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

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May 15, 2021

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 to isolate the impact of women narrowly being elected over male candidates, we find that the election of women legislators in India leads to a 15% decrease in crop-fire incidents. This is accompanied by a large and statistically significant decrease in air pollution for constituencies led by women, in particular black carbon, organic carbon, and SO_2, all of which are precursors to PM2.5. These effects on crop fires and air pollution are predictably concentrated during the winter harvest and post-harvest months (December to April), with comparatively modest effects during the rest of the year. In falsification tests, we show no effects on crop fires or air pollution in the years prior to state elections.

*We thank seminar participants at the University of California - Irvine, 2020 OSWEET and 2020 OARES for valuable feedback. All errors are our own.

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Extended Abstract

Given the enormous scale of environmental decline, large-scale policies by elected leaders may be one of the most effective tools to addressing climate change. For example, 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). In this paper, we examine the causal effect of women leaders on local environmental outcomes.

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

Survey evidence 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). Women may not advocate more for other women's interests, and rather 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, tantalizingly, 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).

In this paper, we estimate the causal effects of women leaders on environmental outcomes in India, focusing on a point source of air pollution that contributes to as much as half of the particulate matter in many parts of the country during winter months: crop fires.[1] Because air pollution disproportionately effects women,[2] female leaders may be particularly

[1] Air pollution remains one of the leading causes of mortality, accounting for 9 million premature deaths annually or roughly 16% of all deaths worldwide and a staggering 268 million disability-adjusted-life-years (Landrigan et al., 2018). Nowhere is the problem more pronounced than in India, which is home to 14 of 20 most polluted cities in the world. In fact, if the city of New Delhi, the capital of India, were to meet World Health Organization air quality standards, average life expectancy would increase by 10 years (Greenstone and Fan, 2019), roughly equivalent to the gains in life expectancy made by the country on average in the 21st century (Max Roser and Ritchie, 2013).

[2] Women experience disproportionately severe effects of air pollution though greater deposition of inhaled particles (Beggs and Bambrick, 2005). Air pollution also negative 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).

invested in implementing policies that tackle air pollution. The majority vote base for female legislators is women, and women leaders may simply 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 has direct benefit to their gender.[3]

Using a close-election regression discontinuity design to isolate the impact of women being elected over male candidates, we provide causal evidence for better environmental outcomes under female leaders than male leaders. Specifically, we study of the effect of female candidates narrowly winning legislative assembly elections over male candidates from 2006-2016 on incidence of crop fires and air pollution. We find election of women legislators leads to an approximately 16% decrease in crop-fire incidents (Table 4). Next, we examine the effects of 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 incidence of crop fires. Indeed, we estimate a decrease of 1.91 $\mu g/m^3$ (25%), 29.39 $\mu g/m^3$ (30%), and 2.34 $\mu g/m^3$ (32%) in monthly black carbon, organic carbon, and SO^2, respectively (Table 5) in legislative assemblies won narrowly by women over men. Figure 5 shows the graphical representation of the effect of women leaders on agricultural fires and air pollution. Furthermore, 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). Lastly, in falsification tests, we show no effects on crop fires or air pollution in the years prior to state elections (Figure 7).

This paper has two 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. Female leaders are more likely to invest in public goods and infrastructure that have a direct benefit to their gender (Chattopadhyay and Duflo, 2004). Furthermore, the election of women has also been shown to lead to higher net growth in economic activity (Baskaran et al., 2018). In terms of health outcomes, female legislators lead to better antenatal and childhood health services (Bhalotra and Clots-Figueras, 2014) and a reduction in maternal mortality (Bhalotra et al., 2020). Finally, the election of female leaders is also be causally linked to higher educational outcomes within their jurisdictions (Clots-Figueras, 2012).

Second, this paper contributes to the ethnographic literature on the historical role of women

[3]It is also possible 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). In late-2021, we will administer a telephonic survey to local male and female leaders in India to parse understand the channels driving our results described below.

in designing policies that promote environmental justice. Women have been at the forefront of environmental awareness and advocacy across the world 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 gained traction in the 1980s, beginning with the anti-nuclear protests in Tamil Nadu, and gaining 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 had vast long-term effects on 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 continue to be important to women voters.

