Women Leaders Improve Environmental Outcomes: Evidence from Crop Fires in India*

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September 15, 2023

Abstract

Effective climate action requires leaders that implement pro-environmental policies. Survey evidence suggests that women have a greater concern for the environment. Yet, whether these concerns translate to policy changes when women are elected to political office is an open question. Using a close-election regression discontinuity design, we find that the election of women legislators in India leads to a 13% decrease in fire incidents arising from crop residue burning. This is accompanied by a large and statistically significant decrease in air pollution for constituencies led by women, particularly black carbon, organic carbon, and SO_2, all of which are precursors to PM2.5. These effects are predictably concentrated during the winter harvest and post-harvest months (October to April). In an original survey of 424 male and female village council leaders in India, we find evidence to suggest female leaders treat residue burning as a more serious issue, weighing its impacts on child health more highly than male leaders, and being more likely to be strongly in favor of regulation against burning. Female leaders are also more likely to implement crop residue management policies like using stubble as fodder.

VERY PRELIMINARY
DO NOT CITE OR CIRCULATE

*Thank you to Sakshi Hallan for excellent project management of the survey, and to the team at Inclusion Economics India Centre for their support. We are grateful to the seminar participants at the Arizona STate University, University of California at Irvine, University of California - Riverside, EPIC Environmental Workshop at U Chicago, IZA Conference 2021, Toulouse School of Economics, Nova School of Business and Economics, OSWEET 2020 and OARES 2020 for useful comments and discussion. Thank you to the generous NBER Grant for work on Gender in the Economy for funding. Any errors are our own.

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1 Introduction

Given the dramatic scale of climate decline and increased incidence of environmental degradation, large-scale policies by elected leaders may be one of the most effective tools to address the causes and consequences of climate change. For instance, one of the largest contributors to climate change, air pollution, has been found to effectively respond to well-implemented environmental policy (Fowlie et al., 2012). However, due to the externalities generated from polluting behavior, effective climate action requires leaders that implement pro-environmental policies. In this paper, we examine the causal effect of women leaders on local environmental outcomes.

Climate change is likely to disproportionately affect women (Dell et al., 2021; Eastin, 2018), indigenous populations (Tsosie, 2007; Green and Raygorodetsky, 2010), and underrepresented minorities (Bullard, 1993). As such, the political representation of groups disproportionately affected may contribute to effective environmental policies as these groups may have a greater stake in preventing further environmental damage. Yet, whether elected women, indigenous or minority leaders implement more stringent or effective environmental policies remains an open question.

Survey evidence from developed countries suggests women have a greater concern for the environment and climate change than men (McCright, 2010; McCright and Dunlap, 2011), but little is known about whether these concerns translate to policy changes when women are elected to political office. Indeed, survey evidence on gender differences in environmental concerns among elected female officials remains inconclusive (Sundström and McCright, 2014; Fredriksson and Wang, 2011). Ex-ante, it is unclear if women leaders will advocate more for other women's interests, and research has shown that they may indeed conform to male expectations in a predominantly male environment like politics (Adams and Funk, 2012). Women leaders are also more likely to deviate from their initial policy proposals under various social pressures (Gangadharan et al., 2019). However, interestingly, new empirical evidence from a cross-country correlational study suggests female representation in parliament leads to more stringent climate change policies (Mavisakalyan and Tarverdi, 2019).

We estimate the causal effects of women leaders on environmental outcomes in India, focusing on polluting behavior that contributes to almost half the total particulate matter in the country during winter: crop fires from multiple agricultural processes, such as stubble burning, sugarcane harvesting, and clearing undergrowth (Bikkina et al., 2019; Cusworth et al.,

2018; Shyamsundar et al., 2019a).[1] Because air pollution disproportionately affects women,[2] female leaders may be particularly invested in implementing policies that tackle air pollution. The majority vote base for female legislators is women, and women leaders may represent the interests of their constituents and themselves by extension. For instance, seminal work by Chattopadhyay and Duflo (2004) shows women leaders invest more in infrastructure that directly benefits their gender.[3]

Using a close-election regression discontinuity design to isolate the impact of women being elected over male candidates, we find, in the Indian context, systematic evidence showing better environmental outcomes under female leaders. Specifically, we study the effect of female candidates narrowly winning legislative assembly elections in India over male candidates from 2002-2019 and study their effect on environmental outcomes. We find three main results. First, we find that the election of women legislators leads to an approximately 13% decrease in the number of agricultural fire incidents. We observe a corresponding fall of almost 15 Kelvin in the mean monthly crop fire brightness as viewed by the MODIS satellite (statistically insignificant at conventional levels) and a 16 Kelvin decline in the max monthly crop fire brightness (statistically significant).

Second, we examine the effects of electing women leaders on black carbon, organic carbon, and SO_2, all of which are precursors to PM2.5, and would likely decrease following the decrease in the incidence of crop fires. Indeed, we estimate a decrease of 3.39 $\mu g/m^3$ (40%), 55.66 $\mu g/m^3$ (46%), and 4.31 $\mu g/m^3$ (46%) in the maximum values of monthly black carbon, organic carbon, and SO^2, respectively in legislative assemblies won narrowly by women over men. These results corroborate the narrative of a decline in crop-fire incidence under women leaders, suggesting that they were particularly effective at reducing some of the worst polluting incidents.

Third, in terms of timing of the effects, precisely as one might expect, the effects on crop fires and air pollution are concentrated during the winter harvest and post-harvest months (October to April), with comparatively modest effects during the rest of the year. This period coincides with the quick turnaround time between rice harvest and wheat planting

[1] Air pollution is one of the largest causes of mortality, leading to 9 million premature deaths annually, 16% of all deaths worldwide, and as high as 268 million disability-adjusted-life-years (Landrigan et al., 2018). 14 of the 20 most polluted cities in the world are located in India alone. In fact, if New Delhi, the Indian capital, met the World Health Organization air quality standards, average life expectancy would increase by as much as ten years (Greenstone and Fan, 2019), almost as much as life expectancy gains on average that India made in all of the 21st century (Max Roser and Ritchie, 2013).

[2] Women experience disproportionately severe effects of air pollution through greater deposition of inhaled particles (Beggs and Bambrick, 2005). Air pollution also negatively impacts maternal and fetal health during critical development phases (Srám et al., 2005; Shah and Balkhair, 2011; Maisonet et al., 2004) and maternal respiratory and cardio health (Glinianaia et al., 2004).

[3] It is also possible that women leaders are effective at implementing all policies. For example, there exists evidence that women CEOs achieve better corporate performance (Glass et al., 2016) and are better at policy coordination (Bhalotra et al., 2021). Our results suggest an alternative explanation: that female and male leaders have different policy priorities.

(October-November), pre-sugarcane harvest (December-March), and clearing of undergrowth to prepare land for cropping. Lastly, in falsification tests, we show no effects on crop fires or air pollution in the years before state elections.

Finally, we conducted a survey of 424 village council leaders (VCLs) in the state of Punjab (the state with the highest per capita incidence of crop fires) between December 2022 and March 2023 to understand both *why* and *how* female leaders may be associated with better air pollution outcomes.[4] VCLs are distinct from MLAs; they are at a lower level of government. However, while MLAs have both legislative and executive duties, VCLs primarily hold executive duties to do with implementing state policies, disbursing aid, and making funding allocations within their jurisdiction. Understanding the preferences of female and male VCLs helps us generalize the findings from our RD analysis to cover female leadership more broadly. To understand why we may be observing female leaders leading to better crop fire outcomes, we find that female leaders report stubble burning as being a more serious problem than male leaders. Specifically, female leaders appear to have different policy priorities than male leaders, citing child health as a cost of stubble burning at statistically and economically significantly higher rates than those reported by male leaders. On the question of how female leaders may be accomplishing lower rates of burning, our survey suggests that they are more likely to strongly favor legislation against crop fires. They appear to be aware of a greater number of policies implemented by the state government against crop burning, for instance, the penalties against such practices. While male and female leaders in Punjab report implementing a similar number of policies, female leaders are more likely to promote crop-management policies that are viewed as substitutes for burning. Further, we find these differences between male and female VCLs to be robust to controlling for observables and district fixed effects.

This paper has three main contributions. First, our results that women leaders improve local environmental outcomes complement a large and vibrant literature on the effects of women leaders on local socioeconomic outcomes. Previous evidence has shown that female leaders are more likely to invest in public goods and infrastructure that directly benefit their gender (Chattopadhyay and Duflo, 2004). Further, the election of women has also been shown to lead to higher net growth in economic activity (Baskaran et al., 2018). Our survey responses showing that female leaders were more aware and concerned about the impacts of crop burning on child health are consistent with evidence showing that women leaders have different policy priorities than men, favoring greater investments in child health and education (Bhalotra and Clots-Figueras, 2014; Clots-Figueras, 2012; Beaman et al., 2007).

[4]Punjab reserves 50% of all VCL seats for female candidates.

To the extent that the concern for child health stems from its salience to women due to their predominant home-production roles, our results are in line with previous work showing female leadership addressing the concerns of women: for instance, it reduces maternal mortality (Bhalotra et al., 2020), results in greater reporting of gender-based crimes (Iyer et al., 2012), leads to a fall in the gender gap in schools, and an increase in female voices being heard in village council public meetings (Beaman et al., 2007). More broadly, conditional on women being major constituents for female leaders, our results are also consistent with literature showing that women are more likely to support policies that encourage spending on child-related expenses (John R. Lott and Kenny, 1999; Edlund and Pande, 2002; Edlund et al., 2005).

A second contribution in contrast to previous work is that we can augment our reduced-form empirical analysis with a first-hand telephonic survey with Indian village council leaders, both male and female, to help shed light on the mechanisms behind the effects generated by female leaders. A wide array of research has shown that women better represent the needs of children (Lundberg et al., 1997; Duflo, 2003). Our survey indicates that, in our case, this is a likely channel through which women leaders act on environmental policy as they specifically report child health as a major cost of stubble burning, and are more aware of government policies addressing the issue. These findings contribute to a growing literature on the determinants of crop stubble burning (Garg et al., 2023), its effects on health (Rangel and Vogl, 2019; He et al., 2020) and human capital (Graff Zivin et al., 2020), and policies to address the problem (Nian, 2023). Recent work discusses the incentives leaders face in enforcing anti-burning policies given that the effects of stubble burning often transcend the origin districts (Dipoppa and Gulzar, 2022). At the same time, other studies have examined how to overcome the complex incentive structures when designing PES structures to limit stubble burning (Jack et al., 2023). This is in line with descriptive data from our survey suggesting that the costs associated with burning alternatives are the largest reasons for perpetuating the practice. This paper offers a new avenue for further examination: the identity of local leaders who are in a position to enforce anti-burning policies. More broadly, our results show significant positive impacts of female leadership on within-assembly pollution despite concerns that they may face weak incentives.

