The Central European University
Department of Public Policy
MAPP Dissertation

"In partial fulfilment of the requirements for the degree of Masters of Arts"

A Quantitative Study of the Relations Between Democracy and Carbon Dioxide Emissions: Do democracies lead to stronger pro-climate policies in terms of cutting carbon dioxide emissions?

Candidate Name: TSE, Tat Hong (Bryan)

Year of Submission: 2023
Supervisor: Martin Kahanec
Place of Submission: Vienna, Austria
Word Count: 11800

Author's Declaration Form (to be included in the final version of the thesis)

I, the undersigned, Tat Hong Tse, candidate for YOUR DEGREE PROGRAM, declare herewith that the present thesis is exclusively my own work, based on my research.

All sources have been properly credited in the text, notes, and the bibliography. I declare that no unidentified and illegitimate use was made of the work of others, and no part of the thesis infringes on any person's or institution's copyright. Furthermore, I declare that no part of thisthesis has been generated using artificial intelligence (ChatGPT).

I also declare that no part of the thesis has been submitted in this form as coursework for credits or to another institution of higher education for an academic degree.

Date: 2nd June 2023.

Name (printed): Tat Hong, Tse

Signature: Tat Hong Tse

Abstract:

In view of the intensifying global policy debate on climate change action, the issue of the environment and democracy has attracted a rising, albeit form a low base, number of studies, including this paper in recent years. As the theoretical analysis of democracy points to both directions regarding its relationship with carbon emissions, this paper endeavours to shed light the issue with an empirical approach, covering a 20 year-period from 2000 to 2019 and 171 countries, in an attempt to identify the relationship, should there be any, between a country's level of democracy and its carbon dioxide emissions. Considering the rising prominence and growing urgency of the issue of climate change, identification of any such relationship, with the potential next step of learning more about the causal mechanism, could go a long way toward crafting more effective climate change policy.

The models find a statistically significant positive relationship between democracy and carbon emissions, although with the important caveat that it is possible the variable of democracy has been subject to impacts of unobserved heterogeneity. Particularly with the huge variation of its estimates between geographic regions and income levels in mind, it is not appropriate to conclude that the identified relationship is of a causal nature.

The author offers various potential explanation and interpretation of the ambiguous results, and reflected on the possible ways to improve the models going forward. Still with no consensus on the relationship in the academia despite more than two decades of research, the nuanced results of the paper in a way does not deviate from the norm, and represent yet another call for caution and a larger number of study in the field in future considering the rapidly rising salience of climate change as a prioritized policy issue.

Table of Contents

List of Figures

Chapter 1: Introduction

Before covid-19, climate change had arguably reigned at the top of the global policy agenda. Its rise in salience marks perhaps the first time that an environmental issue, which is often considered a niche field in public policy and no match for the all-consuming economic and livelihood issues. This may explain why there have been relatively little literature in investigating the links between democracy and the environment. As democracy has been studied thoroughly for its relationships with other desirable socio-economic indicators such as peace and economic growth, the paper attempts to do so with another such indicator, carbon emissions, which has commanded unprecedented attention whose importance will likely only grow going forward. This makes it worthwhile to perform more study on this issue if only to see if and how more effective policies promoting stronger climate action could perhaps be shaped.

The paper presents a simple hypothesis, based on the theory that democracy is conducive to better environmental policy outcome and recent events of climate movements gaining social, and even electoral, momentum. That is, higher level of democracy leads to less carbon emissions, and vice versa. Approaching the issue empirically, the paper designs several models with the aim of identifying potential association, or even causation between the two. In addition to the main independent variable, the measurement of democracy via democracy index, real GDP is also included because of the expected strong relationship it has with emissions. Three more covariates, ones which are not expected to be confounders, are also included in model to reduce the noise and improve the model's accuracy. They also test whether the democracy coefficient will display robustness by remaining consistent throughout.

Following the regression results, the paper analyses the set of findings and relates them to the current understanding of the theories, which is outlined in the literature review. Importantly, it articulates why the results, while valid, should not be interpreted as a causal relationship. Possible reasons behind the results and the limitation of the model design are discussed as the paper ponders on how the model can still be improved amid the significant heterogeneity surrounding the democracy variable.

This paper is structured as follows: Chapter 2 reviews the relevant literature including the theory of the policymaking process, the relationship between democracy and environmental policy, as well as both sides of the debate as to whether the institutional land reform was the crucial factor in boosting output and productivity. Chapter 3 describes the rationale behind the design of the model, the corresponding statistical methodology and sources of the data. Chapter 4 shows the findings of the various regression models. Chapter 5 making sense of the results and further discuss their potential implications in the context of existing theories. Chapter 6 concludes.

Chapter 2: Literature Review

2.1 General policymaking process and dynamics

Before delving into the literature on the issue of democracy and environmental policy, as well as the even narrower topic of climate change and curbing carbon dioxide (CO2) emissions, the paper would like to first spend some time looking at the existing theories on the public policymaking process and dynamics in general. While the particular dimension of environmental policy, and more specifically, climate change policy, may have its uniqueness, in order to reflect on the ways it comes into being in its current form, one cannot do without referring to some overarching conceptual frameworks through which we understand and interpret how, or maybe perhaps even why, policymakers and other stakeholders, including those with a primary interest in environmental policy, behave and interact with one another.

Therefore, the basic theory of policy cycle is probably a good place to start. Instead of a theory portending particular policy outcomes, it is probably better characterized as a conceptualization of the abstract idea of policymaking as a logical, circular, step-by-step process, as perhaps first proposed by Lasswell (1956). What those steps, or stages, are remains a subject of academic discussion, and various political scientists after him have presented their own versions of the specific stages forming a cycle, which differ from the Lasswell's original proposal. However, what they have in common is that they accept the analytical framework of stages, and largely follows what Cairney (2012) termed a "generic policy cycle" (34) even under different political contexts. Such cycles usually name agenda-setting as the starting point followed by selection of and then implementation of the said policy. Evaluation often serves as the end point and also a new catalyst for the renewal of the sequential policymaking process. For instance, Bridgman and Davis (2000) mostly stuck to this blueprint, and added a few more steps, when trying to conceptualize the policymaking process in Australia. Verluis et al. (2011) also referred to (20) and used this blueprint as part of their analysis of the European Union's policymaking process in their book.

Despite its popularity, it is not without its flaws and skeptics. Knill and Tosun (2008) called it an "simplification" (9) of the policymaking process in the real world even when acknowledging its analytical value. This is perhaps the most common criticism of the idea of a clear-cut policy cycle. Clay and Schaffer (1984) described the policymaking in reality as a "chaos of purposes and accidents" (192). While policymaking in the real world is almost certainly more complex and messy than the neat picture conveyed by the policy cycle, this relatively parsimonious conception does make it easier for more focused study on a particular aspect, or phase, of policymaking.

One such aspect is the process through which a policy area or topic becomes prioritized and governments feel prompted to consider taking serious policy action to tackle the said issue. Often termed in the policy cycle theory as "agenda-setting" (Cairney 2012, 34), three theories with an emphasis on this early part of the cycle, among others, with the aim of accounting for policy change or continuity have begun to enter the mainstream since the 1990s (John 2003, 487), namely the advocacy coalition framework (ACF), multiple streams (MS) and punctuated equilibrium (PE). Stronger environmental policy, specifically on meaningful reduction of CO2 in response to climate change, will certainly qualify as a policy change. Sabatier's (1998) ACF model highlights the role played by a group of actors held together by core "shared beliefs" (141) in facilitating policy change. Such active groups in the public sphere, or advocacy coalitions, persistently seek to parlay their beliefs into actual government

policy by outcompeting other coalitions with alternative beliefs for the support of political leaders. One common catalyst for major policy change is when "external events" (137), such as new governments or shocking socio-economic incidents, cause a change in the relative strength of one advocacy coalition over the others. While the existence of advocacy coalitions is not confined to a particular form of political system, one can reasonably expect that the level of democracy and openness of the policymaking process of a country would play a significant role as to the composition, formation and effectiveness of such coalitions.

Kingdon's (1984) multiple stream theory also singles out the roles of the so-called "policy entrepreneurs" who are defined as "individuals willing to invest their resources in return for future policy they favor" (214) in precipitating policy change. Although this model emphasizes the pursuit of self-interests of such policy entreprenuers as part of their motivation of conducting policy-related activities, as Zahariadis (2007) pointed out, it also highlights the importance of events which creates a finite "policy window" (74) allowing policymakers and policy entrepreneurs to take advantage of. The focus and mechanism of the MS theory differ from the ACF model, but it agrees on the point that policy change cannot happen without the "political stream", which consists of the "national mood", pressure-group campaigns" and "administrative or legislative turnover" (73). Again, one could imagine the political system to exert some influence on the possible scope of such "pressure-group campaigns", as well as whether and how government turnover happens.