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1 Tables and Figures

1.1 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
BJP Winner (0/1)	0.28	0.27	0.29	0.02	0.34	0.10	0.14
INC Winner (0/1)	0.24	0.23	0.26	0.03	0.20	0.01	0.85
Regional Winner (0/1)	0.48	0.50	0.45	-0.05	0.05	-0.11	0.13
# of Winner Votes	62390.65	62056.59	62769.93	713.34	0.59	1233.71	0.61
# of Valid Votes	137112.39	135819.13	138561.30	2742.17	0.27	3637.74	0.37
# of Eligible Voters	199815.81	196455.78	203553.81	7098.03	0.06	5587.97	0.34
Turncoat Winner (0/1)	0.07	0.09	0.05	-0.04	0.01	0.02	0.65
Incumbent Winner (0/1)	0.27	0.31	0.22	-0.08	0.00	-0.05	0.54
# of Terms (Winner)	1.88	2.10	1.65	-0.45	0.00	-0.25	0.25
SC/ST Constituency (0/1)	0.35	0.36	0.34	-0.02	0.29	0.01	0.86

Notes: This table shows the mean values for election characteristics. All variables come from the Trivedi Centre for Political Data, Ashoka University. 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 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 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	-0.15**
	(0.06)
State-by-Election Year FE	Yes
Control Mean	2.44
Observations	22368
R^2	0.133

Notes: This table shows regression discontinuity estimates of log monthly number of fires as a function of margin of victory for women over men for 2006 - 2016. Our specification controls for state-by-election-year fixed effects. Standard errors clustered at the assembly level.

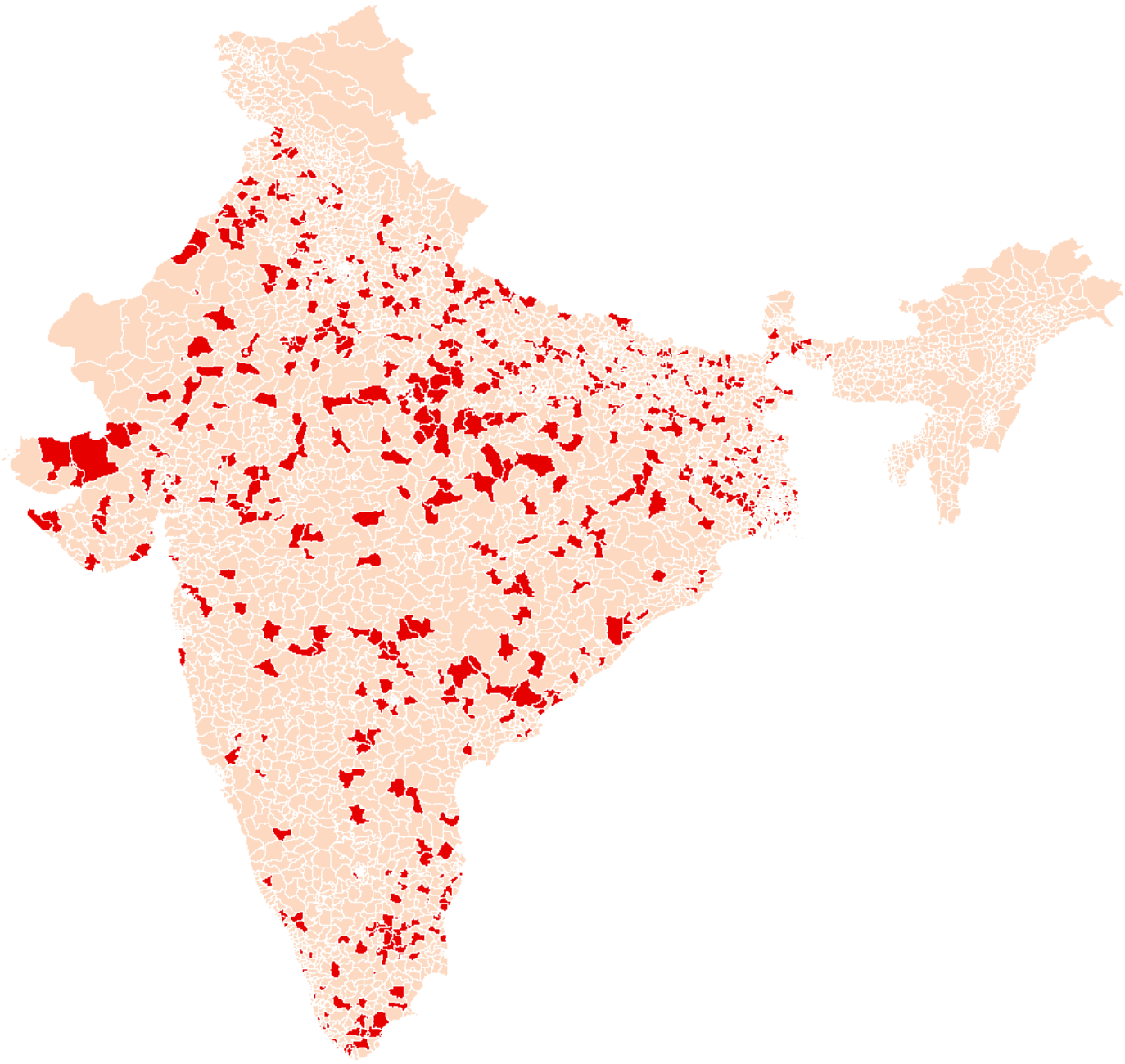
Table 5: Impact of close election victory for women over men on emissions: regression discontinuity estimates