Finally, this paper contributes to a rich ethnographic literature on the historical role of women in designing policies that promote environmental justice. Women have been at the forefront of environmental awareness and advocacy worldwide for several decades (Merchant, 1981). Environmental activism in India traces its feminist roots to 1973 when Indian women coined the term "Chipko movement" (tree huggers). This women-led movement is unique

among international feminist movements in its inextricable link to the environment. It gained traction in the 1980s, beginning with the anti-nuclear protests in Tamil Nadu, and more momentum after the 1984 Bhopal Gas Disaster, where over 40 tons of toxic gas leaked from a pesticide plant. The Bhopal Gas Disaster resulted in the deaths of tens of thousands of individuals and had severe negative health impacts, injuries, and disabilities for over half a million people in the following years (Gupta et al., 1988; Misra and Kalita, 1997). A particularly tragic consequence was the long-term effect on women's health, including their inability to bear children or giving birth to children with birth defects (Eckerman, 2005). The disaster also greatly affected educational attainment and employment (Bharadwaj et al., 2020). However, given the particular salience to women, disproportionately affecting children and women as the tragedy did (Sarangi, 1996), it gave rise to a powerful enviro-feminist movement (Mukherjee, 2010). The institutions and movements started by these tragedies live on, and environmental issues remain important to women voters.

2 Background

2.1 Stubble burning in India

Crop fires, particularly in agriculture, play an important land management role – to clear fields of old crops, to prepare fields for new crops, to ease the harvesting of certain crops like sugarcane, or to clear new land/renew the soil. In India, there are a number of reasons for agricultural fires, including burning crop residue to prepare for a new crop, and clearing away excess dried leaves and growth at the base of certain harvests like sugarcane. Particularly in the last quarter-century, Indian agriculture has seen the adoption of high-yield variety seeds and increased mechanization. These factors have allowed far greater efficiency in agricultural planning, in the form of the multi-cropping system by farmers, which significantly reduces the lag time between the harvest of one crop and the sowing of the next (Gupta et al., 2004). Stubble-burning has therefore risen in popularity and is the quickest way to allow this system to continue. It also follows that the two main harvest seasons during the year tend to see the highest intensity of crop-burning: the rice-harvesting kharif season in the months of October and November and the wheat-harvesting rabi season in the months of March to April (Vadrevu et al., 2011). Farmers light sugarcane fields to remove the outer leaves around the cane stalk before harvesting (in December-March) to make the process less labor-intensive.

Stubble burning is a common agricultural practice in India to clear rice crop residue in particular, which contributes significantly to air pollution. The practice releases particulate

matter, carbon monoxide, nitrogen oxides, and sulfur dioxide into the atmosphere, which causes severe respiratory problems and other health issues (Lan et al., 2022). Despite the harmful effects, the practice continues to flourish due to various obstacles, including a lack of information on economically viable alternatives for the farmers or the negative impacts of stubble burning (Shyamsundar et al., 2019b). Indeed, when considering the pollution externalities of crop burning, mechanized alternatives are highly cost-effective. Similarly, a lack of education and outreach about the negative impacts of stubble burning is a key factor contributing to its persistence (Bhuvaneshwari et al., 2019; Bhatt et al., 2023).

To address the issue of stubble burning, the Indian government has initiated several measures. One of the measures is the provision of financial incentives to farmers for adopting alternative methods of crop residue management. The Indian government has also launched a program to set up biomass-based power plants to generate electricity from crop residues. Most notably, the government has banned stubble burning and imposed fines on farmers who violate the ban. Enforcing the ban is often portrayed as politically unpalatable. State governments have tried to subsidize large machines that clear fields to support the substitutes for burning. However, the options farmers prefer remain largely unsubsidized and in short supply, with the government-subsidized options often being more expensive. The combination of incomplete knowledge on the health effects of stubble burning, the lack of availability of alternatives, and the lack of serious enforcement of bans have all contributed to the continuation of burning practices.

2.2 Political and policy structures in India

In India, both MLAs (Members of Legislative Assembly) and sarpanches (elected heads of a village-level administrative unit) have executive responsibilities and jurisdiction over the enforcement of stubble-burning policies. MLAs are elected representatives who hold legislative and executive powers at the state level. They are responsible for enacting laws and policies related to agriculture, including those related to stubble burning. MLAs can provide necessary funds and resources to the local administration to implement stubble-burning policies. They can also monitor the progress of the policies and take necessary actions to ensure their effective enforcement. In several cases, MLAs may advocate for their constituents to draw state funding to support burning alternatives.

On the other hand, sarpanches, elected representatives at the village level, have a crucial role in enforcing stubble-burning policies. They have jurisdiction over the villages under their administrative unit and are responsible for ensuring that farmers in their area comply with the policies. Sarpanches can create awareness among farmers about the harmful effects of

stubble burning and encourage them to adopt alternative methods of managing crop residue. They can also take punitive actions against those who violate the policies and report the same to the concerned authorities. The involvement of MLAs and sarpanches in the enforcement of stubble burning policies is crucial for their effective implementation and to reduce the harmful impact of this practice on the environment and public health.

3 Empirical Analysis and Research Design

We employ a regression discontinuity design to estimate women leaders' effect on agricultural fires and air pollution. In India, state elections are held every five years following the parliamentary system. The states are divided into constituencies for the legislative assembly, where the eligible voters elect their representative, known as the Member of Legislative Assembly (MLA), from their respective constituencies. To analyze the impact of gender on the electoral outcome, the study compares the results of constituencies where a female candidate narrowly defeats a male candidate with the ones where the opposite happens. The percentage of the winning margin is calculated as the ratio of votes received by a female MLA to those received by other candidates in the assembly election. The Indian context provides a rich ground for close-election regression discontinuity designs (Asher and Novosad, 2017; Bardhan and Mookherjee, 2010; Nagavarapu and Sekhri, 2014) as the constituency-level elections in India are highly competitive and unpredictable, influenced by various factors. The close election RD approach becomes more valid in cases where the possibility of a constituency near the RD cutoff having a female winner is determined almost randomly (Eggers et al., 2015). We use the following regression specification in this paper:

$$\begin{aligned} Y_{cset} = \beta_0 + \beta_1(WomanWinner)_{cse} + \beta_2(WinningMargin)_{cse} + \\ + \beta_3(WomanWinner)_{cse} \times (WinningMargin)_{cse} + \eta_{s,e} + \eta_t + \varepsilon_{cset} \end{aligned} \tag{1}$$

$WomanWinner_{cse}$ takes the value 1 if the winner of a legislative constituency c in state s in election e is a woman, 0 otherwise. $(WinningMargin)_{cse}$ is the winning margin for legislative constituency c in state s in election e for a woman over a man. Y_{cset} is the outcome of interest (number of agricultural fires, black carbon, organic carbon, and SO2) for legislative constituency c in state s in election e in year t. η_t are year fixed effects. $\eta_{s,e}$ are state-by-election fixed effects that control for variables common to all legislative constituencies in a state over a five-year ruling term after the elections. Thus, the RD estimates compare outcomes for legislative constituencies within the same state but on opposite sides of the winning margin of a woman over a man during the five-year ruling term e in year t. Standard

errors are clustered at the legislative constituency level.

In Tables 1 – 3, we present the mean values for various election and constituency baseline characteristics; we find no significant differences when we use the RD specification to test for discontinuous changes at the winning margin threshold. We find no discontinuities in election candidate characteristics above and below the RD cutoff or on village and town characteristics across the cutoff from the 2001 and 2011 population censuses. From the 2001 census, there is a marginally significant discontinuity, with assemblies below the cutoff having a slightly lower level of power access in the agricultural sector, but it is unclear if that has any bearing on our outcomes. We also show that the density of the winning margin distribution across legislative constituencies is continuous across the treatment threshold; the McCrary test statistic is -0.04 (s.e. 0.1) (Figure 4). Finally, as a falsification test, discussed with the results below, we show null effects of a woman leader on our outcomes variables prior to the election of woman leaders.

4 Data

4.1 Cropfire Data

We use the Moderate Resolution Imaging Spectroradiometer (MODIS), a part of NASA's Terra and Aqua satellites for information on fire incidents across India for the years 2002-2016. This satellite records crop fires as fire incidents for each kilometer square pixel (1 km $\times$ 1 km in size) and provides the geometric coordinates of each of these pixels. The use of this data to determine the number of crop-fire incidents is common in the environmental literature (Garg et al., 2023).

We augment this data for post-2016, from 2016-2021 with the latest VIIRS active fires data (VNP14IMGT) on crop fire incidents and their intensity. Information is collected from the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor, and processed with a fire detection algorithm to flag active fires. Each dot on the map represents the center of a 375-meter pixel, contrasting with the 1 km pixel resolution from MODIS. VIIRS is better calibrated to detect fires at night, as well as smaller fires.

Figure 3 depicts the intensity of the number of fires across electoral districts (also called assemblies) in India between 2006 and 2016 using MODIS data.

4.2 Election Data

We derive our data on assembly elections across India from Agarwal et al. (2021). These data compile decades of data from the Election Commission of India (ECI) for each election and geo-coded information on each assembly, in addition to the socio-demographic profile of main parties' candidates and on the sociological profile of constituencies.

We use election data from 2002-2019 to identify the assemblies and years in which women candidates won over male competitors (Figure 1) and then further to identify which of these assemblies faced close elections for our identification strategy (Figure 2).

4.3 Pollution Data

To delineate the emission of polluting substances, specifically from crop fires, we use the Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) satellite data (Global Modeling and Assimilation Office (GMAO), 2015) on emission rates. MERRA-2 is the latest version of global atmospheric reanalysis for the satellite era produced by NASA Global Modeling and Assimilation Office (GMAO) using the Goddard Earth Observing System Model (GEOS) version 5.12.4. The dataset covers the period of 1980-present with a latency of 3 weeks after the end of a month and is a time-averaged 2-dimensional monthly mean data collection effort. It consists of assimilated aerosol diagnostics (extended), such as dry and wet deposition of each aerosol component, dust emission and sedimentation for each sized bin, and organic carbon convective scavenging.

We use this data from 2002-2022 specifically for emission rates from biomass burning for Black Carbon (BCEMBB), Organic Carbon (OCEMBB), and SO2 (SO2EMBB), all of which are precursors to PM2.5 (Cusworth et al., 2018). This dataset provides monthly estimates for the emission of each of these pollutants, and we use these estimates to understand the within-year seasonality in crop burning and its associated pollution. We use within-assembly averages for our estimates.

4.4 Census Data

We use both the 2001 and 2011 Population Censuses to identify assembly-level demographic characteristics. Section 3 describes our identification strategy: a regression discontinuity design (RDD). We use town/village means across assemblies on either side of the RD cutoff to establish baseline balance in characteristics. We use information on the size of towns/villages, populations, and demographic details, mean educational levels, access to public services, occupational sectors, and income levels.

