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Political leaders with professional background in business and climate outcomes

Luis Diaz-Serrano[1,2] (ORCID) **· Giorgos Kallis[3,4]**

Abstract

The literature on how the ideology of political parties in power correlates with climate policy outcomes is abundant, but there is no similar literature for the individual characteristics of government leaders. This assessment is the first study of its kind, building on a dataset of government leaders of OECD countries for the period 1992–2017. We find that national presidents or prime ministers with a professional background in business are strongly correlated with bad climate mitigation outcomes. In particular, higher emissions and lower renewable energy deployment are more likely to occur during the tenure of former business people. Our results suggest that voters and pressure groups should pay attention to candidates' professional backgrounds, in addition to their party's ideology.

Keywords Carbon emissions · Political leaders · Renewable energy · Business

1 Introduction

The election of Donald Trump in 2016 raised concerns about the prospects for climate mitigation in the USA, the world's second highest emitting economy, responsible for almost 15% of global emissions. There is abundant literature linking the ideology of political parties in power with carbon emissions and climate policy (King and Borchardt 1994; Jahn 1998; Scruggs 1999; McCright and Dunlap 2003; Neumayer 2003; Garmann 2014; Dietz et al. 2015). However, studies linking individual characteristics of elected leaders and climate policy outcomes are non-existent. There is a growing literature indicating the important associations between leaders' individual characteristics and a wide variety of economic policy outcomes (Jones and Olken 2005; Congleton and

✉ Luis Diaz-Serrano
  luis.diaz@urv.cat

[1] Universitat Rovira I Virgili, ECO – SOS, Department of Economics, Av de la Universitat 1, 432014 Reus, Spain

[2] Universidad Antonio Nebrija, ECEMIN, Madrid, Spain

[3] The Institute of Environmental Science and Technology, ICTA-UAB, Autonomous University of Barcelona, Barcelona, Spain

[4] Catalan Institution for Research and Advanced Studies, ICREA, Barcelona, Spain

Zhang 2013; Dreher et al. 2009; Besley et al. 2011; Hayo and Neumeier 2014). This becomes even more important given the rise of a "personalization process" in modern politics (Caprara and Zimbardo 2004; Caprara 2007; Garzia 2011), with voters paying attention to the individual characteristics of candidates (Winter 1987; Bittner 2011; King 2002; Cutler 2002; Aarts et al. 2013; Campbell and Cowley 2013; Costa and Ferreira da Silva 2015; Sevi 2020). Voters' attitudes towards climate change and mitigation are also shaped by their political affiliations that, in turn, shape voters' approval (or not) of leaders with positive or negative stances towards climate mitigation (Shao and Hao 2020).

This circumstance raises the question of whether national leaders matter in terms of climate policy and climate policy outcomes, and, if yes, then how? By leader, we mean presidents in presidential democracies, and prime ministers in parliamentary ones. In particular, we are interested in whether there are characteristics of individual leaders that make a difference when it comes to climate mitigation, over and above, say, their party's politics or their ideology. In other words, are there leader features that are more associated to policies that could be good or bad for the climate? In sum, this study finds that leaders' with a professional background in business are associated to worse periods in terms of climate mitigation.

Past research on the determinants of carbon emissions has focused on assessing how economic, technological, and policy factors could be associated with emissions (Sharma 2011; Menyah and Wolde-Rufael 2010; Casey and Galor 2017) — in comparison, we know next to nothing about whether there is an association between political leaders' backgrounds, and climate mitigation. Despite the richness of the environmental literature, the association between leader's background and environmental policy and outcomes has not yet received attention. There are studies that show that left-wing parties in government are associated with lower carbon emissions (Dietz et al. 2015; Garmann 2014), and that political parties with more pro-environmental positions are likely to adopt more environmental policies when in government (Knill et al. 2010). There are no equivalent studies though on whether leaders of government's personal characteristics may correlate with environmental outcomes, on top of the potential effects of their political party's agenda or their own and their parties' ideology.

In this research, we empirically test whether there exists a correlation between leaders' profession and climate mitigation policy and outcomes, while controlling for other country and leaders' characteristics. More specifically, the question that interests us here is whether there is an association between elected leaders in national office with a professional background in business and climate policy and outcomes, and, if yes, whether this association is positive or negative. Datasets used in the previous literature cover long periods of time, but they start before climate policies were introduced, and finish too early for our purposes (early 2000s), nor do they contain personal information regarding elected political leaders in national office. Therefore, we have created a panel dataset of political leaders' ruling OECD countries and evaluated climate mitigation policy for the period 1992–2017 (1992 being the year the United Nations Framework Convention on Climate Change was held, and which can be considered a year that nations committed to tackling climate change). In line with others before us who studied the association of political factors with environmental performance, we focus on OECD countries to compare countries in comparable stages of socio-economic and environmental policy development. Our data contain information regarding personal leader characteristics: that is, leaders' profession, gender, having children, age, and years in politics. We also collected information regarding contextual factors, such as years in office, party ideology, and whether they govern in coalition or in minority

(a proxy for their effective power). Our dataset is constructed using publicly available data that we retrieved through a web-based search of encyclopedias.

We test associations between the above variations and climate policy and outcomes, measured by the proxies of renewable energy deployment (in terms of installed capacity) and carbon emissions. One is an indicator of effort, and the other of outcomes. With this aim, we use linear models with country fixed-effects, which use within-country variations of leader characteristics to estimate the link between these personal and contextual characteristics and environmental outcomes. To answer our main research question, i.e., whether presidents/prime ministers with professional backgrounds in business are correlated with environmental outcomes, we also carry out a diff-in-diff analysis. We do not expect the covariation of this leader feature and emissions and renewable energy will move necessarily in the same direction. Until recently, the deployment of renewable energy had not demonstrably displaced fossil fuels (York 2012); and other policies, such as regulation or taxation, might have a stronger effect on emissions than the development, or not, of renewable energy. Our core finding is that the periods during which business people are governing are associated with 5% more emissions and 28% less renewable energy capacity. However, our diff-in-diff analysis suggests that this association is only robust for carbon emissions, and not for renewable energy.

