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Unpacking democracy: The effects of different democratic qualities on climate change performance over time

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ABSTRACT

Given democracies' moderate success in combatting climate change, some have questioned whether democracy makes it harder, not easier, to reduce greenhouse gas emissions. Two decades of research, however, has not provided an unequivocal answer. Recent studies argue that this is because democracy has been measured with a single indicator, rather than by its multiple and varied characteristics. In this study, we focus on a subset of democratic qualities and the role they play in mitigating climate change. Using recently developed random-effect within-between models, we formally test the relationships between democratic qualities and per capita CO_2 emissions in a panel of 127 countries from 1992 to 2014. With one exception (inequality), we find that democratic qualities have no significant effects on a nation's ability to mitigate climate change. This means that there are no trade-offs between strengthening democratic institutions and mitigating climate change. Consequently, the global challenge of climate change cannot be used as an excuse to weaken democratic institutions.

1. Introduction

Currently, governments are applying policies that have neither the strength nor the scope to limit global warming to necessary and agreed-upon levels (Climate Action Tracker, 2019). Some researchers attribute these insufficient responses to the global decline of democracy (Freedom House, 2020; Lührmann et al., 2020) and argue that more and stronger democracies are needed to produce conscious, cooperative, and binding global commitments (Clulow, 2019; Hammond and Smith, 2017; Stehr, 2016). Democracies need to innovate and become more deliberative and inclusive (Dryzek and Pickering, 2017) or reimagine the roles of the environment (Pickering et al., 2020) and science (Pickering and Persson, 2020). Others argue that the democratic system may be unfit to tackle the impending climate crisis, either because democratic governments accept the public's unwillingness to adopt climate friendly behavior (Midlarsky, 1998; Shearman and Smith, 2007) or because pro-environmental action is overruled by corporate interests in democratic capitalist systems (Maxton and Randers, 2016). They argue that authoritarianism may be the only form of governance capable of producing the societal and economic transformation needed to protect the environment (Beeson, 2010; Drahos, 2021; Maxton and Randers, 2016; Shearman and Smith, 2007).

Still, democracy is the preferable system of government when social and economic development is the goal. Democracies are better at ensuring gender equality and quality education (Glass and Newig, 2019), as well as sustaining economic growth (Acemoglu et al., 2019), to mention only some of the UN's Sustainable Development Goals (SDGs) (United Nations, 2015) the world has agreed to focus on in the next decade. They are also better at achieving most environmental goals and targets (Dasgupta and De Cian, 2018; Glass and Newig, 2019). Although democracy is not explicitly mentioned in the SDGs, democratic principles "run through [the SDGs] like a golden thread" (United Nations, 2016). In certain sustainable development models, democracy is also considered an intrinsic development goal (Linnerud et al., 2021). In a sustainable development context, it is therefore crucial to identify any potential trade-offs between democratization, and the institutions that characterize it, and climate change mitigation efforts.

The relationship between democracy and climate change mitigation efforts has been investigated empirically for two decades, but the results have been inconclusive (e.g. Clulow, 2019; Dasgupta and De Cian, 2018; Escher and Walter-Rogg, 2018): Lv (2017) finds that democratization decreases emissions in high-income countries, Lægreid and Povitkina

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(2018) that it decreases emissions in low-income countries, and Arvin and Lew (2011) that it decreases emissions in middle-income countries, while it *increases* emissions in both high and low-income countries. Other studies argue that corruption (Povitkina, 2018), existing emissions (Bättig and Bernauer, 2009; You et al., 2015), income inequality (Policardo, 2016) and the strength of the domestic tradition for democracy (Gallagher and Thacker, 2008) create conditions in which democracy has significant effects on CO_2 emissions.

This lack of unequivocal conclusions has recently led researchers to question how the concept of democracy is operationalized, measured, and included in statistical models. Mayer (2017) suggests that "future research in this area, rather than relying on single indicators of democracy, could investigate the relationship between different characteristics of democracy and environmental performance." Similarly, Joshi and Beck (2018) argue that "future scholarship on democracy and the environment should aggressively grapple with democracy at the meso-level by focusing on institutions and political subsystems," while Pickering et al. (2020) argue that "large-n quantitative [studies] will continue to be important, but these need to ensure greater nuance in measures of democratic quality."

In this study, we go beyond a narrow definition of democracy by investigating how different democratic qualities influence national CO_2 emissions per capita. The task requires disaggregating the concept of democracy into meaningful components. Until recently, this has not been a straight-forward process because existing measures of democracy have been based on a narrow variety of definitions, usually measuring freedoms, elections, or contestation (Coppedge et al., 2011). Instead, we use the new Varieties of Democracy (V-Dem) (Coppedge et al., 2018) dataset, which separates democracy into five separate components: electoral, liberal, deliberative, egalitarian and participatory democratic qualities.

The approach is similar to Escher and Walter-Rogg (2018) in that it estimates different aspects of democracy separately. However, the measures of electoral accountability, horizontal accountability, civil rights, and political rights that are included in their analysis, does not go beyond the electoral and liberal democratic qualities measured by V-dem. Additionally, Escher and Walter-Rogg (2018) only analyze the effects of the average level of democracy over time in each country, while this study also looks at the important effects of democratic qualities disaggregated for each country and year.

In this paper, we statistically estimate the relations between emissions and each of these democratic qualities by applying a panel data estimation technique to our dataset consisting of 127 countries and data from 1992 to 2014. Former studies have typically applied simple OLS, fixed-effect estimation techniques that assume that parameters are fixed or simple random-effects models that allow for random parameters but rely on stricter assumptions that are often not met (Bell et al., 2018). We apply a recently developed random-effects within-between model that provides a superior estimation of the overall effects by estimating the between- and within-effects separately (Bell et al., 2018).

