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Women's Political Power and Environmental Outcomes

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Abstract

Environmental deterioration is believed to affect women more than men. Thus, in the context of democratic decision-making, an increase in the political power of women should lead to better environmental outcomes. In this paper, we test this intuition by estimating how suffrage rights affected countries' emissions using data for the period 1850-2014. By employing a) a difference-in-difference empirical strategy a la Miller (2008) and b) a calibrated regression discontinuity design that focuses on the few years before and after the suffrage reform, we provide –for the first time– robust evidence suggesting that environmental outcomes strongly depend on the extent of women's political participation.

*K*eywords: women's suffrage; emissions; voting rights; political economy; environmental outcomes.

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1 Introduction

Changes in the environment rarely have a uniform impact on the population. For instance, environmental degradation is widely believed to have different effects on women and men. According to the United Nations Development Programme (UNDP, 2011), women are affected "first and worst" since their "traditional responsibilities as food growers, water and fuel gatherers, and caregivers connect them intimately to available natural resources and the climate, making them more vulnerable to environmental hardships" compared to men. This generates a very clear policy suggestion in the context of democratic politics: the more women participate in the decision-making process, the better the environmental outcomes. Indeed, if democratic institutions generate outcomes that reflect the preferences of politically active individuals, an increase in women's political engagement should deliver outcomes closer to women's interests and preferences.

In particular, if women do care more intensely about the environment than men, we should expect a positive relationship between women's political engagement and the quality of environmental outcomes. This line of reasoning is so convincing that there are many initiatives worldwide that try to promote the involvement of women in the decision-making process exactly on the basis of such arguments. For example, to this end, the UNDP helps women to "gain decision-making power" and actively participate in "environmental planning, budgeting, and policy-making processes."

However, there are no empirical studies that allow us to draw causal inference regarding the effect of women's political participation on environmental outcomes. This is precisely the gap in the literature that this paper aims to fill. We use newly gathered worldwide data on country-level emissions since 1850 to examine emissions as a function of the women's suffrage rights. In particular, we employ a highly regarded empirical strategy –a difference-in-difference model a la Miller (2008)– which allows us to pin down the effect of suffrage rights on environmental outcomes. Indeed, this approach has been used to identify the effect of women's suffrage rights on child mortality rates in the context of U.S. politics, and it has since been accepted as a competent identification strategy for the treatment of such questions. The rich inter-temporal variation of the dates at which different countries granted suffrage rights to women (our data are described in Section 4) provides an excellent setup for the application of this empirical approach since it allows us to apply it both "universally" (i.e., considering all the time period from 1850 until today) and "locally" (i.e., considering a more restricted set of time periods), providing additional robustness to our analysis. We find strong evidence in support of the hypothesized positive relationship between women's political engagement and environmental outcomes, that is robust in a number of dimensions. Namely, it is not driven by a specific set of countries (both large and small countries seem to behave in a similar manner) and it is not driven by a specific time period –changes in suffrage rights that occurred early in the twentieth century, as well as in later periods, have resulted in improved environmental outcomes.

An advantage of the Miller (2008) approach is that it also includes country-specific linear time trends in addition to the standard country and year fixed effects employed in most difference-in-difference models. This is essential to our ability to distinguish the effect of the suffrage reform on other country-specific unobservable factors whose differential evolution might affect both emissions and suffrage rights. In this paper, we expand on this setup by considering additionally non-linear country-specific time trends which generate additional confidence to our results. That is, by including country-specific polynomial year trends (up to the third degree) in the model, we essentially distinguish between countries in which emissions follow a mostly convex rate of increase from countries in which emissions increased in a rather concave manner. Moreover, we permit a country's evolution of emissions to be initially convex and then concave or vice versa, thus, making the identification exercise arguably harder. Despite this more elaborate design we still find a negative effect of the suffrage rights reform on the emission levels. Hence, its effect cannot be attributed to unobserved differential and non-linear evolution of the dependent variable.

To further strengthen our confidence in this finding, we provide a regression discontinuity analysis by focusing on the ten years before and after the universal suffrage rights reform. Since the time of reform was different for each country we first calibrate all countries using a reform-centered time variable which takes value zero at the year of the reform and value t (-t) at t years after (before) the reform. This approach is rather ambitious since it aspires to identify a short-term effect of the suffrage reform on environmental outcomes, while the effect may take years to materialize. Despite that, we believe this analysis provides supplementary assurance regarding our main results. Indeed, the long time span of our sample has many advantages, including: a) rich within-country intertemporal variation in the emission levels and b) significant dispersion of suffrage rights reforms' dates across countries. However, it also has a non-negligible limitation: If the negative effect of suffrage rights on emissions is mainly due to negative pressures exhibited on the dependent many years after the reform, it might be considered mostly as an indirect effect. That is, the women's political empowerment might deliver a change in some other variable (e.g., childrens' education), and this change could be the one that actually pushes towards a decrease in the emissions' levels. Notice that this is not an argument against the causal relationship between women's voting rights and environmental outcomes, but a potential critique against the hypothesized underlying mechanism. Despite that, one would ideally like to know whether women's suffrage has a direct political economy effect on environmental outcomes, or if the mechanism in operation has more than one steps. By employing a regression discontinuity estimation approach which focuses solely on a few years before and after the reform, we protect our results from such concerns and show that indeed emissions exhibit a steep drop at the time of women's political empowerment. Of course, these additional findings should only be viewed as a supporting exercise to our main identification strategy and should not be viewed as an equally robust identification approach. Indeed, typical regression discontinuity designs use a well-defined common threshold in the running variable, while in our case –since reforms did not occur simultaneously– one has first to properly calibrate the time dimension, which might weaken the interpretation of our findings. To our knowledge, though, this is the only paper that employs data from over 142 countries and over one-hundred years to complete a difference-in-difference approach and a regression discontinuity robustness exercise that, arguably, provide the first pieces of causal evidence that support the link between women's political power and environmental outcomes.