2 Leaders with professional background in business and environmental policy outcomes: expectations from the literature

In recent years, there is a growing literature that shows how traits of governing politicians link to policy outcomes, establishing that political leaders' identities have a discernible association with government performance. Factors related to individuals' status (such as occupation, income, or education) and life experiences (related to gender, age, training/profession) have been found to be associated with differences in policy preferences, choices, and outcomes. The decision-making processes and value priorities that leaders use in their own lives transfer into their political lives as well (Burden 2007). Empirical studies have established a link between leader characteristics and economic growth (Jones and Olken 2005). Some studies suggest that more educated leaders are associated with higher rates of economic growth (Congleton and Zhang 2013; Besley et al. 2011), but follow-up studies failed to replicate Besley et al.'s finding (Carnes and Lupu 2016). Constant and Tien (2010) show that foreign education of leaders correlates with foreign direct investments (FDI) inflows in their home countries. Other studies find that leaders from lower social class backgrounds are associated to higher public spending and debt (Hayo and Neumeier 2014); and that younger politicians are linked to more strategic behaviors during elections (Alesina et al. 2019).

The important question here is why and how business people differ in terms of policy preferences and outcomes from other professions, and whether such differences can be associated with climate policy (outcomes). Conceptually, according to Beach and Jones (2016), there are two ways in which business experience might impact policy: in preferences and ability (or quality). Preferences may be determined by distinct characteristics of politicians (Kirkland 2021), including their personal roots or networks (Burden 2007), or more directly, their personal interests, the interests of their peer/professional community (Matter and Stutzer 2015) or the interests of their class (Gilens 2012). While political

scientists have focused mostly on such questions as "personal roots of representation" (Burden 2007), that is, the important role that personal influences and experiences play in politicians' choices, economists have tended to focus on questions of competence, and how expertise and specialized knowledge may make some politicians more capable and willing to adopt certain policies (most notably neo-liberal economic reforms), which, in turn, are said to have positive economic outcomes (see Dreher et al. 2009).

There is suggestive evidence that business people tend to adopt policies that are good for business when they are in power. Szakonyi (2017) gives examples of the downside of this phenomenon. He finds that in Russia, firms connected to winning candidates are associated with higher revenues (by 60%), and higher profit margins (by 15%), during their terms in office. Gehlbach et al. (2010) show that business people are more likely to run for office in countries with weak electoral institutions. Business people are more likely to run for — and take — office compared to candidates with working class backgrounds in liberal democracies, such as the USA (Carnes 2018). Further, business and trade associations are among the most active and well-funded lobbying groups (Baumgartner and Leech 2001). Members of the US Congress with backgrounds in business appear to have closer relationships with corporate political action committees (Witko and Friedman 2008) and their attitudes are likely to be shaped by their membership in business or trade associations that advance strong policy positions (Manza and Brooks 2008). It is not far-fetched to expect then that business owners, when elected, may opt for policies like tax cuts and de-regulation that are favorable to business interests (Kirkland 2021). Indeed Kirkland (2021) finds that US mayors with business backgrounds are associated with reductions in redistributive and welfare spending, while they are also associated with increments in expenditure on road infrastructure. Beach and Jones (2016), on the other hand, in a study with a similar scope, found no difference between business and non-business politicians. For Dreher et al (2009), in fact, the propensity of business people to pursue the interests of business activity when they are in power should be an advantage, to the extent that it should lead to economic reforms that are good for the economy as a whole.

Apart from personal or peer interest, the professional roots of a leader may affect their preferences and outcomes indirectly through their values and beliefs. Values filter evaluations of costs and benefits and how politicians prioritize among competing priorities. Members of the US Congress from profit-oriented professions tend, for example, to be more conservative, and vote against redistribution on economic issues, than do members with a background in working-class occupations who tend to take more redistributive positions (Carnes 2013). It is hard, however, to disentangle the extent to which such differences in preferences are the result of personal and class interests, versus the more general processes of class and professional acculturation that shape the values and beliefs of an individual leader.

Training and professional experience are both factors of acculturation and value/ belief formation, but also, according to a certain strand of economic literature at least, of expertise and competence. To the extent that better educated leaders are associated with better outcomes (Besley et al. 2011), it is reasonable to expect that leaders with professional expertise relevant for specific government tasks will perform better in said tasks.[1] Neumeier (2018), for example, suggests that the better growth performance of US governors with CEO background might be attributable to their competence in

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[1] We say "to the extent," because Besley et al.'s results failed a basic replication by Carnes and Lupu (2016).

recognizing superior economic policies and their willingness to adopt them. Dreher et al (2009) likewise suggest that the background knowledge of business leaders in economics could make them more capable in distinguishing good from bad advice and implementing reforms. According to these authors, business leaders, in view of their knowledge, could be also more likely to have a "better bargaining position" and resist the pressure of lobbying groups preferring the status quo (Dreher et al. 2009). By the same token, however, one might argue that business people may be more likely to be captive to business interests, while their training in a particular type of economics may be a source of ideological bias, producing blind-spots in public policy issues not covered by such training.

