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RESEARCH ARTICLE

Shifting environmental pollution abroad contributes to lower emissions in democracies

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Abstract

Many studies suggest that democracies have, on average, a better environmental protection record than authoritarian states. But this debate is far from resolved. Hence, we take a closer look at an overlooked factor that may shed new light on the ambiguous claims and findings of the democracy-environment nexus: pollution offshoring. We hypothesize that democracies can improve their record and become "greener" not only through genuinely domestic environmental protection, but also through outsourcing environmental impacts of their consumption to other countries. Analyzing data on greenhouse gas emissions, pollution offshoring, and democracy for more than 160 countries since the 1990s, we report evidence that the offshoring of environmental pollution contributes to the superior environmental record of democracies. The main policy implication is that democracies, *per se*, may not have a better environmental record than autocracies when considering global environmental impacts. This implies that democratic countries, in particular, should re-orient their environmental protection efforts from merely domestic to global environmental consequences of local economic activity.

Introduction

Do democracies truly have a better environmental record, as many studies suggest, or do they simply become "greener" by shifting pollution abroad? To find out, this article examines the role of "pollution offshoring" – the outsourcing of polluting production to other countries – in shaping the environmental performance of democracies. Several authors have argued and empirically shown that democratic institutions can contribute to higher environmental quality, whereas more autocratic regimes tend to have worse environmental records [1-5]. However, a positive impact of democracy on environmental outcomes depends on various contextual factors, boundary conditions, and the type of environmental behavior in question [6-13]. Hence, the link between democracy and environmental outcomes is neither unconditional nor



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universal, and the debate over whether democracies, on average, perform better environmentally than authoritarian states remains unresolved [12–16].

We aim to shed light on an overlooked factor that may shed new light on the ambiguous claims and findings of the democracy-environment nexus and, thus, can further explain why more democratic countries presumably may achieve better environmental outcomes than their less democratic counterparts: pollution offshoring, which is defined as the outsourcing of pollution to other states. A UN report [17] suggests, for instance, that democratic countries such as Japan and Germany have reduced their domestic greenhouse gas emissions while significantly increasing the emissions they offshore to countries such as China [18,19]. In this context, existing research focuses on measuring consumption-related environmental impacts that countries impose on one another [20-25] and on exploring the drivers behind pollution outsourcing [24,26–29]. These studies show that, beyond directly externalizing environmental costs of economic activity (e.g., in the form of waste or transboundary air and water pollution), states engage in a more indirect form of externalizing environmental consequences: having changed their production and consumption patterns over the past few decades, some countries offshore major portions of their environmental impacts of domestic consumption. International trade plays a key role in this process: instead of manufacturing highly polluting goods domestically, some countries import these goods from abroad, effectively transferring the environmental burden to the exporting states [24,26–29]. This allows nations to reduce pollution within their borders while outsourcing its consequences elsewhere.

However, this literature does not directly assess whether and by how much democratic pollution offshoring is associated with lower environmental pollution within the borders of the offshoring country. To fill this gap, we take the recent empirical finding that democracies offshore more of their (consumption-based) environmental pollution than autocratic states [27–29] one step further. So far, and as indicated, there is no empirical evidence that pollution outsourcing by democratic states helps them to improve their domestic environmental records. Our main contribution here thus is to focus on whether and by how much democracies' pollution offshoring is, *ceteris paribus*, associated with less pollution within their territory. The empirical focus is on climate change mitigation, which is widely regarded as the largest-scale and most complex environmental policy issue worldwide.

Theoretically, democracies are linked to higher levels of pollution offshoring for two interconnected reasons. First, greater freedom in science, public opinion formation and expression, and the impact of interest groups, competing political parties, or news media outlets allow for stronger public demand for environmental protection [8,9,30]. In response, democratic policymakers – who have stronger incentives to address public concerns compared to their authoritarian counterparts [31] – may implement stricter environmental policies. This, in turn, can drive "domestic greening through pollution offshoring," as more demanding local regulations lead industries to shift pollution-intensive activities abroad or cede the respective market to producers in other countries [24,27,32–34]. Second, political liberties are closely tied to economic freedoms [35], including trade and consumption [36].