In the next section, we describe the theoretical foundation for our analysis and derive hypotheses we will test statistically. In doing so, we refer to a wide set of studies on mechanisms explaining how different qualities of democracy may influence per capita CO_2 emissions. We then present the econometric techniques and data collection procedure as well as the results of the data analysis and explore their significance. Conclusions and policy implications are offered in the final section.

2. Theory

In achieving the SDGs and mitigating most environmental problems, the level of democracy and quality of democratic institutions are important drivers (Dasgupta and De Cian, 2018; Glass and Newig, 2019). An increase in institutional quality improves environmental performance in protected areas, air pollution and deforestation (Dasgupta and De Cian, 2018), while the level of democracy is correlated with better performance in most environmental SDGs, such as clean water and sanitation (SDG 6) and life below water (SDG 15), as well as the total average SDG achievement (Glass and Newig, 2019).

However, as we show in the introduction, democratic institutions are known to be both a driver and barrier for countries' ability to reduce greenhouse gas emissions (Dasgupta and De Cian, 2018; Povitkina, 2018). In this article, we use the five democratic qualities (DQs) measured by the V-dem project (Table 1) to structure the theoretical argumentation (Coppedge et al., 2018). For each DQ, we present theoretical mechanisms that explain how CO_2 emissions are affected by the different types of institution. Finally, we summarize these insights in five hypotheses that can be tested statistically.

2.1. The electoral democratic quality

The electoral DQ measures the core values of democracy that must be in place for a nation to be regarded as democratic (Coppedge et al., 2018). It uses Dahl's (1998) concept of polyarchy, which identifies five political institutions as the defining elements of modern representative democracy: elected officials; free, fair, and frequent elections; freedom of expression and a free media; freedom of association; and universal suffrage. In 2014, Denmark had the highest score (0.93) on this index.

For this DQ, there are three relevant mechanisms that examine how democracies and non-democracies affect environmental performance. First, democratic leaders are held accountable for how they perform (Clulow, 2019; Payne, 1995). Therefore, they cannot ignore the concerns of environmental voters when such issues are dominant (Payne, 1995). However, when people are more concerned with employment and economic growth, democratic leaders may adopt measures that reduce environmental quality (Mayer, 2017). This might especially be the case in developing countries (Povitkina, 2018). Therefore, the accountability of democratic leaders might lead to both environmental degradation and improvement, depending on the context.

Second, climate change is a long-term issue, and the benefits of mitigation policies cannot be reaped by policymakers that are currently in office. Therefore, such policies might be unpopular in democracies (Clulow, 2019). However, autocratic leaders are also inclined to divert their limited resources away from long-term policies into measures that will ensure that they remain in power in the short-term (Li and Reuveny, 2006). Therefore, long-term policies such as climate change mitigation policies might be overlooked by both autocratic and democratic leaders.

Third, the cost of staying in power takes a different form in democracies compared to non-democracies (Bueno de Mesquita et al.,

Table 1
The democratic qualities and their subcomponents.

Democratic quality	Subcomponents
Electoral DQ	Freedom of expression and alternative sources of information
	Freedom of association
	Share of population with suffrage
	Clean elections
	Elected officials
Liberal DQ	Equality before the law and individual liberty
	Judicial constraints on the executive
	Legislative constraints on the executive
Deliberative DQ	Reasoned justification
	Common good
	Respect counterarguments
	Range of consultation
	Engaged society
Egalitarian DQ	Equal protection
	Equal access
	Equal distribution
Participatory DQ	Civil society participation
	Direct popular vote
	Local government
	Regional government

The table is adapted from Coppedge et al. (2018).

2003). For democratic leaders to remain in power, they need to please the majority by providing public goods that benefit all. For non-democratic leaders to remain in power, they need to please a smaller group of military and economic elite members of society by providing private goods, such as real estate and material wealth (Bueno de Mesquita et al., 2003). Because climate change mitigation is a public good, we expect mitigation to have a higher priority in democratic countries and that CO_2 emissions reflect this (Bättig and Bernauer, 2009; Farzin and Bond, 2006).

2.2. The liberal democratic quality

The liberal DQ inhabits the democratic principle of "protecting individual and minority rights against the tyranny of the state and the tyranny of the majority" (Coppedge et al., 2018). It measures this ability by examining the limits placed on government. Countries with high scores on this index have constitutionally protected civil liberties, a strong rule of law with an autonomous judicial branch whose decisions are respected by the executive, and a legislative branch with power to investigate, oversee, and question the executive. In 2014, Norway had the highest score (0.98) on this index.

Escher and Walter-Rogg (2018) argue on the one hand that "civil rights enable citizens to demand the implementation of climate policies via the courts" and on the other that strong civil rights, by protecting individuals from the 'tyranny of the state', also 'protect' individuals from certain unpopular policies aimed at the common good. de Geus (2004) argues that the ability to implement policies aimed at reducing consumption, and consequently CO_2 emissions connected to resource extraction, production, transport, and use, is a difficult task in countries with a high degree of liberal DQs. Escher and Walter-Rogg (2018) finds no significant effect of civil rights on domestic CO_2 emissions, while Bättig and Bernauer (2009) find that democracies have a harder time reducing emissions in the transport sector than in the energy and heat sector, pointing to the fact the policies affecting personal mobility are especially problematic in countries with high levels of liberal DQs. Because of this, we expect that enhanced liberal DQs will slightly increase per capita CO_2 emissions.

2.3. The participatory democratic quality

The participatory DQ includes aspects of active participation by citizens in electoral and non-electoral processes, as well as the presence and strength of local and regional democratic institutions. Countries with high levels of direct democracy, high levels of participation in civil society organizations, and strong local and/or regional governments, such as Switzerland and Uruguay, score the highest on this index (Coppedge et al., 2018).

The first subcomponent, direct democracy, measures the use of ballots to determine policy implementation, a process that increases the number of veto actors in policy processes. Veto actors often inhibit political institutions from being fluid and flexible (Bornstein, 2007). A high number of veto actors is preferable when the status quo is desired (Lægreid and Povitkina, 2018), so this mechanism may slow down implementation of mitigation policies.