How may all this link with environmental policy and outcomes? Let us look separately at each channel of influence identified here (interests, values/beliefs, and knowledge/expertise). First, to the extent that business people tend to respond mostly to the preferences of the affluent class and business interests, the important question is to what extent are these interests compatible or not with better environmental policy and outcomes. There is evidence that economic elites and business interests have organized to undermine environmental policy to benefit their profits and bottom lines (Gonzalez 2001). But business influence may not necessarily mean dismantling or weakening environmental protection, so much as shaping environmental policy in ways that emphasize flexible, deregulated approaches (Kraft and Kamienecki 2007). This is in line with the observation that the potential effect of business backgrounds on economic policy could be in favoring certain policies, e.g., user fees and road spending, against others, say taxes and welfare spending (Kirkland 2021). The potential effect of business leaders on environmental outcomes becomes, then, an empirical question, to the extent that the potential effects of such deregulating approaches must be empirically assessed rather than determined a priori. An important question is whether there is a difference between outcomes, such as carbon emissions, which depend on a variety of factors, such as regulations and economic activity, versus the development of renewable energy technologies, where there are business profits to be made.

Second, in terms of values and beliefs, there is an extensive literature on the determinants of environmental and climate attitudes, but, unfortunately, professional background is not an attribute typically included in such studies (see, for example, reviews by Hornsey et al. 2016; Lewis et al. 2018). It is well established that environmental values and willingness to act on climate change is positively correlated with education and income, but it would be a jump to assume that because leaders with business backgrounds are typically rich and educated, they are more likely to take action on the environment. There is some suggestive experimental empirical evidence that using public-goods games experiments finds that university economics students are more likely to engage in free-riding behavior than students enrolled in other university fields (Marwell and Ames 1981). To complicate matters, beliefs or awareness do not necessarily map onto action. Conservationists, for example, are found to have only marginally lower environmental footprints compared to economists, and this is mostly because the latter have to travel for work more by air (Balmford et al. 2017). Economists tend to value growth over the environment compared to social or environmental scientists, but even among economists the prevalent view by far is that of "green growth" (Drews and van den Bergh 2017), growth seen not only as compatible with, but necessary for mitigating climate change. So, while one may expect business people to be "pro-growth," this does not necessarily translate to being against renewable energy development, nor necessarily causing negative climate outcomes (unless, that is, the pursuit of "green growth" backfires, as some suggest is likely — Hickel and Kallis 2020).

Third, it has been empirically established that business students have lower ecological awareness/knowledge than students in the health professions (Driscoll and Driscoll 2004). To the extent that specialized knowledge is necessary, one would expect this to have a negative effect on environmental policy/outcomes. On the other hand, one could plausibly argue, at least in theory, that some of the alleged competences of business people — to disrupt the status quo, innovate, or bring forward reforms — could help the development of the renewable energy sector against entrenched fossil fuels interests and hence bring down carbon emissions. The potential drawback of business people being captive to business interests could also turn into an advantage, to the extent that mobilizing coalitions and overcoming special interest opposition is necessary for decarbonization.

In sum, we agree here with Beach and Jones (2016, page 294) who, in the case of economic policy, conclude that "there is substantial theoretical ambiguity as to whether we should expect professional experience (specifically, business experience in this case) to impact policy outcomes." This is even more the case for environmental policy, which remains understudied. An important task, then, is to look at the empirical evidence and see the direction the data is pointing to, generating along the way informed research questions about the causal pathways that may produce the observed effects.

3 Data

A paid research assistant constructed the leaders' database under our guidance. The approach was to start with an internet search of open-access encyclopedias (Wikipedia, Britannica) to find the leaders in government for each country in our dataset from 1992 to 2017. A "leader" was defined as the president in presidential and semi-presidential systems, and the prime minister in parliamentary democracies. For the three semi-presidential systems in our dataset (France, Poland, and Portugal), we followed a practical approach and decided based on the encyclopedia entries and background reading who is considered the most important political figure, confirming that this is the figure that is also primarily responsible for climate policy (for example President in France). Table A1 in the Appendix lists the names of the leaders included in our dataset.

Once the name of the leader was found, data were compiled for each leader from the encyclopedias on the start and end date of governing term(s), profession, education, number of children, age, years in politics, political party, and its ideology — where information was missing, this was pursued through additional web searches. We did not include interim governments lasting less than six months (at least 183 days). Each year had a separate entry.

For consistency, we included only the twenty-seven countries that were OECD members in 1992 when our analysis starts, excluding, that is, six countries that joined after 2010 (Chile, Estonia, Israel, Slovenia, Latvia, and Lithuania). The countries included in the analysis are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Turkey, UK, and USA.

We determined a leader's profession by looking into his or her main occupation prior to becoming a professional politician. We created a dummy variable taking the value one for those leaders having a professional background in business and zero otherwise. Our sample includes 154 leaders and 19 of them were found to have a professional background in business (12.3%). We have a total of 681 leader-year observations (see Table 1). Our

Table 1 Frequency analysis of qualitative variables in the model, 1992–2017

	Overall		Between-country		Between-leader	
	n	*%*	*n*	*%*	*n*	*%*
Gender						
Men	632	92.89	27	100.00	143	91.61
Women	49	7.11	9	33.33	13	8.39
Occupation						
Business	77	11.18	15	55.56	19	12.26
Law	110	15.97	16	59.26	23	14.19
College lecturer	78	11.32	12	44.44	20	12.90
Politician/civil servant	237	34.40	22	81.48	52	33.55
School teacher/physician	21	3.05	6	22.22	7	4.52
Economist	35	5.08	7	25.93	8	4.52
Scientist/science related	33	14.08	7	59.26	24	5.16
Other	90	4.93	14	18.52	5	12.90
Children						
No	56	8.13	9	33.33	12	7.74
Yes	625	91.87	27	100.00	144	92.26
Party's orientation						
Left-wing	260	37.74	25	92.59	61	39.35
Center	31	4.50	4	14.81	9	5.81
Right-wing	390	57.76	27	100.00	86	54.84
Ruling with majority						
No	515	75.91	27	100.00	120	76.77
Yes	166	24.09	15	55.56	36	23.23
Ruling in coalition						
No	205	29.75	17	62.96	40	25.81
Yes	476	70.25	25	92.59	116	74.19
Number of observations	681		27		156	

Between-country values indicate how many countries were ruled by a leader with a specific characteristic. For instance, 100% (27) of the countries in our sample have had a man as a ruler at least once, while 33% (9) of the countries have had a woman as a ruler at least once. *Between-leader* values indicate the frequency distribution of the leader characteristics across countries. For instance, 92.2% (141) of the leaders are men, while 8.4% (13) of the leaders are women.

average leader is 55.5 years old, having governed for 4 years, and having been in politics for 30 years (Table 2).