The remainder of the paper is organized as follows. In section 2, we present the scientific background and a brief literature review concerning the relationship between women's political engagement and environmental outcomes. The empirical strategy and the data are presented in Sections 3 and 4, respectively. Section 5 includes the empirical results, and concluding remarks are discussed in the final section.

2 Scientific Background

Undoubtedly, global climate change is a major threat in the modern era, having an observable impact not only on the environment but also on humanity. Over the past few years, the average global temperature has dramatically increased, glaciers and ice have melted, the sea level has risen, greenhouse gas emission levels have increased, and extreme climate-related events have become more intense and frequent. According to the Intergovernmental Panel on Climate Change (IPCC, 2014), climate change not only exacerbates existing risks but also create new ones, especially for vulnerable communities around the world. This, underlines the necessity of effective decision-making mechanisms to decelerate and eliminate the impact of climate change.

Although climate-related changes and the disasters that stem from it affect the poor more than the rich (Joan Martinez-Alier, 2014; Mendelsohn et al. 2006; Olsson et al. 2014), women also are at higher risk. (Buckingham, 2010; Denton, 2002). In the context of global climate change, potential social inequalities among genders have been receiving a great deal of research attention. Several studies provide evidence on the argument that women differ from men in the way they evaluate and respond to climate change, supporting the main claim that women display higher levels of environmental consciousness than men do (Bord and O'Connor, 1997; Davidson and Freudenburg, 1996; Flynn et al. 1994; Gustafsod, 1998; Hunter et al. 2004; Mccright 2010; Zelezny et al. 2000, among others). Moreover, women are more likely to be environmentally sensitized due to their "identity as mothers" (Bell and Braun, 2010), and their role as "care-givers" is deeply associated with concern for environmental issues and risks (Blocker and Eckberg, 1997).

Can the involvement of the women in the political and decision-making processes function as a force against environmental deterioration? Recent research has shown that integrating women into politics may be linked to environmental protection, given the fact that anthropogenic greenhouse emissions are found to be lower in nations in which women's political representation were higher (Ergas and York, 2012). Of course, the cross-country nature of the tests in Ergas and York (2012) and the absence of a time dimension, make the causal interpretation of their findings wanting. Moreover, McKinney and Fulkerson (2015) confirm the important role of females in participating in political processes, emphasizing the negative relationship between women's political representation and climate footprints. In the same vein, Salahodjaev et al. (2016) completed, a panel-data analysis of 163 countries, spanning from 1990 to 2010, and argued that women's political status and reduction of the deforestation is closely linked, underlying the importance of the participation of women in political bodies on environmental issues. [1] Recent literature demonstrates that

[1] More broadly, as Farzin and Bond (2006) famously exhibited, democratic institutions allow affected agents to express their preferences for environmental quality, and hence democratic regimes are known to lead to better environmental outcomes compared to authoritarian ones.

women's political involvement is often key to effecting change across many pressing social issues. Miller (2008) supports that the American women's suffrage rights are associated with a reduction in child mortality rates, Aidt and Dallal (2008) postulate the positive relationship between women's voting right and social spending in Western Europe, and Chen (2013) argues that female political involvement is positively associated with a more "honest government".

However, the causal relationship between women's suffrage rights and environmental outcomes is yet empirically unexplored. Here, we aim to address this gap in the literature by focusing on how the extension of suffrage rights to women worldwide is linked to environmental outcomes. In other words, are climate outcomes and women's political involvement intertwined? Do suffrage rights for women play a decisive role in addressing climate change concerns? We will draw established econometric approaches directly from the literature to shed light on these questions.

3 Empirical Strategy: Miller's (2008) Difference-in-Difference Model

The difference-in-difference technique has received a great attention over the past years in the empirical literature. The main idea of the methodology is to estimate causal effects and inferences by investigating the differential impact of a treatment variable (in our case, women's suffrage) on a dependent variable (in our case, an environmental variable). In other words, it estimates the average causal effect of women's suffrage movement on environmental changes, taking into account the pre- and post-treatment period.
Following the specification of Miller (2008),[2] we consider the following equation:

$$Y_{it} = \alpha + \beta_0 V_{it} + \gamma_t + \gamma_i + \sum_{k=1}^{m} \gamma_i \times t^k + \epsilon_{it} \tag{1}$$

where Y_{it} denotes the environmental variable for the country i at time t; V_{it} is a binary

[2]The difference-in-difference specification was implemented by Miller (2008) to explore the causal effect of American suffrage rights on infant mortality. For more applications, a literature review, and possible issues with the use of this approach, see Abadie (2005), Bertrand et al. (2004), Donald et al. (2007) and Meyer (1995), among others. In our analysis, we carefully address the potential concerns and issues they raise.

variable that takes the value 1 if the women in country i at time t have the right to vote and the value 0, otherwise; γ_t and γ_i are time and country fixed effects, respectively; and finally, $\gamma_i \times t^m$ stands for country-specific polynomial time trend of order m. Miller's (2008) specification corresponds to $m = 1$ (i.e., linear country-specific time trends). We focus on parameter β_0 which captures the causal effect of the suffrage rights on the environmental variable.