The second subcomponent is participation in civil society organizations. Citizens engaged in civil society organizations are more likely to adopt altruistic values (Putnam, 2016), and it is therefore plausible that climate concern is more prominent in highly active civil societies. In addition, vibrant civil society organizations play a crucial part in pressuring governments into adopting value-based policies (Lægreid and Povitkina, 2018).

The third and fourth subcomponents of the participatory DQ are the strength of local and regional democratic institutions. Collier (2007), looking at local governments in EU countries, finds that underfunded municipalities are ineffective in implementing mitigation policy, arguing that weak local and regional institutions inhibit mitigation outcome.

The subcomponents of the participatory DQ index vary greatly, but we believe that the role of civil society organizations in promoting altruistic values is particularly important. Therefore, we expect that enhanced participatory DQs will decrease per capita CO_2 emissions.

2.4. The deliberative democratic quality

The deliberative DQ focuses on the process of reaching decisions in a polity and has five components. The first component measures whether a public and reasoned justification is given by decision makers in policy processes, the second whether the common good is emphasized in these public justifications, the third whether political elites acknowledge and respect counterarguments, the fourth whether there is a wide range of consultation at elite levels, and the fifth whether the public debate and discussions during policy processes are open to and characterized by an engaged society (Coppedge et al., 2018). As of 2014, Norway had the highest score (0.98) on this index.

We understand the deliberative process measured by this index mainly as a contrast to the "decide-announce-defend" approach to policy making, in which agency experts make decisions and then try to "tell people what is good for them" (Stave, 2002). The deliberative DQ has several benefits according to theoretical literature, including the dual benefit of including and consulting a wide range of actors in policy processes (Dryzek and Pickering, 2017; Stave, 2002)· First, policymakers obtain a wider range of views on a policy before implementation, increasing the possibility of choosing the 'best' option. Second, a wide range of consultation, a respectful dialog, and an open debate about the common good of a policy, increases the legitimacy of the chosen output, increasing the chance for a successful outcome (Stave, 2002). Therefore, we expect that increased deliberative DQs will correspond with reduced emissions.

2.5. The egalitarian democratic quality

The egalitarian DQ measures material and immaterial equalities using the subcomponents *equal protection* (i.e., individual rights and freedoms are protected equally across social groups), *equal access* (i.e., access to power is equally distributed across groups, genders, and socioeconomic classes), and *equal distribution*, (i.e., resources are equally distributed) (Coppedge et al., 2018). The Scandinavian countries, which are characterized by their comprehensive welfare state, have had the highest scores on this index.

The equal distribution subcomponent measures equal distribution of food, water, housing, education, and healthcare. It does not measure income or wealth inequality directly, but it is plausible that the index is highly connected to economic inequality. We imagine this working one of two ways. Either food, water, housing, education, and healthcare are distributed more equally through social policies, freeing up disposable household income for everyone, thereby indirectly redistributing income, or income is distributed more equally through social policies that give everyone more equal opportunity to access food, water, housing, education, and healthcare, thereby indirectly redistributing these benefits.

Several studies have investigated the relationship between economic inequality and CO_2 emissions. On the one hand, higher income inequality could lead to more CO_2 emissions because it reinforces the power of the richest members of society, who have less interest in protecting the environment (Berthe and Elie, 2015). Inequality may also lead to an erosion of social trust and cooperation, which inhibits pro-environmental collective action (Cushing et al., 2015). Some studies have also found that high levels of economic inequality lead to increased carbon-intensive consumption through households trying to "emulate the behavior of those socially above them" (Wisman, 2011), a concern that is less prominent when wealth and social status are distributed more equally (Cushing et al., 2015).

On the other hand, higher income inequality can lead to lower CO_2 emissions. Grunewald et al. (2017), Ravallion et al. (2000), and Selseng (2019) all find this to be the case. However, the effect is first and foremost visible in lower-income countries. Gough (2019) argue that, in these countries, the poorest share of the population lives essentially outside of the carbon economy without access to modern energy sources. Reducing inequality in these countries would mean that the poor become richer and can, to a larger degree, afford the basic need satisfiers, such as food, housing, modern domestic energy, and basic transport, which is more carbon intensive than luxury goods (Gough, 2019). In this scenario, the rich might become poorer and reduce their emissions, but because luxury goods are less carbon intensive, the reduction could be smaller than the increase caused by the poor becoming richer, consequently increasing total per capita emissions (Gough, 2019; Grunewald et al., 2017; Ravallion et al., 2000). Both Grunewald et al. (2017) and Ravallion et al. (2000) find signs of the opposite effect for high-income countries, indicating that when the entire population has access to basic goods, there is a synergy between decreasing inequality and mitigating climate change.

Although we interpret the equal distribution subcomponent of the egalitarian DQ as a proxy for income equality, it is important to mention that some of the components of equal distribution might have individual effects on CO_2 emissions as well. Education, for example, particularly educating girls, is considered one of the most effective and influential strategies to reduce emissions (Hawken, 2017). In total, however, we believe the combination of elements in the equal distribution subcomponent to be a good proxy for income equality.

The equal distribution subcomponent of the egalitarian DQ intuitively stands out from among the indices as the most peripherally connected with core ideals of democracy. It relates less to political freedoms and more to economic organization. The fact that equal distribution has historically been closely connected with communism, even though communist countries have historically been far from democratic (Orenstein, 2008), distorts the picture. Considering this, and the ongoing debate on the effects and mechanisms related to the relationship between economic inequality and CO_2 emissions, we find it both necessary and interesting to isolate the effects of the subcomponents of the egalitarian DQ and investigate them separately. We therefore disaggregate the index and use the subcomponents in a supplementary analysis, separate from the main analysis, to determine the isolated effects of the subcomponents.

