place							
	03/20	04/20	05/20	06/20	07/20	08/20	09/20	10/20
Treatment	-1.352	-3.576	-4.349	-3.366	-2.571	-4.899	-6.232	-6.604
	(1.522)	(3.796)	(3.922)	(4.006)	(4.002)	(4.077)	(4.151)	(4.213)
Robust p-value	0.367	0.315	0.239	0.377	0.495	0.215	0.129	0.111
Observations	255	249	249	250	250	245	243	237
Polyn. order	1	1	1	1	1	1	1	1
Bandwidth	0.115	0.110	0.111	0.112	0.113	0.108	0.107	0.104
Mean, left of threshold	3.267	8.453	11.005	11.888	11.713	12.702	13.301	13.413

Notes: The sample is restricted to municipalities for which data on policies are available. The outcome is the number of days during which the policy was in place, separately for each month. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A12: Impact of having a female mayor on transport restrictions by month

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Number of days with transport restrictions in place							
	03/20	04/20	05/20	06/20	07/20	08/20	09/20	10/20
Treatment	0.309	0.949	0.919	2.719	2.696	0.979	0.641	1.293
	(1.196)	(3.063)	(3.110)	(3.087)	(3.123)	(3.262)	(3.432)	(3.649)
Robust p-value	0.846	0.640	0.624	0.308	0.323	0.647	0.699	0.564
Observations	280	257	255	256	256	252	249	237
Polyn. order	1	1	1	1	1	1	1	1
Bandwidth	0.132	0.120	0.115	0.118	0.118	0.114	0.110	0.104
Mean, left of threshold	2.028	5.071	5.064	4.546	4.731	6.114	6.724	6.875

Notes: The sample is restricted to municipalities for which data on policies are available. The outcome is the number of days during which the policy was in place, separately for each month. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A13: Impact of having a female mayor on curfew by month

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome	Number of days with a curfew in place						
	04/20	05/20	06/20	07/20	08/20	09/20	10/20
Treatment	0.898	1.558	2.415	2.354	2.562	2.789	2.789
	(1.780)	(2.246)	(2.557)	(2.686)	(2.655)	(2.674)	(2.674)
Robust p-value	0.663	0.575	0.431	0.486	0.365	0.304	0.304
Observations	277	266	259	256	259	257	257
Polyn. order	1	1	1	1	1	1	1
Bandwidth	0.130	0.125	0.122	0.118	0.121	0.119	0.119
Mean, left of threshold	1.418	1.810	1.987	2.517	2.450	2.423	2.423

Notes: The sample is restricted to municipalities for which data on policies are available. The outcome is the number of days during which the policy was in place, separately for each month. We start in April as no municipality in our sample implemented a curfew in March. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A14: Impact of having a female mayor on lockdown by month

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome	Number of days with a lockdown in place					
	05/20	06/20	07/20	08/20	09/20	10/20
Treatment	0.061	-2.696	-2.380	-2.396	-2.364	-2.329
	(1.363)	(2.330)	(2.540)	(2.491)	(2.494)	(2.484)
Robust p-value	0.875	0.212	0.270	0.274	0.281	0.289
Observations	270	270	245	242	250	250
Polyn. order	1	1	1	1	1	1
Bandwidth	0.128	0.109	0.106	0.111	0.111	0.112
Mean, left of threshold	1.076	3.768	4.001	3.896	3.867	3.813

Notes: The sample is restricted to municipalities for which data on policies are available. The outcome is the number of days during which the policy was in place, separately for each month. We start in May as no municipality in our sample implemented a lockdown in March and April. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A15: Impact on commerce restrictions, adding state fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Number of days with commerce restrictions in place							
	Full sample				Restricted + State FEs			
	03/20	04/20	09/20	10/20	03/20	04/20	09/20	10/20
Treatment	-2.495**	-6.507**	7.254*	7.541*	-2.620***	-5.434*	6.893*	7.108*
	(0.977)	(2.837)	(4.338)	(4.298)	(0.869)	(2.611)	(4.147)	(4.107)
Robust p-value	0.018	0.037	0.067	0.056	0.007	0.075	0.069	0.057
Observations	243	250	232	232	268	214	177	181
Polyn. order	1	1	1	1	1	1	1	1
Bandwidth	0.107	0.112	0.099	0.099	0.143	0.107	0.085	0.087
Mean, left of threshold	3.182	10.624	7.862	6.582	3.913	11.870	9.323	7.877

Notes: The sample is restricted to municipalities for which data on policies are available. In columns 5 to 8, the estimation includes state fixed effects and we remove municipalities part of states with fewer than 20 municipalities in our sample (8.0 percent). The outcome is the number of days during which the policy was in place, separately for each month. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robustp-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A16: Impact of having a female mayor on the isolation index around election day

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Outcome	Share of phone users staying at home on each day from November 10 to 20										
	10	11	12	13	14	15	16	17	18	19	20
Treatment	1.048	0.157	0.950	3.849**	5.581**	0.733	-0.573	3.662*	4.152*	6.951***	1.083
	(2.117)	(2.142)	(1.419)	(1.867)	(2.473)	(1.955)	(1.873)	(1.753)	(2.499)	(1.705)	(2.186)
R. p-value	0.593	0.955	0.520	0.038	0.023	0.609	0.747	0.055	0.071	0.000	0.501
Obs	151	158	187	119	142	140	158	162	114	130	166
Polyn. order	1	1	1	1	1	1	1	1	1	1	1
Bandwidth	0.118	0.125	0.154	0.091	0.108	0.106	0.125	0.128	0.085	0.098	0.133
Mean	36.642	36.917	35.504	33.147	32.739	36.406	39.325	36.654	36.084	34.289	36.828

Notes: The sample is restricted to municipalities with no missing value between Feb-25-2020 and Jan-31-2021. The outcome is the share of phone users staying at home on a given day. We provide the estimated impact for each day from November 10th to November 20th. The day of the election was Sunday November 15th (column 6). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A17: Descriptive statistics by term limit status

	Both can run		Female can run Male cannot		Male can run Female cannot	
	N=502		N=266		N=213	
	Mean	Sd	**Mean**	Sd	**Mean**	Sd
Panel A	*Socio-demographic characteristics*					
Population	**13,353**	12,295	**14,917**	13,734	**14,049**	12,384
Density	**115.4**	144.6	**130.7**	193.8	**115.0**	252.5
Average persons per room	**0.702**	0.259	**0.710**	0.235	**0.699**	0.214
Commuting time	**21.38**	4.56	**21.92**	4.35	**21.57**	4.84
Share of population $\geq$ 65 years old	**0.082**	0.023	**0.081**	0.023	**0.085**	0.023
Nursing home residents per 10k pop	**4.048**	12.710	**3.409**	10.108	**3.437**	10.005
Area	**1,765**	5,104	**1,904**	6,198	**1,593**	5389
Distance to São Paulo	**1,433**	749	**1,454**	706	**1,478**	758
Km to closest airport connecting to hot spots	**305.9**	224.1	**303.2**	199.0	**287.9**	211.1
Median household income p/c	**327.3**	145.8	**311.2**	143.2	**310.4**	140.1
Informality rate	**0.168**	0.056	**0.170**	0.052	**0.171**	0.055
Unemployment rate	**0.044**	0.021	**0.044**	0.021	**0.044**	0.022
College graduate employment share	**0.069**	0.030	**0.066**	0.032	**0.062**	0.026
Black and mixed population share	**0.582**	0.218	**0.612**	0.206	**0.586**	0.215
Panel B	*Political characteristics*					
Turnout	**0.857**	0.062	**0.848**	0.054	**0.860**	0.058
Number of candidates	**2.659**	0.969	**2.609**	0.897	**2.643**	0.827
Elected president's vote share	**0.329**	0.189	**0.312**	0.185	**0.300**	0.176

The sample includes all municipalities in our analysis sample split in groups depending on the incumbent status of the candidates (as indicated in the column titles, when "can run" indicates that the candidate is not term-limited). Socio-demographic variables come from the 2010 census, except for the density that is defined as the total population living within 1 km of the average inhabitant of the municipality and which is computed using the 2015 data from the Global Human Settlement Layer. The political variables are computed using the results of the first round of the 2016 municipal election, except for the last, which uses data from the first round of the 2018 presidential election. All variables are defined in Appendix Table B1.