Due to the fact that the dependent variable might exhibit dissimilar growth patterns from one country to another which the country specific linear trends might not be able to capture (e.g., consider the case of a country that mainly experiences a convex growth of the environmental variable and another that experiences a concave pattern), one may worry that the coefficient of interest might reflect such dissimilarities and not the effect of the dependant variable of interest. For this reason, in this paper, we subsequently enrich Miller's (2008) analysis by also including non-linear time trends –polynomial country-specific time trends of up to third degree (i.e., $m \in \{1, 2, 3\}$)– and some key control variables –namely, GDP per capita and population– showing that the effect of suffrage rights cannot be a simple consequence of heterogeneous non-linearities in the growth patterns. Finally, we run all our regressions clustering standard errors at the country level. This makes our estimates very conservative, since there is no apparent reason why countries who are very similar in their levels of the dependent variable overtime should vary in the noise about the point estimate.

4 Data

The relationship between the women's suffrage movement and the environmental outcome is explored using annual data for a panel of 142 countries through out the world. The data ranges from New Zealand, which is the first country in our dataset to introduce women's suffrage rights in 1893, to the United Arab Emirates, where women were first allowed to vote in 2006. The suffrage data are retrieved from multiple sources including Lewis (2007), Martin (2000) and, in some cases, we used hand-picked data collection methods from public available resources of national organizations and institutes of the corresponding countries. Although women could obtain the right to vote in elections in a country-specific single year, in some cases this right was partial or limited. For instance, in Italy, women gained the right to vote in 1925 only in local elections, while the full suffrage was given to them in 1945. In the same manner, in Romania, women were granted the right to vote in local elections in 1929, followed by an unrestricted voting right in 1946. In our analysis, we are interested in investigating the birth of the women's suffrage movement; hence, the year when the legislative for women's suffrage rights introduced will be considered as the basis year. However, robustness tests will be conducted using the data which represent the full voting rights of females of the corresponding countries, so as to get more insight into the validity of the empirical strategy.

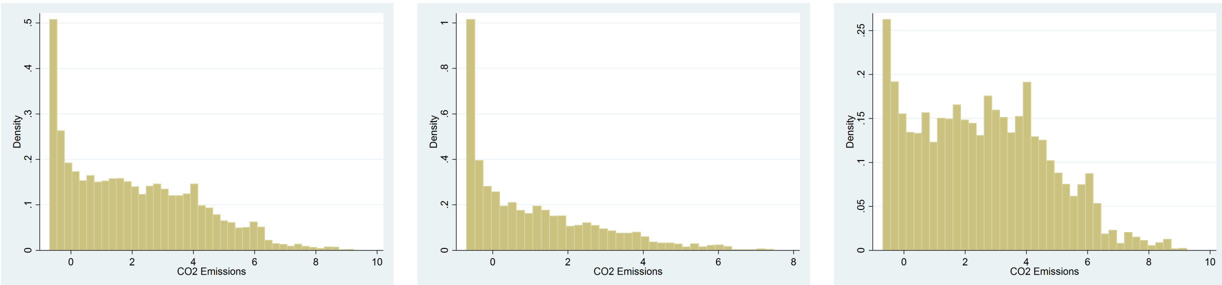
As far as the environmental variables are concerned, we will focus on Total Carbon Dioxide Emissions Excluding Land-Use Change and Forestry (CO_2) as a critical variable of interest for characterizing the climate change. In particular, CO_2 data are obtained from the World Research Institute - CAIT for a panel of 142 countries covering the period from 1850 to 2014.[3] Due to the fact that the majority of observed CO_2 levels are clustered at low levels, and taking into consideration possible non-linear relations between the dependent and independent variables, we transform this data under the two-parameter Box-Cox transformation with parameters one and one half (Box and Cox, 1964).[4] In addition, Gross Domestic Product per capita and population data, expressed in logarithms, will be defined as key control variables and will also be used in our analysis. These data are obtained from Maddison Historical Statistics Project (2018). A complete list of the dates when voting rights were first extended to women, as well as the range of the environmental data for every single country, is available in the Supplementary Material. Histograms of the dependent variable are presented in Figure 1. If anything, observations that correspond to years after the suffrage rights reform are characterized by higher emissions' levels. That is, the raw correlation between suffrage rights and emissions is positive. As we see though in Figures 2 and 3 where the evolution of total CO_2 emissions and the percentage of countries that have granted suffrage rights to women are depicted, this bare-eye observation is a mere artifact of the increasing trend of the emissions' levels over the studied time period;

[3]In some cases, the panel dataset contains some gaps and is unbalanced due to the non-availability of complete historical CO_2 data across countries. We take this into account by dropping the countries in which there are no observations before the suffrage reform.