A tenet of Baumgartner & Jones' (1993) punctuated equilibrium theory is that policy change happens when the existing, stable policy monopoly, which serves to exclude certain policy areas or proposed solution from gaining prominence in the public sphere, is broken by, among other things, emergence of new actors or redefinition of the said policy, such as the use of civilian nuclear power, by proponents or opponents of the said policy (59-82). It is hard to picture that the form of political system would have nothing to do with the emergence and sustenance of such activities.

One last important assumption about public policymaking, even though it may not be directly or specifically related to policy change, is the idea of rationality. This term is perhaps most clearly defined in the rational choice theory, which originated from microeconomics, as "utility maximization" (Kraus and Coleman 1987, 715). While different public policy theories, including the aforementioned three, diverge on how rational an agent is or can be in real life policymaking situation, it is difficult to find a mainstream or influential theory that does not assume the agent, with the responsibility of making policy decisions, is at least partially rational.

2.2 Democracy and Environmental Policy

Any strong level of agreement in the academia regarding the links between democracy and stronger environmental protection policy has yet to emerge in the academia (von Stein 2020, 339-340), which may partly stem from the relatively small number of studies on the issue, especially when compared to the conceptually related topic of the relationship between democracy and peace as well as democracy and equity (Midlarsky 1998, 341-342). There are two approaches when it comes to the studies on this issue, namely the theoretical (or qualitative) one and the empirical (or quantitative) one.

On the theoretical side, proponents of a positive relationship between the two often put forward at least one of the following conceptual logics (Payne 1995, 43-49):

1. Fundamental freedoms of speech and assembly, among other rights, are best guaranteed under a democracy. Activists can thus make their case and raise public awareness of the environment.

   In essence, this argument underscores the roles of civil society, such as environmental NGOs, or interest groups, in swaying public opinions, which echoes the aforementioned mechanisms proposed by the advocacy coalition and multiple streams theories in the causes of policy change.

2. In a democracy, governments constantly face public and electoral pressure, which serves as mechanism through which the public can push the governments to do a better job of protecting the environment.

3. Somewhat related to the first point, democracy allows for the emergence of new information in the absence of censorship, which is crucial for policy learning, as highlighted by the aforementioned advocacy coalition theory, and potentially policy change. In general, a more open political system enhances the likelihood of adopting best practice, which could include stronger environmental protection.

4. This argument relies on the notion that democratic states are more inclined to and better at cooperating with each other on the international stage, and such cooperation include signing and implementing transnational environmental agreements.

5. Assuming free market economies are best protected under democracy, polluting businesses are more subject to public pressure campaigns.

Other arguments in favour of a positive relationship include:

6. Democracy tends to have greater respect for human life and rights, and thus should be more responsive to environmental damage which put life and public welfare in jeopardy (Gleditsch and Sverdrup 2002, 45-70).

7. Autocrats are more disinclined to sanction or accept potentially costly environmental regulation compared to the general public because of the concentration of wealth in their hands (Congleton 1992, 416).

These theoretical logics represent a logical extension of the conventional academic wisdom on democracy and public policymaking, but there are also convincing arguments on theoretical grounds as to why democracy could actually compromise work on environmental protection.

One of the most influential reasoning, known as Tragedy of the Commons (Hardin 1968, 1244-1246), hinted at a negative relationship between democracy and environmental protection is that the individual economic and political freedoms, maximized under a democracy, leads to impulses for greater environmental degradation.

Another popular argument is that the strong corporate influence, made possible under a democracy, consistently favours profit maximization over environmental protection, and their massive resources mean they usually win out in terms of outcompeting environmental

interest groups to gain support of the political class even in a free and democratic society without censorship (Dryzek 1987, 121). This is a direct rebuttal of the general idea, often alluded to by proponents of a positive relationship including the above, that market economies and businesses are good for the environment.

Third, some scholars recognize that sometimes stronger environmental policies are not necessarily the popular vote-winners. Heilbronner (1974), for one, cited the issue of population control as an example of environmentally-friendly but unpopular policy, which is thus unlikely to be enacted by democratic governments whereas autocracies could disregard such pressure (136-150). A related but not identical argument, put forward by Midlarsky (1998), suggested that when compared to other priorities, environmental policy may often be eclipsed by economic issues in democratic elections (344).

These conflicting theories have been accompanied by mixed results of empirical studies on the relationship. Congleton (1992) found that democracy produced more methane and Chlorofluorocarbons (CFCs) per capita than autocracy (419-420), albeit without controlling for economic development, but also that democratic countries were more likely to support transnational effort to tackle environmental issues. Midlarsky (1998) reported that countries' per capita CO2 emissions, level of soil erosion and deforestation increases with rise in level of democracy (358). It should be noted though that the study, with a sample of just under 100 countries, mostly covered the period of 1980s and 1990, which is more than 30 years old.

On the other hand, Barrett and Graddy (2000) recorded a negative statistically significant relationship between democracy and per capita sulphur dioxide emissions (453-455). Similarly, Scruggs (1998) reported an association between greater democracy and per capita sulphur dioxide emissions, although there was no statistically significant relationship found between democracy and water pollution (270-74). Li and Reuveny (2006) found that greater democracy led to less CO2 and nitrous oxide emissions per capita, as well as less intense deforestation (950-954). Using a different set of models and including covariates such as trade openness and military conflicts, this study refuted the earlier findings of Midlarsky in 1998.

A detailed study by von Stein (2022) filled the middle ground. She found that whether the level of democracy has a positive or negative relationship with various environmental outcomes, such as greenhouse gas and air pollutant emissions, depends on the definition of democracy and also the socio-economic context of the countries. For example, democracy defined as elections yielded an across-the-board positive relationship with worse environmental outcomes. If it is civil liberties being measured, however, there were mostly a significant and negative relationship between stronger environmental protection (348-349). However, when considering the interaction between civil liberty and manufacturing as a share of the economy, it was associated with better environmental protection when the sector was weak but worse environmental outcomes when the sector was strong (350).

Another theory to consider in relation to the research topic at hand is the idea of the Environmental Kuznets Curve (EKC). It refers to the proposed phenomenon that environmental degradation will at first intensify as the economy develops, but this trend will start to reverse after the per capita incomes reaches a certain level (Yasin et al. 2020, 6700-6701). Its relationship to democracy is that this could suggest the population's policy priority changes after they have met a threshold of economic well-being, which could have implications on how the policymaking dynamics, according to the aforementioned theories

on policy change and continuity, may behave differently across economically developing and developed democracies.

2.3 Democracy and Climate Change

Climate change is traditionally considered as an environmental policy, and so the literature in section 2.2 should apply to it. On the other hand, during the past one or two decades, this topic has gained prominence arguably unrivalled by any environmental issues in recent history, to the point that it has risen to the top of global policy agenda, with many of the world's most powerful and wealthiest countries have classified the issue as an emergency call it the most significant policy challenge (Global Declaration List, CEDAMIA). Considering the salience of the issue and the revolutionary changes required across all other areas of socio-economic life to meet the ambitious carbon net-zero target by 2050, the paper also attempts to review the literature specifically on this narrow topic, and covering a more recent timeframe.

Perhaps unsurprisingly, researchers who are sanguine about the positive effects of democracy on stronger climate policy action appear to be on firmer ground when examining it in a more roundabout way, echoing what seems to emerge from section 2.2 of the literature review. Schaffer et al. (2021) found a clear, positive relationship in 6 OECD countries between the changing demand for climate policy and governments' responsiveness, lending further credence to this long-proposed causal logic. However, this paper did not show the actual outcome of the climate policies that according to it, tended to be more frequently adopted. In a similar vein, Battig and Bernauer (2009) reported from their studies of 185 countries in 1990–2004 a positive impact democracy had on the political commitment to climate change policy, but an unclear relationship when it turns to the outcome, i.e. the actual greenhouse gas emissions level. They attributed this to difficulties in implementing such policies and the fact that the outcomes were often affected by outside factors with nothing to do with the nature of the political system.

Given the global nature of the issue of climate change, which has become more emphasized in recent years amid calls for stronger solidarity transcending borders, a popular argument about the benefits of democracy on emissions is the greater willingness to champion and promote global climate cooperation. Bernauer and Bohmelt (2013) built a dataset of Climate Change Cooperation Index (C3-I) covering 172 countries from 1996-2008 (197) to measure their performance in tackling climate change over this period. 50% of the index score concerned CO2 emissions and trends and the other 50% measures the quality of climate change policy, such as whether they have made pledges or contributed to UN environmental agencies. This differs from an older index, the aforementioned Climate Change Performance Index (CCPI), which weighs the component of emissions more heavily (70%). The purposefully parsimonious simple models found that democracy exhibited a statistically significant and positive relationship with C3-I. However, once the weighting of international cooperation came down and that of actual emissions went up, the relationship turned insignificant (202).