	(1) Black Carbon (nano-gram/sq-meter/sec) β / SE	(2) Organic Carbon (nano-gram/sq-meter/sec) β / SE	(3) SO2 (nano-gram/sq-meter/sec) β / SE
Female Winner	-1.91	-29.39*	-2.34*
	(1.17)	(17.20)	(1.32)
State-by-Election Year FE	Yes	Yes	Yes
Control Mean	7.39	97.92	7.46
Observations	22368	22368	22368
R^2	0.094	0.092	0.092

Notes: This table shows regression discontinuity estimates of monthly black carbon, organic carbon, and SO2 emission rates from 2006-2016 (in $ng/m^2/s$) as a function of margin of victory for women over men for 2006 - 2016. All columns control for state-by-election-year fixed effects. Standard errors clustered at the assembly level.

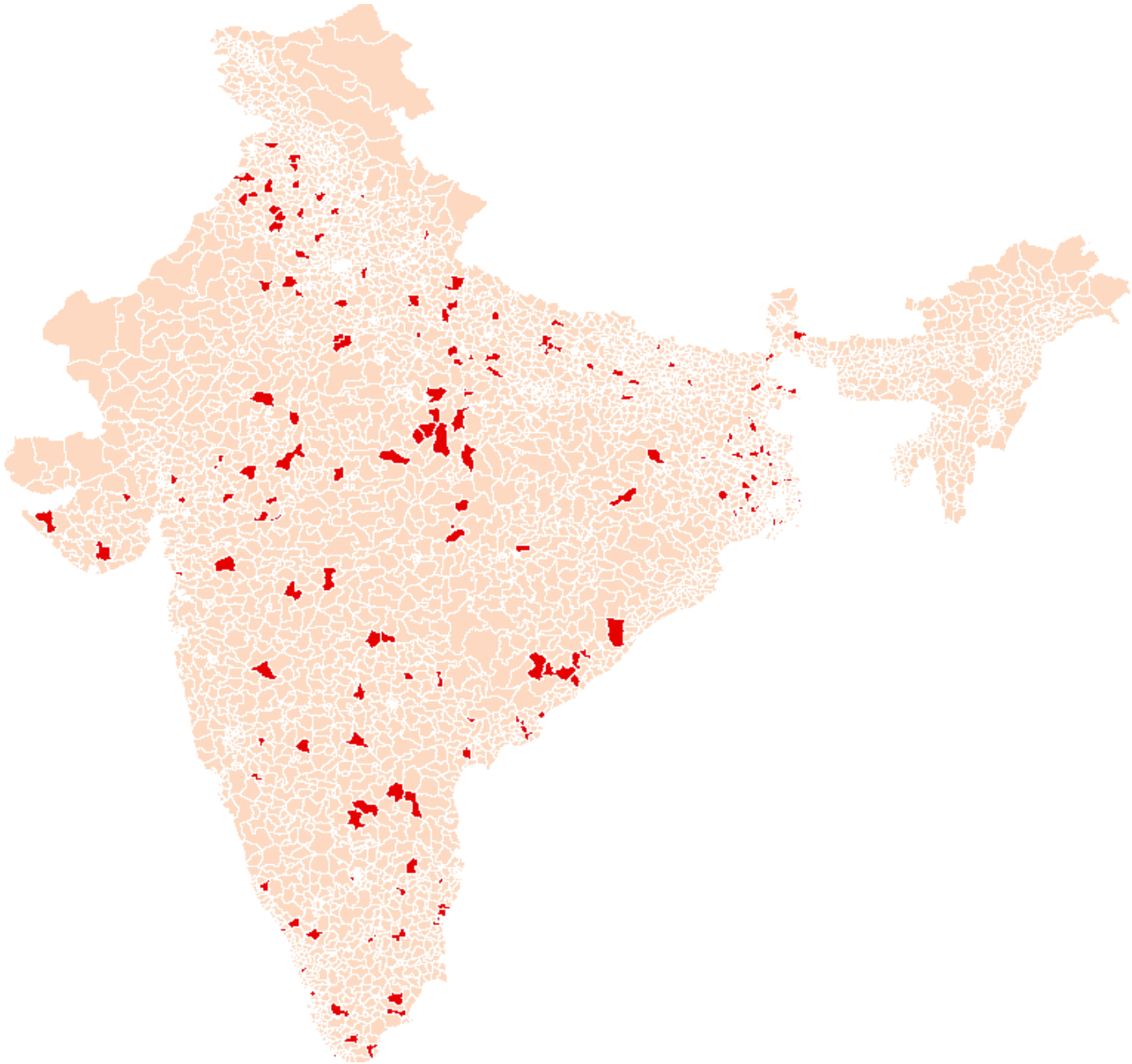
1.2 Figures

Figure 1: Assembly elections won by female candidates over males



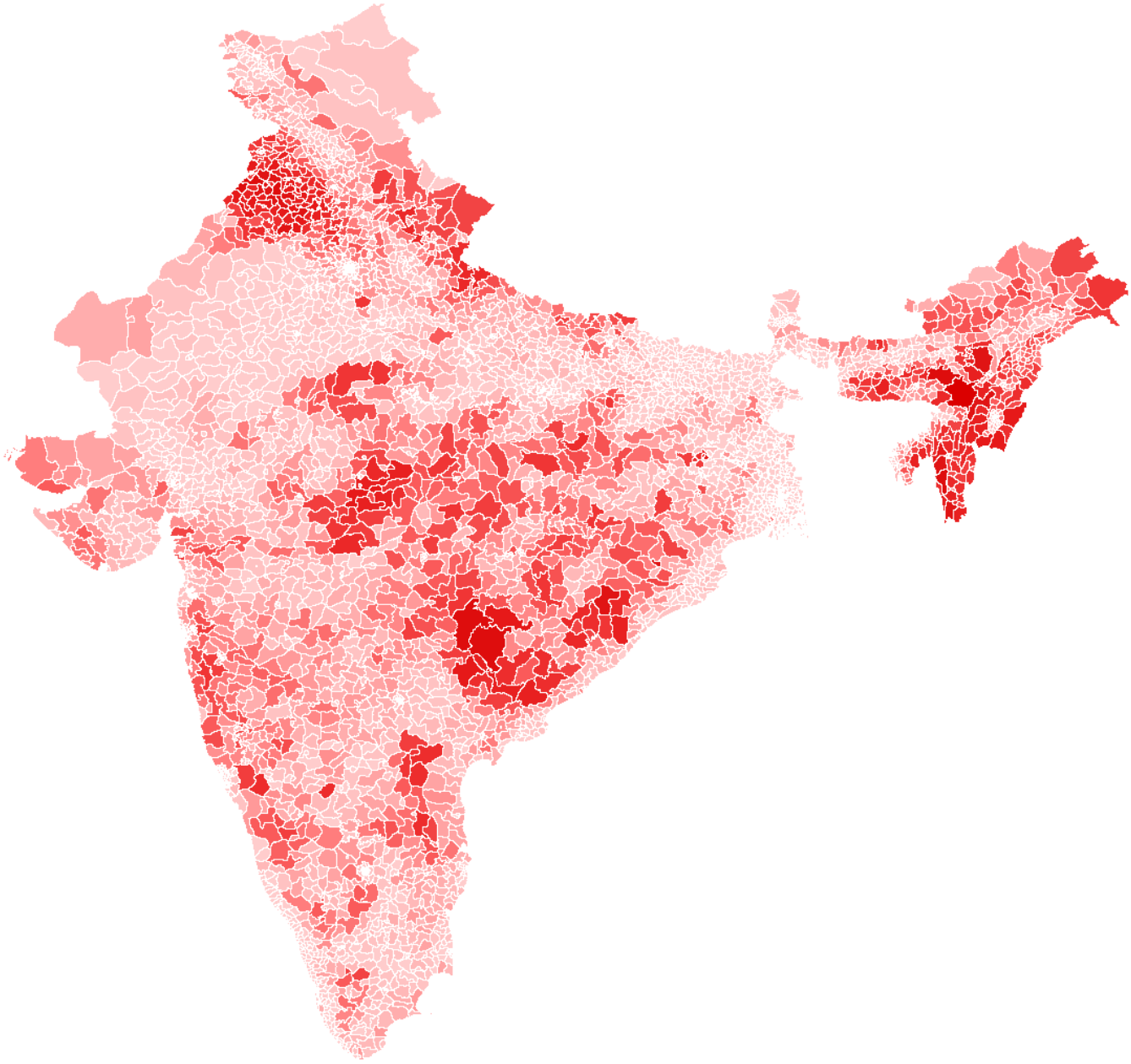
Notes: This figure shows all the assemblies in which female candidates won elections over male rivals between 2006 and 2016.