[4]That is, our dependent variable will be $\log(CO_2 + \frac{1}{2})$. This is a common transformation for variables that follow such a skewed distribution with many observation very close to zero, since it makes the support of the distribution of the dependent variable more compact (a simple logarithmic transformation would simply result in a distribution severely skewed towards the negative side since it would give very negative values to observations that are close to zero). We note, though, that our main results are robust to other monotonic transformations of the dependent variable including power-transformations and the simple logarithmic transformation.

and, hence, should not be taken seriously.

To get further insight into the nature of the women's suffrage laws, consider Figure 4, which summarizes information regarding the introduction of women's voting rights across the world. New Zealand was the first country to grant voting rights to women in 1893, followed by Australia in 1902, Finland in 1906, Denmark in 1908 and Norway in 1913. By 1940, an additional 39 countries implemented suffrage laws for women, including 21 countries in Europe, 10 in Asia, 7 in North and South America and 1 in Africa. Over the next 35 years, there was a rapid increase in suffrage laws, with 90 countries (in Africa (38), North and South America (15), Asia (21), Europe (9) and Oceania (7)). Oman, Kuwait and the United Arab Emirates were the last countries to introduce women's voting rights in our dataset in 2003, 2005 and 2006, respectively.



a) Full sample **b)** Before the reform **c)** After the reform

Figure 1: Histograms of the dependent variable (Box-Cox transformation of CO_2 emissions).

