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DEPARTMENT OF POLITICAL SCIENCE

THE ENVIRONMENTAL IMPACT OF INSTITUTIONAL QUALITY AND ENVIRONMENTAL POLICY INSTRUMENTS

A study regarding the moderating influence of corruption on climate change-related tax from a global perspective

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Abstract

While previous research has focused on the bivariate relationships between environmental policy instruments, CO_2 emissions and corruption, a study looking at the combination of the components while examining the direct impact on CO_2 emissions is missing. This thesis examines whether corruption moderates the relationship between climate change-related tax and CO_2 emission levels. By arguing that the innovation and behavioral change that environmental policy instruments normally incite, are disrupted by corruption and its hampering effect on innovation, embezzlement, free-riding and non-compliance - the thesis hypothesizes that higher levels of climate change-related tax will show a decreasing effect on CO_2 emission levels - and further that the presence of corruption will reduce this decreasing effect. Conducting time-series analysis with panel data that covers 196 countries from 1992-2020, the result of the study indicates no support for any of the hypotheses. Based on the findings, an improved model that can better capture the effect of corruption without being overshadowed by the high influence of economic growth on CO2 emissions is suggested.

Keywords

Climate change-related tax, corruption, CO_2 emissions

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1. Introduction

In February 2022, the UN IPCC report once again declared the urgency of climate change, reminding the world that time is running out to meet the established environmental goals. Global emissions continue to rise, and researchers, as well as policymakers and individuals, agree that much too little is being done to reverse this trend. According to the IPCC panel, emissions need to decrease rapidly n the near future in order to reach “net zero” within a few decades and reduce climate change effects (IPCC, 2022-04).

Some of the disastrous repercussions that climate change has already caused human life include water access, food production, natural capital, and overall health (Masron & Subramaniam, 2018). It is further anticipated to disrupt ecological systems, causing major damage to both economic growth and human well-being, due to a lack of appropriate action from societies as a result of the challenges in initiating effective cooperative behavior on a large scale (Baloch & Wang, 2019; Jagers et al., 2020). Over the years, a number of global agreements aimed at reducing climate change have been established, including the Kyoto Protocol from 1997 and the Paris Agreement from 2015. However, because environmental policies are negotiated at the supranational, national, and sub-national levels, the effectiveness of sustainable environmental governance varies substantially between countries (Rodrguez-Pose & Di Cataldo, 2015). This further highlights the need for more effective environmental governance to ensure resource sustainability and overall environmental quality (Baloch & Wang, 2019). Here, the Coalition of Finance Ministers for Climate Action can be exemplified as a multilateral initiative bringing fiscal and economic policymakers together in the purpose of facilitating the adoption of practices and policies aimed to reduce CO_2 emissions while maintaining climate-resilient economic growth, where carbon pricing-and taxes are highlighted as an important tool for climate change mitigation (FM Coalition, 2022-04: 2).

Carbon taxes further illustrates an example of a widely utilized environmental policy instrument that has risen in recent decades (Wittneben, 2009). When compared to similar tools such as trading schemes, the policy instrument is frequently recognized as favorable by economists, given its cost-effectiveness and high incentives for green innovation (Svenskt Näringsliv, 2018-06; Wittneben, 2009). Since the tax rate is set at the national level, the impact of carbon taxes on CO2 emissions has shown to vary widely across states, with large differences between developed and developing countries (Lin & Li, 2011; Masron & Subramaniam, 2018). Previous research has discovered a link between corruption and poor environmental performance, with the finding being especially applicable to developing countries (Povitkina, 2018; Masron & Subramaniam, 2018; Haldar & Sethi, 2021). Given that carbon taxes has proven to be on of the most effective, but yet an ambiguous instrument in terms of actual results, the purpose of this study is to examine whether corruption plays a role in the implementation process of environmental policy instruments across countries. Adding corruption into the equation would thereby capture the often overlooked aspects regarding the inhibitory effects corruption and low-quality institutions have on tax revenues (Holmberg & Rothstein, 2009), innovation/technical development (Rodriguez-Pose & Di Cataldo, 2015), environmental policy support (Harring, 2016) and the overall efficiency of implementing environmental policies (Masron & Subramaniam, 2018).