Proponents of the theory also often rely on the conventional wisdom of the benevolent role played by environmental (I)NGOs to justify and expand the case regarding the positive dynamics between democracy and emissions reduction, especially in the age of globalization when non-commercial private actors can acquire significant public influence. Newell (2008) regarded the increasingly prominent activity of environmental (I)NGOs in 2000s, whose

operation presumes the protection of civil liberty under democracy, as having introduced much-needed democratic accountability to the global climate change politics (149). The underlying idea of empowering the otherwise passive segments of society, across borders, to demand change to the old way of downplaying the topic and related issues such as equity is one of the most consistent causal links invoked to support the thesis of a positive relationship between democracy and more pro-climate policies.

When the definition of environmental outcomes changes specifically to the level of greenhouse gas emissions, however, the picture becomes noticeably more mixed. Povitkina's (2018) study of 144 countries over 1970–2011 suggested that democracies tend to produce less CO2, but with the caveats that this only applies to democracy which is not corrupt. In case of countries which are democratic but corrupt, there was no statistically significant difference between the performance of an autocracy or democracy. Note that her definition of corruption is quite robust since she characterized Slovakia as "moderately corrupt" (425), implying that the number of countries where the positive relationship between democracy and stronger CO2 reduction applies could be quite limited. Burnell (2012) observed that when it come to the Climate Change Performance Index, a measurement metric compiled by the NGOs Germanwatch and Climate Action Network Europe to track countries' CO2 emissions and future trends, both major autocracies and democracies received a similarly dismal rating (825). Particular attention was paid to the fact that China's score in recent years in this matrix has been impressive and outstripped that of many democracies. Held and Hervey (2013) concluded that "the detailed empirical evidence is inconclusive" (92) and the findings were "varied" when looking at studies covering different geographical regions.

Instead of looking at just one composite measurement of democracy as the independent variable, Selseng et al (2022) decided to break it down into 5 smaller elements, namely election, liberty, deliberation, equity as well as civil and political participation. This study of 127 countries from 1992 to 2014 could not find any significant relations between CO2 emissions per capita and the different elements of democracy, except a positive relationship with equity (332) after controlling for socio-economic indicators including GNP and urbanization.

If there is a consensus on this issue, it is probably that few of the relevant literature exudes confidence to in claiming a definitive associational relationship, much less a causal one, between actual greenhouse gas emissions and democracy.

Chapter 3: Model Design, Methodology and Data

3.1 Empirical Model Design

Based on the author's understanding of the aforementioned literature, as well as the seemingly growing momentum of climate protest movements, the main hypothesis to be examined in this paper is whether it is indeed the case that a country with a more democratic political system emits less CO2, and vice versa. Given that the main purpose of the paper is to investigate the existence of any association, and depending on the result, perhaps even causation between how democratic a country is and its level of CO2 emissions, the model, in terms of the inclusion of independent variables, is designed in accordance with the parameters of a causal model.

While the relationship, if any, derived may not meet the threshold for it to be deemed causal (which will be discussed in details in the interpretation of the results in subsequent section), the model strives to identify as accurate as possible a relationship, or lack thereof, between political systems and level of CO2 emissions. In other words, in designing the model, the author seeks to eliminate or minimize any possible confounder bias (Pearce and Lawlor 2016, 1897), which results from factors affecting both the independent variable of interests (in this case, the level of democracy of a country) and the dependent variable (in this case, the level of CO2 emissions), via controlling for such observable and measurable common causes in the model and via other appropriate statistical methods. It also makes sure to exclude intermediate variables, which is a mechanism through which another variable exercises its influence on the dependent variable (Suchinta and MacNeil 2022, 1742-43). Likewise, colliders, which are factors affected by both the dependent and independent variables, are excluded from the causal model in this paper. They both lead to biased estimate of and possible inappropriate adjudication of the existence of a statistically significant relationship (Pearce and Lawlor 2016, 1897) between the variables of interests. In other words, this design is intended to close all open or backdoor pathways between the independent and dependent variable (Pearce and Lawlor 2016, 1897-1898) so that there is only one path flowing from the former to the latter. One thing that works in favour for the model is that the nature of CO2 emissions as the dependent variable means the often-intricate issue of reverse causality is likely irrelevant here, which makes it easier to identify and interpret the real relationship between our variables of interests.

An important note is that this also means the model is not intended to be a predictive one in terms of generating forecasts of future CO2 emissions. As a result, some factors that may be useful in generating more precise forecasts but compromises the establishment of relevant causal or associative relationships, such as previous levels of CO2 emissions, have not been included in the model. Instead of looking to it for expected level of CO2 emissions going forward, the focus of the paper is on trying to understand and suggest potential explanation for the existence or lack of any such relationship.

The corresponding causal model is as follows:
Y (level of CO2 emissions) = α (constant) + β_1X (level of democracy) + β_2C (level of econ. development) + ε (error term)

This simple model contains the main variable of interests, that is the level of democracy. While the definition of democracy in the academic world remains debated and contested, this is not a concern for this paper and it adopts the general understanding of liberal democracy as

it is used in day-to-day contexts. Simply put, it consists of two components: i) political rights to choose leadership, and ii) civil and political liberties. The UN perhaps does a good job of explaining it as a political system which "provides an environment that respects human rights and fundamental freedoms, and in which the freely expressed will of people is exercised. People have a say in decisions and can hold decision-makers to account" ("Democracy", UN). In concrete terms, this will be measured by the score of the V-Dem democracy index.

The measurement of carbon dioxide emission is straightforward without needing proxy index and the unit is tonne. The main variable included here alongside level of democracy is the level of economic development. This stems from the fact that a country's economic development has long been identified as a key contributor of CO2 emissions, as more intense economic activities almost inevitably produces more carbon dioxide. Another reason for its inclusion is that economic development could potentially be a confounder, affecting both the level of democracy of CO2 emissions of a country. There is a theory, albeit by far not a consensus, that greater economic development could lead to more democratic form of government (Easterly, 330-333). Regardless of the actual relationship between the two, this should not be an issue anyway with GDP now being part of the model.

This factor is measured by a country's real GDP. In concrete terms, the simple model is presented as:
(Log) Annual CO2 emissions (Y) = **α + Average Democracy Index Score (of 5 years)** (β_1X) **+ (Log) Real GDP** (β_2C) **+ ε (1)**

One thing to note is that the model looks at the total volume of CO2 emissions and real GDP, rather than per capita CO2 emissions or GDP. The reason is that when it comes to the debate on curbing global CO2 emissions or setting national targets of reduction, it always concerns the overall level of emissions of a country, rather than emissions on a per capita basis. Some major emitters of CO2, such as Brazil, India and Indonesia, still post quite low per capita emissions on virtue of their huge population. Therefore, the focus of the model is on the total level of emissions even though the issue of per capita emissions is a significant one among developing countries in climate negotiations, especially over the discussion of the equity of any proposed climate change mitigation measures. That said, the author also tested the design of the empirical models with the per capita metrics of CO2 emissions and real GDP. The statistical significance and direction of the relationship remains fundamentally similar, in the global models as well as across the subsets of regions and income categories, with only the coefficient of real per capita GDP becoming smaller, to around 0.75 in the global model (but still a strong and decently large positive value), and that of democracy index score being slightly larger simultaneously (to around 0.55).

Another thing the merits discussion in this model is that the model uses annual CO2 emissions, rather than the accumulated CO2 emissions as the dependent variable. This corresponds to the purpose of the paper, which is not about examining the historical dynamics contributing to CO2 emissions.

The democracy index score of the prevailing year (e.g. 2010) is the average value of the score for a 5-year period up to the current year (e.g. 2006-10) because the model assumes that any emissions-related policy would take some time to implement. Therefore, the climate policy that informs the CO2 emissions of the relevant year should not simply be related to the level of democracy of the current year, but the few years before it as well.

While the simple model contains only two independent variables, it is designed to be parsimonious and inclusion of more covariates should, in theory, not significantly affect the relationship between the independent variable of interest and dependent variable since those covariates are not confounders, but merely factors affecting only the latter. Including them can still help improve the efficiency of the model and reduce the standard errors, and thus the paper also presents a long model containing more covariates.