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



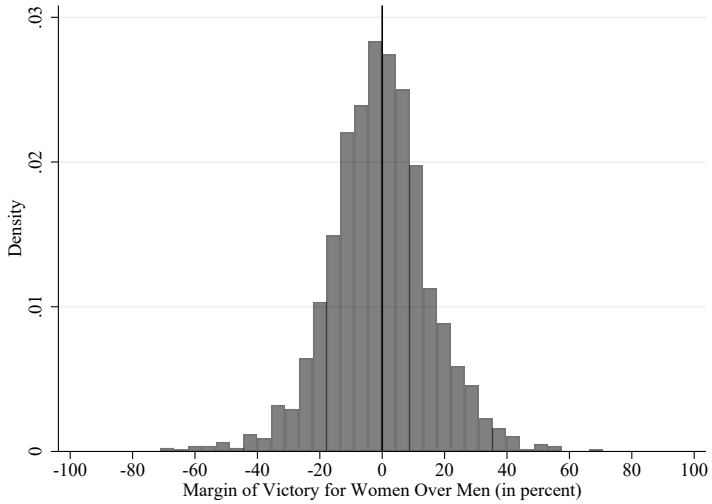
Notes: This figure shows all the close-assemblies in which female candidates won elections over male rivals between 2006 and 2016.

Figure 3: Intensity of number of crop-fires

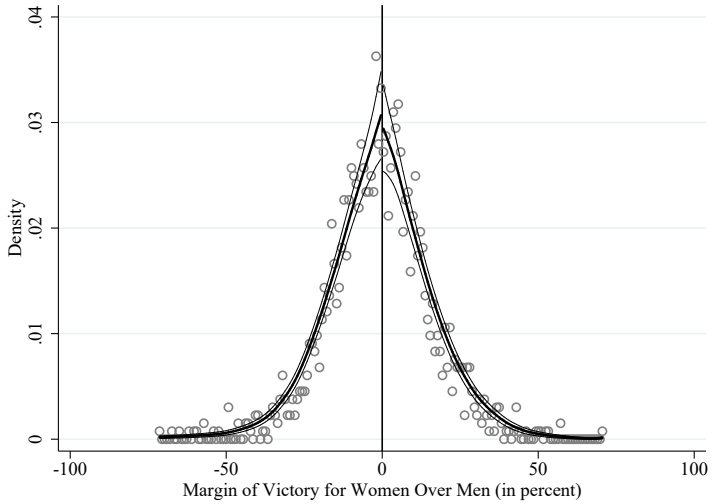


Notes: This figure shows all the assemblies in India, with the color ramp depicting the frequency of crop-fire incidents (the darkest colors meaning the highest frequency cases).