GDP and population data were taken from the World Bank Databank. For carbon emissions, measured in tonnes per year, we used Global Carbon Project (2019) data. For renewable energy, we created a new consolidated Renewable Capacity dataset, merging data from the International Energy Agency (IEA), which has data available from 1980 to 1999, with data from the US Energy Information Administration (EIA), which has complete data from

Table 2 Descriptive statistics of the continuous variables in the model, 1992–2017

	n	**Mean**	**s.d**	**Min**	**Max**
Age	681	55.54	8.50	35	78
Years in politics	681	29.71	10.24	0	61
Years in office	681	3.96	2.79	1	13
GDP per capita (2010 US $)	681	35,454	17,311	5,632	91,566
Population/1,000	681	40,900	59,400	261	323,000
% urban population	681	75.90	10.96	49.13	97.961
Installed renewable capacity pc (watts)	681	0.0099	0.0155	0.00007	0.0819
CO_2 emissions pc (tonnes)	681	9,394	3,884	2,263	21,266

2000 onwards (before this date only hydroelectric capacity was measured). We indexed both datasets to the year 2000 to do this. A statistical summary is reported in Table 3.

The outcome variables used in our models are the logarithm of countries' annual emissions per capita (tonnes), and the logarithm of countries' installed renewable capacity per capita (kw).[2] In Fig. 1, we show the distribution of our outcome variables. The log of renewable energy is symmetric and leptokurtic, i.e., for this variable most of the countries report values around the mean. However, the log of CO_2 emissions exhibits bimodality, with a relative mode in the upper side of the distribution, which suggests the existence of a small "club" of highly polluting OECD countries.

In Fig. 2, we show scatterplots of the log of CO_2 emissions and renewable energy capacity crossed with leaders' characteristics. Each dot in the graph represents the time-average of the variables in each country. These scatterplots allow us to see graphically the raw linear association between leaders' characteristics and our outcome variables. A line with an upwards slope indicates a positive association, while a line with a downwards slope indicates a negative association. Contrariwise, a flat line indicates no association. It is important to bear in mind, however, that these are raw unconditional bivariate associations, and therefore may disappear or even reverse in a multivariate regression model where the outcome variables are conditioned to other variables (controls).

4 Empirical model

4.1 Basic model

To estimate the association between leaders' characteristics and CO_2 emissions and installed renewable energy capacity, we use a linear model with country fixed-effects, while also controlling for other demographic and economic country characteristics. In this

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[2] When both the dependent variable and the regressor are in logs, the estimated parameters are elasticities, i.e., the percentual increases in the model due to a 1% increase in the regressor. This means that elasticities do not depend on the units the variables measure, which facilitates the interpretation of the effects and the comparison across alternative models. Since log-transformation implies a compression of the distribution of the variable, it also corrects potential problems derived from the presence of outliers in the sample or overdispersion, which we expect to be very high for renewable energy. For example, the coefficient of variation for renewable energy is 1.56, which is very high, whereas for CO_2 emissions, it is 0.41.

Table 3 Estimation of Eq. 2 (carbon emissions and renewable energy development, 1992–2014)

	Log(CO_2) (2)	Log(renewable) (4)
Business	0.0510***	−0.276***
	(0.0112)	(0.0505)
Years 1–4 (first mandate)	−0.0560***	0.0240
	(0.0133)	(0.0602)
Years 5–8 after (second mandate)	−0.0366***	0.0119
	(0.0134)	(0.0600)
Have children (yes/no)	0.00736	−0.0757
	(0.0151)	(0.0684)
Female	0.0805***	0.0922
	(0.0156)	(0.0705)
Age	−0.0148***	0.00617**
	(0.00468)	(0.00252)
Age square	0.000122***	
	(4.20e-05)	
Years in politics	0.00385***	−0.00435**
	(0.00147)	(0.00204)
Years in politics square	−7.48e-05***	
	(2.70e-05)	
Left-wing party	0.0193**	−0.0502
	(0.00772)	(0.0348)
Governing in majority	0.0458***	−0.155***
	(0.0111)	(0.0496)
Governing in coalition	0.0146	−0.159***
	(0.0120)	(0.0529)
log(GDP)	0.402***	1.025***
	(0.0418)	(0.183)
% of urban population	0.0116***	0.0350***
	(0.00166)	(0.00747)
log(population)	1.697***	−3.934***
	(0.0890)	(0.396)
Observations	681	681
R-squared	0.685	0.733
# number of countries	27	27

Standard errors in parentheses; all models include year dummies

***$p<0.01$;**$p<0.05$;*$p<0.1$

model, we are interested in estimating the coefficients associated with leader characteristics, with special attention to the dummy variable picking-up whether the leader has a professional background in business. Our basic specification is:

$$\ln Y_{it} = \sum_{k} \beta_k Z_{jit} + \sum_{m} \lambda_m X_{it} + \delta_t + \mu_i + \varepsilon_{it} \tag{1}$$
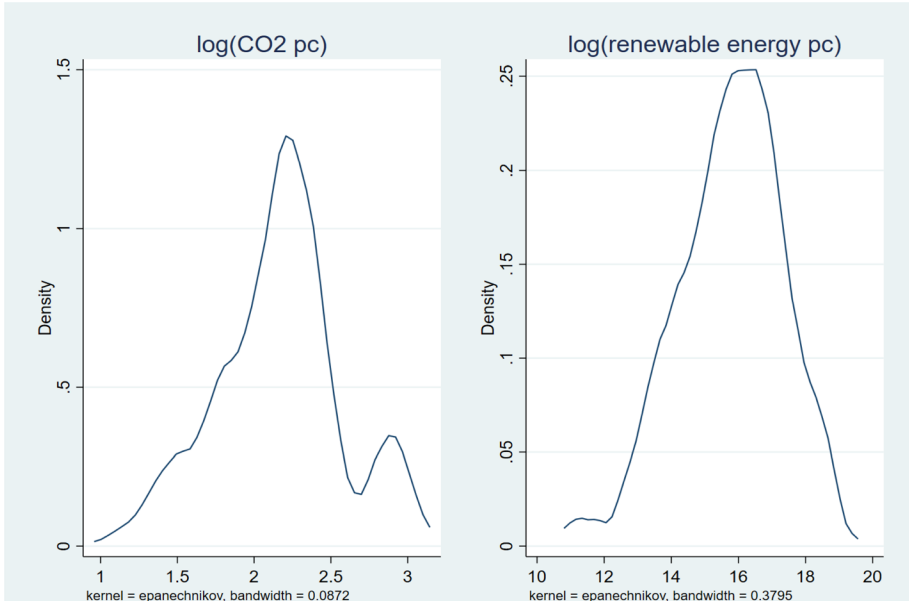
Kernel density of the outcome variables

Fig. 1 Kernel density of the outcome variables

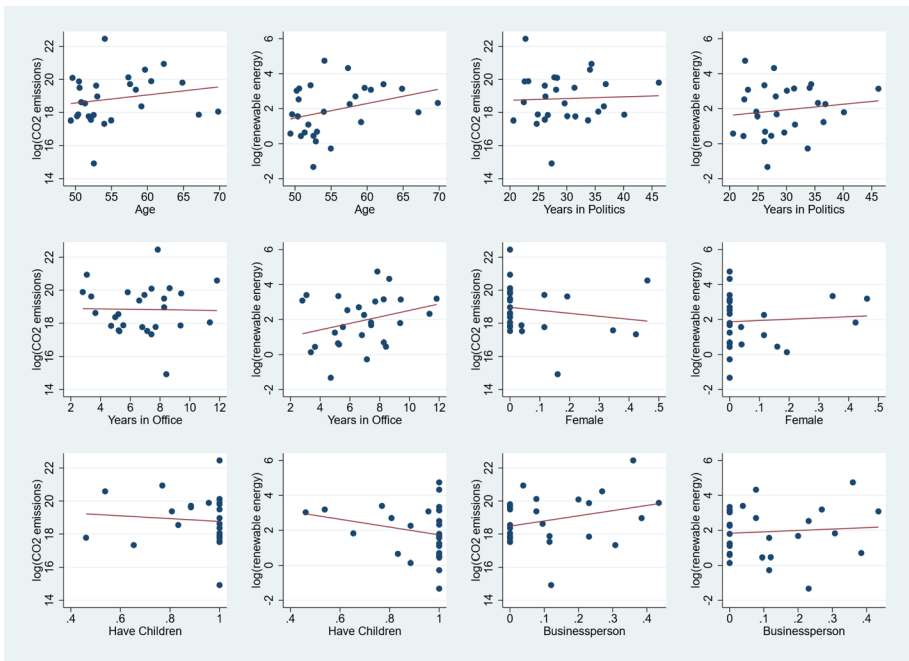Scatterplots Leader Characteristics vs. CO2 Emissions and Renewable Energy

Fig. 2 Scatterplots leader characteristics vs. CO_2 emissions and renewable energy

where Y_{it} is the outcome variable, CO_2 emissions or renewable capacity, for country i in year t, Z_{jit} is a set of socio-economic characteristics for leader j, ruling country i in year t, and X_{it} is country controls. β_k and λ_m are the set of parameters associated with our explanatory variables to be estimated, and ε_{it} is a random error term. δ_t is year fixed-effects (t), which are estimated by including year dummies, and μ_i are country fixed-effects.

The matrix X_{it} contains the following country level variables: logarithm of the GDP per capita and of the total population, and the percentage of urban population. Controlling for national income (GDP), our model isolates the effect of leaders on climate policy and outcomes, and controls for the possible effect of income on both emissions and types of leaders elected (e.g., higher income countries emitting more and electing specific types of leaders).

We address time-constant unobserved heterogeneity across countries with the consideration of country fixed-effects (μ_i). This unobserved heterogeneity comes from factors such as location, geography, culture, and other idiosyncratic factors that differ among countries but do not change over time. These factors may affect both climate policy/outcomes and the pool of candidates or voters' choice between politicians with different characteristics. If country fixed-effects are not considered, estimated effects might be biased. We also include year fixed-effects by including year dummies, which control for changes in the outcome variables over time but do not differ across countries (say global oil prices, or a global macro-economic shock). The omission of the country fixed-effects may jeopardize the strict exogeneity assumption if unobserved time-invariant country-level factors captured by u_i are correlated with the covariates in Eq. (1). Strict exogeneity is a necessary condition to obtain consistent/unbiased estimates.

The matrix Z_{jit} is composed by our explanatory variables of interest, i.e., a wide variety of leader socio-demographic characteristics: leader's profession, having children, gender, age, years in politics, years in office, ideology of the party, type of government (majority, coalition).

To estimate Eq. (1), and get rid of the unobserved heterogeneity across countries, we resort to the following equation:

$$\left(\ln Y_{it} - \ln \overline{Y}_i \right) = \sum_k \beta_k \left(Z_{k,jit} - \overline{Z}_{k,i} \right) + \sum_m \pi_m \left(X_{m,it} - \overline{X}_{m,i} \right) + \delta_t + \left(\varepsilon_{it} - \overline{\varepsilon}_i \right) \quad (2)$$

In Eq. (2), each variable is demeaned with its time-average in each country. In this setting, the identification strategy hinges around the within-country variation of the outcome and the explanatory variables around their means.