The various long models contain up to 3 more covariates compared to the short model. These covariates are selected because of their possible effects on CO2 emissions, but which are not considered confounders, intermediate variables or colliers. Here, the issue multicollinearity likely arises as socio-economic indicators are generally related to a country's real GDP. After taking this into account, the paper decides to include two more covariates in the long model, namely the population's general level of education and an economy's reliance on energy exports, as well as a country's level of urbanization. These three factors, according to intuition, may have some association with CO2 emissions. Using concrete indicators to measure the aforementioned additional covariates, the long models derived are as follows:

(Log) Annual CO2 emissions (Y) = **α + Average Democracy Index Score (of 5 years)** (β_1X) **+ (Log) Real GDP** (β_2C) **+ Mean Years of Schooling** (β_3X) **+ ε (2)**

(Log) Annual CO2 emissions (Y) = **α + Average Democracy Index Score (of 5 years)** (β_1X) **+ (Log) Real GDP** (β_2C) **+ Mean Years of Schooling** (β_3D) **+ Fuel Export as a percentage of goods exports (**β_3E) **+ ε (3)**

(Log) Annual CO2 emissions (Y) = **α + Average Democracy Index Score (of 5 years)** (β_1X) **+ (Log) Real GDP** (β_2C) **+ Mean Years of Schooling** (β_3D) **+ Fuel Export as a percentage of goods exports (**β_3E) **+ Percentage of Urban Population + ε (4)**

Considering such a large number of vastly diverse countries, the paper will also apply the same short and long models **(1-4)** for each continent to account for the possible different dynamics in each region, which may not be captured by the uniform results if the models are only applied globally. Likewise, the same models will be applied in the four different income categories (high income, upper-middle income, lower middle-income, low income), which are defined by the United Nations based on a country's per capita GDP ("Country Classification", UN), to elucidate any significant variation of the relationship across income levels.

All the models presented in this paper only consider data from a relatively short period of 20 years, from 2000 to 2019. The reason for this is twofold. On the one hand, data from 2020-22 are not included because of the unprecedented disruptive impact of the Covid-19 pandemic. Data in the 1990s are also excluded as the paper would like to exclude any possible major global impacts, both political and socio-economic, resulting from the dissolution of the Soviet Union and the end of the Cold War. Such impacts should have faded by 2000. The more fundamental reason for this lies with the fact that climate change has only become a prominent issue on the global and domestic policy agenda quite recently. Without much public awareness and prioritization on the climate issue, which had arguably been the case for much of the post-WWII era, it does not make a lot of sense to investigate the relationship between the prevailing political system and CO2 emissions during those times.

3.2 Statistical Methodology

The data are processed via both a simple ordinary least square (OLS) model and a two-way fixed effects model, the latter which should control for country-invariant and time-invariant factors. Considering the large number of diverse countries that the models will work on, the conventional wisdom is that the fixed effects model will be more appropriate in terms of obtaining unbiased estimates since it can eliminate the potentially myriad of variables unique to each country, including the history and culture among others. Also, there could be global changes which affect all countries roughly to a similar extent over the twenty-year period. These variables are often unobservable or hard to measure, and it is not realistic for the model to be able to include all of them. Therefore, it is important to use a fixed effects models to control for these factors, which could well be confounders and thus could engender biases which skew the true relationship between our variables of interests - democracy and CO2 emissions. The impossibility to use exact matching with this set of observational panel data to exclude these potential biases also makes the fixed effects model the preferred statistical method. It should be noted though that there are still limitations of fixed effects models even though they should be better than simple OLS models. Fixed effects models cannot exclude the potential bias stemming from the existence of country-variant or time-variant factors, which are effects that apply to only some countries and whose impact on the countries changes over time. Therefore, interpretation of the findings of the fixed effects models especially on the question of causality, which will be discussed in greater details, still calls for caution.

Another way the paper seeks to account for the unmeasurable and measurable heterogeneity, as well as the resultant bias is by creating subsets of data of matched countries according to the categories of continent and income level respectively. While this is not exact matching and thus cannot eliminate the potential bias stemming from other diverging categorical covariates, the geographical region and income levels of countries represent two of the most significant variables on which the effect of democracy, if any, could behave differently. Although subsetting the global dataset into different continents and income level will reduce the size of the data sample and thus possibly its accuracy and efficiency, doing so could account for their individual effects as well as the unobserved heterogeneity stemming from their interactive dynamics with other variables.

Statistically, the paper uses the Hausman test to help inform whether a fixed effects model or random effects model should be used. In the model comparison phase, the author also makes references to the results of the Akaike's Information Criteria (AIC) and Bayesian Information Criteria (BIC) tests. In addition to the aforementioned theoretical reasoning, all the statistical tests also point to the fixed effects model being the preferred method. That said, the paper will still present the results using the simple OLS regression, as the potential differences between them and those of the fixed effects model could help in the interpretation of the findings. The fixed effects models are performed using the "fixest" package in R.

In designing the multiple linear regression models, the paper pays attention to the issue of multicollinearity. As both the democracy index and GDP can be considered general measurement of the state of a society and the economy, it is likely they are related to various socio-economic indicators. When deciding on the inclusion of particular covariates in the model, the author prioritizes those which do not show an unambiguous correlation to democracy and GDP. For this reason, some variables such as population have been excluded from the model even though it probably exercises major influence on CO2 emissions. The

collinearity tests suggest a lack of clear correlation between the covariates of mean years of schooling and fuel exports share to either the democracy index or GDP. While urbanization may have some relationship to GDP performance, the correlation does not appear to be as strong as that between population and GDP. Since it is plausible that the choice and ramifications of an urban or rural lifestyle on CO2 emissions contain elements beyond the purely economic dimensions captured by the GDP, the urbanization rate is included as a covariate in one of the long models.

The last thing to note is about the statistical side of the models is that they use log CO2 emissions and log real GDP to ensure that the distribution of the two variables somewhat resemble a normal distribution, which is an important assumption when using the linear regression method.

3.3: Data Collection, Details and Validity

The data on each country's CO2 emissions throughout the years, measured in tonne, are from the Our World in Data repository and the measurement of the level of democracy is based on the score compiled by the V-Dem Institute. The other socio-economic indicators are aggregated from the World Bank. These are all prestigious institutions and their data have been widely used and cited in both academic papers and non-academic research, which should minimize the possibility of systemic measurement errors. Even though individual measurement errors cannot be ruled out, the relatively large size of the data means such errors are unlikely to affect the overall integrity of the models.

Of all the indicators, the metric of democracy index is probably the most complicated. There are several mainstream democracy indices including that compiled by the Economist and the Polity series. The V-Dem's democracy index score is between 0-1, with 0 being completely non-democratic and 1 being a full democracy. This particular Index is chosen because of its thoroughness both in terms of the time period (annual data dating back to the 18th century) and its scoring categories, which highlights the distinction between different concepts of democracy such as liberal democracy and electoral democracy. It also includes universal suffrage as a scoring criteria, which is an assumption of the hypothesis of the paper. The scores used by the models are those measuring the liberal democracy as the ability to exert influence on government policy by means other than elections is a key tenet of the hypothesis of the paper. The EIU's Democracy Index was first published only in 2006 and has only become an annual publication since 2010. The Polity data series' emphasis on constraints on executive power in measuring democracy does not exactly align with the dimensions of democracy that likely have more to do with CO2 emissions. Nevertheless, in anticipation of possible questions about the robustness of the V-Dem's democracy index used in the model, the paper runs a similarity test between the V-Dem's, the Economist's and Polity's democracy indices. The result shows that even though there are some differences between the scores, there exists a very high, positive correlation between the three indices (all close to or over 0.9 using the Spearman's rank correlation coefficient to account for different scales of the indices), which echoes the results reported by other researchers studying democracy indices (Bowman and Mahoney, 943). This should provide validation to the quality of the V-Dem scores used in this paper and support the idea that the choice of a particular democracy index should not significantly affect the regression outcomes.

The lack of a clear and strong relation between the democracy index scores and GDP is also a promising sign of the validity of the data. To test for multicollinearity, the paper first checks

the relationship between the two and finds that there is not a statistically significant one once fixed effects are controlled for. This results mirrors that of the general consensus of economic historians, who tend to find no relationship, or sometimes even a weak negative relationship between the two variables (Gerring et al. 2005, 323).

The number of countries include in the model is 171 because there are countries which lack one type of data, or another. The regional breakdown of the included countries are as follows: 42 in Asia, 54 in Africa, 42 in Europe, 15 in North and Central America (including Caribbean countries), 11 in South America, and 7 in Oceania. For the few countries with territories in two continents, their regional classification is based on the author's discretion. Some countries do not report data for all years (2000-2019), partly because a few of them only gained their independence after 2000.