5 Results

The election of women leaders over male competitors leads to a fall in crop fires and subsequent pollution compared to constituencies where male candidates narrowly defeat female ones. Figure 5, panel (a) shows the graphical representation of the effect of women leaders on agricultural fires. We observe a large and statistically significant decrease in the number of fires for legislative constituencies where women narrowly defeated men in legislative elections, following these elections. Table 4 shows the corresponding point estimates for crop fires. Legislative constituencies where women narrowly defeat men observe as high as a 13% decrease in the number of crop fires every month. Table 5, shows the effects of female leadership on the intensity of fires caused, as measured by their brightness in Kelvin. We find a reduction in the total fire brightness (a measure of cumulative fire impact), mean brightness, max brightness and min brightness. All four measures register a large decline. However, the total and max brightness measures are the only statistically significant estimates. While this does not rule out an effect on mean and min brightness, it certainly suggests a fall in the most intense fires, with a fall in maximum brightness of about 25%. To compare this to other work, for instance, Clots-Figueras (2012) finds that increased female representation in a district leads to a 9% increase in primary school attainment in that district. In both cases, these magnitudes are large and significant in response to female leadership.

We find a corresponding decline in pollution levels following the lower level of crop fires in constituencies where female leaders narrowly won elections over male counterparts. Figure 5, panels b, c, and d show the effects of female leadership on the maximum levels of black carbon, organic carbon, and SO2, all of which are precursors to PM2.5. These graphs show a clear decline in levels of these pollutants at the RD cutoff. To provide further details, Table 6 shows the point estimates for the maximum values of black carbon, organic carbon, and SO2. Legislative constituencies where women narrowly defeat men observe a 3.39 $\mu g/m^3$ (40%), 55.66 $\mu g/m^3$ (46%), and 4.31 $\mu g/m^3$ (46%) decrease in monthly max values of black carbon, organic carbon, and SO2, respectively. Table 7 shows similar patterns for mean values of black carbon, organic carbon, and SO2, with smaller magnitudes of decline than those observed for the max values, but these remain statistically insignificant.

Given that crop fires mostly serve to clear fields during and after a harvest, a fall in the use of this practice should lead to a decline in pollution levels during the same period. When examining the month-to-month changes, precisely as one might expect, the effects on crop fires and air pollution are concentrated during the winter harvest and post-harvest months (December to April), with comparatively modest effects during the rest of the year (Figure 6). The timing of the month-on-month effects also suggests the importance of sugarcane crop

burning on the estimates – this is far less in the public discourse compared to rice-wheat related stubble burning. Next, as a placebo, we show no effects on crop fires or air pollution in the years prior to state elections (Figure 7). If the election of women leaders had not been the primary cause of these effects, we would have expected to see similar effects under the male leaders previously in power. However, the absence of such effects bolsters our results that these effects on crop fires and pollution result from female leadership. Finally, Figure 8 shows the main result on the number of crop fires, as well as the effects on maximum monthly values of OC, BC and SO2 are robust to a range of bandwidths.

The results presented above demonstrate a pattern of female leadership leading to a lower incidence of crop stubble burning and, consequently, lower pollution, but it is harder to understand why or how this may be occurring. In the next section, we present evidence from a survey we conducted of village council leaders in the state of Punjab to shed some light on the reasons for these patterns.

6 Survey Evidence on Women Leaders

From December 2022 to March 2023, we administered a large telephonic survey to a population of male and female leaders at the gram panchayat (village council) level (n = 424). These surveys were administered with the intent of eliciting beliefs, awareness, and preferences for environmental policy. We target a different layer of government than the one examined in the reduced form analysis: the village level, rather than the constituency level. This is done with goals in mind: (a) to examine if there are differences between male and female leaders on environmental matters in all forms of government, and (b) from a practical standpoint, given that our survey was a telephonic one, we are more likely to get responses from village council leaders than constituency level leaders. However, both levels of leadership have significant executive functions and powers. While MLAs control how much money to disburse to different villages, what policies to prioritize, and what goals to meet, sarpanches perform similar roles at a lower level. They also control funding for their villages and enforce higher-level policies. In the context of stubble burning, both MLAs and sarpanches have the power to enforce anti-stubble burning rules and address their constituents' concerns.

We asked sarpanches (village council leaders, henceforth VCLs) to rank priorities among a long list of policy agendas, including poverty, inequality, and environment. The survey responses complement the empirical analysis in helping us understand whether the decrease in the incidence of crop fires in legislative assemblies won narrowly by women is driven by differences in (i) beliefs about the causes and consequences of air pollution, (ii) preferences

on policy priorities, (iii) whether these effects are driven by female leaders trying to represent the interest of their majority voter base: other rural women, or (iv) alternatively, whether female leaders share the beliefs and preferences of their male counterparts, but women leaders are simply more effective on this dimension.

First, we present descriptive evidence in Table 9 on why crop burning continues to occur and what the village council leaders perceive as its costs. In line with anecdotal data, and previous research (Jack et al., 2023), the fact that burning is both quick and cheap is mentioned very frequently, along with the high cost of labor and machine substitutes. VCLs are aware of the costs of this practice, listing respiratory diseases, soil nutrition, and air pollution as a few of the biggest damages. Going by these responses, our survey respondents seem representative of the widely held views on crop burning.

Second, addressing the question of *why* we observe the reduced form estimates we do, we find that a statistically significantly higher proportion of female sarpanches report stubble burning as a serious or very serious problem, and they are much more likely to report being strongly in favor of regulation against crop burning (Figure 10). Both of these responses reflect differences in beliefs on stubble burning and its effects. There is a divergence among male and female leaders on what the costs of stubble burning are: a far greater proportion of female leaders tend to believe that it has adverse impacts on child health. We find that female VCLs report greater awareness of government policies than their male counterparts, even though both may implement the same number of policies.

Finally, investigating the question of *how* female leaders may have reduced crop burning, and digging deeper into policy preferences, Figure 11 shows that female VCLs are more likely to be aware of the penalties against crop burning (which is consistent with them viewing burning as a more serious problem). Following through on their previous responses, female mukhiyas also report promoting alternative crop residue management policies in Punjab, favoring using stubble as fodder and private stubble collection.

7 Conclusion

This paper shows that the election of female leaders over male competitors led to a marked reduction in crop fires and associated pollution markers. The reasons for these observed effects could be one of many: female leaders may want to represent their female constituents, who climate change may affect more severely than males, they may be better managers and, therefore more efficiently execute the same objectives as their male counterparts, or they may have stronger priors about the effects of pollution and more interested in environmental

policy. We conduct a primary survey following our extensive empirical analysis and find that female village council leaders weigh the costs of stubble burning, particularly child health higher than their male counterparts. They tackle crop burning by reportedly being in favor of stronger anti-burning regulations and promoting alternatives to crop burning.

A major conclusion is that diverse representation in local political offices was important for tackling serious environmental issues. An interesting avenue for future research would be whether these findings translate to the representation of other vulnerable groups, such as ethnic minorities and indigenous populations. Given the disproportionate impacts of climate change on previously marginalized groups, better and more diverse representation of these groups at the decision-making table may be one of the most important tools in tackling these inevitable challenges.

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Tables and Figures

Tables

Table 1: Regression discontinuity sample: summary statistics and balance for assembly election characteristics

	Full sample	Below threshold	Over threshold	Difference of means	p-value on difference	RD estimate	p-value on RD estimate
INC Winner (0/1)	0.24	0.23	0.24	0.02	0.31	0.03	0.70
BJP Winner (0/1)	0.28	0.28	0.28	-0.00	0.90	0.13	0.14
# of Winner Votes	61615.54	61516.11	61726.14	210.03	0.84	3207.40	0.19
# of Valid Votes	132635.25	132350.59	132940.67	590.08	0.77	2083.16	0.64
# of Eligible Voters	199852.27	198309.47	201455.72	3146.25	0.31	2958.13	0.63
Turncoat Winner (0/1)	0.07	0.08	0.05	-0.03	0.00	-0.05	0.35
Incumbent Winner (0/1)	0.32	0.37	0.27	-0.09	0.00	-0.03	0.78
# of Terms (Winner)	1.81	2.00	1.61	-0.39	0.00	-0.34	0.20
SC/ST Constituency (0/1)	0.33	0.33	0.33	-0.01	0.74	0.02	0.82
Years of Education (Winner)	13.25	13.49	13.00	-0.49	0.01	-0.23	0.81

Notes: This table shows the mean values for election characteristics using data on Indian legislative elections from 2002-2019. All variables come from the Trivedi Centre for Political Data, Ashoka University (Agarwal et al., 2021). Columns 1-3 show the unconditional means for all assembly election, assembly elections below the treatment threshold, and assembly elections above the treatment threshold, respectively. Column 4 shows the difference of means across Columns 2 and 3, and Column 5 shows the p-value for the difference of means. Column 6 test for balance in these outcomes. It shows the regression discontinuity estimate, following the main estimating equation, of the effect of being above the treatment threshold. Column 7 is the p-value for this estimate, using cluster robust standard errors at the assembly level.