5 Empirical results

In Table 3, we report the association between being a president or prime-minister with background in business and emissions and renewable energy, while controlling for other leader characteristics (gender, age, etc.), other country-level variables of interest, country fixed-effects and year fixed-effects. This association is estimated using a dummy variable that takes the value 1 if the leader has a professional background in business and 0 otherwise.

The first general conclusion from our results is that leader characteristics matter: several characteristics of political leaders have statistically significant association on either or both carbon emissions and renewable energy deployment. The estimated coefficient for our main variable of interest (dummy for leaders with professional background in business), is highly statistically significant and sizeable. Years in which business people are governing are associated with 5% more emissions and almost 28% less renewable energy capacity (Table 3).

Table 4 Diff-in-diff estimation (Eqs. (3) and (4))

	Log(CO_2)		Log(Renewable)	
	(1)	**(2)**	**(3)**	**(4)**
Before transition	− 0.0471***		0.0708	
	(0.0129)		(0.0592)	
After transition	0.00294		0.0073	
	(0.0172)		(0.0792)	
> = 7 before transition		− 0.0584***		0.205***
		(0.0162)		(0.0737)
5–6 years before transition		− 0.0425**		0.0555
		(0.0191)		(0.0870)
3–4 years before transition		− 0.0429**		0.00600
		(0.0186)		(0.0847)
1–2 years before transition		− 0.0415**		− 0.0242
		(0.0187)		(0.0853)
3–4 years after transition		0.00261		0.0333
		(0.0221)		(0.101)
5–6 years after transition		0.00591		0.0456
		(0.0270)		(0.123)
7–8 years before transition		− 0.0111		− 0.0621
		(0.0371)		(0.169)
Observations	672	672	672	672
R-squared	0.660	0.660	0.699	0.704
Number of countries	27	27	27	27

All models include all other controls included in Table 3 and year dummies; standard errors in parentheses
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

One might think that the worst evolution of climate outcomes during the mandate of business people is not surprising. But the businessmen in our sample do not fare any better in terms of renewable energy development,[3] a dynamic economic sector which one would expect entrepreneurs to support more.

Our main focus here is on the links between the profession of leaders (business background) and climate outcomes. However, several interesting observations emerge from looking at some of the other characteristics that we use here as controls (Table 4), and which could inform further research on leader characteristics and climate policy.

First, women leaders are associated with 8% more emissions in the years that they govern, though they have no effect on renewable energies. Gender, however, is highly correlated with profession (for example, there are no women leaders who were businesspersons in our sample), and it is likely that part of the effect of gender is taken away by profession that acts as a "bad control" — in separate regressions, not reported here,[4] we find that if

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[3] All leaders with business background in our sample are men.

[4] One variable is said to be a "bad control" if it determines the behavior of another explanatory variable in the same regression, thus taking away some of the direct effect of this explanatory variable (Angrist and Pischke 2008, page 47).

we test for gender excluding the other controls, the effect of women's tenures on carbon emissions remains positive, though it falls to 5%, while their effect on renewables becomes positive (25% increase compared to men, statistically significant at 1%). Previous literature shows that female politicians are less corrupt or opportunistic and less prone than men to short-term, strategic political-electoral thinking (Brollo and Troiano 2016), more likely to support foreign aid (Hicks et al. 2016), and that, once in power, the choices women make are more "other regarding" than those of men (Gneezy et al. 2003; Song et al. 2004) — all these factors would make one expect women leaders to be better for climate policy. On the other hand, the "Queen Bee-phenomenon" suggests that women leaders in male-dominated organizations tend to succeed by acting as men do and distancing themselves from preferences associated with women (Derks et al. 2016; Faniko et al. 2017). What is interesting in our results is not just that women's actions resemble men's in climate (in)action, but that they actually perform worse — an intensified Queen-bee effect of sorts. What requires further study is also why the effect of women's leadership on renewable energies would go in a different direction from that of carbon emissions.

Second, age is associated with declining emissions at a decreasing rate (that is with a slowdown at older ages, indicted by the quadratic polynomial), while the more years a leader has in politics the higher the emissions (with an increase that also slows down with age). For renewable energy, we find only linear effects: renewable energy increasing with age and decreasing with years in politics. Note here, however, that controlling, as we do, for one variable when we test the other, we take out its effect, so for instance, we check the effect of age controlling for years in politics. When we take out the controls, in regressions not reported here, both age and years in politics have a negative effect on emissions and there is no statistically significant effect on renewables. Given that age and experience are not a key concern of this paper, we refrain from offering broader conclusions, but suffice it to note that simplistic expectations that younger and fresh politicians will be better for climate mitigation because their generations care more about the future, do not seem, on a first look at least, to be confirmed by the empirical record.

Finally, a generational perspective is not observed in the case of parenthood. Parents, whom one could expect to care more about the longer-term impacts of climate change, do not seem to have discernable differences on either carbon emissions or renewable energy from non-parents (Table 3). Note, however, that there is limited variation in our sample since 92% of our leaders (and leader years) are parents.

5.1 Robustness checks: difference-in-differences estimation

The empirical evidence, reported in the previous section using the linear regression model with fixed-effects (Eq. 1), reports a correlation between leader's occupation and CO_2 emissions and renewable energy deployment in the countries they govern. More specifically, we have reported a positive link between elected leaders with previous professional backgrounds as business people and CO_2 emissions, and negative links with the deployment of renewable energy.