The aim of the study is thus to examine whether institutional quality impacts the efficiency of environmental policy instruments in terms of CO_2 emission levels. As a result, the following research question has been formulated; *does institutional quality moderate the mitigating effect of environmental policy instruments?*

The paper has been structured as follows; the first section of the paper gives a broad overview of previous research regarding carbon taxation and corruption. I will further discuss the theoretical anchoring of the study and explain mechanisms through which the factors are related. I will then formulate a set of hypotheses regarding the relationship, based on the theoretical framework and research question presented above. Thereafter, a methodological research plan will be presented along with operationalizations of the variables before conducting a statistical analysis of the data. Lastly, I will discuss my empirical findings in relation to my hypotheses and clarify the relevance of my proposed research idea.

2. Previous Research

The use of environmentally related taxation in regards to both carbon dioxide emissions and greenhouse gasses has become more and more common in both OECD and non-OECD countries during the last decades (Masron & Subramaniam, 2018: 12492). This has in general triggered economic responses and influenced the behavior of industries to perform productions with less greenhouse gas impact, as well as individuals and their consumption habits (OECD, 2017: 5). However, the empirical findings of the actual effectiveness of environmental tax and other environmental regulations, vary. Since carbon tax is often negotiated on a national level, it has been argued to complicate the effectiveness of using it as a tool for equivalent behavioral change and cooperation on a larger global scale (Wittneben, 2009: 2462; Jagers et al., 2019: 1283). Hence, a nationally negotiated carbon tax creates problems since the character of the establishment behind the tax rate varies across nations due to numerous factors such as political climate and culture (Wittenben, 2009; Harring, 2018) or institutional quality and political and social trust (Harring, 2016).

When it comes to developed countries, Dogan et al. (2022) find that environmental tax moderates the relationship between energy consumption and CO_2 emissions in the G7 countries (i.e. Canada, France, Germany, Italy, Japan, the United Kingdom, the United States), where statistical results signify that a higher amount of tax leads to higher use of renewable energy sources. Similarly, Rafique et al. (2022) and Bashir et al. (2021) find that environmental taxes can help reduce the ecological footprint within OECD countries by influencing industries to lower their energy intensity and/or using renewable energy sources. The work of Andersson (2017) further presents an example of a case study concerning a developed country, where the author finds that carbon tax connected to transportation has substantially reduced emissions in a Swedish context over a scope of 15 years between 1991-2005.

Similar to developed countries, developing countries also implement a large number of environmental policies (Masron & Subramaniam, 2018: 12492). However, the results on the environmental performance through these regulations and policies have shown to diverge from that of developed countries. The findings of Povitkina (2018) indicate that countries with higher democratic standards only reduce CO_2 emissions within contexts where corruption levels are low. When corruption levels are high, the environmental performance of democracies is not necessarily better than authoritarian regimes. Masron & Subramaniam (2018) is on the same track, exemplifying China (authoritarian) and India (democratic) as two countries that both have enforced several environmental policies during the last decades with the goal to reduce air pollution, although with limited success and mostly with a reversed effect. In turn, this signals that challenges exist within the implementation process of these policies that originally are relatively well designed. It is thus argued that the presence of corruption negatively affects the environment both directly (via the formation of environmental laws) and indirectly (via reduction of income, e.g. funds and tax revenues). Haldar & Sethi (2021) find that institutional quality plays a moderating role in the relationship between energy consumption and CO_2 emissions, whereas developing countries with higher levels of corruption tend to prioritize economic growth and increasing production rather than using renewable energy sources, in contrast to developed countries with lower levels of corruption.

However, high levels of institutional quality would still not be enough to decrease emissions, since levels of CO_2 seem to increase in line with production and consumption nevertheless (Haldar & Sethi, 2021). This further implies that a tool with a mitigating effect is needed to reduce emissions and change the behavior of actors. However, while carbon tax is argued to be one of the most effective environmental regulations within developed countries, corruption is argued to worsen environmental performance in developing nations while simultaneously creating a hazardous atmosphere for tax revenues (Povitkina, 2018; Masron & Subramaniam, 2018). While Povitkina (2018) shows that the presence of corruption inhibits the state's ability to introduce environmental policy instruments in the first place, it would be interesting to further examine how the presence of an environmental policy instrument is affected by a corrupt environment, post-implementation. This further generates room for an empirical elaboration on the topic regarding the effectiveness of environmental policy instruments to see if institutional quality could be a significant factor behind the varying environmental performances among countries that use environmental policy instruments, such as taxes.