Almost all major economies are recorded in the data and most of the missing countries are very small (both in terms of economy, population and CO2 emissions) without the ability or willingness to report statistical data. The only exceptions to this are Taiwan, Venezuela and North Korea. However, the most potentially significant issue here potentially is the lack of data for South Pacific countries in Oceania (e.g. Tuvalu, Samoa), which play an outsized role in global climate debates and whose absence could also affect the reliability of region-specific analysis. In terms of income categories, roughly are in the four categories of "low-income", "lower-middle income", "upper-middle income" and "high-income" respectively (the count is not exactly precise because some countries fall into different categories in different years).

Chapter 4: Model Results

First, the paper looks at the results of the regression models (both short and long) with and without country- and year- fixed effects being applied. Figure 1 presents the simple OLS models and Figure 2 presents the fixed models:

Figure 1. Regression Results of the Short and Long OLS Models

	Dependent variable:			
	logco2			
	(1)	(2)	(3)	(4)
AVERAGEDemocracyIndexScore	-0.837***	-1.328***	-1.188***	-1.158***
	(0.050)	(0.052)	(0.061)	(0.062)
logGDP	1.060***	1.006***	0.988***	0.993***
	(0.006)	(0.007)	(0.007)	(0.007)
Mean_Years_of_Education		0.095***	0.079***	0.087***
		(0.004)	(0.005)	(0.005)
FossilFuel_Export_Percentage			0.461***	0.507***
			(0.051)	(0.054)
Urbanization_Rate				-0.213***
				(0.080)
Constant	-8.962***	-8.204***	-7.747***	-7.824***
	(0.150)	(0.147)	(0.162)	(0.165)
Observations	3,346	3,290	2,733	2,733
R2	0.899	0.911	0.908	0.909
Adjusted R2	0.899	0.911	0.908	0.909
Residual Std. Error	0.722 (df = 3343)	0.674 (df = 3286)	0.640 (df = 2728)	0.639 (df = 2727)
F Statistic	14,955.460*** (df = 2; 3343)	11,237.090*** (df = 3; 3286)	6,768.713*** (df = 4; 2728)	5,428.245*** (df = 5; 2727)
Note:				*p<0.1; **p<0.05; ***p<0.01

Figure 2. Regression Results of the Short and Long Fixed Effects Models

	SimpleFixedModel	LongFixedModelEdu	LongFixedModelE..	LongFixedModelA..
Dependent Var.:	logco2	logco2	logco2	logco2
AVERAGEDemocracyIndexScore	0.4790** (0.1818)	0.4679* (0.1894)	0.2550. (0.1508)	0.2605. (0.1495)
logGDP	1.028*** (0.1000)	1.039*** (0.1025)	1.104*** (0.1187)	1.047*** (0.1180)
Mean_Years_of_Education		-0.0185 (0.0290)	0.0002 (0.0285)	-0.0016 (0.0265)
FossilFuel_Export_Percentage			-0.2221 (0.1888)	-0.2254 (0.1864)
Urbanization_Rate				2.059** (0.6511)
Fixed-Effects:				
Country_Name	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
S.E.: Clustered	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name
Observations	3,346	3,290	2,733	2,733
R2	0.99261	0.99252	0.99368	0.99395
Within R2	0.35056	0.35282	0.38966	0.41636

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Both the OLS and fixed-effects models show a statistically significant relationship between democracy and CO2 emissions (as well as GDP and emissions) but the fixed model show a positive relationship while OLS model shows a negative one. The statistically significant and positive relationship displayed by the various short and long fixed effects models means when democracy score increases by 1, the CO2 emission should increase by 25.5% to 47.9%. Since the maximum score of the democracy index is 1, in practical terms, an increase of the democracy score of 0.1 should see an increase of 2.6% to 4.8% of CO2 emissions. Similarly, the other coefficients of the models can be interpreted this way. As expected, GDP shows a very strong, and positive relationship with CO2 emissions, and all other covariates with the exception of the level of urban population do not appear to have a discernable impact on CO2 emissions.

A notable finding across these fixed effects models is that once the variable of fuel export as a share of total goods export is included, the statistical significance and coefficient of democracy index comes down markedly. One could make the case that this stems from some sort of collinearity between the two, as countries more reliant on energy may tend to be less democratic (Ross 2001, 355-361). However, as previously stated, all covariates have been tested for multicollinearity during the period of 2000 to 2019 and when controlled for country- and year- fixed effects, the share of fuel exports do not exhibit a statistically significant relationship with the democracy index score. One explanation could be that this variable, even though it is not significant on its own, interacts with a (possibly unobserved) factor not included in the model to exert influence over the level of democracy.

Looking at the various OLS models, the level of democracy, as with all other independent variables included, show a statistically significant relationship with CO2 emissions. The most striking distinction from the fixed effects models is that the OLS models all find a strong and negative relationship rather than a positive one. In other words, the OLS models suggest that for each 0.1 increase in democracy score, the country's CO2 emissions should be associated with a fall of 8.4% to 13.3%. Another interesting difference is that the relationship of urbanization and CO2 emissions is negative according to OLS models but very positive in the fixed effects models.

Applying the same models to the six different regions give rise to the following results in Figure 3 below. As the main models are the fixed effects ones, the paper only reports their detailed results and not those of the OLS models for the sake of length and concision.

Figure 3. Regression Results of the Short and Long Models by Continent

	SimpleAsia	EduAsia	EduFuelAsia	AllAsia	SimpleAfr	EduAfr	EduFuelAfr	AllAfr
Dependent Var.:	logco2	logco2	logco2	logco2	logco2	logco2	logco2	logco2
AVERAGEDemocracyIndexScore	1.174** (0.3767)	1.206* (0.4465)	0.8270** (0.2757)	0.8421** (0.2795)	-0.4587 (0.2764)	-0.4936. (0.2750)	-0.6838* (0.3363)	-0.6563. (0.3397)
logGDP	0.8258*** (0.1855)	0.8297*** (0.1825)	0.7153** (0.2276)	0.6912** (0.2295)	0.7488*** (0.1213)	0.7514*** (0.1171)	0.8910*** (0.1316)	0.8738*** (0.1243)
Mean_Years_of_Education		0.0509 (0.0440)	0.0773. (0.0433)	0.0638 (0.0422)		-0.1350* (0.0641)	-0.1331* (0.0610)	-0.1267* (0.0614)
FossilFuel_Export_Percentage			0.3913 (0.3711)	0.3897 (0.3538)			-0.2528 (0.1723)	-0.2661 (0.1808)
Urbanization_Rate				1.197 (1.056)				1.051 (1.103)
Fixed-Effects:								
Country_Name	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
S.E.: Clustered	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name
Observations	824	809	658	658	1,032	1,015	719	719
R2	0.98893	0.98843	0.99213	0.99226	0.98795	0.98838	0.99033	0.99042
Within R2	0.31273	0.31452	0.25750	0.27026	0.20340	0.24648	0.30587	0.31226

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

	SimpleEU	EduEU	EduFuelEU	AllEU	SimpleNA	EduNA	EduFuelNA	AllNA
Dependent Var.:	logco2	logco2	logco2	logco2	logco2	logco2	logco2	logco2
AVERAGEDemocracyIndexScore	-0.2531 (0.2426)	-0.2557 (0.2348)	-0.2493 (0.2497)	-0.1907 (0.2101)	-0.0486 (0.2839)	-0.1015 (0.3045)	-0.0282 (0.2470)	0.0334 (0.2678)
logGDP	0.5510*** (0.1421)	0.5128*** (0.1323)	0.5027*** (0.1306)	0.5326*** (0.1197)	0.7619*** (0.1570)	0.6813*** (0.1469)	0.7732*** (0.1373)	0.8392*** (0.1382)
Mean_Years_of_Education		0.0326 (0.0311)	0.0419 (0.0271)	0.0385 (0.0266)		0.1028* (0.0391)	0.1095** (0.0331)	0.0968* (0.0401)
FossilFuel_Export_Percentage			-0.2303 (0.2490)	-0.2398 (0.2432)			-0.2484 (0.2774)	-0.2448 (0.2827)
Urbanization_Rate				1.501* (0.6896)				-0.5313 (0.5473)
Fixed-Effects:								
Country_Name	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
S.E.: Clustered	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name
Observations	833	818	795	795	300	300	264	264
R2	0.99655	0.99658	0.99681	0.99700	0.99793	0.99807	0.99899	0.99901
Within R2	0.22426	0.23410	0.25830	0.30131	0.36703	0.41090	0.64329	0.65032