This creates a tension between economic liberty and the public demand for higher environmental quality. When goods are produced domestically, greater economic freedoms often lead to increased pollution. However, unrestricted international trade allows democratic policymakers to meet domestic environmental demands without imposing strict regulations or making pollution-intensive consumption more expensive [37–39]. Citizens, who are also consumers, tend to prioritize environmental quality within their own country over the environmental impact of goods produced abroad [40], and this contributes to a shift in polluting industries to countries abroad that prioritize economic growth over environmental protection. International trade and the presence of less affluent, less democratic countries with weaker environmental regulations facilitate this process [29]. In fact, Presberger and Bernauer [28] show that democracies "offshore" more environmental impacts of consumption to other countries, whereas less or non-democratic countries tend to be "onshorers" in this process.

To disentangle the mechanisms through which democracies end up with a superior domestic environmental protection record, we proceed in two steps. The first step in our analysis re-evaluates Presberger and Bernauer's [28] key finding on the relationship between democracy and pollution offshoring [29]. Although we use a somewhat different empirical model specification, our results confirm that democracies outsource more environmental impacts of domestic consumption, relative to non-democracies. We then focus on the extent to which such outsourcing correlates with domestic-level greenhouse gas emissions. We find support for the claim that pollution offshoring is, at least in part, associated with a better environmental record of democracies in the form of lower emission levels.

Materials and methods

We compiled a time-series cross-sectional data set, with the country-year as the unit of analysis, which comprises 161 countries in 1990–2015 (before accounting for missing values). Our findings are thus widely generalizable due to the global character of our sample, although data availability prevents us from extending this research to the pre-1990 period and including all states worldwide in the analysis. We analyze this data set in two stages. First, we focus on the relation-ship between democracy and pollution offshoring. The second-stage analysis then assesses whether and how democratic pollution offshoring correlates with domestic-level environmental pollution in the form of greenhouse gas emissions. Since our theoretical and empirical arguments center on between-country differences, we estimate OLS regression models with year fixed effects for the main results discussed below. Accordingly, we control for the temporal variation (any global or time-specific shocks affecting all countries) in our data and focus on differences in outsourcing (first stage of the analysis) as well as greenhouse gas emission levels (second stage) between countries. In the Supporting Information (Tables J and K in <u>S1 Text</u>), we demonstrate that our main results are robust to estimating models with both fixed effects for countries and years or random effects at the country level.

In the first-stage analysis, we seek to re-assess whether democratic countries offshore more pollution than autocratic countries. However, due to the shift in our research focus compared to previous work [28], and to avoid an overinflation of the sample size, we analyze the data at the monadic (country) level. Data for the dependent variable in this first analysis are taken from Presberger and Bernauer [28] and are based on multi-regional input-output (MRIO) information from Eora26 [41], resulting in measures that reflect how countries importing goods offshore pollution to exporting states. We focus on what is widely regarded as a crucial environmental impact type: greenhouse gas emissions. These are measured in gigagrams, and comprise carbon dioxide, methane, sulfur dioxide emissions, and other emissions that affect the global climate. Whereas the data in Presberger and Bernauer [28] are based on directed dyads, we modified the data for our monadic unit of analysis and constructed a variable capturing the logged average amount of greenhouse gases outsourced by a specific country in each year as our dependent variable. Specifically, across all pairs of countries in the Presberger and Bernauer [28] data, we calculate how much pollution (greenhouse gas emissions) a state outsources on average per country-year (arithmetic mean). In turn, we log-transform this monadic-level score to arrive at the final dependent variable.



The Varieties of Democracy (V-Dem) "electoral democracy" index [42] is our main explanatory variable in the first analysis. The variable is based on the question "to what extent is the ideal of electoral democracy in its fullest sense achieved?" According to Teorell et al. [43], the electoral principle of democracy incorporates the core value of responsiveness, which is achieved through "electoral competition for the electorate's approval under circumstances when suffrage is extensive; political and civil society organizations can operate freely; elections are clean and not marred by fraud or systematic irregularities; and elections affect the composition of the chief executive of the country." Moreover, between elections, "there is freedom of expression and an independent media capable of presenting alternative views on matters of political relevance." The V-Dem project [42] sees electoral democracy as one of the main components of any conception of (representative) democracy [43]. In technical terms, the index is formed by averaging over the sum of several sub-indices measuring freedom of association, suffrage, clean elections, elected executive, and freedom of expression as well as these sub-indices' five-way interaction [43]. This variable outperforms other sources as it corresponds to widely adopted definitions of democracy and is advantageous in terms of the coherence of its definitions, measurement strategies, and aggregation procedures [44].