3. Method

3.1. Regression analysis

To formally examine the impact of the five DQs in Table 1 on per capita CO_2 emissions, we use a random-effect within-between regression model (Bell et al., 2018) on a panel dataset consisting of 127 countries, from 1992, the year of the Rio Conference, to 2014. 2014 because of data availability for oil production. We estimate the following equation:

$$y_{it} = \beta_0 + \beta_{1W}(x_{it} - \overline{x}_i) + \beta_{2B}\overline{x}_i + \beta_3 z_i + \upsilon_{i0} + \upsilon_{i1}(x_{it} - \overline{x}_i) + \epsilon_{it} \quad (1)$$

where y_{it} is the dependent variable (per capita CO_2 emissions), measured for country i in year t, and x_{it} is a vector representing the time-varying independent variables presented in Table 2. The rationale for including these are given in subsection 3.2. There are two impacts of these variables: β_{1W} represents the weighted average within-effect of x_{it} for each country, while β_{2B} represents the average between-effect for each country. β_3 represents the effect of the time-invariant variables z_i and is therefore a between-effect. The random part of the model includes two terms for the higher-level entities: υ_{i0} represents the random effect attached to the intercept, while υ_{i1} represents the random effect attached to the slope of the within-effect of the main time-varying independent variable, the DQs. ϵ_{it} represents the residuals for each year for each country, and β_0 is the intercept.

Table 2
Variables.

Variable	Definition	Source
$\ln CO_2pc$	Natural logarithm of carbon dioxide emissions (metric tons per capita). Dependent variable.	World Bank (2019)
Electoral DQ	Electoral democratic quality.	Coppedge et al., (2018)
Liberal DQ	Liberal democratic quality.	Coppedge et al., (2018)
Deliberative DQ	Deliberative democratic quality.	Coppedge et al., (2018)
Egalitarian DQ	Egalitarian democratic quality.	Coppedge et al., (2018)
Participatory DQ	Participatory democratic quality.	Coppedge et al., (2018)
Equal distribution	Equal distribution of resources. Subcomponent of Egalitarian DQ.	Coppedge et al., (2018)
Equal access	Equal access to power. Subcomponent of Egalitarian DQ.	Coppedge et al., (2018)
Equal protection	Equal protection across social group. Subcomponent of Egalitarian DQ.	Coppedge et al., (2018)
FH index	Alternative democracy index.	Freedom House (2018)
Polity2	Alternative democracy index.	Marshall and Gurr (2018)
lnGDPpc	Natural logarithm of gross domestic product per capita (constant 2005 international $).	Institute for Health Metrics and Evaluation (2012)
$\ln GDPpc^2$	Natural logarithm of GDPpc squared.	
lnEnergy intensity	Energy consumption per capita divided by GDP per capita.	World Bank (2019)
Service Sector Output	Service sector output as a percentage of GDP.	World Bank (2019)
Urbanization	Share of population living in urban areas.	World Bank (2019)
lnOilpc	Natural logarithm of oil production per capita (billion metric tons).	Ross and Mahdavi (2015)
Fossil Energy	Fossil energy as a percentage of total energy consumption.	World Bank (2019)
Trend	General time trend.	
Communist influence	Dummy variable for the nations with communist regime in 1989.	Global Museum of Communism (2013)

All variables except Communist influence are time-varying variables.

The random-effects within-between model is an estimation technique that models heterogeneity both at the country and year level. It thereby estimates both how DQs influence CO_2 emissions over time within each country and how DQs influence CO_2 emissions between countries.

The justification for our chosen method and the model validation process are presented in Appendix B and C.

3.2. Variables

The dependent variable in this study is national production-based carbon dioxide (CO_2) emissions, measured in metric tons per capita. This proxy is commonly used in the literature (e.g., Clulow, 2019; Joshi and Beck, 2018; Lægreid and Povitkina, 2018; Lv, 2017; Mayer, 2017; You et al., 2015) because of data availability and reliability (Clulow, 2019).[2] Some studies have used climate policy output (Fredriksson and Neumayer, 2013; Hanusch, 2018) or international climate policy cooperation (Escher and Walter-Rogg, 2018) as more indirect proxies for mitigation performance, but the data availability, in terms of time period, or number of countries, is typically more limited (for a comprehensive list, see Dieler, 2016). Additionally, we believe

[2] Although superior in terms of data quality, this measure of domestic CO_2 emissions is not perfect. Importantly, it does not include emissions embedded in imports. To correct for this, we included a measure of merchandise exports per capita in our models before validation (e.g., Ben Jebli et al., 2015; Povitkina, 2018). This variable did not have any significant impact on CO_2 or influence other variables and reduced the model fit (e.g. Snijders, Bosker, 2012; Zuur et al., 2009).

mitigation outcome to be both more important and a more relevant proxy for mitigation performance than mitigation policy output.

The five main independent variables are electoral DQs, liberal DQs, deliberative DQs, egalitarian DQs, and participatory DQs. The indices range on a continuous scale from 0 to 1, with 1 being the highest possible measure of either of the qualities. All of the component indices used in this analysis are conceptually unique in the sense that they do not share any of the same indicators. Nonetheless, the indices are correlated (Spearman's $r = 0.6–0.9$) because they are measures of qualities related to the same concept.

All data on democratic qualities comes from V-dem (Coppedge et al., 2018), a globally based project with more than 3000 country experts involved in measuring democracy, institutions, and governance in over 200 countries (Coppedge et al., 2018). The V-dem dataset consists of 450 indicators that help make up five entirely separate measures of DQs (Coppedge et al., 2016). The data availability, quality, and reliability are superior (Povitkina, 2018). Typically, every one of the 450 indicators in the dataset is coded based on input from at least five separate country experts for every year and country (Coppedge et al., 2016).

V-dem is the only dataset that disaggregates democracy into conceptually unique measures of DQs. Alternative measures of democracy exist, but these only measure a few subcomponents of DQs, typically a combination of liberal DQs and electoral democracy (Coppedge et al., 2011; Freedom House, 2018; Marshall and Gurr, 2018). Therefore, we rely on V-dem data for our main analysis.