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

	SimpleSA	EduSA	EduFuelSA	AllSA	SimpleOceania	EduOceania	EduFuelOceania	AllOceania
Dependent Var.:	logco2	logco2	logco2	logco2	logco2	logco2	logco2	logco2
AVERAGEDemocracyIndexScore	-0.3525 (0.2958)	-0.3814 (0.2348)	-0.3943. (0.2075)	-0.3237* (0.1432)	1.012 (0.9233)	1.241 (1.028)	0.6107 (0.4944)	0.6132 (0.5026)
logGDP	1.188** (0.2951)	1.278*** (0.2459)	1.288*** (0.2379)	1.073*** (0.1636)	0.9990. (0.4375)	0.9582. (0.4123)	1.530 (0.9392)	1.505 (0.8337)
Mean_Years_of_Education		0.0428 (0.0394)	0.0497 (0.0368)	0.0504. (0.0253)		0.0804 (0.1082)	0.1101 (0.0743)	0.0984 (0.1675)
FossilFuel_Export_Percentage			0.2328 (0.1969)	0.1793 (0.1475)			-0.3583 (0.4374)	-0.3736 (0.4235)
Urbanization_Rate				3.035* (1.218)				0.4292 (5.230)
Fixed-Effects:								
Country_Name	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
S.E.: Clustered	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name
Observations	220	216	213	213	137	132	84	84
R2	0.99664	0.99722	0.99726	0.99748	0.99653	0.99648	0.99820	0.99820
Within R2	0.28816	0.37525	0.39512	0.44441	0.25630	0.26686	0.36126	0.36148

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The biggest takeaway of the regional models is the considerable variation among them when it comes to the estimated relationship between democracy and CO2 emissions. The relationship remains statistically significant across all short and long models only in Asia, and are across-the-board insignificant in Europe, North & Central America and Oceania. Moreover, while the relationship is significant and strongly positive in Asia, the coefficients in Africa, Europe, North & Central America and South America are negative (some are significant, others are not). The paper does not show the full results of the regional OLM models here, but they are similar in the sense that there are huge differences between the regions, both in terms of the relationship being positive or negative, as well as the coefficients. However, mirroring the global OLS model, almost all variables remain statistically significant even when broken down into regions.

Another way of looking at the data is by the category of countries' per capita income level, which is presented is Figure 4 below:

Figure 4. Regression Results of the Short and Long Models by Income Categories

Dependent Var.:	SimpleLowIncome logco2	EduLowIncome logco2	EduFuelLowIncome logco2	AllLowIncome logco2	SimpleLowMidInc.. logco2	SimpleLowMidInc...1 logco2	EduFuelLowMidIn.. logco2	AllLowMidIncome logco2
AVERAGEDemocracyIndexScore	0.5751 (0.5154)	0.5845 (0.5242)	-0.6146 (0.7518)	-0.3272 (0.8761)	0.0309 (0.2365)	0.0309 (0.2365)	-0.0469 (0.1893)	-0.1142 (0.1800)
logGDP	0.7562** (0.2193)	0.7914*** (0.2206)	0.9376*** (0.2420)	0.9126*** (0.1995)	0.8180** (0.2405)	0.8180** (0.2405)	1.034*** (0.1908)	0.9718*** (0.1844)
Mean_Years_of_Education		-0.1160 (0.0846)	-0.1135 (0.1262)	-0.0929 (0.1178)			-0.0285 (0.0403)	-0.0406 (0.0405)
FossilFuel_Export_Percentage			0.6552 (0.4677)	0.8108 (0.5195)			-0.1718 (0.1969)	-0.2043 (0.1918)
Urbanization_Rate				3.182 (1.984)				1.817. (0.9554)
Fixed-Effects:								
Country_Name	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
S.E.: Clustered	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name
Observations	593	579	357	357	1,044	1,044	798	798
R2	0.98246	0.98236	0.98807	0.98866	0.99062	0.99062	0.99191	0.99210
Within R2	0.19967	0.20963	0.29989	0.33474	0.15685	0.15685	0.23525	0.25349

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Dependent Var.:	SimpleUpMidIncome logco2	EduUpMidIncome logco2	EduFuelUpMidIncome logco2	AllUpMidIncome logco2	SimpleHIIncome logco2	EduHIIncome logco2	EduFuelHIIncome logco2	AllHIIncome logco2
AVERAGEDemocracyIndexScore	0.3236 (0.3195)	0.2681 (0.2780)	0.0388 (0.2840)	0.0472 (0.2776)	0.5616 (0.8247)	0.5720 (0.8159)	0.6186 (0.8458)	0.5497 (0.8124)
logGDP	0.7702*** (0.1514)	0.7438*** (0.1347)	0.8730*** (0.1264)	0.8604*** (0.1342)	0.7715*** (0.1315)	0.7119*** (0.1111)	0.6525*** (0.1064)	0.6764*** (0.1035)
Mean_Years_of_Education		0.0839* (0.0329)	0.0620* (0.0299)	0.0633* (0.0313)		0.0721 (0.0502)	0.0744 (0.0448)	0.0684. (0.0373)
FossilFuel_Export_Percentage			-0.0408 (0.2186)	-0.0387 (0.2194)			-0.7390** (0.2201)	-0.7240** (0.2123)
Urbanization_Rate				0.2778 (0.6536)				1.041 (0.9939)
Fixed-Effects:								
Country_Name	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
S.E.: Clustered	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name	by: Country_Name
Observations	829	816	709	709	880	880	869	869
R2	0.99687	0.99707	0.99773	0.99773	0.99554	0.99579	0.99616	0.99621
Within R2	0.28283	0.32989	0.36512	0.36661	0.32706	0.36384	0.42690	0.43507

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Similar to the regional models, there emerges major divergence regarding the estimate of the coefficient of the democracy index score between different income levels. Here, the most striking result is that there is no statistically significant relationship between the level of democracy and CO2 emissions across all four income categories as well as the short and long models. It is important to note that "high income countries" do not only refer to OECD countries", as the UN's threshold for this classification is "only" around US$12,500 per capita, meaning many countries not traditionally considered "developed countries", such as Argentina and Middle East oil producers also belonging in this category. The category of "lower middle income" also includes many economies commonly associated with being developing countries.

Chapter 5. Discussion, Interpretation and Limitations

5.1 Interpretation of Results and Discussion on Theory Validation

As expounded on in the previous section, from the perspective of the causal research design, the results of the two-way fixed effect models should carry more weight for their ability to control for the potential myriads of unobserved confounders, such as the national political culture and history. As such, the positive relationship shown by the global models does not validate the hypothesis of the paper that a more democratic country should be more proactive in taking pro-climate policy action and thus emit less CO2. One logical interpretation of this overall result could be that in a democracy, the governments feel more incentivized or pushed by the public to adopt policies which will generate more CO2 emissions, but which are not related to boosting economic growth. Or it could be something about more democratic countries where the populace tends to lead a more CO2-heavy lifestyle independent of economic growth (as this would be captured by the presence of the GDP variable in the models).

However, before coming to this conclusion, there are still several major caveats to consider in interpreting the results and the real relationship between democracy and CO2 emissions given the findings at hand.

First, even though the findings of a positive relationship may be valid, the nature of that relationship would likely be associational rather than causal. Although the models are designed along the parameters of a causal model, the differences of the democracy coefficient between the short and long models using the fixed effect method, and those between the OLS and fixed effects model suggest the estimate of the democracy variable is inconsistent. A much different coefficient between fixed effects and OLS models likely means that that variable is subject to substantial influence from confounders unaccounted for by the latter method. Even though fixed effects models have controlled for the country- and year-invariant heterogeneity here, the fact that the democracy variable is so heavily affected by unobserved variables provides little confidence that it is not still swayed by unobserved country- or year-variant factors. The inability to rule out the existence of such influence, which cannot be eliminated by fixed effects models, means the relationship cannot be taken as causal at this point.

This interpretation is bolstered by the even starker differences of the democracy coefficient across different continents and countries of different income categories, when even the statistical significance of the relationship becomes contested. In the model, in fact, there is a good reference point as to when a relationship can be considered causal. If we look at the coefficient of the log of real GDP, even though it is not the independent variable of interest of the paper, one can conclude that it is little changed across OLS and fixed effects models (between 0.99 and 1.1), between the short and long models (between 1.03 and 1.1), and even across continents (around 0.7 to 0.9 excluding Europe) and income categories (around 0.65 to 1). In the case of GDP, its relationship with CO2 emissions always remains highly positive and strongly significant, with perhaps the only notable exception being a slightly weaker (but still very positive) relationship in the European region. It is with this kind of robustness that the paper can be fairly confident in asserting a causal relationship, which is not the case for the democracy variable.