Table 2: Regression discontinuity sample: summary statistics and balance for baseline (2011) constituency characteristics

	Full sample	Below threshold	Over threshold	Difference of means	p-value on difference	RD estimate	p-value on RD estimate
Town characteristics:							
Area of town (sq. km)	35.47	25.47	29.93	4.46	0.11	-27.98	0.29
# of senior secondary schools	7.94	7.56	7.95	0.39	0.47	-0.85	0.69
# of college	4.78	4.25	4.42	0.17	0.68	-1.69	0.31
# of secondary schools	13.39	11.98	12.83	0.85	0.39	-2.54	0.42
# of middle schools	21.96	19.06	21.64	2.58	0.13	-0.95	0.90
# of primary schools	36.74	34.62	38.10	3.48	0.13	-2.76	0.82
Village characteristics:							
Share with power	0.66	0.64	0.62	-0.03	0.25	0.14	0.09
Share with agriculture power	0.72	0.72	0.71	-0.01	0.60	0.13	0.13
Share with domestic power	0.94	0.94	0.92	-0.02	0.11	0.12	0.18
Area of village (hectares)	80586.36	80640.72	76844.55	-3796.17	0.59	13937.43	0.37
Share access to paved road	0.79	0.76	0.75	-0.01	0.48	0.06	0.47
# of college	2.99	2.68	3.24	0.56	0.06	1.79	0.14
# of senior secondary schools	16.88	17.73	17.48	-0.25	0.78	0.10	0.98
# of secondary schools	44.99	44.65	44.56	-0.09	0.97	6.68	0.22
# of middle schools	117.07	116.94	118.89	1.94	0.67	15.83	0.39
# of primary schools	263.93	266.21	271.90	5.70	0.54	43.00	0.34
All:							
Share of HHs-income from agr.	0.32	0.31	0.32	0.01	0.37	-0.00	0.97
Per capita consumption (Rs)	17605.68	17440.53	17336.72	-103.80	0.71	66.65	0.94
Literate total population	186196.23	188188.48	193004.98	4816.50	0.23	3263.43	0.80
ST total population	34871.71	38743.97	37558.59	-1185.38	0.78	12247.58	0.58
# of households	63825.82	64645.27	66754.67	2109.41	0.09	-203.26	0.96
SC total population	53156.66	56189.30	57459.63	1270.33	0.60	-4972.94	0.62
Urban population	54768.22	53673.74	53849.82	176.09	0.97	-4118.64	0.80
Rural population	255409.80	260101.89	276302.16	16200.27	0.03	11543.37	0.63
Total population	310178.03	313775.63	330152.00	16376.38	0.02	7424.72	0.69

Notes: This table shows the mean values for town and village characteristics measured in 2011 in constituencies where assembly elections that took place after 2011. All variables come from the from the 2011 Population Census. Columns 1-3 show the unconditional means for all towns/villages, towns/villages in constituencies below the treatment threshold, and towns/villages in constituencies above the treatment threshold, respectively. Column 4 shows the difference of means across Columns 2 and 3, and Column 5 shows the p-value for the difference of means. Column 6 shows the regression discontinuity estimate, following the main estimating equation, of the effect of being above the treatment threshold, and Column 7 is the p-value for this estimate, using cluster robust standard errors at the assembly level.

Table 3: Regression discontinuity sample: summary statistics and balance for baseline (2001) constituency characteristics

	Full sample	Below threshold	Over threshold	Difference of means	p-value on difference	RD estimate	p-value on RD estimate
Town characteristics:							
Area of town (sq. km)	23.79	21.73	26.17	4.44	0.14	-12.94	0.49
# of senior secondary schools	4.52	4.32	4.63	0.31	0.37	0.06	0.95
# of college	2.13	1.74	1.83	0.09	0.68	0.73	0.17
# of secondary schools	7.99	7.03	7.84	0.81	0.24	2.04	0.22
# of middle schools	12.60	10.56	12.91	2.35	0.02	3.22	0.21
# of primary schools	24.55	22.04	24.39	2.36	0.18	9.15	0.10
Village characteristics:							
Share with power	0.70	0.62	0.65	0.03	0.31	0.03	0.52
Share with agriculture power	0.09	0.06	0.12	0.06	0.01	0.27	0.07
Share with domestic power	0.79	0.75	0.73	-0.03	0.49	0.07	0.67
Area of village (hectares)	79986.81	79458.44	76164.90	-3293.54	0.63	18110.50	0.45
Share access to dirt road	0.71	0.74	0.70	-0.05	0.04	-0.07	0.23
Share access to paved road	0.72	0.71	0.71	-0.01	0.64	0.03	0.39
# of college	1.35	1.34	1.16	-0.18	0.19	0.20	0.63
# of senior secondary schools	5.88	6.38	5.51	-0.87	0.01	0.02	0.98
# of secondary schools	22.78	21.90	20.13	-1.78	0.08	-2.96	0.26
# of middle schools	60.58	58.30	57.48	-0.82	0.75	-5.34	0.48
# of primary schools	208.01	209.99	211.07	1.08	0.88	-40.54	0.26
All:							
Literate total population	135575.78	137605.11	137951.47	346.36	0.91	1857.86	0.82
ST total population	28184.81	31010.55	29795.70	-1214.85	0.72	-2218.64	0.87
# of households	49809.23	50095.15	51541.00	1445.85	0.13	-3805.00	0.15
SC total population	44203.11	46971.17	48249.00	1277.82	0.54	-2844.06	0.64
Urban population	40082.51	38007.73	39215.70	1207.98	0.72	5377.40	0.59
Rural population	224986.13	229669.00	241129.09	11460.09	0.05	-14222.10	0.31
Total population	265098.44	267854.75	280265.25	12410.50	0.02	-10147.58	0.37

Notes: This table shows the mean values for town and village characteristics measured in 2001 in constituencies where assembly elections that took place after 2001. All variables come from the from the 2001 Population Census. Columns 1-3 show the unconditional means for all towns/villages, towns/villages in constituencies below the treatment threshold, and towns/villages in constituencies above the treatment threshold, respectively. Column 4 shows the difference of means across Columns 2 and 3, and Column 5 shows the p-value for the difference of means. Column 6 shows the regression discontinuity estimate, following the main estimating equation, of the effect of being above the treatment threshold, and Column 7 is the p-value for this estimate, using cluster robust standard errors at the assembly level.

Table 4: Impact of close election victory for women over men on fire activity: regression discontinuity estimates

	(1) Log Monthly Number of Crop Fires β / SE
Female Winner	-0.13**
	(0.07)
State-by-Election Year FE	Yes
Year FE	Yes
Control Mean	3.88
Observations	25452
R^2	0.170

Notes: This table shows regression discontinuity estimates of log monthly number of fires (MODIS (2002-2016) and VIIRS (2016-2021) satellite data) as a function of the margin of victory for women over men for elections held between 2002 - 2019. Our specification controls for state-by-election year fixed effects, and year fixed effects. Standard errors clustered at the assembly level.

Table 5: Effects of election of women leaders on monthly fire brightness measures

	(1) Total Fire Brightness (in Kelvins) β / SE	(2) Mean Fire Brightness (in Kelvins) β / SE	(3) Max Fire Brightness (in Kelvins) β / SE	(4) Min Fire Brightness (in Kelvins) β / SE
Female Winner	-1380.37**	-14.87	-15.65*	-14.27
	(614.70)	(9.14)	(9.46)	(8.88)
State-by-Election Year FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Control Mean	1281.62	60.62	62.33	59.10
Observations	25452	25452	25452	25452
R^2	0.061	0.149	0.152	0.146

Notes: This table shows regression discontinuity estimates of total fire brightness, mean fire brightness, max fire brightness and min fire brightness (all measured in Kelvin, and sourced from MODIS (2002-2016) and VIIRS (2016-2021) satellite data) as a function of the margin of victory for women over men for elections held between 2002 - 2019. Our specification controls for state-by-election year fixed effects, and year fixed effects. Standard errors clustered at the assembly level. Note that we show balance in the area of towns and villages in the assemblies included in the RD bandwidth.

Table 6: Effects of election of women leaders on monthly max. emissions: regression discontinuity estimates

	(1) Max Black Carbon (nano-gram/sq-meter/sec) β / SE	(2) Max Organic Carbon (nano-gram/sq-meter/sec) β / SE	(3) Max SO2 (nano-gram/sq-meter/sec) β / SE
Female Winner	-3.39**	-55.66*	-4.31*
	(1.72)	(29.95)	(2.29)
State-by-Election Year FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Control Mean	8.28	120.74	9.29
Observations	25452	25452	25452
R^2	0.098	0.094	0.093

Notes: This table shows regression discontinuity estimates of monthly max values of black carbon, organic carbon, and SO2 emission rates from 2002-2022 (in $ng/m^2/s$), sourced from MERRA 2 Aesosols dataset, as a function of margin of victory for women over men for 2002 - 2019. All columns control for state-by-election-year fixed effects. Standard errors clustered at the assembly level.

Table 7: Effects of election of women leaders on monthly mean emissions: regression discontinuity estimates

	(1) Mean Black Carbon (nano-gram/sq-meter/sec) β / SE	(2) Mean Organic Carbon (nano-gram/sq-meter/sec) β / SE	(3) Mean SO2 (nano-gram/sq-meter/sec) β / SE
Female Winner	-0.89	-9.99	-0.78
	(1.23)	(14.44)	(1.01)
State-by-Election Year FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Control Mean	5.80	83.92	6.43
Observations	25452	25452	25452
R^2	0.100	0.097	0.097

Notes: This table shows regression discontinuity estimates of monthly mean values of black carbon, organic carbon, and SO2 emission rates from 2002-2022 (in $ng/m^2/s$), sourced from MERRA 2 Aesosols dataset, as a function of margin of victory for women over men for 2002 - 2019. All columns control for state-by-election-year fixed effects, and year fixed effects. Standard errors clustered at the assembly level.

Table 9: Differences in survey responses by VCL gender

	Full sample	Male	Female	Difference of means	p-value on difference	OLS estimate estimate (controls)	p-value on OLS OLS estimate (controls)
Very Serious Problem (0/1)	59.20	53.61	63.91	10.30	0.03	12.64	0.14
Strongly Agree Regulation Needed (0/1)	64.39	58.76	69.13	10.37	0.03	13.95	0.09
Effects on Child Health (0/1)	0.23	0.19	0.27	0.09	0.03	0.12	0.06
Aware of # of Policies Implemented by Govt.	2.25	2.11	2.38	0.27	0.03	0.20	0.24
Aware of Penalties (0/1)	0.52	0.48	0.56	0.08	0.09	0.15	0.05
# of Policies Implemented	1.50	1.52	1.49	-0.02	0.81	-0.15	0.40
Private Stubble Collection (0/1)	0.15	0.12	0.18	0.06	0.09	0.05	0.41
Stubble as Fodder (0/1)	0.32	0.27	0.36	0.10	0.05	0.16	0.02

Notes: This table shows the main outcomes from the survey that we discuss in this paper, conducted for this paper from December 2022 - March 2023. All results shown include sample means for the full sample, male VCLs only, and female VCLs only, followed by the differences in means and the respective p-values. We also show OLS estimates from regressing the outcomes of interest on gender of the VCL, while controlling for the observables listed in Table 8. All survey responses on VCL characteristics and preferences were conducted for this paper between December 2022 and March 2023.