Table A18: Impact on COVID-19 deaths, by mayors' education level

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome	Number of Covid-19 deaths - Mayor can run					
	Full sample		No higher educaton		Higher education	
Periods	1	4	1	4	1	4
Treatment	0.548**	-1.250**	0.839**	-1.545	0.371*	-1.009**
	(0.224)	(0.523)	(0.405)	(0.876)	(0.213)	(0.506)
Robust p-value	0.014	0.019	0.045	0.108	0.068	0.037
Observations	387	375	194	182	204	176
Polyn. order	1	1	1	1	1	1
Bandwidth	0.120	0.111	0.128	0.118	0.117	0.095
Mean	0.197	2.722	0.266	3.182	0.125	2.310

The sample is restricted to municipalities in which the mayor is elected for the first time in 2016 and can thus run for re-election. In columns 3 and 4 (resp. 5 and 6), the sample is restricted to municipalities where the mayor has not completed higher education (resp. has completed higher education). In columns 1, 3 and 5 (resp. 2, 4 and 6), the outcomes is the total number of deaths per 10,000 inhabitants during period 1 (resp. 4), corresponding to April-May 2020 (resp. November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A19: Impact on COVID-19 deaths, by mayors' age

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome	Number of Covid-19 deaths - Mayor can run					
	Full sample		Below age median		Above age median	
Periods	1	4	1	4	1	4
Treatment	0.548**	-1.250**	0.495**	-1.647**	0.534*	-0.810
	(0.224)	(0.523)	(0.230)	(0.720)	(0.310)	(0.760)
Robust p-value	0.014	0.019	0.022	0.025	0.083	0.334
Observations	387	375	183	191	230	187
Polyn. order	1	1	1	1	1	1
Bandwidth	0.120	0.111	0.107	0.116	0.148	0.110
Mean	0.197	2.722	0.137	2.782	0.320	2.602

The sample is restricted to municipalities in which the mayor is elected for the first time in 2016 and can thus run for re-election. In columns 3 and 4 (resp. 5 and 6), the sample is restricted to municipalities where mayor is below (resp. above) the median age. In columns 1, 3 and 5 (resp. 2, 4 and 6), the outcomes is the total number of deaths per 10,000 inhabitants during period 1 (resp. 4), corresponding to April-May 2020 (resp. November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A20: Impact on COVID-19 deaths, by mayors' previous legislative office

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome	Number of Covid-19 deaths - Mayor can run					
	Full sample		Has not served		Has served	
Periods	1	4	1	4	1	4
Treatment	0.548**	-1.250**	0.574**	-0.795	0.470	-4.328**
	(0.224)	(0.523)	(0.250)	(0.510)	(0.369)	(1.827)
Robust p-value	0.014	0.019	0.019	0.108	0.200	0.034
Observations	387	375	341	330	45	46
Polyn. order	1	1	1	1	1	1
Bandwidth	0.120	0.111	0.117	0.112	0.114	0.123
Mean	0.197	2.722	0.225	2.190	-0.037	6.431

The sample is restricted to municipalities in which the mayor is elected for the first time in 2016 and can thus run for re-election. In columns 3 and 4 (resp. 5 and 6), the sample is restricted to municipalities where the mayor in 2016 has not served as a legislator during the 2012-2016 term (resp. as served as a legislator). In columns 1, 3 and 5 (resp. 2, 4 and 6), the outcomes is the total number of deaths per 10,000 inhabitants during period 1 (resp. 4), corresponding to April-May 2020 (resp. November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold. Note that the means at the threshold are estimated quite imprecisely in columns 5 and 6 due to the small sample size.

Table A21: Impact on COVID-19 deaths, by municipalities's gender gap in labor force participation

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome	Number of Covid-19 deaths - Mayor can run					
	Full sample		Above median		Below median	
Periods	1	4	1	4	1	4
Treatment	0.548**	-1.250**	0.525*	-2.032***	0.346	-0.525
	(0.224)	(0.523)	(0.309)	(0.768)	(0.261)	(0.687)
Robust p-value	0.014	0.019	0.063	0.008	0.214	0.562
Observations	387	375	246	191	214	214
Polyn. order	1	1	1	1	1	1
Bandwidth	0.120	0.111	0.158	0.111	0.138	0.137
Mean	0.197	2.722	0.322	3.191	0.188	2.264

Notes: The sample is restricted to municipalities in which the mayor is elected for the first time in 2016 and can thus run for re-election. In columns 3 and 4 (resp. 5 and 6), the sample is further restricted to municipalities where the gap in the labor force participation of female and male residents is above the median (resp. below the median). In columns 1, 3 and 5 (resp. 2, 4 and 6), the outcomes is the total number of deaths per 10,000 inhabitants during period 1 (resp. 4), corresponding to April-May 2020 (resp. November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table A22: Impact on the 2020 election

Outcome	(1) Run	(2) Win	(3) Conditional on running vote share	(4) win
Treatment	0.024	0.035	0.012	0.042
	(0.084)	(0.075)	(0.040)	(0.115)
Robust p-value	0.799	0.550	0.619	0.563
Observations	655	664	284	386
Polyn. order	1	1	1	1
Bandwidth	0.154	0.157	0.113	0.161
Mean, left of threshold	0.569	0.252	0.445	0.448

Notes: In column 1, the outcome is an indicator variable equal to one if the 2016 mayor runs in the 2020 election. In columns 2 and 4 the outcome is an indicator variable equal to one if the 2016 mayor gets re-elected in 2020. In column 3, the outcome is the vote share obtained by the 2016 mayor in the first round of the 2020 election. In columns 3 and 4 the sample is restricted to mayors who ran again in 2020. Note that this restriction is unlikely to create selection issues due to the null impact on running in column 1. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

B Data appendix

B1 Variable definitions and sources

Table B1: Definition and sources of variables used in the analysis

Variables	Dataset	Date	Description / comments
			Panel A: Municipality level socio-demographic characteristics
Population	Census	2010	Total population of the municipality.
Density	GHSL	2015	Total population living within 10 km of the average inhabitant of the municipality. For each municipality, we count the total population living in a 10km radius (encompassing both areas inside and outside the municipality's perimeter) around each 1 square km pixel composing the area of the municipality. We then average this count using each pixel's population as weights.
Average persons per room	Census	2010	Number of individuals living in the household, divided by the number of rooms in the dwelling.
Commuting time	Census	2010	Average time that the municipality's employed population usually spend in travel from home to work, in minutes.
Share of population $\geq$65 years old	Census	2010	Share of the municipality´s population aged 65 or above.
Nursing home residents per 10k pop	Census	2010	Number of individuals aged 65 or above living in nursings homes or asylums, per 10,000 individuals (considering residents aged 18 or above) living in the municipality.
Area	IBGE	2010	Area of the municipality in squared-kilometers.
Distance to São Paulo	IBGE	2010	Geographical distance (straight line along earth's surface), in kilometers, between each municipality and the city of São Paulo.
Km to closest airport connecting to hot spots	ANAC	2010	Geographical distance, in kilometers (straight line along earth's surface), to nearest airport having at least a flight connecting Brazil with the US, UK, France, Spain, Italy, Germany, or China.
Median household income p/c	Census	2010	Municipality's median household income per capita. Total household income includes all sources of income, both labor and non-labor income, and is divided by the total number of household members.
Informality rate	Census	2010	Share of the municipality's working age population (18 y.o. or above) that work as employees without a signed work card. Self-employed individuals are not considered informal.
Unemployment rate	Census	2010	Share of the municipality's working age population (18 y.o. or above) that did not work for at least one hour in the week of reference, but that actively looked for a job in that month.
Gender wage gap	Census	2010	Gender difference in the municipality's mean residual labor income. Residual income is computed from a linear regression of the individual's total labor income on age, education, and job occupation.
Labor force participation gap	Census	2010	Gender difference in the municipality's labor force participation rate. The participation rate is the share of the municipality's working age population (18 y.o. or above) that is employed or unemployed.
College graduate employment share	Census	2010	The share of the municipality's population that had completed college education or a higher educational level among those employed who reported their educational status in the census.
Black and mixed population share	Census	2010	Share of the municipality's population that declares to be black or mixed-race.