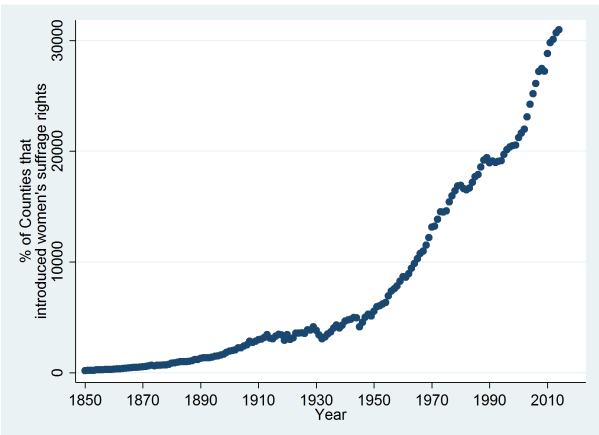


Figure 2: Evolution of total CO_2 emissions

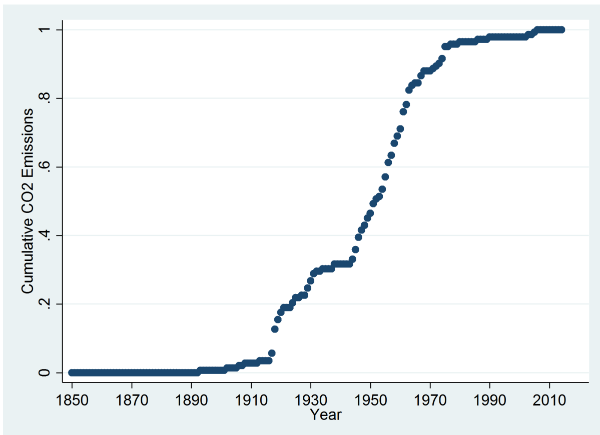


Figure 3: Percentage of countries that have granted sufragge rights to women

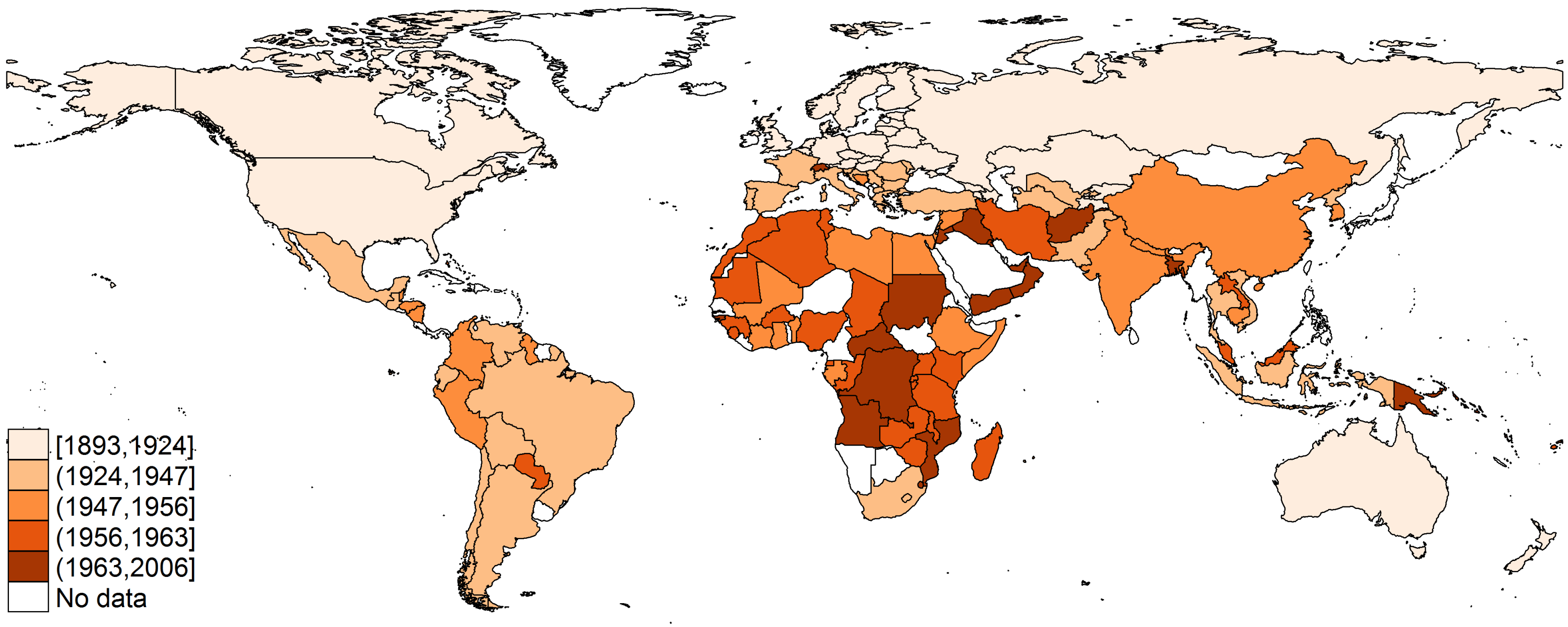


Figure 4: The introduction of women's suffrage rights

5 Results

Following the difference-in-difference approach of Miller (2008) as a starting point, we report the results of our analysis in Table 1, which consists of four different regression models. In particular, model (1) consists of the standard specification as introduced in Miller (2008) and in equation (1) in Section 3. In models (2) and (3), non-linear time trends are taken into consideration and, finally, in model (4) control variables are included. Overall, we find strong evidence in support of a negative and statistically significant relationship between women's political engagement and CO_2 emissions.

More specifically, in model (1), women's suffrage rights are strongly associated with a decrease in CO_2 emissions. When non-linear time trends are taken into account, women's suffrage rights are also strongly associated with a decrease in CO_2 emissions, in models (2) and (3), respectively. When control variables are added in the model, similar estimations are provided, indicating that women's suffrage does not act as a proxy for vast economic and demographic changes. Although there is some variation in the β_0 coefficients, there is strong evidence supporting our initial hypothesis.

Table 1: The Difference-in-Difference Model

Independent Variables	(1) Miller Standard Specification	(2) Non-Linear Time Squared	(3) Non-Linear Time Cubed	(4) Control Variables
Suffrage Right	-0.187***	-0.164**	-0.0917*	-0.169***
	(0.0568)	(0.0644)	(0.0516)	(0.0546)
GDP per capita				0.638***
				(0.0748)
Population				0.929***
				(0.292)
Constant	-20.16***	947.8***	20,246***	-19.30**
	(1.126)	(87.56)	(4,431)	(7.599)
Observations	14,634	14,634	14,634	10,067
R-squared	0.925	0.947	0.959	0.942
Number of Countries	142	142	142	126
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Country Linear Time Trends	Yes	Yes	Yes	Yes
Country Linear Time Trends Squared		Yes	Yes	
Country Linear Time Trends Cubed			Yes	

Notes: Robust standard errors clustered at the country level are in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Moreover, we explore the robustness and the validity of the above results by splitting the sample in sub-periods and by focusing on low- and high-emission countries. We report these results in Tables 2 and 3. Again, it can be concluded that our empirical results are not driven by a specific time period and are not affected by a specific set of countries. Table 3 shows that the extension of women's voting rights has a greater impact on environmental outcomes in high-emission countries than in low-emission ones. However, the relationship is negative and statistically significant in both high- and low- emission countries.[5]

Table 2: The Difference-in-Difference Model for sub-periods

Independent Variables	(1) 1850-1950	(2) 1951-2014
Suffrage Right	-0.157*	-0.311***
	(0.0872)	(0.0602)
Constant	22.13***	-22.55***
	(4.636)	(0.201)
Observations	5,608	9,026
R-squared	0.856	0.884
Number of Countries	135	142
Country Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Country Linear Time Trends	Yes	Yes

Notes: Robust standard errors clustered at the country level are in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

[5]We split the sample into two groups -low and high- by comparing the average value of CO_2 emissions of each country to the average value of all countries.

Table 3: The Difference-in-Difference Model for low- and high-emission countries

Independent Variables	(1) low-emission countries	(2) high-emission countries
Suffrage Right	-0.157***	-0.276*
	(0.0592)	(0.134)
Constant	-23.46***	-19.33***
	(1.456)	(0.953)
Observations	11,326	3,308
R-squared	0.921	0.949
Number of Countries	119	23
Country Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Country Linear Time Trends	Yes	Yes

Notes: Robust standard errors clustered at the country level are in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

5.1 Robustness

5.1.1 A Regression Discontinuity Design

One may worry that the strong effect of suffrage rights on CO_2 emissions might be an artifact of underlying progressive forces that promote both equal political participation of all citizens and policies that protect the environment.[6] Indeed, if a country is becoming gradually more sensitive to democratic and environmental issues, it could be argued that the correlation that we are picking up captures this fact. Despite the fact that country-specific non-linear trends should be able to bullet proof our analysis from such concerns, we consider additional tests.