Second, the lack of statistical significance and significant regional and income-level variation, including even the direction of the relationship (i.e. positive or negative), suggests that it may be more productive to acknowledge that the forces at play influencing the level of democracy or its ability to shape climate policy could be too divergent for a global model to work. Simply looking at the global model appears to give a very misleading sense of the relationship between democracy and CO2 emissions. One can, with justification, question the validity of the findings of certain regions such as Oceania and South America owing to the small number of countries, but the sample size of Asia, Africa and Europe should be sufficiently large and the value as well as the statistically significance of the democracy coefficient are still vastly divergent. This could mean that the existing literature, or perhaps the author's understanding of the literature about greater democracy and stronger climate action is skewed in a Western-centric way (Europe, USA, Canada and AUSNZ) and the political interaction, culture or policymaking dynamics is often different in the rest of the world (which accounts for a majority of countries and population) even if they all qualify as a democracy.

Regarding the literature, it is possible that the theories are universally applicable regardless of regions, but certain socio-economic requirements are needed in place for them to apply. For instance, one standout result is that Asia posts a stronger and more highly positive relationship between democracy and CO2 emissions, compared to other regions. This might be explained by the relatively large number of "developmental state" on the continent (Wong 2004, 345), which has been the world's fastest-growing economic region for years. Under such socio-economic contexts, the mechanism of democracy could translate into more climate-unfriendly policies. In discussing pollution, there is this theory, already introduced in the literature review section called the Environmental Kuznets curve. Greater democracy may empower a more environmental-conscious populace to push for more pro-climate policy, but this assumes the pre-existence of such consciousness, which may be harder to come by in a developmental state. However, if/when a country reaches the level of a mature economy, achieve an enviable HDI and meets other potential criterion such as lack of corruption, greater level of democracy would work as expected, as per the proponents of the theory, to promote more climate-friendly policy. It may just be that the number of countries able to meet these prerequisites for the theory to work is a small minority, perhaps too small to matter for the paper's global dataset and data subsets of regions and income categories.

Another potential caution to interpreting the relationship is that the time period may not be long enough for the effects of the pro-climate policy to manifest themselves in terms of a marked reduction of CO2 emissions. Although the model already uses the average of 5 years' democracy index score to try to account for this possibility, serious action to tackle climate change has arguably only been part of the mainstream policy agenda in the past decade, or perhaps even shorter period. This could potentially mean that more democratic countries have indeed championed stronger CO2 reduction policies, but they are too recent for the effects to have largely materialized by 2019, which is the last year of the panel data. A model tracking a longer time period into the future, from when the issue of climate change is taken seriously, might report relationship between democracy and CO2 emissions differently.

There is another possibility to interpreting the result, and that is pledges of climate action from national governments are just hollow talks and no corresponding follow-up policy. The hypothesis of the paper assumes that greater democracy could compel leaders to commit to promising and then implementing deeper cuts of CO2 emissions via electoral pressure. However, this causal mechanism, based on the literature, conceptually ends at the point of

leaders being elected after making such promises, without considering the implementation part. Policies contained in an electoral winner's campaign platform does not necessarily mean it will translate into actual, implemented policy. This possible gap of policy pledges during democratic elections and their actual implementation is beyond the scope of the quantitative models of this paper. In this case, the positive relationship between democracy and CO2 emissions in the global model could stem from the fact that the elected leaders, despite running and winning power on a stronger pro-climate platform than their non-democratic counterparts, do not follow through on their mandate. One way of addressing this gap is to replace the CO2 emissions with a metric quantifying the climate pledges of governments (both democratic and non-democratic) as the dependent variable. Results on the nature of the relationship between greater democracy and more robust climate pledges could then be compared against the findings of the models in this paper, and any major differences between the two relationships might then be down to the aforementioned implementation shortfall.

5.2 Limitations and Model Improvement

In terms of further improvements to the model for the purpose of establishing causality, more covariates, with a view of them being potential confounders, could be included. One promising candidate would be the classification of climate/environmental geography (as opposed to the broad continental classification used in this paper), or an index measuring the likely damage or risk from unmitigated global warming stemming from their locations, of each country. There is a school of thoughts in economic history that geography affects the outcome of political institutions (Auer, 2), and geography/climate has a direct impact on policy intervention on CO2 emissions.

Another covariate that would be quite useful in shedding light on the theory on democracy and CO2 emissions is reliable and consistent polling data of public consciousness of the policy issue of climate change of each country for a sufficiently long period. A major question mark as to the results above is whether the positive relationship stems from more powerful public demands for policies that would emit more CO2 in a democracy. Controlling for this variable, perhaps in an interactive term or pre-model selection collinearity test, could go a long way toward revealing more of the potential logical causal chain between democracy and CO2 emissions. However, what has stopped the paper from such an attempt is that such data are hard to attain, and are likely much less complete in terms of the number of countries and years covered. A more fundamental issue is that the respondents' answers do not necessarily align with reality. Just because they answer they care about something, especially something seen as political correct, does not mean they actually do when it comes to their voting behavior or lifestyle choice. Therefore, a better metric would be the respondents' attitude on the climate change issue even when specifically told that steeper CO2 emissions reduction could adversely affect the economy and costs of living. This makes such data collection an even more daunting task.

A smaller refinement to the model could be to change the criterion of income classification. Instead of using the UN's definition, future models can adopt a stricter threshold for high-income and more relaxed one for low-income countries. This way, the models may report something different as one would expect perhaps a more negative relationship might result if the high-income countries only include OECD or the developed Western countries. The drawback of this approach is that this will reduce the sample size for the sub-category, and increases uncertainty about interpreting the outcomes and applicability beyond a small select group of countries. However, this may help answer one of the discussion points identified in

the previous section, namely the socio-economic contexts required for the application of the theory or hypothesis.

Lastly, there are two important notes on the data used in the models. The paper has already discussed in some details the variety of the concept and measurement of democracy indices, and why they should have no bearing on the integrity of the models. That said, the scores are ultimately scored by researchers and are therefore inherently subjective. The author would also be remiss not to specify there is one strand of criticism in the political science realm that all the mainstream indices fail to do an adequate job of measuring the level of democracy (Bowman et al. 2005, 939-945). Debates continue as to whether it is possible or appropriate to properly measure the level of democracy across such a diverse spectrum of countries and rank them accordingly. However, given that the current indices are the best metrics one can work with, especially for panel data covering various countries and multiple time periods, there does not seem to be a better alternative.

The lack of data of many South Pacific countries mean the model only has 7 countries of Oceania represented. Similarly, there are notably much less countries in South America and North & Central America (11 and 16 respectively). These relatively small and unbalanced sample size of the data subsets may mean the coefficient estimates may be subject to more variance than its counterparts in Africa, Asia and Europe and raises questions about the accuracy of their estimates. It should be noted though that the paper, in interpreting and discussing the relevant findings, has already taken this into account. Of course, supplementing the missing data will help improve any future models, especially when it comes to regional analysis. The South Pacific is a particularly interesting case since its domestic political dynamic on the issue of climate change may differ significantly from its counterparts considering the considerable and uniquely urgent risk confronting many of low-lying island countries in the region.

Chapter 6: Conclusion

This paper seeks to contribute to the literature by adding to the long-running but still unresolved debate on whether democracy will lead to stronger carbon emissions cut, or vice versa, by building an empirical model along the lines of the causal model. The models use fixed effects methods to root out country- and time-invariant heterogeneity inherent in a dataset of over 170 countries through a period of 20 years (2000-2019), so as to ensure the resultant democracy coefficient remains unbiased from these unobservable confounders. There are mostly two models being used, one containing only two independent variables – democracy and real GDP level, which has its appeal as a parsimonious model. The other longer models also control for the covariates of education, fuel export share and urbanization, which are included also to see if the democracy coefficient will remain consistent across different model specification. Regression analysis is first conducted on a global scale, and then on data subsets based on geographical regions and income categories.

The global models find a statistically significant positive relationship between democracy and CO2 emissions, which is a surprise to the author based on the hypothesis. It is logically plausible, though, that this could be the case on the basis that the public prioritizes over development or other climate un-friendly policy over curbing CO2 emissions. The huge variation of the democracy coefficient, nature of relationship with the dependent variable and loss of statistical significance following the application of the models to the two data subsets suggests that the interpretation of the statistically significant relationships found in the global models should not go beyond acknowledgment of an associational relationship, as opposed to a causal one. It also means that there are potentially indicators that gives rise to different CO2 emissions outcome upon interaction with greater freedom and democracy.