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Variables	Dataset	Date	Description / comments
			Panel B: Municipality level electoral variables
Turnout	TSE	2016	Share of registered voters who cast a vote in the first round of the 2016 election.
Number of candidates	TSE	2016	Number of candidates running for mayor in the first round of the 2016 election.
Elected president's vote share	TSE	2018	Share of votes in the first round of the 2018 presidential elections that went to the elected president.
			Panel C: Candidate-level electoral variables
Election winner	TSE	2016	Dummy variable that equals one if the candidate has the largest share of valid votes as registered by the electoral justice in the first round, in case there was not second round, or in the second round, in case there was one.
Gender of the candidates	TSE	2016	Dummy variable that equals one if the candidate is a female, as registered by the electoral justice (not self-declared), and zero if male. This variable was verified using an algorithm that computes the probability of being a female according to the candidate's first name. Only one correction was manually made after this check.
Incumbency status of the candidates	TSE	2016	Dummy variable that equals one if the candidate ran the election as the incumbent, i.e., ran for reelection, and zero otherwise. This variable was constructed by using the self-declaration of candidates and verified by matching the name of the candidate with the name of the winner of the 2012 election.
Age	TSE	2016	Age of the candidate at the time of the election, computed using the election's date and the candidate's date of birth as registered by the electoral justice. In the case of supplementary elections we follow the same logic and compute the candidate's age as of the supplementary election date.
Education	TSE	2016	Dummy variable that equals one if the candidate has completed tertiary-level education.
Race	TSE	2016	Dummy variable that equals one if the candidate has self-declared as white.
Occupation	TSE	2016	Professional occupation of the candidate. There are 167 different occupations declared by the candidates in the 2016 election data. We manually classified these occupations into four relevant areas: (1) politics; (2) public servants; (3) health-related; and (4) business owners.
Political party	TSE	2016	Political party under which the mayoral candidate ran in the 2016 elections.
Ideological Score	BLS	2019	To each candidate we assign their party's ideology score from the 2018 wave of the Brazilian Legislative Survey (BLS) (Zucco and Power, 2019). We use data and replications files from Power and Rodrigues-Silveira (2019), who further impute the score for smaller parties. The score is centered around zero and goes from -1 (extreme-left) to +1 (extreme-right), and are adjusted to take into account party movements across years.

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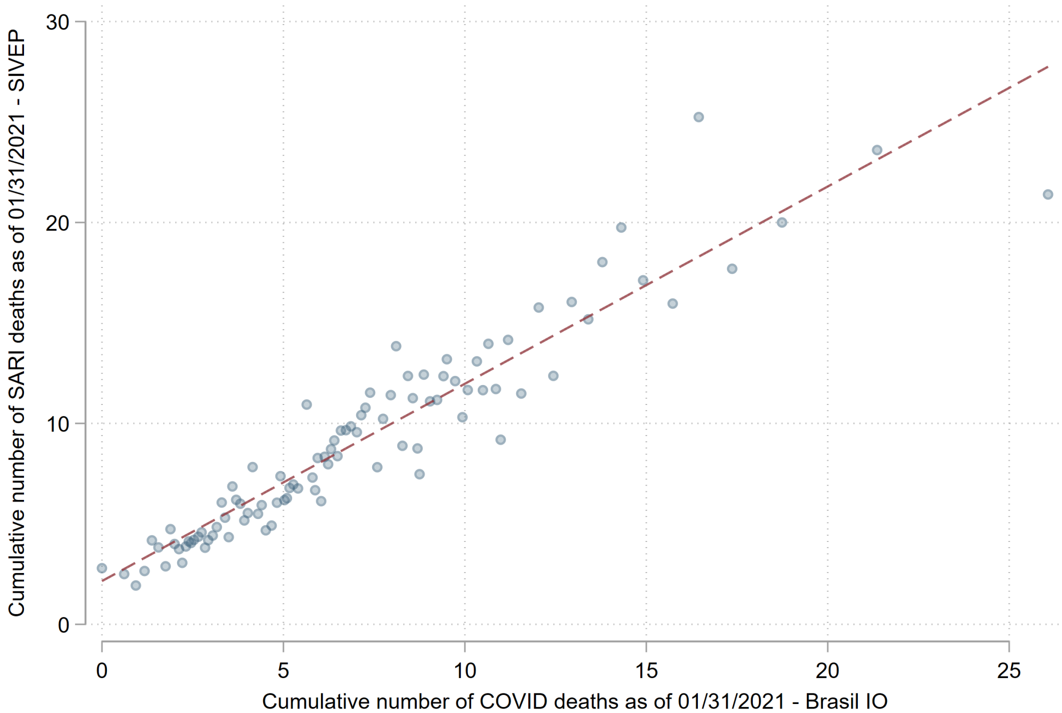
Variables	Dataset	Date	Description / comments
			Panel D: Main outcomes
Deaths per 10k	Brazil IO	2020-21	Number of confirmed COVID-19 deaths registered in the municipality for each day, normalized using the 2010 population so that it gives the number of daily deaths per 10,000 inhabitants. We then either use the data day by day or aggregate it by months and periods. Brazil IO collected the data directly from state's secretaries.
Deaths per 10k	SIVEP-Gripe	2020-21	Number of confirmed COVID-19 deaths registered in the municipality for each day, normalized using the 2010 population so that it gives the number of daily deaths per 10,000 inhabitants. We then either use the data day by day or aggregate it by months and periods. SIVEP-Gripe is a registry maintained by the Ministry of Health of deaths from Severe Acute Respiratory Infection (SARI), a broader category that includes deaths coming from COVID-19 as well as deaths coming from other diseases with similar symptoms. The registry contains data from both public and private hospitals.
Timing of first confirmed death	Brazil IO	2020-21	Number of days between 12/31/2019 and the first confirmed COVID-19 death registered in each municipality.
Policy variables	Own data collection	2020	Policies types: commerce restrictions (closing non-essential businesses), gathering, transport, travel, and workplace restrictions, events cancellations, school closures, curfews, lockdowns and face mask mandates. Dummy equals to one if the policy was in place in the municipality on a given day. We use it daily and also aggregate it by week. Data was collected directly from the cities' own official diaries, where all decrees and policies must be formally published before being valid (Diário Oficial do Município). Data collection follows Chauvin et al. (2021).
Daily Social Distancing Index	InLoco	2020-21	Share of active phone users staying within 450 meters of their residence in a given municipality on a given day. The index is measured using anonymized geolocalization data from around 30 million cellphones in Brazil. InLoco infers residences' locations through users' usual night-time location.