For this reason, we will now turn to a Regression Discontinuity Design (RDD). [7] These designs were first introduced by Thistlewaite and Campbell (1960) and have been widely adopted in the empirical literature over the last decades as a means for causal inference. This empirical approach isolates causal effects below and above a specific cut-off point.

[6]See Miller (2008) for a detailed discussion of this issue.

[7]For a more comprehensive review of the Regression Discontinuity Design, see Imbens and Lemieux (2008); Lee and Lemieux (2010) and Skovron and Titiunik (2015).

We, then are able to investigate the existence of a discontinuity in the dependent variable. We consider the following polynomial parametric model under the sharp RDD framework:[8]

$$Y_{it} = \alpha + \beta_0 V_{it} + \sum_{k=1}^{n} \beta_k \times X_{it}^k + \gamma_i + \epsilon_{it} \tag{2}$$

where, Y_{it} denotes the environmental variable for the country i in time t; V_{it} is a binary variable that takes the value 1 if the women in country i in time t have the right to vote and the value 0, otherwise; X_{it} is a variable that takes value 0 at the year of the reform and value t (-t) at t years after (before) the reform; and γ_i are country fixed effects. Gelamn and Imbens (2017) suggest that high-order polynomials should not be applied in RDD designs as they state that they tend to lead to inaccurate estimations. For this reason we focus on $n = 1$, $n = 2$, and $n = 3$.

Let $X_{it} = t - \hat{h_i}$ be our "running" or "forcing" variable, where $\hat{h_i}$ is the cut-off: the time when the right to vote was given to women. If $X_{it} \geq \hat{h_i}$, then our binary variable V_{it} takes the value 1, and the corresponding country i is exposed to the intervention or treatment. Similarly, if $X_{it} < \hat{h_i}$, then our binary variable V_{it} takes the value 0, and the corresponding country i has not received the treatment. We focus only on a period very close to the cut-off; in particular, we examine the period 10 years before and after the reform. This makes the identification approach very hard, as it requires that noticeable changes in the CO_2 emissions take place rapidly after the suffrage reform. Again, here, the causal effect of our interest will be depicted in the parameter β_0.

The results are reported in Table 4. We can clearly see that the polynomial models of 1st, 2nd degree, (models (1) and (2), respectively), strongly support the negative relationship between women's suffrage rights and CO_2 emissions at statistical significance of 1%. As expected, as higher-order polynomials enter the equation, the effect becomes weaker (model (3)), though it still remains significant at the 5% level. Overall, the exercise provides additional support to our main findings and novel insights regarding the timing of the effect: part of it takes place directly after the reform and does not need much time to become identifiable.

[8]The RDD in the literature consists of two general settings: the sharp and the fuzzy. For an excellent guide, see Imbens and Lemieux (2008).

Table 4: Reggression Discontinuity Analysis

Independent Variables	(1) 1st degree polynomial	(2) 2nd degree polynomial	(3) 3rd degree polynomial
Suffrage Right	-0.111***	-0.111***	-0.0729**
	(0.0389)	(0.0389)	(0.0365)
X	0.0371***	0.0385***	0.0300***
	(0.00380)	(0.00373)	(0.00754)
X^2		0.00133***	0.00148***
		(0.000470)	(0.000497)
X^3			9.57e-05
			(7.08e-05)
Constant	1.513***	1.469***	1.446***
	(0.0200)	(0.0244)	(0.0261)
Observations	2,177	2,177	2,177
R-squared	0.174	0.184	0.184
Number of Countries	109	109	109

Notes: Robust standard errors clustered at the country level are in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

5.1.2 Alternative Suffrage Rights' Dates

As it was stated in section 4, the first year when the legislative for women's suffrage rights were introduced is considered as the basis year in our analysis. However, this data may lead to biased results due to the fact that women used to vote under specific restrictions and conditions. For this reason, we replicate the above analysis by taking in account the dates that full voting rights were given to women. We report the results in Tables 5, 6, 7 and 8 in the Appendix. The results are consistent with the main findings of the paper –the more women participate in the decision-making process, the better the environmental outcomes.

6 Conclusion

The challenges of implementing policies curbing the global climate change have been debated by scientists and policy-makers alike. In the context of environmental politics, one critical issue arising in this debate is whether the extension of women's political participation affect environmental outcomes. In this paper, we find strong evidence in support of a positive relationship between the extension of women's suffrage rights and environmental outcomes. By using data spanning from 1850 to 2014 for a panel of 142 countries, we implement a difference-in-difference approach a la Miller (2008), as well as complete a regression discontinuity analysis as a robustness exercise. We provide evidence suggesting that the birth of women's suffrage exhibited a strong negative force on CO_2 emission levels. Our results are robust across a number of dimensions, including alternative settings, different sub-periods and different set of countries.

Given the risks associated with global climate change in conjunction with the vulnerability of females to environmental deterioration, we generate a policy suggestion: Include more women in the decision-making process, to improve environmental outcomes. Given the fact that the design of adequate strategies and policies to successfully respond to the impact of the climate change is at the top of the UNDP's agenda, the results we provide are promising for the implementation of more effective policies in the future.