For a robustness test of the impacts of democracy and DQs on CO_2 emissions, we include two alternative measures of democracy. Before the introduction of V-dem and the five DQs discussed above, two indicators were by far the most commonly used in the environmental democracy literature (Coppedge et al., 2011): the Freedom House project index on civil liberties and individual rights (Freedom House, 2018), aspects of democracy that are covered by the electoral and liberal DQs in V-dem; and the Polity Project's Polity2 indicator, which provides measures of free and fair elections, suffrage, constraints on the executive branch, and political competitiveness (Marshall and Gurr, 2018), aspects that are similarly covered by the electoral and liberal DQs in V-dem. The Freedom House index is scored on a six-point scale in which the scores are inverted so that high values equal high levels of rights and liberties. The Polity2 indicator from the Polity Project is scored on a scale ranging from 10 (strongly democratic) to -10 (strongly autocratic).

Other variables that influence the dependent variable are national income, energy intensity, time, service sector output, urbanization, fossil energy consumption, and oil production. The effect of economic growth on CO_2 emissions depends on the outcome of three separate mechanisms: changes in scale (i.e., production), composition, and technology, where the composition and technology effects may dampen the emission increases due to economic growth (Grossman and Krueger, 1995). The Environmental Kuznets Curve anticipates such an inverted-U shape of the relationship between GDP per capita and CO_2 emissions; as the income level grows, a country will first experience a growth in emissions, which is replaced by a slower or even negative growth in emissions at higher income levels (Blanco et al., 2014). To model this hypothesized non-linear effect of GDP per capita on CO_2 emissions, we include a squared GDP per capita term (Sarkodie and Strezov, 2019).

To account for the "technology" effect, we include energy intensity (i.e., energy consumption/income) and a time trend. These variables control for the effects of technological progress on CO_2 emissions (Lægreid and Povitkina, 2018) and may serve as proxies for substitution of direct fossil fuels with higher quality fuels and electrics. To measure the "composition" effects of GDP, we include service sector output as a percentage of GDP. This variable accounts for the shift in economic activity towards low-emission tertiary sectors in higher-income countries (Sarkodie and Strezov, 2019).

Urbanization can lead to reduced CO_2 emissions, particularly in compact cities, because transport needs are lower and can be covered by public transportation (Poumanyvong and Kaneko, 2010). The energy needs for heating may also be lower because people live in smaller housing units (Timmons et al., 2016). We include oil production per capita to capture the presence of strong petroleum lobbies that might make climate policies harder to implement (Lægreid and Povitkina, 2018; Povitkina, 2018). Oil production is measured in billion metric tons per capita (Ross and Mahdavi, 2015). We include the share of fossil energy in total energy consumption to measure the carbon intensity of energy consumption (e.g., Bölük and Mert, 2014). We do not include a separate measure for renewable energy because the carbon footprint of renewables is similar to that of nuclear energy (Pehl et al., 2017).

In the models for the egalitarian DQ and its subcomponent, equal distribution, we include a dummy variable for communist influence, because the equal distribution of goods and services has a historical association with communist ideals. The variable is coded 1 if the country had a communist regime in 1989. Data covering 97 countries come from the Global Museum of Communism (Global Museum of Communism, 2013), and the remaining 30 countries are coded manually based on country information.

We estimate three separate sets of models. The first is the main analysis, where we estimate the model once for each DQ to estimate the comparative within- and between-effects of each DQ on CO_2 emissions per capita in both. In the second sets of models, we estimate the model once for every subcomponent of the egalitarian DQ. In the models for the egalitarian DQ and equal distribution, we include a dummy variable for communist influence. In the third set of models, we estimate the model for the alternative democracy indices Freedom House and Polity2 for robustness.

4. Results

4.1. The five democratic qualities

Comparing changes in DQs over time (i.e., the estimated within-coefficients in Table 3), we find that only the egalitarian DQ has a significant effect on CO_2 emissions (Model 1.4), and interestingly, the effect is positive. An increase in 0.1 in egalitarian DQs corresponds with an increase in CO_2 emissions per capita of 1.02%, holding other variables constant. For a large, high-emitting country in the medium range (0.36–0.49) of the egalitarian DQ index, such as China, an increase of 0.2 in the index would correspond to a 2.06% increase in CO_2 emissions per capita, or a total 206 million metric tons from the 2014 level.

Comparing differences in democratic qualities *across* countries (i.e., the estimated between-coefficients in Table 3), we find that none of the DQs has a significant effect on CO_2 emissions per capita. Thus, not even differences in egalitarian DQs can explain why one country has a higher/lower emission than another, all else being equal. This implies that the highly egalitarian Scandinavian countries do not have higher emissions than countries with low levels of egalitarian DQs, such as Egypt or Somalia, *because of* their egalitarian welfare state model. The effect of the communist influence is positive and significant, indicating that the relationship between egalitarian DQs and emissions is moderated by the historical influence of communism.

An increase in income significantly increases emissions. A 1% increase in GDP per capita increases CO_2 emissions per capita by 0.6%. As income increases, this impact is reduced, although the coefficient of the squared income variable is not significant at the 5% level. Similarly, we find no clear support for a non-linear relationship between income and emissions when we make comparisons across countries (the between-

Table 3
Relationships between democratic qualities and the CO_2 emissions per capita.