Notes: Census' period of reference is the last week of July 2010, unless otherwise stated.

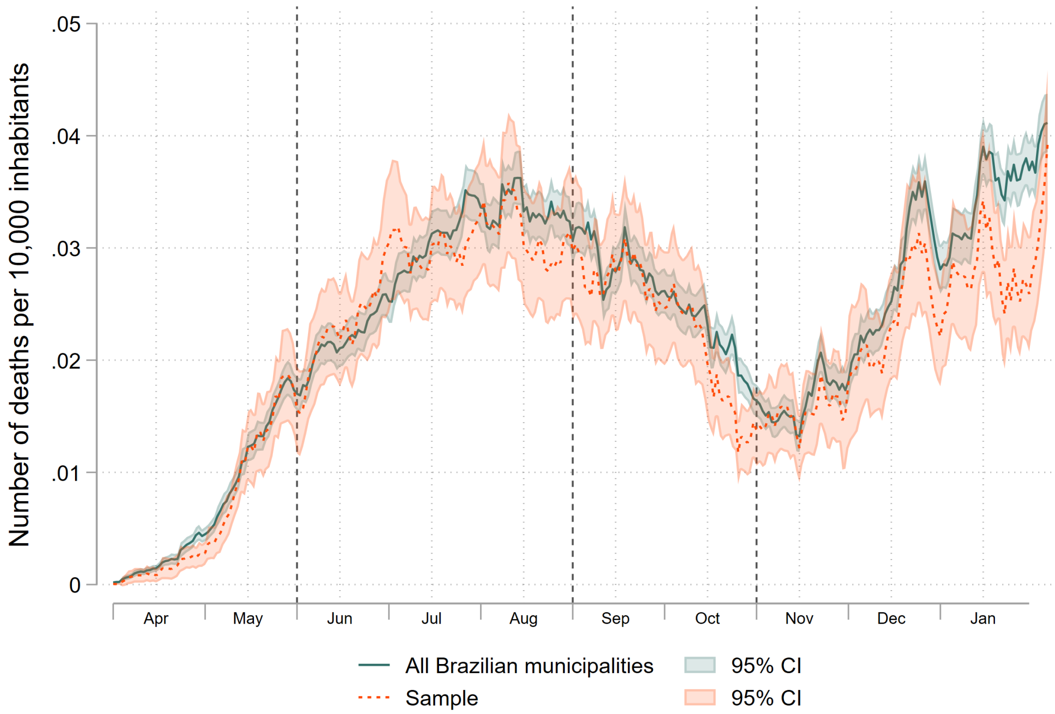
B2 COVID-19 data

Figure B1: Correlation of municipal COVID-19 deaths (Brasil.io) and deaths attributed to Severe Acute Respiratory Infections (SIVEP-Gripe)



Notes: This scatterplot reports the cumulative number of COVID-19 deaths per 10,000 inhabitants as of January 31, 2021 in each municipality part of our sample coming from the Brasil.io dataset (x-axis) and the cumulative number of deaths per 10,000 inhabitants attributed to Severe Acute Respiratory Infections (SARI) using the SIVEP-Gripe dataset (y-axis).

Figure B2: Evolution of COVID-19 deaths across Brazilian municipalities



Notes: This graph plots the cross-municipality averages of the 7-day moving average of the number of deaths per 10,000 inhabitants (using the 2010 population) across Brazilian municipalities for each day from April 1st to January 31st. In blue, we consider all Brazilian municipalities, while in orange we consider only municipalities part of our sample of analysis. For both, we exclude municipalities in the state of Mato Grosso (3.3 percent), where we detected some misreporting issues. The vertical lines separate the four main periods that characterize the evolution of COVID-19 in Brazil and that we analyze separately in Section 4.1: the beginning of the first wave (April-May 2020), peak of the first wave (June-August 2020), end of the first wave (September-October 2020), and the beginning of the second wave (November 2020-January 2021).

B3 Policies data

Table B2: Number and share of municipalities that implemented containment policies

Policy	Representative municipalities	Share of total (%)	Municipalities in sample	Share of total (%)
Commerce restrictions	353	70.46	315	66.18
Curfew	54	10.78	57	11.97
Events cancellations	474	94.61	453	95.17
Facemask mandatory	457	91.22	419	88.03
Gathering restrictions	453	90.42	428	89.92
Lockdown	40	7.98	38	7.98
School closure	461	92.02	447	93.91
Transport restrictions	200	39.92	144	30.25
Travel restrictions	199	39.72	202	42.44
Workplace restrictions	147	29.34	145	30.46
Total	501	100	476	100

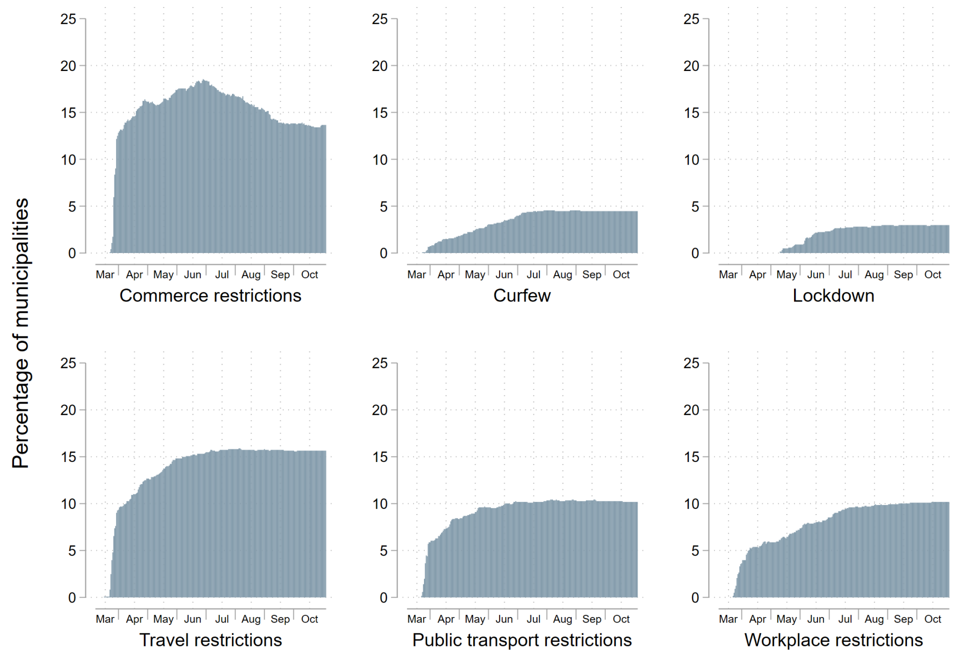
Notes: This table gives the number and share of municipalities that implemented the policy at least once from March to October 2020. The first two columns consider a random sample of representative Brazilian municipalities, taken from Chauvin et al. (2021). The last two columns consider the municipalities part of our sample of analysis for which data on policies are available.