Figure 4: Distribution of running variable



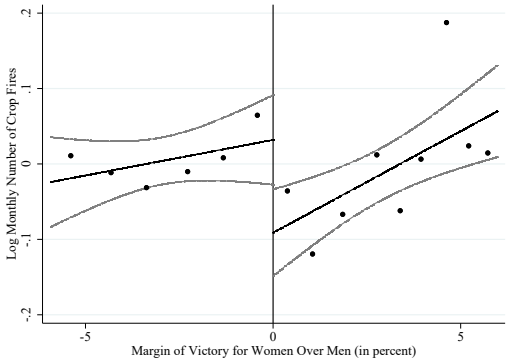
(a) Histograph of Margin of Victory for Women Over Men



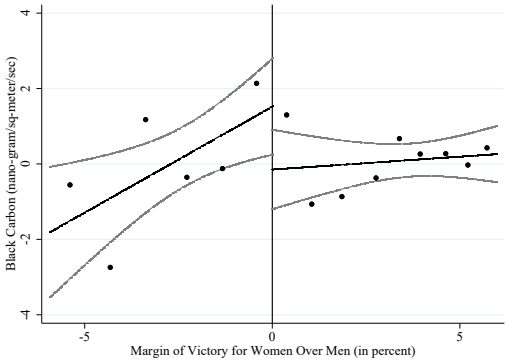
(b) McCary Test

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). 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.

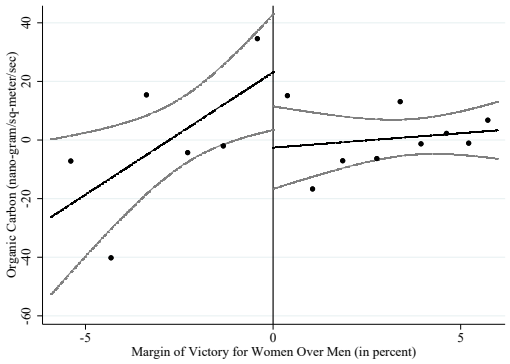
Figure 5: Impact of close election victory for women over men on fire activity and emissions: regression discontinuity plots



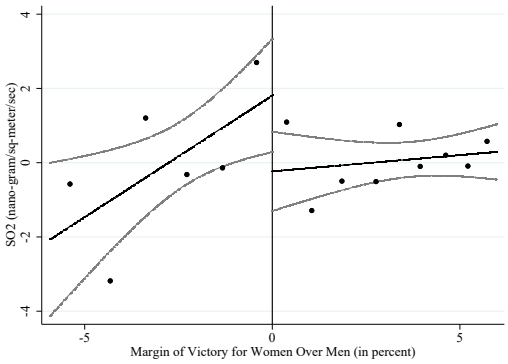
(a) Log Monthly Crop Fires



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



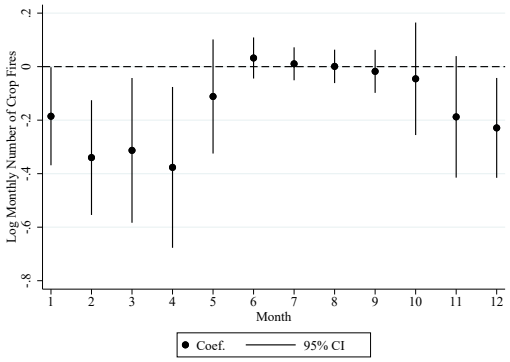
(c) Organic Carbon (nano-gram/sq-meter/sec)



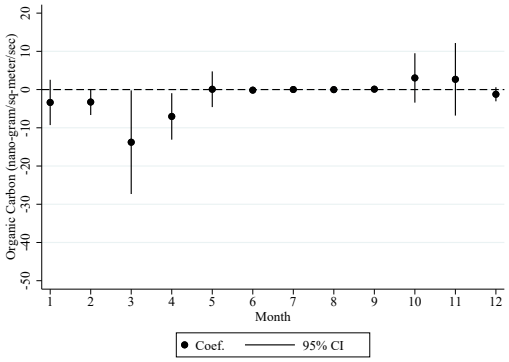
(d) SO2 (nano-gram/sq-meter/sec)

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 2006 - 2016. Figures (b), (c), and (d) plot the monthly black carbon, organic carbon, and SO2 emission rates from 2006-2016 (in $ng/m^2/s$), respectively. Estimates in all figures control for state-by-election-year fixed effects.