Finally, the paper offers pointers for future empirical research of the topic, based on the reflections on the findings and limitations of the models. Inclusion of geography based on climate risk and polling data on public attitude toward climate change could help fill the void. The possible reasons behind the unexpected results, proposed in the interpretation section, also provide clues as to how future models can be further improved, Further investigation to identify the potential interactive socio-economic indicators, which could account for the coefficient variation across categories. Ultimately the findings of the paper, albeit one contrary to the paper's initial expectations, confirms the status quo of the existing literature on the issue, that is one of nuance and continued search for definitive causal relationship.

Bibliography

Primary Data Sources:

"Country-Year: V-Dem Core version 13." V-Dem Institute. Accessed June 2, 2023. https://www.v-dem.net/data/the-v-dem-dataset/country-year-v-dem-core-v13/

"CO2 emissions." Our World in Data. Accessed June 2, 2023. https://ourworldindata.org/co2-emissions

"GDP (constant 2015 US$)." World Bank. Accessed June 2, 2023. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD

"Fuel exports (% of merchandise exports)." UN. Accessed June 2, 2023. "https://data.worldbank.org/indicator/TX.VAL.FUEL.ZS.UN?end=2019&start=2000

"Human Development Index." Our World in Data. Accessed June 2, 2023. https://ourworldindata.org/human-development-index

"Urban Population (% of total population). UN. Accessed June 2, 2023. https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS

Secondary Sources:

Arif, Suchinta, and M. Aaron MacNeil. "Predictive models aren't for causal inference." *Ecology Letters* 25, no. 8 (2022): 1741-1745.

Barrett, S. and Graddy, K., 2000. Freedom, growth, and the environment. *Environment and development economics*, *5*(4), pp.433-456.

Bättig, Michèle B., and Thomas Bernauer. "National Institutions and Global Public Goods: Are Democracies More Cooperative in Climate Change Policy?" *International Organization* 63, no. 2 (2009): 281–308. https://doi.org/10.1017/s0020818309090092.

Baumgartner, Frank R., and Bryan D. JONES. *Agendas and instability in American politics*. Chicago: University of Chicago Press, 1993.

Bernauer, Thomas, and Tobias Böhmelt. "National Climate Policies in International Comparison: The Climate Change Cooperation Index." Environmental Science & Policy 25 (2013): 196–206.

Bowman, Kirk, Fabrice Lehoucq, and James Mahoney. "Measuring political democracy: Case expertise, data adequacy, and Central America." *Comparative Political Studies* 38, no. 8 (2005): 939-970.

Bridgman, P & G Davis (2000). *Australian Policy Handbook*, 2nd edn (first published in 1998) Allen& Unwin, Sydney.

Burnell, Peter. "Democracy, Democratization and Climate Change: Complex Relationships." Democratization 19, no. 5 (2012): 813–42. https://doi.org/10.1080/13510347.2012.709684.

Cairney, Paul. *Understanding public policy: Theories and issues*. Basingstoke: Palgrave Macmillan, 2011.

Clay, Edward J., and Bernard Schaffer, eds. *Room for manoeuvre: an exploration of public policy planning in agricultural and rural development*. Associated University Press, 1984.

Congleton, Roger D. "Political Institutions and Pollution Control." *The Review of Economics and Statistics* 74, no. 3 (1992): 412. https://doi.org/10.2307/2109485.

"Country Classification." United Nations. Accessed June 2, 2023. https://www.un.org/en/development/desa/policy/wesp/wesp_current/2014wesp_country_classification.pdf.

Christoph Knill/Jale Tosun: *Policy Making*. In: Daniele Caramani (ed.), Comparative Politics. Oxford: Oxford University Press, 2008, pp. 495-519.

"Democracy." United Nations. Accessed June 2, 2023. https://www.un.org/en/global-issues/democracy.
Dryzek, John S. *Rational ecology: Environment and political economy*. Oxford, OX, UK: Blackwell, 1992.
Easterly, William. "The middle class consensus and economic development." *Journal of economic growth* 6, no. 4 (2001): 317-335.
Gerring, John, Philip Bond, William T. Barndt, and Carola Moreno. "Democracy and economic growth: A historical perspective." *World politics* 57, no. 3 (2005): 323-364.
Gleditsch, Nils Petter, and Bjørn Otto Sverdrup. "Democracy and the Environment." *Human Security and the Environment*, 2002. https://doi.org/10.4337/9781781950937.00009.
"Global Declaration List." cedamia, December 18, 2022. https://www.cedamia.org/global/.
Hardin, G. "The Tragedy of the Commons." *Science* 162 (1968): 1243-1248. http://dx.doi.org/10.1126/science.162.3859.1243
Heilbroner, R. (1974). An Inquiry into the Human Prospect. New York: Norton.
John, Peter. "Is There Life after Policy Streams, Advocacy Coalitions, and Punctuations: Using Evolutionary Theory to Explain Policy Change?" *Policy Studies Journal* 31, no. 4 (2003): 481–98. https://doi.org/10.1111/1541-0072.00039.
Held, David, Angus Fane-Hervey, and Marika Theros, eds. *The governance of climate change*. Polity, 2011.
Kingdon, John W., and Eric Stano. *Agendas, alternatives, and public policies*. Vol. 45. Boston: Little, Brown, 1984.
Kraus, Jody S., and Jules L. Coleman. "Morality and the Theory of Rational Choice." *Ethics* 97, no. 4 (1987): 715–49. https://doi.org/10.1086/292886.
Lasswell, Harold Dwight. *The decision process: Seven categories of functional analysis*. Bureau of Governmental Research, College of Business and Public Administration, University of Maryland, 1956.
Li, Quan, and Rafael Reuveny. "Democracy and Environmental Degradation." *International Studies Quarterly* 50, no. 4 (2006): 935–56. https://doi.org/10.1111/j.1468-2478.2006.00432.x.
Midlarsky, Manus I. "Democracy and the Environment: An Empirical Assessment." *Journal of Peace Research* 35, no. 3 (1998): 341–61. https://doi.org/10.1177/0022343398035003005.
Newell, Peter. "Civil Society, Corporate Accountability and the Politics of Climate Change." *Global Environmental Politics* 8, no. 3 (2008): 122–53.
Payne, Rodger A. "Freedom and the Environment." Journal of Democracy 6, no. 3 (1995): 41–55. https://doi.org/10.1353/jod.1995.0053.
Pearce, Neil, and Debbie A. Lawlor. "Causal inference—so much more than statistics." *International journal of epidemiology* 45, no. 6 (2016): 1895-1903.
Povitkina, Marina. "The Limits of Democracy in Tackling Climate Change." Environmental Politics 27, no. 3 (2018): 411–32. https://doi.org/10.1080/09644016.2018.1444723.
Ross, Michael L. "Does oil hinder democracy?." *World politics* 53, no. 3 (2001): 325-361.
Sabatier, Paul A. "An Advocacy Coalition Framework of Policy Change and the Role of Policy-Oriented Learning Therein." *Policy Sciences* 21, no. 2–3 (1988): 129–68. https://doi.org/10.1007/bf00136406.
Scruggs, Lyle A. "Political and economic inequality and the environment." *Ecological economics* 26, no. 3 (1998): 259-275.
Stein, Jana von. "Democracy, Autocracy, and Everything in between: How Domestic Institutions Affect Environmental Protection." *British Journal of Political Science* 52, no. 1 (2020): 339–57. https://doi.org/10.1017/s000712342000054x.

Versluis, Esther, Mendeltje van Keulen, and Paul Stephenson. *Analyzing the European Union Policy Process*, 2011. https://doi.org/10.1007/978-1-137-10001-6.

Yasin, I., Ahmad, N. & Chaudhary, M.A. "The impact of financial development, political institutions, and urbanization on environmental degradation: evidence from 59 less-developed economies." *Environment, Development and Sustainability* 23 (2021): 6698–6721. https://doi.org/10.1007/s10668-020-00885-w

Schaffer, Lena Maria, Bianca Oehl, and Thomas Bernauer. "Are Policymakers Responsive to Public Demand in Climate Politics?" *Journal of Public Policy* 42, no. 1 (2021): 136–64. https://doi.org/10.1017/s0143814x21000088.

Selseng, Torbjørn, Kristin Linnerud, and Erling Holden. "Unpacking Democracy: The Effects of Different Democratic Qualities on Climate Change Performance over Time." *Environmental Science & Policy* 128 (2022): 326–35. https://doi.org/10.1016/j.envsci.2021.12.009.

Wong, Joseph. "The adaptive developmental state in East Asia." *Journal of East Asian Studies* 4, no. 3 (2004): 345-362.

Zahariadis, Nikolaos, 2007: The Multiple Streams Framework. Structure, Limitations, Prospects, in: Sabatier, Paul A. (Ed.): *Theories of the Policy Process*. 2nd edition, Boulder, CO: Westview, 65-92.