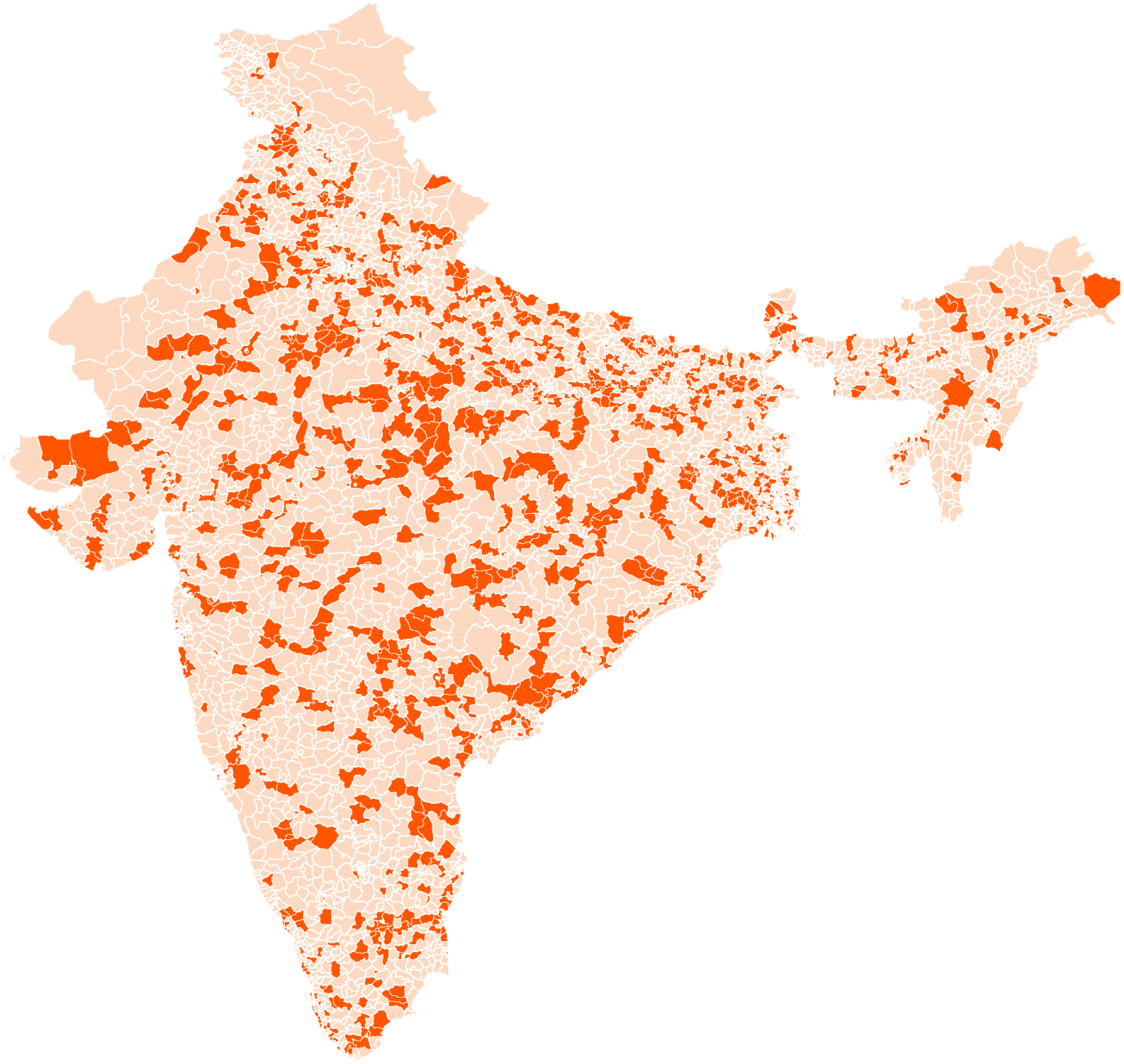
Table 8: Similarities and differences in observables between women and men Village Council Leaders (VCLs)

	Full sample	Male	Female	Difference of means	p-value on difference
Age	47.59	48.15	47.12	-1.03	0.32
# of Children	2.15	2.08	2.22	0.14	0.18
Married (0/1)	0.95	0.94	0.96	0.01	0.54
Years of Education	9.59	10.61	8.72	-1.89	0.00
Years of Education (Spouse)	8.75	7.73	9.62	1.89	0.00
First Term (0/1)	0.86	0.82	0.90	0.08	0.03
Lead Discussion in Meetings (0/1)	0.56	0.56	0.56	-0.00	0.98
Homemaker (0/1)	0.51	0.11	0.85	0.74	0.00
Homemaker (Spouse) (0/1)	0.40	0.78	0.08	-0.70	0.00
Farm Work (0/1)	0.31	0.59	0.07	-0.53	0.00
Farm Work (Spouse) (0/1)	0.34	0.05	0.58	0.53	0.00

Notes: This table shows the means and balance tests for survey responses on VCL characteristics, conducted for this paper between December 2022 and March 2023. Columns 1-3 show the unconditional means for all VCLs, male VCLs, and female VCLs respectively. Column 4 shows the difference of means across Columns 2 and 3, and Column 5 shows the p-value for the difference of means.

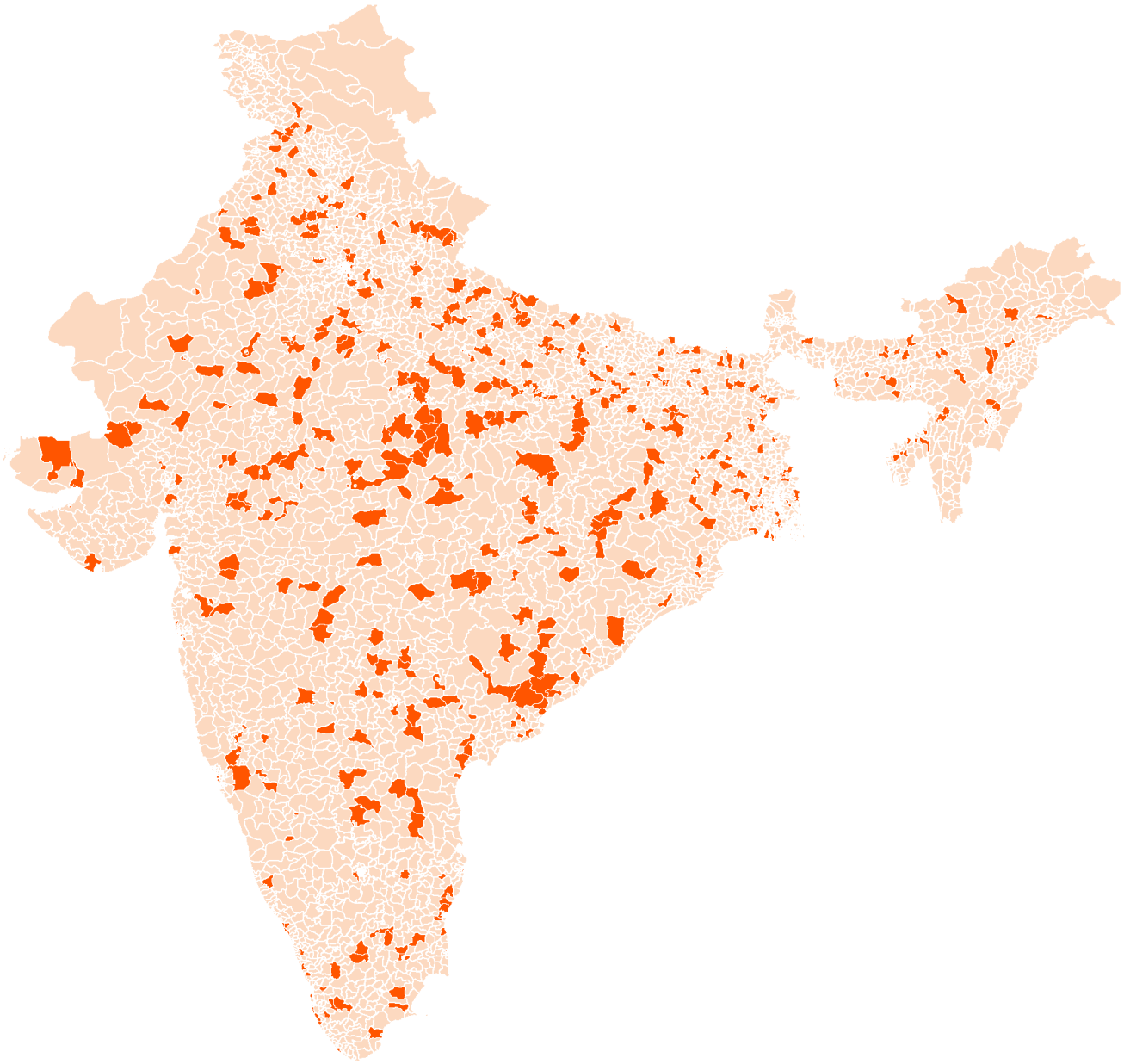
Figures

Figure 1: Assembly elections won by female candidates over males between 2002 and 2019



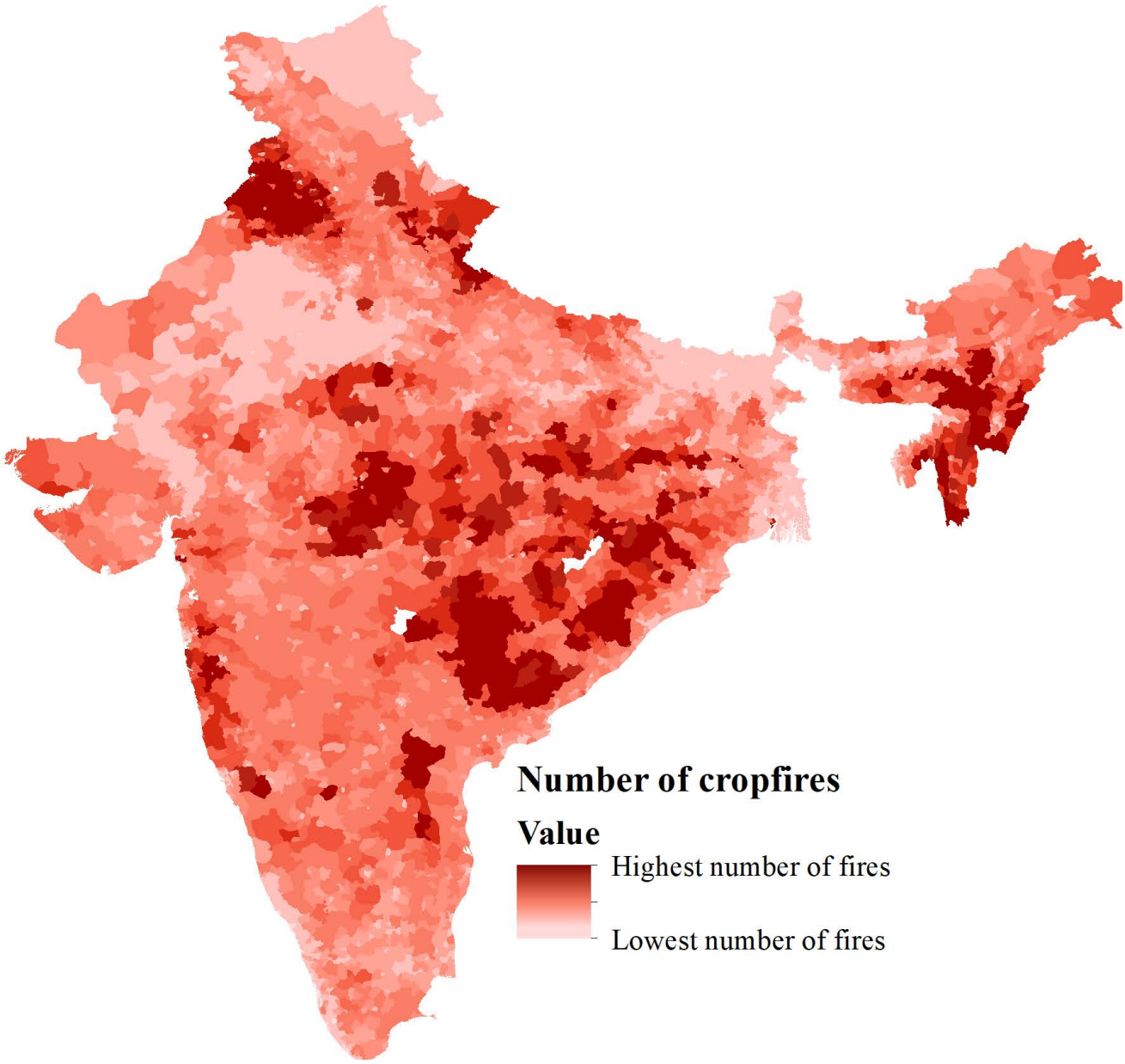
Notes: This figure depicts all the assemblies in India in which female candidates won elections over male rivals between 2002 and 2019 using data from Agarwal et al. (2021). The assemblies shown in this map include post-2008-delimitation boundaries.