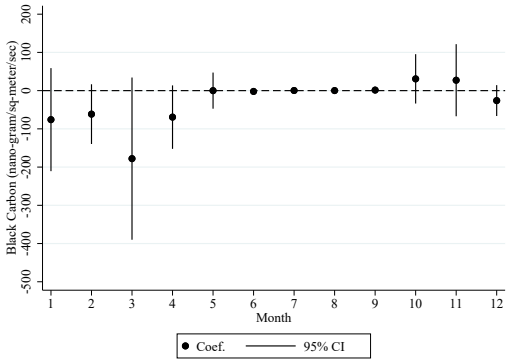
Figure 6: Impact of close election victory for women over men on fire activity and emissions by month: regression discontinuity estimates



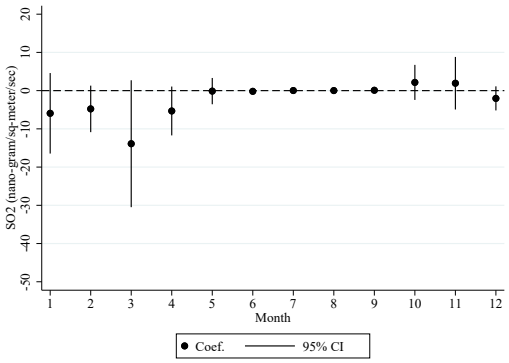
(a) Log Monthly Crop Fires



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



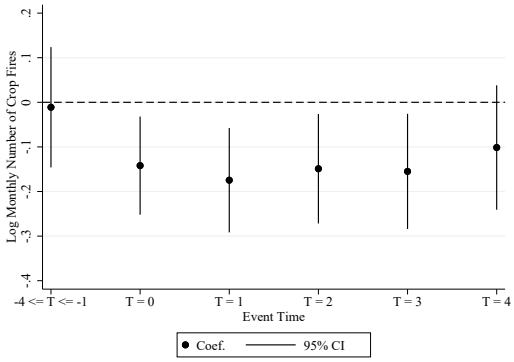
(c) Organic Carbon (nano-gram/sq-meter/sec)



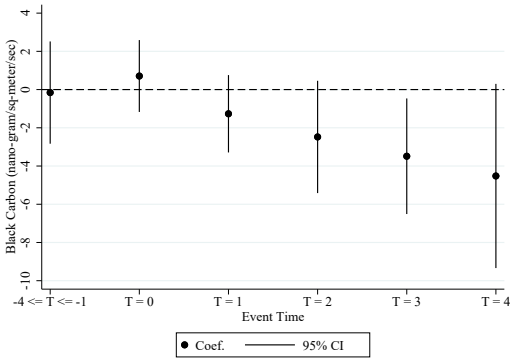
(d) SO2 (nano-gram/sq-meter/sec)

Notes: Graphs show regression discontinuity estimates of the outcomes as a function of margin of victory for women over men by month. Figure (a) plots estimates for the log monthly number of fires between 2006 - 2016. Figures (b), (c), and (d) plot the estimates for monthly black carbon, organic carbon, and SO2 emission rates from 2006-2016 (in $ng/m^2/s$), respectively. Estimates in all figures control for state-by-election-year fixed effects.

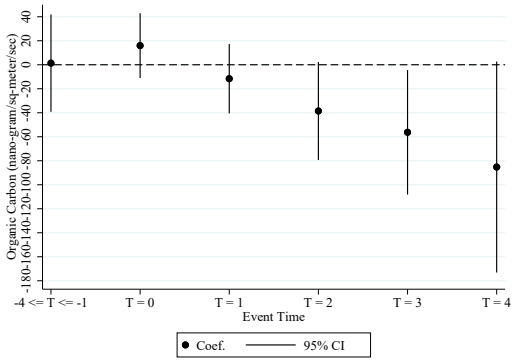
Figure 7: Impact of close election victory for women over men on fire activity and emissions before and after elections: regression discontinuity plots