Table B3: Probability of implementing policy A (Row) given that policy B (Column) is in place the same day

	Commerce	Curfew	Events cancel	Face-masks	Gatherings	Lockdown	School	Transport	Travel	Workplace
Commerce	100	50.69	41.88	42.35	45.06	30.85	40.94	44.02	45.53	50.65
Curfew	11.43	100	9.17	11.57	9.7	18.15	9.14	10.87	12.52	14.1
Events cancel	96.19	93.38	100	93.19	95.47	95.15	93.63	94.58	94.86	95.79
Face-masks	76.87	93.15	73.65	100	75.5	100	75.25	83.73	81.77	84.23
Gatherings	88.71	84.72	81.82	81.88	100	77.89	80.13	84.25	85.89	85.21
Lockdown	3.83	10.01	5.15	6.85	4.92	100	5.17	5.36	6.37	4.33
School	93.33	92.46	92.93	94.51	92.79	94.81	100	92.07	94.58	94.48
Transport	26.92	29.49	25.19	28.21	26.18	26.35	24.7	100	36.76	29.72
Travel	42.57	51.93	38.62	42.13	40.8	47.93	38.79	56.19	100	52.2
Workplace	27.08	33.45	22.3	24.82	23.15	18.62	22.16	25.98	29.85	100

Notes: Each cell represents the days a policy in the row was implemented during the days a policy in the column was in place in the same municipality, expressed as a share of the total number of days that the policy in the column was in place (across all municipality-date units of observation) in the period from March 1, 2020 through October 31, 2020. The sample is made by a random sample of representative Brazilian municipalities taken from Chauvin et al. (2021), and restricted to municipalities also part of our analysis sample.

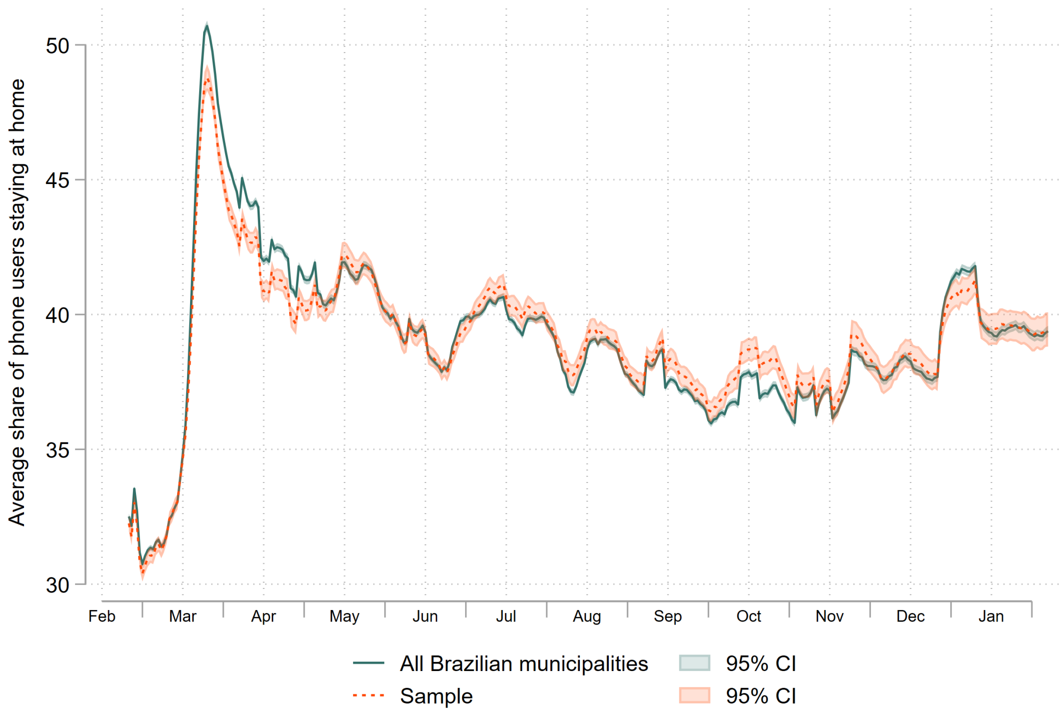
Figure B3: Frequency of use of containment policies over time



Notes: Each graph plots the share of municipalities adopting the policy on a given day, from March 1st to October 31st 2020.

B4 Isolation data

Figure B4: Evolution of the isolation index across Brazilian municipalities



Notes: This graph plots the average share of phone users staying at home across Brazilian municipalities for each day from February 25, 2020 to January 31, 2021. In blue, we consider all Brazilian municipalities, while in orange we consider only municipalities part of our sample of analysis. For both, we consider a balanced panel of municipalities, excluding those with missing values during the period of interest.

C Balance tests

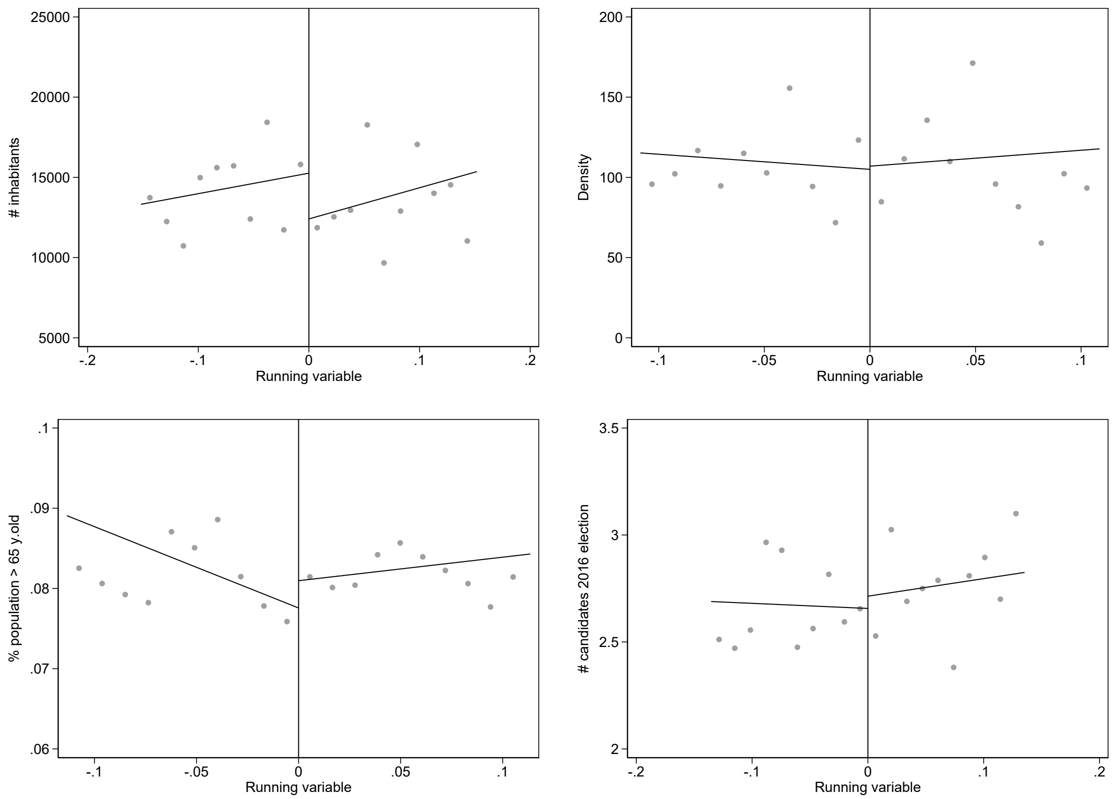
Table C1: Balance Test: Municipalities' characteristics

Outc.	(1) pop	(2) density	(3) persons /room	(4) commuting	(5) % above 65 y.old	(6) nursing h. residents	(7) area	(8) distance to São Paulo	(9) km to airport
Treat.	-2,851	2.0	-0.032	0.276	0.003	-1.096	-1,794*	-109	-65.0
	(1,993)	(23.7)	(0.037)	(0.858)	(0.004)	(1.458)	(838)	(123)	(36.6)
P-value	0.201	0.780	0.456	0.736	0.359	0.610	0.062	0.487	0.117
Obs	648	489	606	515	499	580	538	604	587
Polyn.	1	1	1	1	1	1	1	1	1
Bdw	0.152	0.109	0.142	0.119	0.114	0.134	0.125	0.140	0.136
Mean	15,263	105.0	0.731	21.300	0.078	4.007	2,923	1,552	344.72