To assess more robustly the association between electing a businessperson and climate mitigation, we now use the difference-in-differences (diff-in-diff) approach. Diff-in-diff attempts to mimic an experimental research design using observational study data, by studying the differential effect of a treatment on a "treatment group" (equivalent to a "control group" in a natural experiment). We do not have experimental data, but we can design an identification strategy based on that leader with background as a businessperson

(treatment) is elected only in some countries. Therefore, we can have a "comparison" group composed of those countries for which the "treatment" has never been applied. The diff-in-diff model is generally expressed as follows:

$$y_{it} = \gamma D_i + \delta T + \lambda \left(D_i \cdot T \right) + \beta X_{it} + \varepsilon_{it} \tag{3}$$

where y_{it} is the outcome variable in the country i at time t; D_i is a dummy variable that takes the value 1 for all those countries who received the "treatment" (having an elected leader with professional background as a businessperson); T is a dummy variable that takes the value 1 for the post-treatment period; and ε_{it} is a time-varying error. The impact of the treatment on the treated (e.g., country's CO_2 emissions where a given leader is elected) is picked-up by the parameter λ.

Due to the non-randomization in the "treated" group (i.e., countries where a leader with professional background as businessperson is elected), to identify the effect of the "treatment" on the outcome (CO_2 emissions or renewable energy deployment), as in Eq. (1), it is convenient to include country controls (X_{it}), such as GDP and the share of urban population overall population in the country, total population, and to keep constant the cross-country differences by including country fixed-effects. In the model, we also need to take into account that leaders with a specific background have been elected in a different year in each country. With all these considerations, Eq. (3) becomes:

$$y_{it} = \theta_t + \alpha_i + \lambda \left(\sum_{t=k}^{T} D_{it} \right) + \beta X_{it} + \varepsilon_{it} \tag{4}$$

where α_i are country fixed-effects that allow us to control for unobserved heterogeneity across countries and θ_t are year dummies. In this setting, the inclusion of the country fixed-effects removes D_i from Eq. (3) since this variable is constant throughout the sample period in all "treated" countries. Analogously, the dummy for the post-treatment period (T) in Eq. (1) is absorbed by the year dummies in Eq. (4), which account for the fact that the "treatment" is applied in each country in different years. In Eq. (4), D_{it} is a dummy variable that takes the value of one in the country i treated in period k during the subsequent periods (D_{ik}, D_{ik+1}, ..., D_{iT}). Our main coefficient of interest is λ, which picks up the association between the treatment (having elected a leader with professional background as a businessperson) on our outcome variables (CO_2 emissions or renewable energy deployment). In Eq. (4), the parameter λ picks up the in/decrease in the outcome after the implementation of the treatment ($t=k$, $k+1$, ..., T). Analogously, if we want to know whether the link between the treatment and the outcome is time-constant or time-varying, we can also estimate the following equation:

$$y_{it} = \theta_t + \alpha_i + \sum_{t=m}^{-1} \gamma_t T_{it} + \sum_{t=1}^{k} \lambda_t D_{it} + \beta X_{it} + \varepsilon_{it} \tag{5}$$

In Eq. (5), we estimate pre- and post-treatment trends by standardizing the time dimension in m periods before and k periods after the treatment. Thus, we create a certain time window around the application of the treatment ($t = -m$, ..., $-2, -1, 0, 1, 2, ..., k$), where $t=0$ is the moment when the political leader is elected. T_{it} are interactions of the treatment indicator and time dummies for the m pre-treatment periods, and D_{it} are interactions of the treatment indicator and time dummies for the k post-treatment periods. This is a test for whether the outcome variable evolves similarly across "treated" and "comparison" groups

Estimated marginal effects (Diff-in-Diff)
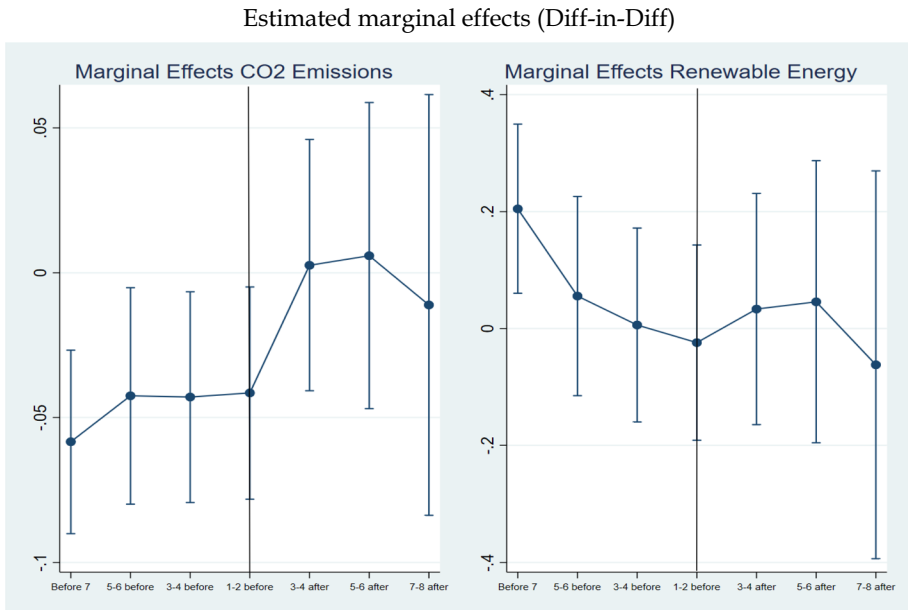
Fig. 3 Estimated marginal effects (diff-in-diff)

before the "treatment." To conclude that a leader with a specific background can be associated with the outcome variables, in Eq. (5), we should observe that the coefficients associated with the pre-treatment periods behave significantly differently than the coefficients associated with the post-treatment period. This result would indicate that the outcome variable has a similar behavior in both the "comparison" and "treated" countries during one of the periods (pre- or post-treatment period); however, if the evolution of the outcome variables cannot be associated with the "treatment," during the pre- or post-treatment period, the outcomes would exhibit a different evolution in the "treated" group, with respect to the "comparison" group.