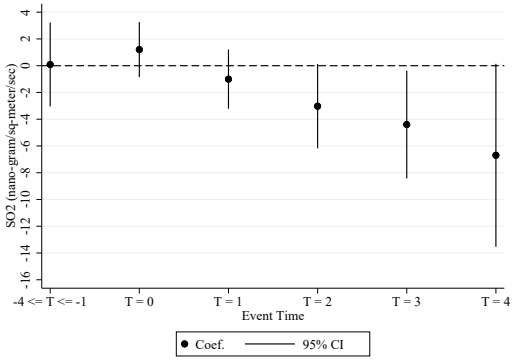
(a) Log Monthly Crop Fires



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



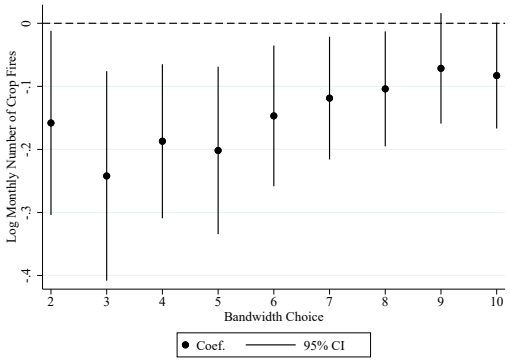
(c) Organic Carbon (nano-gram/sq-meter/sec)



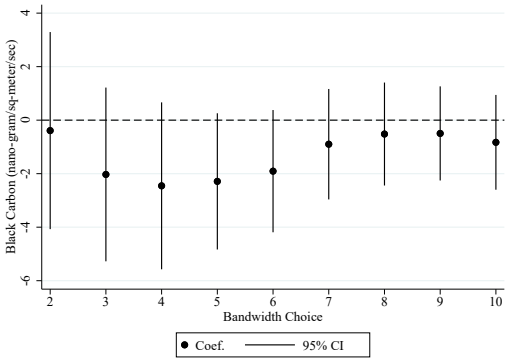
(d) SO2 (nano-gram/sq-meter/sec)

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 estimates for the log monthly number of fires between 2006 - 2016. Figures (b), (c), and (d) plot the estimates for monthly black carbon, organic carbon, and SO2 emission rates from 2006-2016 (in $ng/m^2/s$), respectively. Estimates in all figures control for state-by-election-year fixed effects.

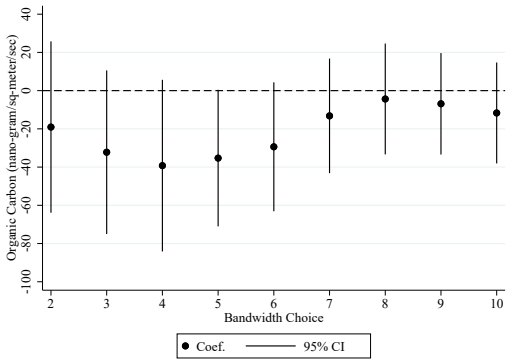
Figure 8: Impact of close election victory for women over men on fire activity and emissions by bandwidth choice: regression discontinuity plots



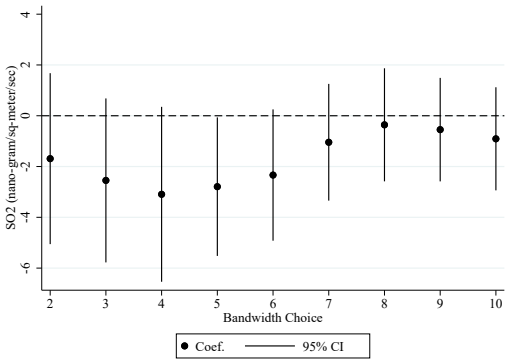
(a) Log Monthly Crop Fires



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



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



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

Notes: Graphs show regression discontinuity estimates of the outcomes as a function of margin of victory for women over men by bandwidth choice. Figure (a) plots estimates for the log monthly number of fires between 2006 - 2016. Figures (b), (c), and (d) plot the estimates for monthly black carbon, organic carbon, and SO2 emission rates from 2006-2016 (in $ng/m^2/s$), respectively. Estimates in all figures control for state-by-election-year fixed effects.