Outc.	(10) median income	(11) inform. rate	(12) unemp. rate	(13) % college employed	(14) % black & mixed	(15) turnout	(16) number cand	(17) elected president's vote share
Treat.	34.4	0.003	-0.004	-0.005	-0.045	0.019	0.057	0.014
	(20.6)	(0.010)	(0.004)	(0.005)	(0.037)	(0.010)	(0.181)	(0.030)
P-value	0.136	0.779	0.497	0.439	0.311	0.138	0.898	0.849
Obs	719	565	606	584	570	579	586	677
Polyn.	1	1	1	1	1	1	1	1
Bdw	0.184	0.130	0.141	0.135	0.131	0.133	0.135	0.163
Mean	293.1	0.168	0.046	0.069	0.613	0.846	2.657	0.301

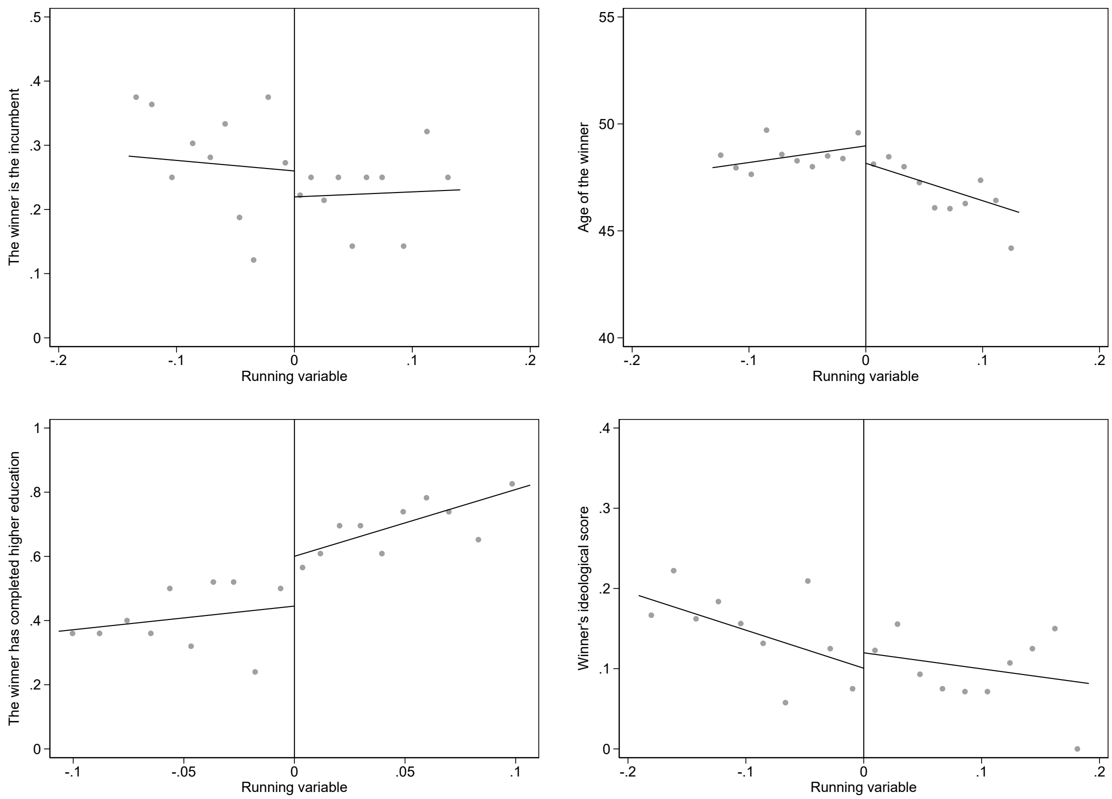
Notes: Each column considers a specific baseline characteristic, as defined in Table B1. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Figure C1: Balance Test: Municipality's characteristics



Notes: This figure shows the balance test results visually for four baseline variables (population, density, share of the population above 65 years old, and the number of candidates in the 2016 election). Each graph is constructed by restricting the support to observations in the estimation bandwidths and by setting the fit to match the local polynomial point estimator (polynomial order 1 and triangular kernel). Dots represent the local averages of the baseline characteristic. Averages are calculated within evenly-spaced bins of the running variable. The running variable is the margin of victory of the female candidate in the 2016 election (percentage point difference between the vote share of the female and the male candidates). Positive values denote that the female candidate won the election, and negative values that the male candidate prevailed.

Figure C2: Balance test: Characteristics of the winner of the election



Notes: This figure shows the balance test results visually for four winner's characteristics (incumbency, age, education, and ideological score). Each graph is constructed by restricting the support to observations in the estimation bandwidths and by setting the fit to match the local polynomial point estimator (polynomial order 1 and triangular kernel). Dots represent the local averages of the outcome variable. Averages are calculated within evenly-spaced (resp. quantile-spaced) bins of the running variable for continuous (resp. binary) outcome variables. The running variable is the margin of victory of the female candidate in the 2016 election (percentage point difference between the vote share of the female and the male candidates). Positive values denote that the female candidate won the election, and negative values that the male candidate prevailed.

D Robustness tests

Alternative death measure. To make sure that our results are not affected by misreporting issues, we use as alternative outcome the number of deaths attributed to Severe Acute Respiratory Infections (SARI) from the SIVEP-Gripe dataset described in Section 2.3. Tables D1 and D2 replicate our main results using the total number of deaths by period and month, respectively. As in our main tables (Table 3 and Appendix Table A7) the point estimate is large and positive in period 1, an effect driven by the month of May 2020, while the point estimate is large and negative in period 4, an effect driven by the months of November and December 2020. Finally, Figure D1 plots the daily estimates for both SARI deaths and our main measure of COVID-19 deaths. The patterns are very similar, with positive coefficients at the beginning of the period and negative coefficients at the end of the year.

Controls. We test the robustness of our results to adding a wide range of controls. In Panel A of Appendix Table D3, we include the 17 municipality characteristics presented in Table 1, while in Panel B we include the 12 winner characteristics presented in Table 2. All estimates are very close in magnitude when including either sets of controls, and they all remain significant at the 5 percent level.

State fixed effects. The policies implemented at the state level might influence mayors' decisions and COVID-19 outcomes. However, variations in state policies are unlikely to explain our results. First, Figure 1 and the balance tests performed in Appendix C show that female- and male-led municipalities are evenly distributed over the territory. Second, Appendix Table D4 shows that our results remain virtually unchanged when we exploit within state variation only, through the inclusion of state fixed effects. Note that in order to include state fixed effects, we had to remove 9 states that contain less than 20 municipalities, accounting for 8.0 percent of our sample.

Sample selection. We test the robustness of the results to excluding some unusual observations from the sample: municipalities in the state of Mato Grosso, for which we observed some irregularities in the data (3.3 percent of the sample), and municipalities that held supplementary elections (2.6 percent). As shown in Table D5, the results are not affected by this restriction.

Polynomial order and bandwidth choice. Table D6 shows that our results are robust to using a second-order polynomial, while Figure D2 shows that the point estimates remain stable over a wide range of different bandwidths.