Table 4 reports the empirical estimates of the diff-in-diff models evaluating the association between having an elected leader with a professional background in business and CO_2 emissions and the deployment of renewable energy. In this table, we report the estimates of Eqs. (4) and (5). In Table 5, columns (1) and (3) correspond to the estimation of Eq. (4), while columns (2) and (4) correspond to the estimation of Eq. (5). The control variables (leader and country characteristics) included in these models are the same as the ones included in the previous estimates reported in Table 4.

Results reported in Table 4 reveal that electing a leader with a professional background in business is associated with higher CO_2 emissions (columns (1) and (2)). In these countries, before this type of leader was elected, we estimate an annual average long-run decrease of -4.6%. However, after the election of this type of leader, the fall in the CO_2 emissions slows down and remains constant while this leader is in power. This result is more evident in Model (2), where we report an average biannual decrease in CO_2 emissions that stops after a leader with a professional background as a businessperson is elected. Results reported in Model (2) are depicted in Fig. 3, where a significant jump in the behavior of CO_2 emissions can be observed. Regarding the deployment of renewable energy, we do not find significant differences before and after a

businessperson is elected, which suggests that the link between having a businessperson as national executive and the deployment of renewable energy is rather weak. Results derived from this analysis are depicted in Fig. 3, where we can observe an already-existing decreasing trend in the behavior of this outcome before this type of leader was elected, and a businessperson making no subsequent difference.

6 Discussion and conclusions

In line with what related literature in economics has shown, as in many economic policy outcomes, our research confirms that leader features are correlated with environmental policy outcomes, in this case climate mitigation. More specifically, regarding our main leader characteristic of interest, having a professional background in business, while from the literature, we did not have strong reasons to expect this correlation to be positive or negative, the empirical evidence reported here suggests that during the mandate of presidents/prime ministers with professional background in business, CO_2 emissions are considerably higher.

In our first empirical analysis, we use a standard linear model with country fixed-effect that includes a dummy variable for leaders with professional background in business. This means that the identification strategy hinges on linking within-country variations in CO_2 emission and in the deployment of renewable energies with within-country variations of political leader characteristics when ruling the country. This implies that the size effect is taken away, that is, countries responsible for a higher share of world global emissions do not have a higher incidence in our results than smaller economies responsible for a smaller share of global emissions.

Even though our results indicate that the correlations between leader's characteristics and climate outcomes are strong and sizeable, our research has certain limitations that should be taken into consideration. First, there are idiosyncratic effects that may be missed by research such as ours focused as it is on systematic patterns. The antipathy of President Trump for example towards climate mitigation action is probably not reduced to his experience as a businessperson only. However, this type of personality trait is generally unobservable for the researcher. Second, the fact that leader characteristics are, other factors being equal, correlated with emissions or renewable energy development does not mean that these associations are stronger than other macro-economic, technological, or ideological factors. What it means is that leader characteristics matter and that electorates concerned with climate change should take them into consideration when deciding who to vote for, alongside the ideologies and explicit statements and promises of the leaders and their parties. Third, even with year- and country-specific fixed effects, this study's research design cannot rule out the possibility that some change within countries (e.g., rising levels of political conservatism that emphasize the importance of both business and environmental deregulation) drives both the election of business people and the erosion of climate policies that reduce emissions and promote renewable energy. While we have not proven causation, we do demonstrate a strong association, robust to a different specification based on differences-in-differences.

The main contribution of our research is to address for the first time the gap in the literature on possible links between political leaders and environmental outcomes, which to the best of our knowledge is virtually non-existent.

Our diff-in-diff analysis reports a strong association between electing leaders with professional backgrounds in business and CO_2 emissions, whereas we do not observe a pattern on the development of renewable energy technologies. This suggests that the potential difference business people make may not have anything to do with their willingness to invest and support a new and potentially profitable activity, but with an unwillingness or disinterest in stopping fossil fuels via regulations, taxes, or other mechanisms, which are generally disfavoured by business people when in power (Kirkland 2021). Further research may seek to shed more light by attempting to disentangle values and beliefs from personal interest, network effects and questions of awareness/ knowledge and specialization. Let us note here that this is a general shortcoming of the economics literature on the link between leaders' characteristics and policy outcome, which is statistically advanced in this type of analyses, but the attribution to one versus another causal mechanism remains in our view, quite speculative. Political science is often better in this respect to the extent that it employs multiple methods and complements statistical analyses with richer historical and case study-based accounts. A closer look, for example, in the biographies and decision record of the business leaders in our sample, including a look at their networks of interests (including relations to fossil fuel interests), could shed more light on the general empirical association established within this research.

Future research should also consider possible "spill-over" effects leaders in core countries might have on the emissions of others and which are not the object of our research (think of the effect of a Trump presidency on the emissions of other countries given the withdrawal of the USA from the Paris agreement). A businessperson elected in the USA, the hypothesis is, might have a bigger impact on global emissions, than, say, a businessperson in Greece. Second, it would be important to look at whether the emergence of a new breed of authoritarian/populist leader and ideologically extremist parties changes the associations we found here in any significant way.

Although we cannot talk about "policy" implications of our findings, there are clear "political" implications. Our research suggests that voters who care about the climate should pay attention to candidates' characteristics, in addition to the candidate's party ideology or specific positions on climate change and policy. Pressure groups who also want to push for climate mitigation legislation or funding should know that times where, for example, the governors are not businesspersons are times when they can be more ambitious and push for more action, perhaps even more than the political affiliations or stated preferences of the candidates suggest. Conversely, periods where the leaders are business people are perhaps periods for more oppositional politics, and vigilance and pressure should be maintained, even if such leaders or their parties express pro-climate action preferences.

Data Availability Available upon request.

Code availability Available upon request.

Declarations

Conflict of interest The authors declare no competing interests.

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