	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5
Within					
Electoral DQ	0.031				
Liberal DQ		0.010			
Deliberative DQ			0.024		
Egalitarian DQ				0.102**	
Participatory DQ					0.049
lnGDPpc	0.624***	0.621***	0.623***	0.617***	0.619***
$lnGDPpc^2$	–0.016*	–0.015*	–0.015*	–0.015*	–0.013
lnEnergy Intensity	1.953***	1.952***	1.965***	1.957***	1.960***
Service Sector Output	–0.001**	–0.001**	–0.001***	–0.001**	–0.001**
Urbanization	0.004**	0.004**	0.005**	0.004*	0.004**
lnOilpc	0.023	0.022	0.019	0.028	0.021
Fossil energy	0.007***	0.007***	0.007***	0.007***	0.007***
Trend	–0.007***	–0.007***	–0.007***	–0.007***	–0.007***
Between					
Electoral DQ	–0.015				
Liberal DQ		0.063			
Deliberative DQ			0.092		
Egalitarian DQ				0.161	
Participatory DQ					–0.076
lnGDPpc	0.693***	0.677***	0.679***	0.646***	0.692***
$lnGDPpc^2$	0.026*	0.027*	0.027*	0.032*	0.028*
lnEnergy Intensity	2.281***	2.299***	2.310***	2.121***	2.296***
Service Sector Output	–0.005	–0.005*	–0.005*	–0.004	–0.005
Urbanization	–0.001	–0.001	–0.001	–0.001	–0.001
lnOilpc	0.051	0.062	0.061*	0.081**	0.047
Fossil Energy	0.008***	0.008***	0.008***	0.008***	0.008***
Constant	1.220***	1.218***	1.215***	1.185***	1.217***
Communist Influence				0.096**	
Observations	2 640	2 642	2 642	2 640	2 642
Countries	127	127	127	127	127
AIC	–8 032	–8 035	–8 041	–8 036	–8 047
BIC	–7 874	–7 877	–7 883	–7 872	–7 888

*p < 0.1, **p < 0.05, ***p < 0.01. Dependent variable: natural logarithm of CO_2 emissions per capita. All right-hand side variables centered. DQ: democratic quality, GDP: gross domestic product, pc: per capita, ln: natural logarithm, AIC: Akaike's Information Criterion, BIC: Bayesian Information Criterion.

coefficients of Table 3).[3] Thus, our model offers support for a largely linear GDP–CO_2 relationship (Joshi and Beck, 2018; Sarkodie and Strezov, 2019).

Technological advances over time reduce emissions per capita, all else being equal. The "technology" effects of GDP, measured by Energy Intensity and Trend, have significant effects on CO_2 emissions per capita both over time and across countries. The "composition" effect, measured by Service Sector Output, is only significant within countries. The coefficient for Energy Intensity is positive, highly significant, and large. A 1% increase in Energy Intensity corresponds with a 1.9% increase in per capita CO_2 emissions. This indicates that the potential impact of technological innovation and energy efficiency on emissions is large. The coefficient is slightly larger than in other studies (e.g., Ghazali and Ali, 2019), but the difference is not excessive considering that the measure for CO_2 emissions is calculated largely through energy consumption (World Bank, 2019). The negative coefficient for Service Sector Output indicates that emissions decrease when the domestic tertiary sector expands.

Fossil energy consumption has a small, but significantly positive effect on CO_2 emissions, while the effects of Urbanization and Oil production per capita are not significant.

4.2. Egalitarian democratic quality

Table 4 shows the predicted effect of the subcomponents of the egalitarian DQ on CO_2 emissions per capita. Only the subcomponent equal distribution has an impact on emissions (Model 2.3), and it is only significant over time in each country. This subcomponent measures equal distribution of food, water, housing, education, and healthcare. Thus, if a country distributes access to these universal goods more equally over time, its emissions increase (all else being equal).

Table 4
Relationships between subcomponents of egalitarian DQs and CO_2 per capita.

	Model 2.1	Model 2.2	Model 2.3
Within			
Equal Protection	0.045		
Equal Access		0.052	
Equal Distribution			0.097**
Between			
Equal Protection	0.167		
Equal Access		0.171	
Equal Distribution			0.096
Observations	2 642	2 642	2 642
Countries	127	127	127
AIC	–8 040	–8 045	–8 044
BIC	–7 788	–7 887	–7 879

*p < 0.1, **p < 0.05, ***p < 0.01. Dependent variable: natural logarithm of CO_2 emissions per capita. All right-hand side variables centered.

4.3. Alternative democracy indices

Table 5 shows the predicted effect of the alternative democracy indices from Freedom House and the Polity Project. Neither alternative index has a significant effect on emissions. The alternative indices both measure a combination of liberal and electoral DQs, so the finding of no significant effect supports the results presented in Table 3.

[3] In the between part of the estimated model (Table 3), there is only small evidence of an Environmental Kuznets Curve, but in contrast to the within part, the model estimates a convex relationship. Still, the effect of squared GDP per capita term is small and only significant at the 0.1 level, indicating a largely monotonic relationship in the between part as well.

Table 5
Relationships between alternative democracy indices and CO_2 per capita.

	Model 3.1	Model 3.2
Within		
Polity2	0.001	
Freedom House		–0.001
Between		
Polity2	–0.001	
Freedom House		–0.002
Observations	2 642	2 642
Countries	127	127
AIC	–7 871	–8 030
BIC	–7 714	–7 872

Dependent variable: natural logarithm of CO_2 emissions per capita. All right-hand side variables centered.

5. Discussion

In this study, we conducted a nuanced empirical investigation into the democracy-CO_2 relationship by focusing on a wide subset of democratic qualities in addition to democracy itself (Joshi and Beck, 2018; Mayer, 2017; Pickering et al., 2020). We used random-effect within-between models and controlled for relevant variables in a panel dataset covering 127 countries from 1992 to 2014. We found that the level of democracy and most of the related democratic qualities have had no significant impact on countries' abilities to reduce emissions. Moreover, this result is the same if we focused on changes over time within a country or differences across countries at a given point in time. Only the level of equal distribution, a subcomponent of egalitarian DQs, significantly increased per capita CO_2 emissions. That is, countries that over time have provided more equal access to universal goods, such as food, water and housing, have increased their emissions (all else being equal). Here, we discuss the second finding first.