Table D1: Impact of having a female mayor on SARI deaths by period

	(1)	(2)	(3)	(4)
Outcome	# SARI deaths per 10,000 inhabitants			
	Period 1	Period 2	Period 3	Period 4
Treatment	0.739**	-0.050	-0.219	-0.854
	(0.303)	(0.538)	(0.313)	(0.476)
Robust p-value	0.014	0.972	0.397	0.107
Observations	487	487	621	579
Polyn. order	1	1	1	1
Bandwidth	0.108	0.108	0.145	0.133
Mean, left of threshold	0.640	3.123	1.707	2.728

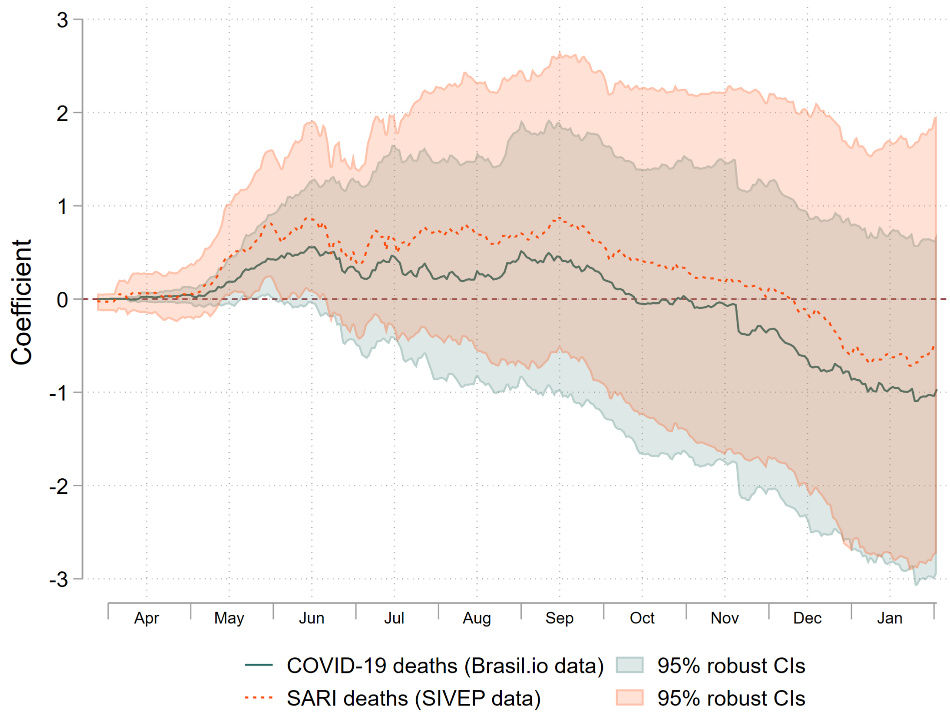
Notes: Each column takes as outcome the total number of SARI deaths per 10,000 inhabitants (using the 2010 population) during the period of interest. Period 1 (resp. 2, 3, and 4) corresponds to April-May 2020 (resp. June-August 2020, September-October 2020, and November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table D2: Impact of having a female mayor on SARI deaths by month

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Outcome	Number of SARI deaths per 10,000 inhabitants									
	04/20	05/20	06/20	07/20	08/20	09/20	10/20	11/20	12/20	01/21
Treatment	0.050	0.619**	0.127	-0.119	-0.025	-0.002	-0.320	-0.344*	-0.611**	0.118
	(0.110)	(0.261)	(0.293)	(0.255)	(0.283)	(0.223)	(0.228)	(0.163)	(0.279)	(0.250)
R. p-value	0.614	0.018	0.538	0.678	0.870	0.997	0.133	0.084	0.036	0.666
Obs.	576	524	489	491	518	584	495	580	574	543
Polyn.	1	1	1	1	1	1	1	1	1	1
Bandwidth	0.132	0.122	0.109	0.109	0.121	0.135	0.111	0.134	0.131	0.126
Mean	0.242	0.425	0.915	1.142	1.062	0.956	0.820	0.697	1.185	0.836

Notes: Each column takes as outcome the total number of SARI deaths per 10,000 inhabitants (using the 2010 population) during the month of interest. The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robust p-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Figure D1: Impact on the cumulative number of SARI and COVID-19 deaths



Notes: This figure plots the RD estimates obtained by taking as outcome the cumulative number of deaths per 10,000 inhabitants, for each day from April 1st, 2020 to January 31st, 2021. In orange, the point estimates and 95 percent robust confidence intervals correspond to deaths attributed to Severe Acute Respiratory Infections (SARI) using SIVEP dataset. In blue, the point estimates and 95 percent robust confidence intervals correspond to COVID-19 deaths coming from Brasil.io dataset.

Table D3: Impact on COVID-19 deaths, including controls

Panel A: Controlling for municipality characteristics

	(1)	(2)	(3)	(4)
Outcome	Number of Covid-19 deaths			
	No control		With controls	
	Period 1	Period 4	Period 1	Period 4
Treatment	0.391**	-0.999**	0.461***	-0.983**
	(0.176)	(0.405)	(0.163)	(0.387)
Robust p-value	0.035	0.016	0.007	0.022
Observations	578	513	485	495
Polyn. order	1	1	1	1
Bandwidth	0.133	0.118	0.108	0.110
Mean	0.203	2.432	0.171	2.396

Panel B: Controlling for the winner characteristics

	(1)	(2)	(3)	(4)
Outcome	Number of Covid-19 deaths			
	No control		With controls	
	Period 1	Period 4	Period 1	Period 4
Treatment	0.391**	-0.999**	0.456**	-1.049**
	(0.176)	(0.405)	(0.179)	(0.413)
Robust p-value	0.035	0.016	0.015	0.015
Observations	578	513	513	479
Polyn. order	1	1	1	1
Bandwidth	0.133	0.118	0.117	0.105
Mean	0.203	2.432	0.177	2.367

Notes: In Panel A (resp. B), columns 3 and 4, we include as controls all the municipal (resp. winner) characteristics presented in Table 1 (resp. Table 2). The outcome is the total number of COVID-19 deaths per 10,000 inhabitants (using the 2010 population) during the period of interest. Period 1 (resp. 4) corresponds to April-May 2020 (resp. November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robustp-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table D4: Impact on COVID-19 deaths, including state fixed effects

	(1)	(2)	(3)	(4)
Outcome	Number of Covid-19 deaths			
	Full sample		Restricted + State FE	
	Period 1	Period 4	Period 1	Period 4
Treatment	0.391**	-0.999**	0.414**	-1.045**
	(0.176)	(0.405)	(0.159)	(0.410)
Robust p-value	0.035	0.016	0.015	0.013
Observations	578	513	560	471
Polyn. order	1	1	1	1
Bandwidth	0.133	0.118	0.142	0.117
Mean	0.203	2.432	0.206	2.423

Notes: In columns 3 and 4, we include state fixed effects and remove municipalities part of states with fewer than 20 municipalities in our sample (8.0 percent). The outcome is the total number of COVID-19 deaths per 10,000 inhabitants (using the 2010 population) during the period of interest. Period 1 (resp. 4) corresponds to April-May 2020 (resp. November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robustp-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table D5: Impact on COVID-19 deaths, excluding unusual observations

	(1)	(2)	(3)	(4)
Outcome	Number of Covid-19 deaths			
	Full sample		Robustness sample	
	Period 1	Period 4	Period 1	Period 4
Treatment	0.391**	-0.999**	0.395**	-0.881**
	(0.176)	(0.405)	(0.178)	(0.414)
Robust p-value	0.035	0.016	0.034	0.040
Observations	578	513	560	486
Polyn. order	1	1	1	1
Bandwidth	0.133	0.118	0.137	0.117
Mean	0.203	2.432	0.216	2.309