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Appendix

Table 5: The Difference-in-Difference Model using alternative suffrage rights' dates

Independent Variables	(1) Miller Standard Specification	(2) Non-Linear Time Squared	(3) Non-Linear Time Cubed	(4) Control Variables
Suffrage Right	-0.189***	-0.153**	-0.107**	-0.111
	(0.0617)	(0.0622)	(0.0504)	(0.0696)
GDP per capita				0.644***
				(0.0767)
Population				0.895***
				(0.300)
Constant	-20.30***	980.2***	20,397***	-18.76**
	(1.124)	(86.68)	(4,478)	(7.746)
Observations	14,634	14,634	14,634	10,067
R-squared	0.925	0.947	0.959	0.942
Number of Countries	142	142	142	126
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Country Linear Time Trends	Yes	Yes	Yes	Yes
Country Linear Time Trends Squared		Yes	Yes	
Country Linear Time Trends Cubed			Yes	

Notes: Robust standard errors clustered at the country level are in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 6: The Difference-in-Difference Model for sub-periods using alternative suffrage rights' dates

Independent Variables	(1) 1850-1950	(2) 1951-2014
Suffrage Right	-0.165*	-0.283***
	(0.0905)	(0.0580)
Constant	23.11***	-22.94***
	(4.269)	(0.140)
Observations	5,608	9,026
R-squared	0.856	0.884
Number of Countries	135	142
Country Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Country Linear Time Trends	Yes	Yes

Notes: Robust standard errors clustered at the country level are in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 7: The Difference-in-Difference Model for low- and high-emission countries using alternative suffrage rights' dates

Independent Variables	(1) low-emission countries	(2) high-emission countries
Suffrage Right	-0.127*	-0.289**
	(0.0699)	(0.103)
Constant	-23.44***	-19.00***
	(1.470)	(0.878)
Observations	11,326	3,308
R-squared	0.921	0.950
Number of Countries	119	23
Country Fixed Effetcs	Yes	Yes
Time Fixed Effects	Yes	Yes
Country Linear Time Trends	Yes	Yes

Notes: Robust standard errors clustered at the country level are in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 8: Reggression Discontinuity Analysis using alternative suffrage rights' dates

Independent Variables	(1) 1st degree polynomial	(2) 2nd degree polynomial	(3) 3rd degree polynomial
Suffrage Right	-0.117***	-0.117***	-0.0593
	(0.0396)	(0.0396)	(0.0383)
X	0.0376***	0.0391***	0.0261***
	(0.00395)	(0.00391)	(0.00791)
X^2		0.00146***	0.00168***
		(0.000486)	(0.000512)
X^3			0.000146**
			(6.79e-05)
Constant	1.627***	1.579***	1.544***
	(0.0204)	(0.0247)	(0.0270)
Observations	2,177	2,177	2,177
R-squared	0.167	0.178	0.179
Number of Countries	109	109	109

Notes: Robust standard errors clustered at the country level are in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Supplementary Material

List of Countries and data range

Country	Region	Time of reform	CO_2 Emissions data range
Afghanistan	Asia	1965	1949 - 2014
Algeria	Africa	1962	1916 - 2014
Angola	Africa	1975	1950 - 2014
Argentina	The Americas	1947	1887 - 2014
Armenia	Asia	1921	1850 - 2014
Australia	Oceania	1902	1860 - 2014
Austria	Europe	1918	1850 - 2014
Azerbaijan	Asia	1917	1850 - 2014
Bahamas	The Americas	1961	1950 - 2014
Bahrain	Asia	1973	1933 - 2014
Bangladesh	Asia	1972	1946 - 2014
Barbados	The Americas	1950	1928 - 2014
Belarus	Europe	1919	1858 - 2014
Belgium	Europe	1919	1850 - 2014
Belize	The Americas	1954	1950 - 2014
Benin	Africa	1956	1950 - 2014
Bolivia	The Americas	1938	1928 - 2014
Bosnia and Herzegovina	Europe	1949	1890 - 2014
Brazil	The Americas	1934	1901 - 2014
Brunei	Asia	1959	1933 - 2014
Bulgaria	Europe	1944	1881 - 2014
Burkina Faso	Africa	1958	1950 - 2014
Burundi	Africa	1961	1950 - 2014
Cambodia	Asia	1955	1946 - 2014
Canada	The Americas	1918	1850 - 2014

Cape Verde	Africa	1975	1950 - 2014
Central African Republic	Africa	1986	1950 - 2014
Chad	Africa	1958	1950 - 2014
Chile	The Americas	1931	1895 - 2014
China	Asia	1949	1899 - 2014
Colombia	The Americas	1954	1921 - 2014
Congo	Africa	1963	1950 - 2014
Congo, Dem. Republic	Africa	1967	1920 - 2014
Cote d'Ivoire	Africa	1952	1950 - 2014
Croatia	Europe	1945	1890 - 2014
Cyprus	Europe	1960	1950 - 2014
Czech Republic	Europe	1920	1860 - 2014
Denmark	Europe	1908	1850 - 2014
Ecuador	The Americas	1929	1917 - 2014
Egypt	Africa	1956	1911 - 2014
Equatorial Guinea	Africa	1963	1950 - 2014
Estonia	Europe	1918	1850 - 2014
Ethiopia	Africa	1955	1941 - 2014
Fiji	Oceania	1963	1950 - 2014
Finland	Europe	1906	1860 - 2014
France	Europe	1944	1850 - 2014
Gabon	Africa	1956	1950 - 2014
Gambia	Africa	1960	1950 - 2014
Georgia	Asia	1918	1850 - 2014
Germany	Europe	1918	1850 - 2014
Ghana	Africa	1954	1950 - 2014
Greece	Europe	1930	1867 - 2014
Grenada	The Americas	1951	1950 - 2014
Guatemala	The Americas	1946	1941 - 2014
Guinea	Africa	1958	1950 - 2014
Guinea-Bissau	Africa	1977	1950 - 2014
Guyana	The Americas	1953	1950 - 2014