Second, and this is our main contribution, we analyze how pollution offshoring relates to emissions (environmental performance) at the domestic level, particularly in more democratic countries. To operationalize the dependent variable for this second-stage analysis, we look at the flipside of outsourcing greenhouse gas emissions and explore variation in greenhouse gas emission levels (in metric tons of CO_2 equivalent per capita, log-transformed) within the territory of each state. The data are provided by the World Development Indicators, which define these emissions as those composed of CO_2 totals excluding short-cycle biomass burning (such as agricultural waste burning and savanna burning), but including other biomass burning (such as forest fires, post-burn decay, peat fires, and decay of drained peatlands), all anthropogenic methane sources, nitrous oxides sources, and fluorinated gases.

For the main explanatory variables in the second-stage analysis, we interact the greenhouse-gas outsourcing variable from Presberger and Bernauer [28] with the V-Dem democracy variable. We expect the multiplicative term to have a statistically significant and negatively signed association with the outcome variable on greenhouse gas emissions. This would suggest that the offshoring of environmental degradation is linked to lower emissions within democracies.

Across both analyses, we opted for a parsimonious set of controls, which nonetheless address two of the most commonly hypothesized and empirically observed alternative drivers of emissions. On one hand, we include population size (log-transformed), which commonly correlates with more environmental pollution. The data on countries' populations are taken from the World Bank Development Indicators and are based on a country's midyear total population. All residents regardless of legal status or citizenship (except for refugees not permanently settled) are considered. On the other hand, we control for income using GDP per capita and allow for a curvilinear relationship along the lines of the Environmental Kuznets Curve (EKC) by adding this item's squared term [45,46]. The variables are log-transformed and also taken from the World Bank, which defines income as the gross domestic product (GDP) divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. In the SI, we also discuss models that include additional control variables.

Results

Fig 1 summarizes the main findings for the first-stage analysis. The corresponding regression tables for all figures are presented in <u>S1 Text</u>. The association between democracy and pollution offshoring is positive and statistically significant. Accordingly, more democratic systems tend to offshore more environmental impacts than less democratic countries. This result is further substantiated when simulating the expected values of pollution outsourcing over the range of *Democracy* [47,48]. We rely on the low and high values identified by the binning estimator (min=0.22; max=0.86) to determine the range of the democracy variable. Other items vary over their observed values, i.e., we implement the observed-value approach by Hanmer and Kalkan [49]. When increasing *Democracy* from its minimum to its maximum, the outsourcing variable is raised by 17.69 (13.04; 22.20) gigagrams, which equals around 0.66 standard deviations of this variable.







Fig 1. Democracy and Pollution Offshoring. The plot shows the estimated regression coefficients and 95% confidence intervals. *Pollution offshoring* is the dependent variable. The displayed results are from Model 1 in Table A in the <u>S1 Text</u>.

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Hence, there is robust evidence for a positive relationship between democracy and pollution offshoring: more democratic countries outsource more environmental impacts, on average, than less democratic countries. This finding mirrors and extends Presberger and Bernauer [28]. The control variables display statistically significant estimates (see SI). Population is positively signed, i.e., a more populous state is associated with more pollution outsourcing. Second, the income variables (GDP per capita and GDP per capita²) suggest that higher GDP per capita is linearly (rather than curvilinearly) linked to more pollution outsourcing.

The second-stage analysis assesses whether democratic pollution offshoring correlates with lower domestic-level emissions. Accordingly, our focus is on the interaction term *Pollution offshoring x Democracy*. Fig 2 summarizes the main results, which show that *Pollution offshoring x Democracy* is negatively signed and statistically significant. Following King et al. [47,48], we use the estimates of Fig 2 to simulate the expected difference in greenhouse gas emissions in more vs. less democratic countries, while changing the pollution-offshoring variable from its observed minimum to its







Fig 2. Pollution Offshoring and Greenhouse Gas Emission Levels. The plot shows the estimated regression coefficients and 95% confidence intervals. *Greenhouse gas emissions per capita (In)* is the dependent variable. The displayed results are from Model 2 in Table B in the <u>S1 Text</u>.

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maximum. Again, we rely on the low and high values identified by the binning estimator (min=0.24; max=0.85) to distinguish between the most and the least democratic countries. For low and high values of the offshoring variable, we take the 20th and the 80th percentile. As before, the other variables in the model vary over their observed values [49]. When concentrating on the more democratic countries in our sample, altering environmental offshoring from its minimum to its maximum corresponds to a statistically significant difference in expected greenhouse gas emissions of about -1.75. The effect is more weakly pronounced for less democratic regimes (about -0.75). Moreover, in comparison to less democratic countries, greenhouse gas emissions are -1.01 (-1.55; -0.45) metric tons per capita lower in the more democratic regimes when increasing pollution offshoring. This provides rigorous evidence that environmental offshoring in democracies is related to lower greenhouse gas emission "at home."