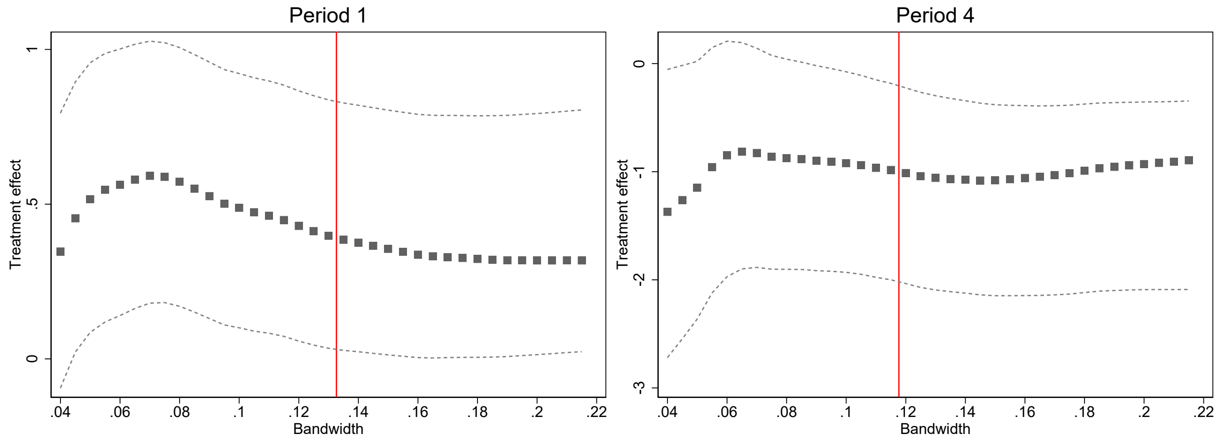
Notes: In columns 3 and 4, we exclude municipalities part of Mato Grosso state and municipalities that held a supplementary election, corresponding to 3.3 and 2.6 percent of the sample, respectively. The outcome is the total number of COVID-19 deaths per 10,000 inhabitants (using the 2010 population) during the period of interest. Period 1 (resp. 4) corresponds to April-May 2020 (resp. November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold) and we use MSERD data-driven bandwidths. We assess statistical significance based on the robustp-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

Table D6: Impact on COVID-19 deaths, using a second order polynomial

	(1)	(2)	(3)	(4)
Outcome	Number of Covid-19 deaths			
	Period 1	Period 4	Period 1	Period 4
Treatment	0.391**	-0.999**	0.483**	-1.173**
	(0.176)	(0.405)	(0.207)	(0.464)
Robust p-value	0.035	0.016	0.023	0.027
Observations	578	513	727	736
Polyn. order	1	1	2	2
Bandwidth	0.133	0.118	0.190	0.195
Mean	0.203	2.432	0.139	2.451

Notes: In columns 3 and 4, we use a second-order polynomial instead of fitting linear regressions. The outcome is the total number of COVID-19 deaths per 10,000 inhabitants (using the 2010 population) during the period of interest. Period 1 (resp. 4) corresponds to April-May 2020 (resp. November 2020-January 2021). The independent variable is an indicator equal to one if the female candidate won in 2016. We use MSERD data-driven bandwidths and assess statistical significance based on the robustp-value. ***, **, and * indicate significance at 1, 5, and 10 percent, respectively. The mean gives the average value of the outcome for male-led municipalities at the threshold.

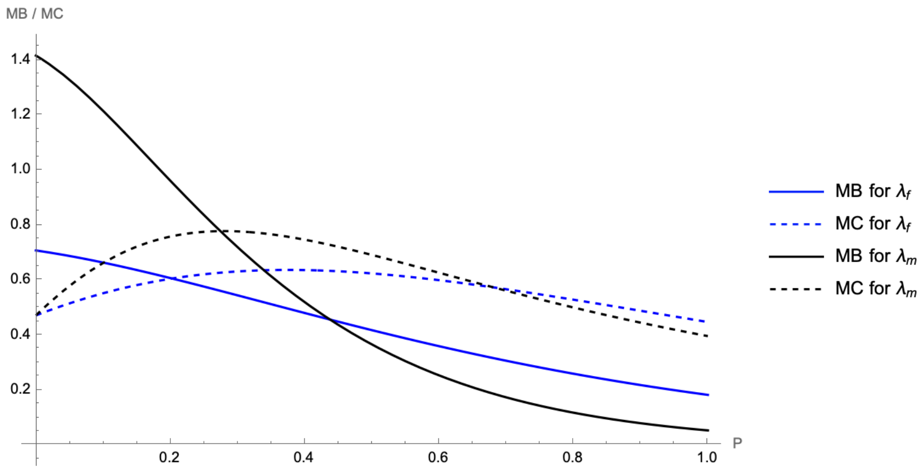
Figure D2: Impact on COVID-19 deaths: Robustness to bandwidth choice



Notes: These figures show the sensitivity of the point estimate to bandwidth choice. Dots represent the estimated treatment effect using different bandwidths (horizontal axis). Dotted lines represent the 95 percent robust confidence interval. The estimates are reported for values of the bandwidth from 4 to 22 percentage points, in steps of 0.2 percentage points. The vertical red line gives the value of the MSERD optimal bandwidth used in the main estimation. The outcome is the number of COVID-19 deaths per 10,000 inhabitants in period 1 (left graph) or in period 4 (right graph). The independent variable is an indicator equal to one if the female candidate won in 2016. Each estimation uses a non-parametric estimation procedure (fitting two linear regressions separately on each side of the threshold).

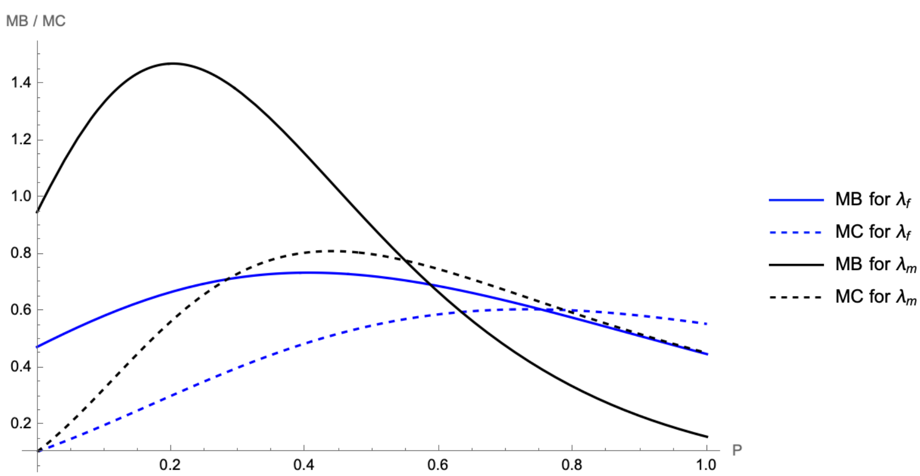
E Model Appendix

Figure E1: Marginal benefits and marginal costs of the policy at low levels of belief in the shock ($p = 0.25$)



Notes: The figure plots the marginal benefits (MB) and marginal costs (MC) to voters of the policy P for the case where voters believe that the policy is relatively ineffective ($\lambda_s = \lambda_f = 2$) and for the case where they believe that the policy is relatively effective ($\lambda_s = \lambda_m = 4$). It assumes low levels of belief in the shock ($p = 0.25$), a pre-crisis amount of the public good of $\tilde{g} = 1$, and a shock of magnitude $\psi = 3$.

Figure E2: Marginal benefits and marginal costs of the policy at high levels of belief in the shock ($p = 0.75$)



Notes: The figure plots the marginal benefits (MB) and marginal costs (MC) to voters of the policy P for the case where voters believe that the policy is relatively ineffective ($\lambda_s = \lambda_f = 2$) and for the case where they believe that the policy is relatively effective ($\lambda_s = \lambda_m = 4$). It assumes high levels of belief in the shock ($p = 0.75$), a pre-crisis amount of the public good of $\tilde{g} = 1$, and a shock of magnitude $\psi = 3$.