The equal distribution subcomponent measures actual distribution of food, water, housing, education, and healthcare, but we argue that it can be also be understood as a measure of economic inequality because distribution of these universal goods indirectly redistributes income. Some earlier studies have found evidence that a lower level of income inequality, in particular in lower-income countries, may result in higher emissions (Grunewald et al., 2017; Ravallion et al., 2000; Selseng, 2019). Our analysis supports this conclusion.

Because universal goods are often more carbon intensive than luxury goods (Gough, 2019), per capita CO_2 emissions may increase when income is redistributed from the rich to the poor. Thus, a redistribution of income from the richest to the poorest (keeping national income constant), would increase total CO_2 emissions. This happens because although reduced consumption of luxury goods would lower emissions, this reduction would be smaller than the increase in emissions stemming from increased access to necessities such as housing and basic transport.

This implies an unpleasant trade-off between mitigating climate change and decreasing inequality, but there are important caveats to this finding. First, most high-income high-emitting countries already have low income inequality and therefore a limited potential for future reduction (Rao and Min, 2018). Non-OECD countries currently produce two-thirds of global emissions. Our model predicts that a global increase in distribution equality from 0.58 (the average for non-OECD countries in 2014) to that of the OECD countries (0.88), although extremely unlikely in the near future, would only increase global emissions by about 2% given the current mix of technology and energy. Similarly, Rao and Min (2018) model the potential impact of a highly optimistic reduction in global inequality on carbon emissions using a pessimistic carbon elasticity of income and find that the effects would be largely negligible, even if high-income countries were able to reduce inequality at the same optimistic rates as lower-income countries. Second, and most importantly, decreasing inequalities is a crucial component of global development roadmaps, the most important being Agenda 2030, where SDG 10 (Reduced Inequalities) and the overarching principle of "leaving no one behind" specifically address inequality (United Nations, 2015). In Selseng (2019), using dummies to separate the effect of equality on emissions for countries at different levels of GDP per capita levels, we find that the effect was first and foremost visible in low-income countries, a finding that mirrors those of other studies (Grunewald et al., 2017; Ravallion et al., 2000). Considering this, it would be morally repugnant and socially regressive to imply that developing regions, such as Sub-Saharan Africa, where 413 million people live in extreme poverty (World Bank, 2018), should be guarded in their efforts to reduce income inequality.

The more important message from this study is the robust finding that the level of democracy and democratic qualities, both over time and across countries, has had no significant effect on CO_2 emissions from 1992 to 2014. This finding provides strong evidence against the idea that democracy is incompatible with climate change mitigation and therefore that forms of authoritarian climate governance may be needed to deliver sufficient mitigation outcomes (Fischer, 2017; Hammond and Smith, 2017; Stehr, 2015). Proponents of so-called eco-authoritarianism, such as Shearman and Smith (2007), have made the case for a new authoritarian technocratic government model to replace democracy, arguing that humanity may "have to trade its liberty to live as it wishes in favor of a system where survival is paramount" (2007, p. 4). Others, such as Maxton and Randers (2016), Drahos (2021) and Beeson (2010), look to Chinese institutions and policies for inspiration on how to combat climate change. Although none of them advocate for the Chinese form of government or any form of current authoritarianism, Beeson (2010) argues that "forms of 'good' authoritarianism" may become "essential for the survival of humanity". According to Hammond and Smith (2017) and Stehr (2015), these and similar views have an increasing number of followers, both within and outside of the scientific community. Wells (2007) urges vigilance against a right wing "green junta" that might spur from further inadequate global climate mitigation efforts, while Gilbert (2012) warns against a "militarization of climate change" as it becomes an increasing threat to nations' security. Our finding instead shows that decreasing democracy in favor of more authoritarianism does not improve climate outcomes. As an illustrative example, China, which certain authors use as an inspiration for ways to tackle climate change (Beeson, 2010; Drahos, 2021; Maxton and Randers, 2016), nearly doubled its per capita emissions from 2004 to 2014 (from 4 to 7.5 metric tons CO_2 per capita), while in the same period decreasing their level of electoral democracy (from 0.11 to 0.09), deliberative DQs (from 0.65 to 0.59), egalitarian DQs (from 0.42 to 0.36), and participatory DQs (from 0.16 to 0.12).

For future global development, this finding is important. It shows that there is little reason to desire authoritarianism for the sake of climate change mitigation. Likewise, it shows that democracy and democratic qualities can be increased, either for their intrinsic value or to achieve the synergies and co-benefits connected to them, without adverse climate effects. Using the SDGs as an example, such synergies and co-benefits are numerous: democracies are better at sustaining economic growth (SDG 8) (Acemoglu et al., 2019), ensuring gender equality (SDG 5), quality education (SDG 4), clean water and sanitation (SDG 6), and life below water (SDG 14), as well as the total average SDG achievement (Glass and Newig, 2019). Without democratic governance, achieving the SDGs will be an insurmountable challenge. Therefore, as Stehr (2016) reminds us, climate policy "must be compatible with democracy; otherwise the threat to civilization will be much more than just changes to our physical environment."

However, our findings are not a validation of the performance of democracies either. In its current form, increasing democracy and DQs has not improved mitigation outcomes. One commonly suggested solution to the inability of democratic governments to reduce emissions has been to increase the level of deliberation in environmental policy processes (Dryzek and Pickering, 2017; Pickering et al., 2020). This insight is also being acknowledged by policymakers. The EU's extensive policy roadmap for reaching net-zero emissions in 2050, the European Green Deal (European Commission, 2019), emphasizes the role of institutions in future development, arguing that inclusive and deliberative processes are crucial in producing successful mitigation policy. Although we do not explicitly measure deliberation in climate policy processes, the inclusion of citizens and stakeholders in policy processes are key elements in our measure of deliberative DQs, which we find to have no effect on CO_2 emissions. A possible reason for this might be that citizen deliberation has not yet been deployed at the scale necessary to have an influence on national CO_2 emissions.