Since little work has been done on the moderating effect of corruption in the context of environmental taxes, let alone the direct outcome in terms of CO_2 emissions, a model combining these aspects is needed to improve the knowledge of the potentially disruptive effect that institutional quality and corruption have on governments' ability to use environmental policy instruments as an effective tool for dealing with climate change. It is further important in terms of policy implication, as a greater understanding of the subject may lead to better-suited policies that are more resilient to corrupt environments.

3. Theoretical Framework

In this section, main concepts are defined and the mechanisms behind the relationship between environmental taxes, CO_2 emissions and corruption are explained.

3.1 Collective Action Theory and environmental policy instruments

A collective action problem, or dilemma, can be described as a situation where the benefits for an individual to act in short-term self-interest outweighs acting in favor of the long-term interest of the collective, which in turn hampers cooperative behavior. Therefore, the expected behavior of other actors regulates the behavior of the individual and in turn determines the likeliness of collective action. Thus, to solve a collective action dilemma, cooperation is a necessity (Ostrom et al., 2002: 3; Ostrom, 1998: 2).

The notion of 'common-pool resources' refers to a resource that a large number of people have access to and it is usually described as impossible to exclude actors from using it, often due to the extent of it (Ostrom, 2002: 3). According to Ostrom et al. (2002), the atmosphere can be described as a type of common-pool resource due to its immense accessibility. The dilemmas involving collective action can thus lead to 'overusing' of the atmosphere (in terms of emissions) and eventually climate change (Ostrom et al., 2002, 3; Becker & Ostrom, 1995: 116). Earlier empirical results further indicate that it for various reasons becomes more difficult to encourage cooperative behavior on a larger scale such as; a large number of involved actors, complexity (which entails comprehension obstacles), large *spatial* distances (i.e. that the dilemma applies to a larger geographical territory with multiple countries involved) and also large *temporal* distances (i.e. the magnitude of the time span from cause to effect) (Jagers et al., 2020: 1286; Ostrom, 2002: 23). The endless accessibility to the atmosphere thus makes climate change, and the pollution/emissions that cause it, a large-scale collective action problem per definition. Moreover, due to difficulties to reach cooperation on a larger scale, it has been argued that intervention by a third party is required. An external authority of this sort usually refers to a state, social movement, or trade association. Market-and legal-based instruments or incentive-based policy instruments are examples of such interventions where the purpose is to create behavioral change amongst actors, where environmental taxes have been argued to be one of the most effective tools so far (Jagers et al., 2020: 1282; Wittneben, 2009: 2463). As a state-enforced market-based tool, environmental tax aims to reduce emissions by influencing behavior and creating economic incentives for actors to cut down their fossil fuel production (Wittneben, 2009: 2463; Svenskt Näringsliv, 2018-06: 12; Jagers et al., 2020: 1282). However, since carbon tax is often negotiated on a national level, it complicates the effectiveness of using it as a tool for equivalent behavioral change and cooperation on a larger global scale (Wittneben, 2009: 2462; Jagers et al., 2020: 1283). Hence, a nationally negotiated carbon tax may cause problems when trying to achieve cooperation on a global scale since the character of the establishment behind the policy instrument varies across nations. In turn, this may depend on numerous factors such as political climate and culture (Wittenben, 2009; Harring, 2018) , institutional quality/corruption or political and social trust (Harring, 2016).

3.2 Environmental taxes as a steering instrument

Although all taxes related to the environment can be referred to as an "environmental tax", there are some distinctions worth mentioning. For instance, taxes that specifically target emissions are GHGs, carbon, energy and petroleum/fuel taxes (Scrimgeour et al., 2005; OECD, 2017). Sometimes, these types of taxes are also referred to as climate change-related taxes, which is considered a domain under the environmental tax umbrella. Additionally, some taxes are explained to have either a direct or indirect effect on certain environmental domains, where climate change and emissions can be exemplified. For instance, while taxes on petroleum within the transport sector are considered to have a direct effect on climate change and emissions, taxes related to the domain of biodiversity, e.g., fishing taxes, are not (OECD, 2022-02). On the other hand, taxes concerning fishing can be argued to have an indirect effect on climate change by creating incentives for preserving marine ecosystems (Greenpeace, 2020-08-06). Furthermore, due to the exclusive focus on atmospheric emissions that this thesis addresses, only taxes related to the domain of climate change (i.e., emissions), will be taken into consideration.