Figure 2: Close-elections won by female candidates over males



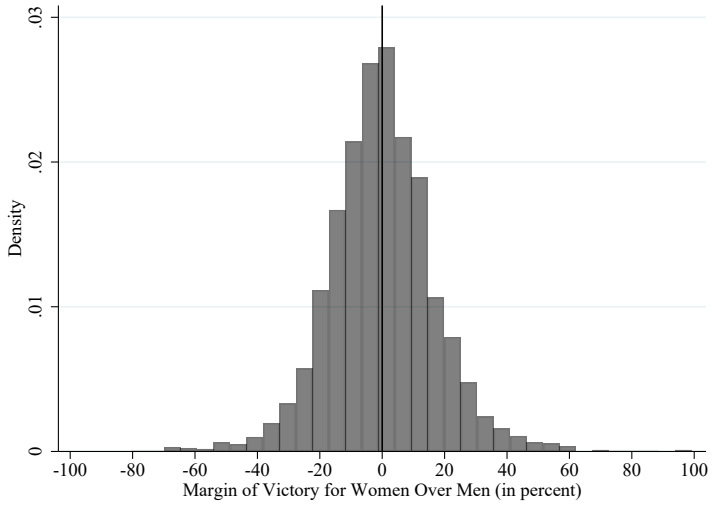
Notes: This figure shows all the close-assemblies in which female candidates won elections over male rivals between 2002 and 2019 using data from Agarwal et al. (2021). The assemblies shown in this map include post-2008-delimitation boundaries.

Figure 3: Intensity of number of crop-fires

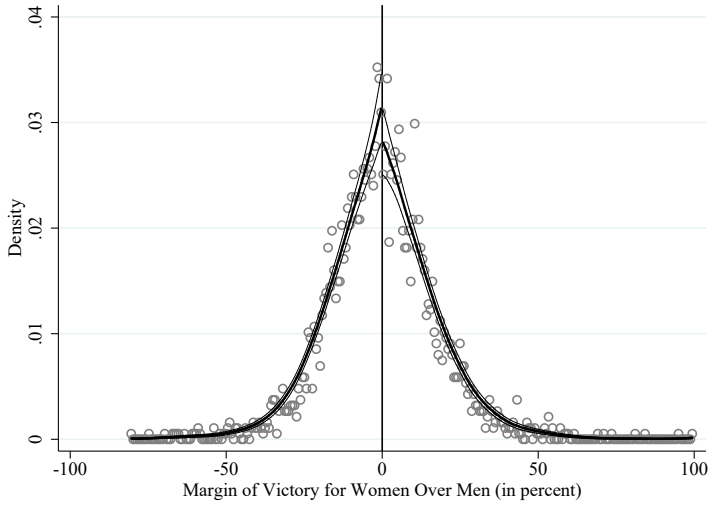


Notes: This figure shows all the assemblies in India, with the color ramp depicting the frequency of crop-fire incidents (the darkest colors meaning the highest frequency cases) arising from biomass burning. We use a combination of MODIS (2002-2016) and VIIRS (2016-2022) satellite data on cropfire incidents to create this graph. The assemblies shown in this map include post-2008-delimitation boundaries.

Figure 4: Distribution of running variable



(a) Histograph of Margin of Victory for Women Over Men



(b) McCary Test

Notes: This graph shows the distribution of margin of victory for women over men (in percent). The top panel is a histogram of margin of victory for women over men (in percent) for all legislative elections in India from 2002-2019. The bottom panel plots a non-parametric regression to each half of the distribution following McCrary (2008), testing for a discontinuity at zero. The point estimate for the discontinuity is -0.04, with a standard error of 0.1. The graphs do not show evidence of any significant discontinuities at the RD cutoff.

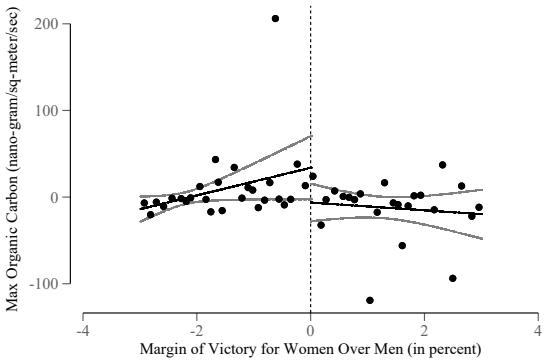
Figure 5: Impact of close election victory for women over men on fire activity and emissions: regression discontinuity plots



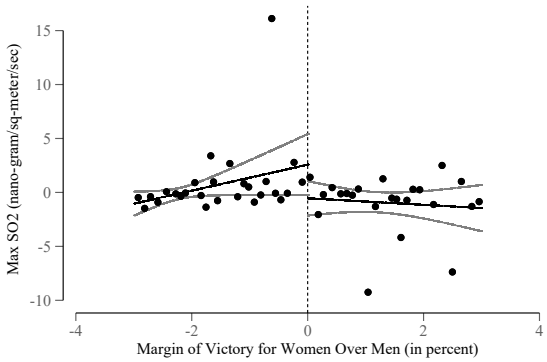
(a) Log Monthly Crop Fires (2002-2021)



(b) Black Carbon (nano-gram/sq-meter/sec) (2002-2022)



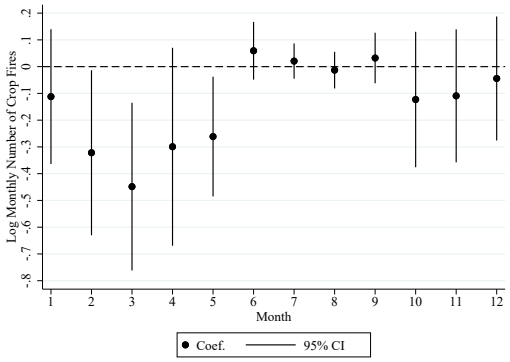
(c) Organic Carbon (nano-gram/sq-meter/sec) (2002-2022)



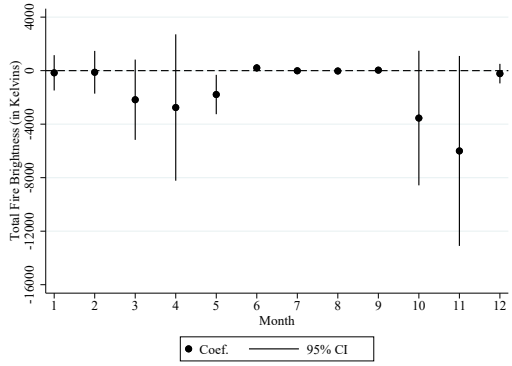
(d) SO2 (nano-gram/sq-meter/sec) (2002-2022)

Notes: Graphs show regression discontinuity estimates by plotting values of the outcomes as a function of margin of victory for women over men. Figure (a) plots the log monthly number of fires between 2002 - 2021 sourcing from both the MODIS (2002-2016) and VIIRS (2016-2021) satellite data. Figures (b), (c), and (d) plot the maximum values of monthly black carbon, organic carbon, and SO2 emission rates from 2002-2022 (in $ng/m^2/s$), respectively sourced from MERRA 2 Aesosols dataset. Estimates in all figures control for state-by-election-year fixed effects. We consider election results from 2002-2019 to generate these graphs (Agarwal et al., 2021).

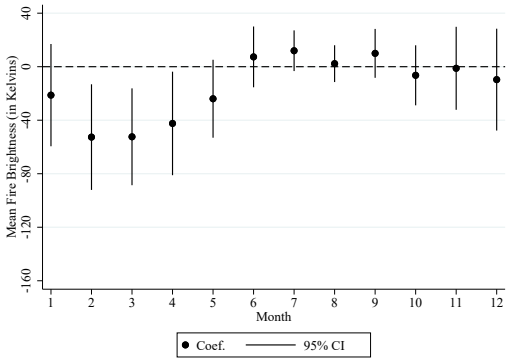
Figure 6: Impact of close election victory for women over men on fire activity and emissions by month: regression discontinuity estimates