Other commonly suggested solutions on how to enhance democratic climate governance include strengthening local levels of government where democratic transformation can be more readily achieved (Fischer, 2017) and empowering civil society participation (Pickering et al., 2020), both of which are elements included in the measure of participatory DQs. As already discussed, we do not find any significant impact of these qualities on per capita CO_2.

The finding that the different forms of democracy or DQs are equally important for the tested mitigation outcome has implications for future research. As Burch et al. (2019) point out, there is already an "unprecedented urgency" for theoretical development, empirical assessment, and policy innovation at the democracy-environment nexus (see also Pickering et al., 2020). Although this study contributes to filling some of the empirical knowledge gap, the puzzle remains why democratic institutions' effect on climate change performance seems weaker than other aspects of environmental performance. This study does not explain why some democratic polities perform better than others and how democratic processes and institutions can evolve to improve climate performance. The most interesting finding in this regard is that deliberative DQs, commonly considered the "catalyst for reflexive environmental governance" (Dryzek and Pickering, 2017), seemingly have no impact on per capita CO_2 emissions.

Ideals of democracy are currently under pressure both in the developed and developing world (Freedom House, 2020; Lührmann et al., 2020), while Agenda 2030, a framework that does not include democracy as a goal or target, is successfully manifesting both in public and private spheres around the world. Knowledge about the relationship between democracy and the paramount goal of mitigating climate change is therefore more important than ever. This study has found that there are no trade-offs between strengthening democratic institutions and mitigating climate change. Consequently, the global challenge of climate change cannot be used as an excuse to weaken democratic institutions.

CRediT authorship contribution statement

Torbjørn Selseng: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Formal analysis, Validation. **Kristin Linnerud**: Conceptualization, Methodology, Writing – review & editing, Supervision. **Erling Holden**: Conceptualization, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendices

A. Countries included in the panel (127)

Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Cambodia, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Cyprus, Czech Republic, Democratic Republic of Vietnam, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Guatemala, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, Latvia, Lebanon, Lithuania, Luxembourg, Macedonia, Malaysia, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Republic of the Congo, Russia, Saudi Arabia, Senegal, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sri Lanka, Sudan, Surinam, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Venezuela, Yemen, Zambia, Zimbabwe.

B. Choice of model

The random-effects within-between (REWB) model was deemed to be suitable for our purpose for the following reasons.

First, the Hausman specification test show that the between-effect and the within-effect in our sample are different ($p < 0.001$) (Hausman, 1978), thereby ruling out traditional simple random-effects estimation (Bell et al., 2018). The common response to a significant Hausman test is to use fixed-effects estimation. However, Bell et al. (2018) argue that a superior approach is to use the REWB model, which estimates the between-effect and within-effect variables separately. In this way, the endogeneity issue is solved without removing important, and often very interesting, between-sample properties. This means also that time-invariant explanatory variables can be included.

Second, calculation of the intra-class correlation coefficient shows that 92% of the variation in the data comes from the between-country sample. Modeling between-country information is therefore crucial to understand the underlying relationship between the DQs and per capita CO_2 emissions.

Finally, we expect the effect of DQs on per capita CO_2 emissions to vary across countries (see our discussion in Section 2). Thus, our model should allow for variations in coefficients or the standard errors may be underestimated (Barr et al., 2013; Bell et al., 2018). We include random coefficients for the DQs in addition to the trend variable (Bell et al., 2018), in the estimation of all random-effect models.

C. Model validation. The estimated coefficients of the REWB model may be biased if relevant unobserved time-varying and time-invariant characteristics are not accounted for (Bell et al., 2018). To address this concern, we initially estimated the model with several variables suggested in the literature and reduced the model via a model selection method.[4] We used Akaike's Information Criterion, Bayesian Information Criterion, and the log-likelihood function to determine the appropriate fixed structure in our models both before and after model validation (Zuur et al., 2009).

[4] In a recent study, Povitkina (2018) finds that corruption is an important mediator of the democracy-CO_2 relationship. Before validation, we therefore included the same operationalization of corruption as Povitkina (2018) in our models but did not find it to have any significant impact on CO_2 or influence on other variables (see also Clulow, 2019; Lægreid and Povitkina, 2018).

Assumptions of normality, homogeneity, and independence were examined mainly graphically, following recommendations from Zuur et al. (2009) and Finch et al. (2014). To achieve residual normality, we transformed the data for the following heavily skewed variables using the natural logarithm of the values (Mayer, 2017; Lægreid and Povitkina, 2018; Povitkina, 2018; Lv, 2017): GDP per capita and GDP per capita squared, oil production per capita, energy consumption, energy intensity, and per capita CO_2 emissions (the dependent variable).

To test for independence and stationarity, we performed several tests. First, a Pesaran CD test for cross-sectional dependence (Pesaran, 2007) was significant ($p > 0.01$), indicating the presence of cross-sectional dependence in the panel. Levin-Lin-Chu unit-root tests (Levin et al., 2002), Im-Pesaran-Shin unit-root tests (Im et al., 2003), and Maddala-Wu unit-root tests (Maddala and Wu, 1999) then showed non-stationarity at level in the GDP and energy consumption variables, while all variables were stationary at the first difference level. Finally, the autocorrelation function was plotted, and the results indicated serial correlation.

Homogeneity was assessed by plotting the residuals of the models against the fitted values and against variables included in the model. Some unequal variance was detected when comparing the residuals from the model to the country variable. To correct for this as well as the spatial and temporal correlation detected, we added an exponential correlation structure, using model selection criterion Akaike's Information Criterion, Bayesian Information Criterion, and the log-likelihood function (Zuur et al., 2009). The exponential correlation structure is computationally similar to a first-order autoregression correlation structure (Diggle et al., 2002), meaning it solves the stationarity issues detected. No violations of assumptions were detected after validation.

Finally, some residual outliers were detected and removed. These were the United Arab Emirates (1996–1997), Mongolia (2011–2014), Ghana (1992), Estonia (1992), Slovakia (1992–1994), Moldova (1992), and Singapore (2003–2014).

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