Some of the overall benefits of carbon tax regularly highlighted by advocators are firstly its cost-effectiveness since each and every actor or individual has equal marginal cost for adjusting their behavior (Hammar & Jagers, 2006: 613; Svenskt Näringsliv, 2018-06: 12; Grieder et al., 2021: 1). Wittneben (2009) clarifies that as long as the cost for reduction is lower than the rate of the carbon tax, actors will reduce their emissions. Based on this logic, the carbon tax can further be adjusted by state actors over time in order to steer the volume of reduction, which is further one of the reasons why economists usually advocate carbon taxes over trading scheme systems (Wittneben, 2009: 2463; Andersson, 2017; 2). Wittneben (2009) further highlights the effectiveness of carbon taxes in comparison to the cap-and-trade/trading scheme system in the EU, where the former is argued to have a greater effect on emission reduction since the given "cap" is often set at the lowest common denominator as a result of negotiations between the countries involved, compared to taxation with a limitless possibility for emission reduction. The author further argues that the cap-and-trade system does not create as strong incentives or rewards for green conversion or technological innovation since the strategy involves more ways of avoiding the taxation (Wittneben, 2009: 2463). The Coalition of Finance Ministers for Climate Action exemplifies Sweden as a successful case when it comes to climate tax as both cost-effective and efficient in terms of CO_2 reduction (FM Coalition, 2022-04: 9).

An additional mechanism that determines the effectiveness of environmental taxes on CO_2 emissions involve the behavior of individuals and households, where car transportation and overall consumption can be exemplified (Lin & Li, 2011: 5137). The goal on an individual level is similar to that on an industrial level; avoiding tax to the largest extent, although the incentive to change behavior is more focused on lowering consumption of goods with high impact on CO_2 emissions, such as transportation. The motivation builds on the idea that introducing a tax will result in higher consumer prices, which in turn will lower the demand for the products that are influenced by the environmental tax (such as gasoline). The behavioral change is based on either economic or moral incentives, i.e., either acting in the greater good of the environment or in regards to the private economy (Grieder et al., 2017: 1 & 4).

However, as slightly touched upon earlier, there are several factors that determine the success of carbon taxes/carbon pricings in different settings where institutional quality and corruption might be some of them (Povitkina, 2018; Masron & Subramaniam, 2018). These mechanisms will be discussed in the following sections below, starting with a general conceptualizing the notion of Quality of Government and corruption.

3.3 Quality of Government

The conceptualization of Quality of Government (from now on abbreviated as QoG) occurred within the literature not too long ago. It was in conjunction with the demand for explaining the varying performances of democracies that the notion emerged (Rothstein, 2011: 6). The definition of QoG provided by Rothstein & Teorell (2008) is formulated as follows; " [...] the impartiality of institutions that exercise government authority" (Rothstein & Teorell, 2008: 165). In *The Quality of Government* (2011) Rothstein clarifies that the output-side of the political system, i.e. "the *exercise* of public authority", should constitute the basis for which the meaning of QoG is built on, rather than the input side, which refers to the *access* to public authority (Rothstein, 2011: 13).

In the current literature on corruption, the Principal-Agent Theory constitutes the most widespread theory (Rothstein, 2011; Prasad et al., 2018). The Principal-Agent Theory describes the presence of corruption as when the agent, a bureaucrat for example, does not act in the interest of the principal (which could be the government, head of a company or the public), which in many ways has to do with the impartial exercise of power (Rothstein & Teorell, 2008; Rothstein, 2011). Although corruption (i.e. the opposing behavior towards the principal) is commonly seen as criminal behavior, the complex web of the multiple actors involved in a highly corrupt system usually makes it hard to identify the principal. From a perspective of Collective Action, this creates benefits for agents to act in a corrupt way since acting "honest" would be disadvantageous in a system where no one can be trusted to do the same (Rothstein, 2011: 99; Ostrom; 1998). Rothstein (2018) and Prasad (2018) further points to the difficulties in tackling corruption since its general occurrence usually remains the same even though efforts to prevent corruption began decades ago.