Honduras	The Americas	1955	1950 - 2014
Hungary	Europe	1918	1851 - 2014
India	Asia	1950	1858 - 2014
Indonesia	Asia	1945	1889 - 2014
Iran	Asia	1963	1906 - 2014
Iraq	Asia	1980	1927 - 2014
Israel	Asia	1948	1930 - 2014
Italy	Europe	1925	1860 - 2014
Jordan	Asia	1974	1950 - 2014
Kazakhstan	Asia	1924	1850 - 2014
Kenya	Africa	1963	1950 - 2014
Kiribati	Oceania	1967	1961 - 2014
Korea (North)	Asia	1946	1905 - 2014
Korea (South)	Asia	1948	1905 - 2014
Kuwait	Asia	2005	1946 - 2014
Kyrgyzstan	Asia	1918	1850 - 2014
Laos	Asia	1958	1946 - 2014
Latvia	Europe	1918	1850 - 2014
Lebanon	Asia	1952	1931 - 2014
Libya	Africa	1951	1950 - 2014
Lithuania	Europe	1921	1850 - 2014
Macedonia, FYR	Europe	1946	1890 - 2014
Madagascar	Africa	1959	1933 - 2014
Malawi	Africa	1961	1950 - 2014
Malaysia	Asia	1957	1890 - 2014
Mali	Africa	1956	1950 - 2014
Mauritania	Africa	1961	1950 - 2014
Mauritius	Africa	1956	1950 - 2014
Mexico	The Americas	1947	1891 - 2014
Moldova	Europe	1929	1850 - 2014
Morocco	Africa	1963	1928 - 2014
Mozambique	Africa	1975	1927 - 2014

Nauru	Oceania	1968	1964 - 2014
Nepal	Asia	1951	1950 - 2014
Netherlands	Europe	1917	1850 - 2014
New Zealand	Oceania	1893	1878 - 2014
Nicaragua	The Americas	1955	1943 - 2014
Nigeria	Africa	1958	1915 - 2014
Norway	Europe	1913	1850 - 2014
Oman	Asia	2003	1964 - 2014
Pakistan	Asia	1947	1946 - 2014
Papua New Guinea	Oceania	1964	1950 - 2014
Paraguay	The Americas	1961	1950 - 2014
Peru	The Americas	1955	1884 - 2014
Poland	Europe	1918	1850 - 2014
Portugal	Europe	1931	1870 - 2014
Romania	Europe	1929	1858 - 2014
Russian Federation	Europe	1917	1850 - 2014
Rwanda	Africa	1961	1950 - 2014
Saint Vincent & Grenadines	The Americas	1951	1950 - 2014
Samoa	Oceania	1990	1950 - 2014
Sao Tome and Principe	Africa	1975	1951 - 2014
Serbia	Europe	1945	1890 - 2014
Sierra Leone	Africa	1961	1950 - 2014
Slovakia	Europe	1920	1860 - 2014
Slovenia	Europe	1945	1890 - 2014
Solomon Islands	Oceania	1974	1952 - 2014
Somalia	Africa	1956	1950 - 2014
South Africa	Africa	1930	1884 - 2014
Spain	Europe	1931	1850 - 2014
Sudan	Africa	1964	1950 - 2014
Swaziland	Africa	1968	1950 - 2014
Sweden	Europe	1919	1850 - 2014
Switzerland	Europe	1971	1858 - 2014

Syria	Asia	1949	1931 - 2014
Tajikistan	Asia	1924	1850 - 2014
Tanzania	Africa	1959	1950 - 2014
Thailand	Asia	1932	1931 - 2014
Tonga	Oceania	1960	1950 - 2014
Trinidad & Tobago	The Americas	1925	1909 - 2014
Tunisia	Africa	1957	1916 - 2014
Turkey	Asia	1930	1865 - 2014
Turkmenistan	Asia	1927	1850 - 2014
Uganda	Africa	1962	1950 - 2014
Ukraine	Europe	1919	1850 - 2014
United Arab Emirates	Asia	2006	1959 - 2014
United Kingdom	Europe	1918	1850 - 2014
United States of America	The Americas	1920	1850 - 2014
Uzbekistan	Asia	1938	1850 - 2014
Vanuatu	Oceania	1975	1962 - 2014
Venezuela	The Americas	1946	1904 - 2014
Vietnam	Asia	1946	1892 - 2014
Yemen	Asia	1967	1950 - 2014
Zambia	Africa	1962	1950 - 2014
Zimbabwe	Africa	1957	1903 - 2014