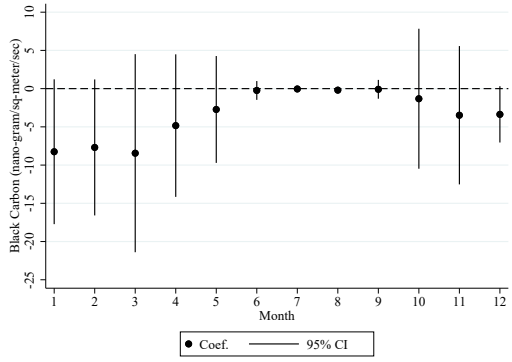
(a) Fires



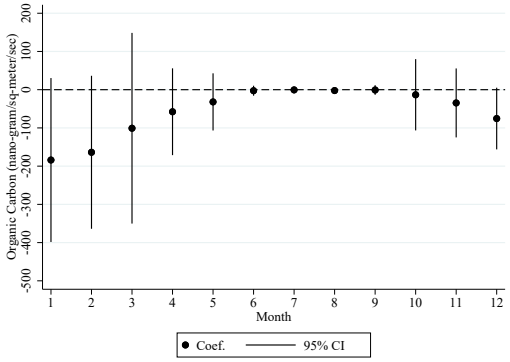
(b) Total Fire Brightness



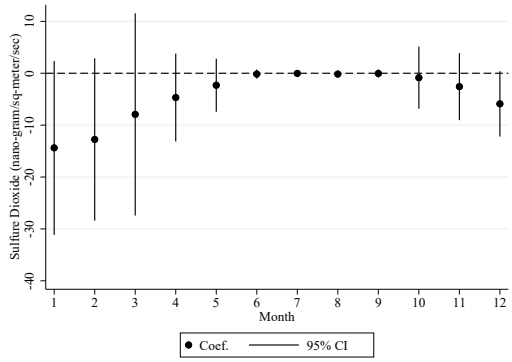
(c) Mean Fire Brightness



(d) Max Black Carbon



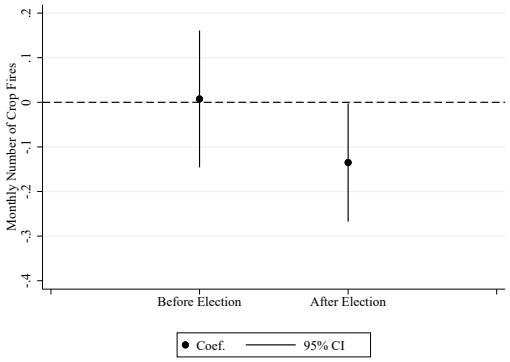
(e) Max Organic Carbon



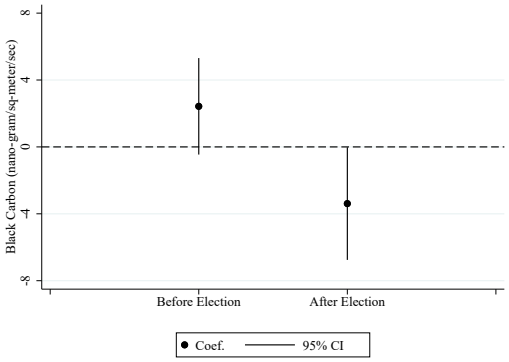
(f) Max Sulfur Dioxide

Notes: Graphs show regression discontinuity estimates by plotting values of the outcomes as a function of margin of victory for women over men by month. Figure (a) plots the log monthly number of fires between 2002 - 2021 sourcing from both the MODIS (2002-2016) and VIIRS (2016-2021) satellite data. Figures (b) and (c) plot RD estimates for the total and mean values of fire brightness (Kelvin) from MODIS (2002-2016) and VIIRS (2016-2021) satellite data. Figures (d), (e), and (f) plot the RD estimates for the maximum values of monthly black carbon, organic carbon, and SO2 emission rates from 2002-2022 (in $ng/m^2/s$), respectively sourced from MERRA 2 Aesosols dataset. Estimates in all figures control for state-by-election-year fixed effects. We consider election results from 2002-2019 to generate these graphs (Agarwal et al., 2021).

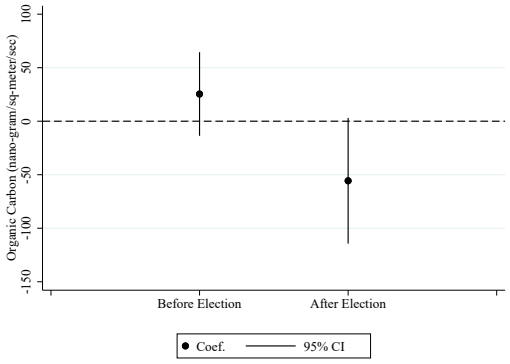
Figure 7: Impact of close election victory for women over men on fire activity and emissions before and after elections: regression discontinuity plots



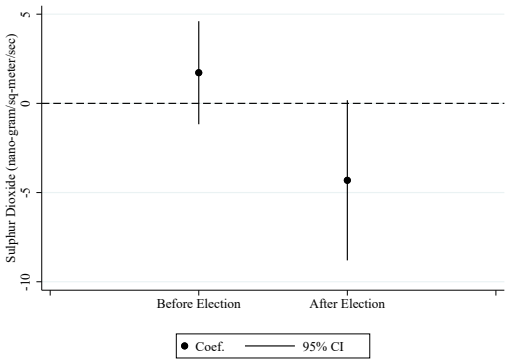
(a) Log Monthly Crop Fires



(b) Black Carbon



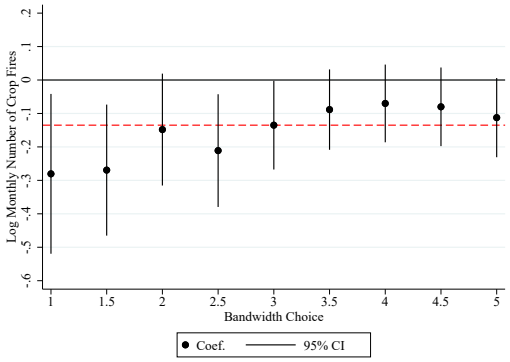
(c) Organic Carbon



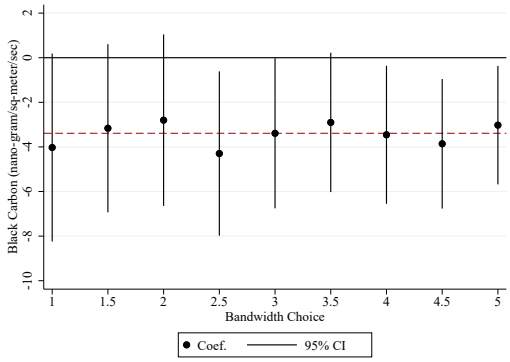
(d) Sulfur Dioxide

Notes: Graphs show regression discontinuity estimates of the outcomes as a function of margin of victory for women over men before and after elections. Figure (a) plots the log monthly number of fires between 2002 - 2021 sourcing from both the MODIS (2002-2016) and VIIRS (2016-2021) satellite data. Figures (b), (c), and (d) plot the maximum values of monthly black carbon, organic carbon, and SO2 emission rates from 2002-2022 (in $ng/m^2/s$), respectively sourced from MERRA 2 Aesosols dataset. Estimates in all figures control for state-by-election-year fixed effects. We consider election results from 2002-2019 to generate these graphs (Agarwal et al., 2021).

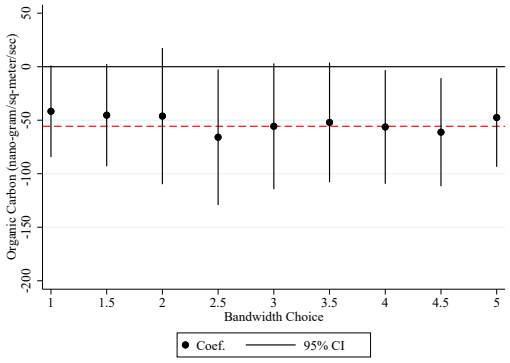
Figure 8: Impact of close election victory for women over men on fire activity and emissions by bandwidth choice: regression discontinuity plots



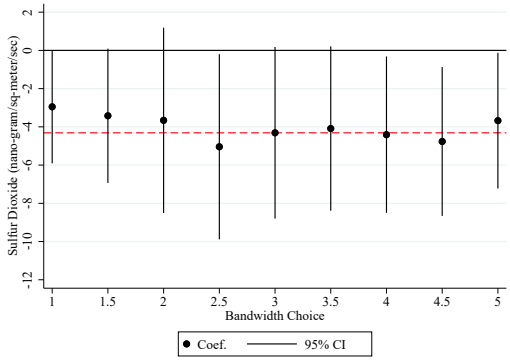
(a) Log Monthly Crop Fires



(b) Black Carbon



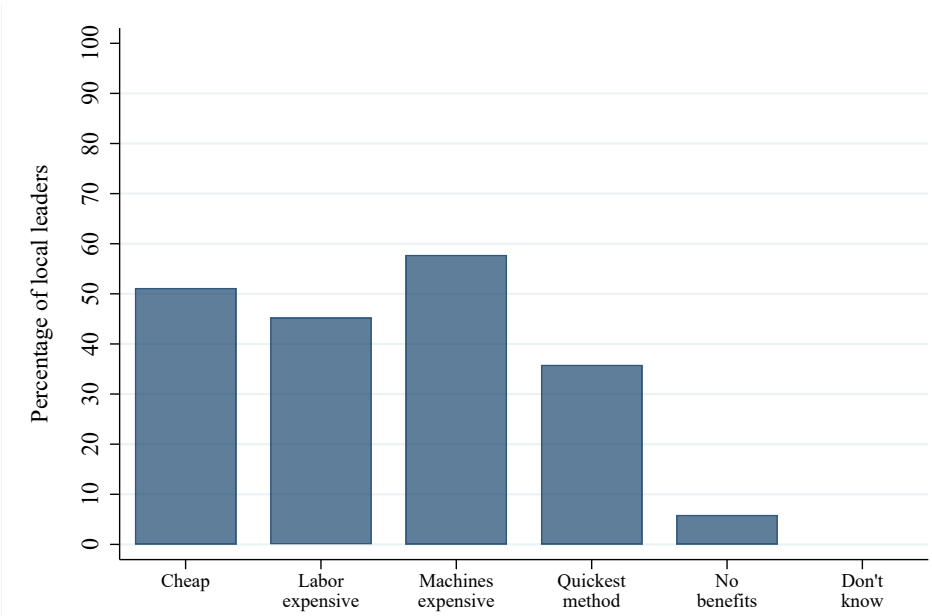
(c) Organic Carbon



(d) Sulfur Dioxide

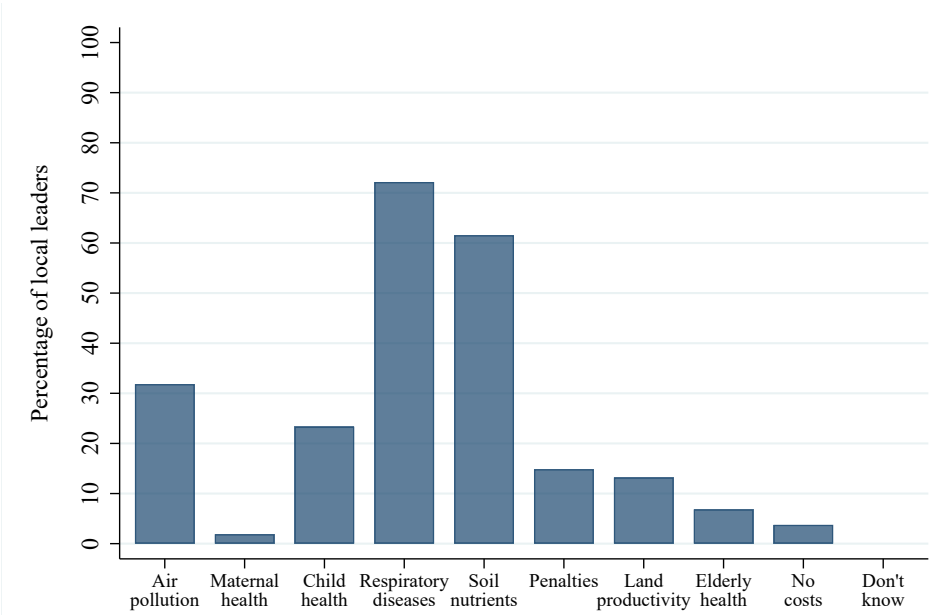
Notes: Graphs show regression discontinuity estimates of the outcomes as a function of margin of victory for women over men by bandwidth choice. The red dotted line depicts our preferred specification using a bandwidth of 3 percentage points. Figure (a) plots the log monthly number of fires between 2002 - 2021 sourcing from both the MODIS (2002-2016) and VIIRS (2016-2021) satellite data. Figures (b), (c), and (d) plot the maximum values of monthly black carbon, organic carbon, and SO2 emission rates from 2002-2022 (in $ng/m^2/s$), respectively sourced from MERRA 2 Aesosols dataset. Estimates in all figures control for state-by-election-year fixed effects. We consider election results from 2002-2019 to generate these graphs (Agarwal et al., 2021).