Fig 3 plots the marginal effects of *Pollution offshoring* for values of *Democracy*, employing Hainmueller et al.'s [50] binning estimator to account for potential non-linearities in the interaction effects and to address concerns over the lack of common support. The marginal effect of pollution offshoring on greenhouse gas emissions is negative for all values of democracy, although it is more strongly pronounced for medium and higher levels of democracy. For the least democratic





Fig 3. Marginal Effects of Pollution Offshoring. The plot shows the estimated marginal effects and 95% confidence intervals at the mean of *Pollution offshoring*, over values of the moderator, *Democracy.* We distinguish between low (L), medium (M), and highly (H) democratic countries. *Greenhouse gas emissions per capita (In)* is the dependent variable. The histogram at the horizontal axis displays the distribution of *Democracy.* Marginal effect of 0 is highlighted by grey solid horizontal line. The graph is based on Model 2 in Table B in the <u>S1 Text</u>.

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societies in our sample, the effect is estimated to be statistically insignificant. This pattern suggests, in line with our theoretical expectations and Fig 2, that pollution offshoring is associated with lower emission levels especially in more democratic countries.

In sum, our results report consistent and robust evidence in favor of a pollution-reduction effect "at home" for democracies' environmental offshoring. In the Supporting Information, we present additional empirical analyses to corroborate our core findings. First, after describing the estimation technique in more detail and summarizing the regression tables corresponding to the graphs discussed above (Tables A and B in <u>S1 Text</u>), we consider two alternative dependent variables: air pollution ($PM_{2.5}$ concentrations) and the consumption-based carbon footprint (Table C in <u>S1 Text</u>). Second, we use other indicators of pollution offshoring, i.e., blue water, energy use, land use, and material footprint (Table D in <u>S1 Text</u>). Third, we re-estimate both the first and the second analysis using the total sum of pollution offshored rather than the average amount per country-year (Tables E and F in <u>S1 Text</u>). Fourth, we change the operationalization of democracy (Table G in <u>S1 Text</u>). Fifth, we consider additional control variables: trade openness, participation in international environmental agreements, political globalization, and economic size measured by GDP (Table H in <u>S1 Text</u>). Sixth, we omit higher-income countries from the sample (Table I in <u>S1 Text</u>). Seventh, we re-estimate the models when including two-way fixed-effects and considering random effects (Tables J and K in <u>S1 Text</u>). Overall, the main findings uphold.



Conclusion

We provide one of the first systematic studies on the relationship between pollution offshoring and domestic (territorial) emissions in democracies. Our main finding is that pollution offshoring is significantly and substantively associated with lower greenhouse gas emissions "at home" in democratic countries.

This study advances research on the link between political institutions and environmental behavior in several ways. First, building on Presberger and Bernauer [28], we provide further evidence that democracies outsource environmental impacts more extensively than non-democracies. Unlike their dyadic approach, which can inflate the sample size, we analyze monadic data, ensuring more robust results. Second, we move beyond identifying the determinants of pollution offshoring to examining its consequences. While democracies offshore more of their consumption-based environmental impacts, we find that this outsourcing correlates with lower domestic emissions. Third, we assess democratic governance using the V-Dem index, which we consider superior to alternative democracy measures due to its alignment with widely accepted definitions in political science and its methodological rigor [44].

Future research could expand on our findings – potentially in combination with Presberger and Bernauer [28] – by exploring how geographic proximity influences the onset and impact of pollution offshoring. In addition, also based on the analyses in Table D of <u>S1 Text</u>, it may be an effort worth making to explore which pollutants are mostly responsible for democracies' better environmental record once offshoring is considered.

From a policy perspective, the main implication of our findings is that democracies, and high-income democracies in particular, should consider re-orienting their environmental policy focus from primarily territorial to global environmental impacts of their domestic economic activity. What is more, our findings clearly question the often-claimed "moral high ground" of democracies vis-à-vis autocracies regarding environmental performance. The observation that the global environmental impacts of consumption, relative to the territorial impact of production, is larger for democracies than for non-democracies gives rise to normative debates on the democracy-environment nexus and environmental justice. Our work adds to the discussion on whether countries are – or should be – politically responsible for consumption-related environmental impacts abroad; or whether the principle of sovereignty of nations implies that producing countries benefiting economically from exports to higher-income democracies should be responsible because they are free to make their own tradeoffs between economic benefits and environmental harm.

Supporting information

S1 Text. Additional information and robustness checks. (PDF)

Author contributions

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