Figure 9: Descriptive evidence on the costs of crop burning and why it continues to be practiced from survey of Mukhiyas (Village Council Leaders) in Punjab



Notes: Survey data from 424 panchayat mukhiyas (community leaders) across Punjab, India, December 22 - March 23.

(a) Why does crop burning continue?

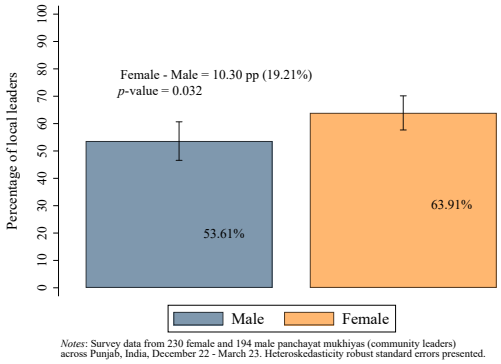


Notes: Survey data from 424 panchayat mukhiyas (community leaders) across Punjab, India, December 22 - March 23.

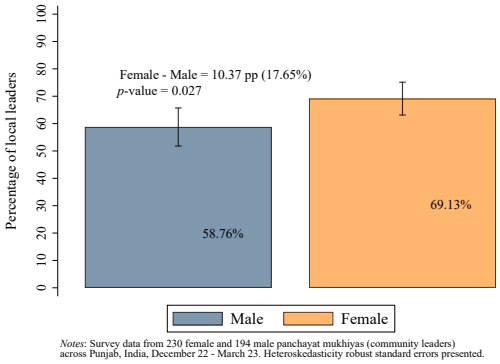
(b) What are the costs of crop burning?

Notes: The above graph shows 2 panels each of which depicts the mean responses of all mukhiyas (village council leaders) in a large telephonic survey conducted between December 2022 and March 2023. Each graph depicts a bar chart with point estimates for the difference between female and male leader responses and a 95% confidence interval.

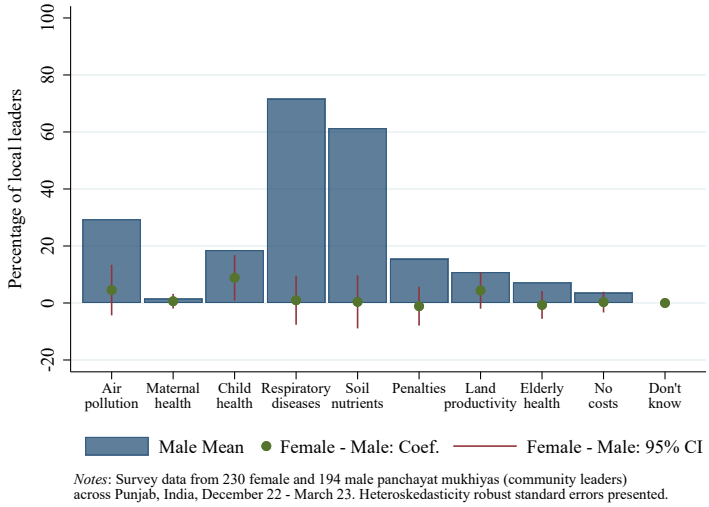
Figure 10: Results from survey of Mukhiyas (Village Council Leaders) in Punjab



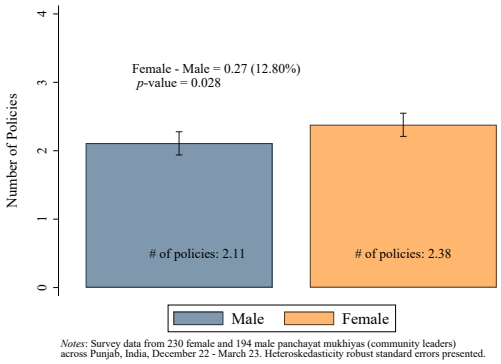
(a) More female leaders rate crop fires as a very serious problem



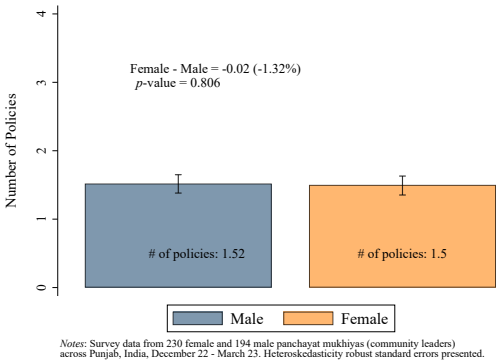
(b) Female leaders more likely to favor regulation against crop burning



(c) Female leaders more concerned about child health costs of crop fires



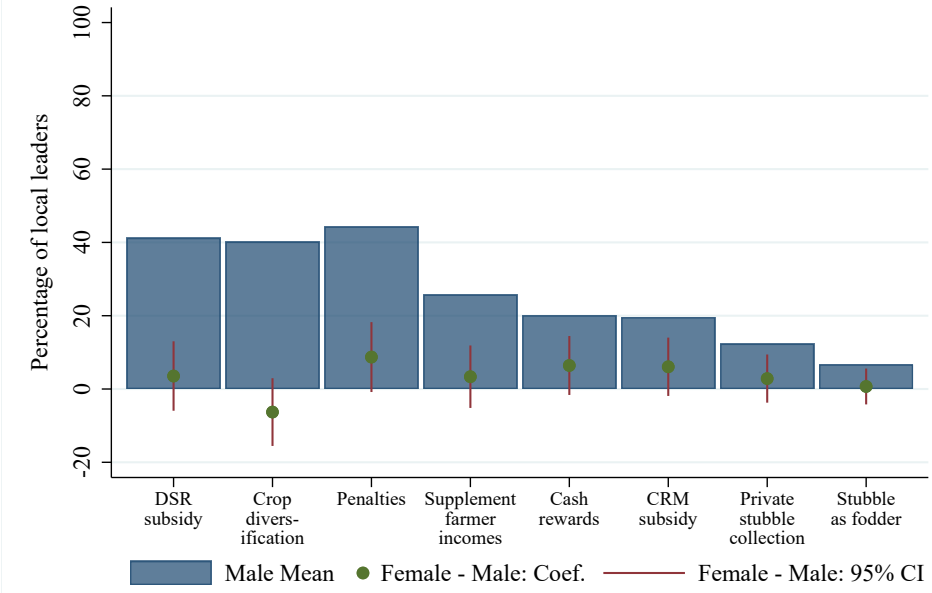
(d) Female leaders have greater awareness of govt. policies for crop fires



(e) Implement similar # policies for crop fires

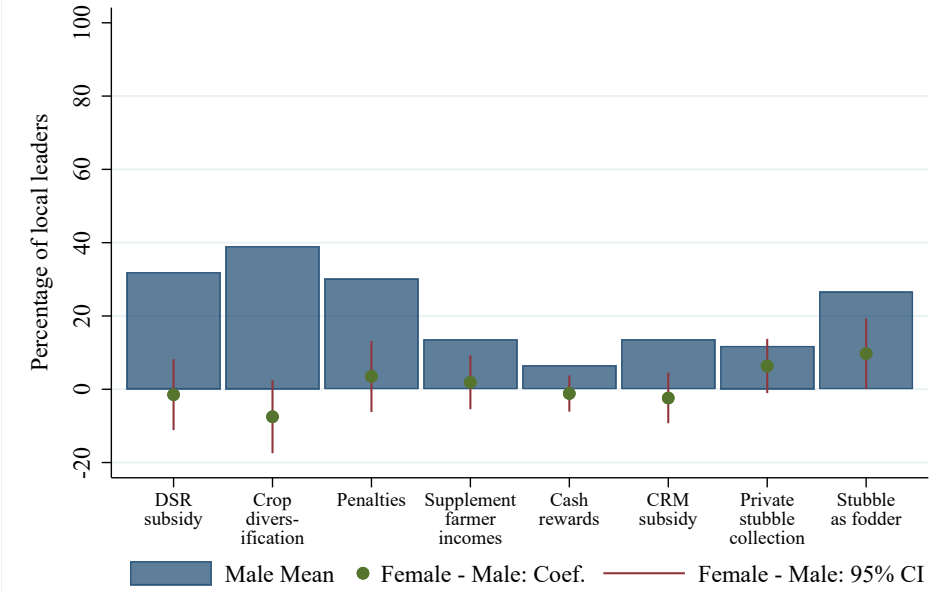
Notes: The above graph shows 5 panels each of which depicts the differences between the responses of 424 male and female mukhiyas (village council leaders) in a telephonic survey conducted between December 2022 and March 2023. The survey asked a range of questions related to issues from poverty, unemployment, inflation to discrimination against women, and stubble burning in order to elicit true policy priorities from the respondents. We did not reveal that the goal of the survey was to understand beliefs and preferences on stubble burning. Each graph depicts mean responses for male and female leaders with 95% confidence intervals and the p-values of the differences in response.

Figure 11: Results from survey of Mukhiyas (Village Council Leaders) in Punjab



Notes: Survey data from 230 female and 194 male panchayat mukhiyas (community leaders) across Punjab, India, December 22 - March 23. Heteroskedasticity robust standard errors presented.

(a) What policies are village leaders aware of?



Notes: Survey data from 230 female and 194 male panchayat mukhiyas (community leaders) across Punjab, India, December 22 - March 23. Heteroskedasticity robust standard errors presented.

(b) What policies were implemented?

Notes: The above graph shows 2 panels each of which depicts the differences between the responses of male and female mukhiyas (village council leaders) in a large telephonic survey conducted between December 2022 and March 2023. Each graph depicts a bar chart with point estimates for the difference between female and male leader responses and a 95% confidence interval.