3.4 Corruption and emissions

There has been provided evidence that corruption increases pollution, and more specifically that countries with higher levels of corruption also have higher levels of pollution compared to countries with lower corruption levels (Masron & Subramaniam, 2018; Fredriksson et al. 2003; Baloch & Wang, 2019). This link has further been established on a local level, where Carlitz & Povitkina (2021) found that air and water quality differed between districts in Vietnam depending on the level of corrupt business interests.

The study of Fredriksson et al. (2003) shows results indicating that higher levels of corruption among policymakers and other capitalist interest groups reduce the stringency and ultimately the efficiency of energy policy implementation in industrialized countries (Fredriksson et al. 2003: 208). There are several reasons why corruption has a negative effect on the environment and why the implementation of environmental policies fails. Some examples are the embezzlement of funds that are allocated for programs of environmental protection, as well as creating rent-seeking behavior and extensive bribery of officials when it comes to environmental inspections which in turn allows for the depletion of natural resources along with pollution (Masron & Subramaniam, 2018: 12493). Good environmental governance is thereby argued as necessary in terms of sustainable resource usage and that an institutional improvement helps reduce CO_2 emissions by higher accessibility to political freedom and information, which leads to more public awareness and thus more support for environmental legislation (Baloch & Wang, 2019: 124).

3.5 Corruption and taxation

Taxes are considered one of the most important tools for creating well-functioning bureaucracies and societies overall and "the main nexus that binds state officials with interest groups and citizens" (Di John, 2009: 3). Holmberg and Rothstein (2009) emphasize effective taxation as an indicator of high institutional quality, considering that higher levels of corruption have shown to decrease tax revenues (Holmberg & Rothstein, 2009: 147). Firms and other actors are explained to be driven into the corrupt informal sector where they are offered to pay less tax and rent in exchange for payoffs to the administrators in charge of the collections (Chetwynd et al., 2003: 7).

Lieberman (2003) argues that both high administrative quality and high levels of civil cooperation are necessary in order for taxation to become an efficient instrument. A well-functioning bureaucracy is only helpful if the citizens are paying the amount of taxes agreed on, which means that in contexts where false reporting and evasion are seen as the norm, the collection of tax revenues will be a difficult task even for the most impartial administrator (Lieberman, 2003: 31-32). However, Di John (2009) emphasizes the role of legitimacy in order to achieve an efficient tax system and achieve compliance (Di John, 2009: 2). Harring (2016) links the evasion of paying tax to low levels of social and political trust. The author argues that contexts of low QoG tend to generate negative attitudes toward economic instruments that require high levels of social trust, where taxation is exemplified since money transfers in low QoG-societies imply higher risks of corrupt activities (Harring, 2016: 574). These corrupt activities in themselves can be seen as an illegal, regressive tax according to Holmberg and Rothstein (2009), distorting both decision-making- and economic processes and making the monetary contributions from actors and citizens futile (Holmberg & Rothstein, 2009: 142). Rothstein (2011) further argues that tax bureaucrats, who constitute an actor at the bottom of the corrupt system, usually continue with corrupt activities since they know that their "honest behavior" would not have any impact on the system in its entirety (Rothstein, 2011: 99).

Thus, the low levels of trust in conjunction with low institutional quality and corruption is further argued to increase the risk for free-riding and non-compliance (Sholz & Lubell, 1998: 398; Tam & Chan, 2018: 182), which in this case can be linked to the evasion of paying tax. This goes in line with the study of Davidovic et al. (2020) where the authors, from an environmental perspective, find that environmentally concerned people in high QoG countries, where political and social trust is higher, are more likely to pay environmental taxes (Davidovid et al., 2020: 675).

3.6 The effect of corruption on innovation and development

Over the past decades, the idea that institutions play an important role in innovation and eventually economic growth has become more prominent (Rodriguez-Pose & Di Cataldo, 2015; Rothstein, 2011). Some mechanisms explaining this relationship imply that people become more encouraged to exploit their capital if for example, the presence of social capital and generalized trust is high. High-quality institutions are thus needed in order to hinder the occurrence and continuation of anticompetitive, fraudulent and overall impartial behaviors that in turn risk hampering economic growth (Rothstein, 2011: 36-37). Rodriguez-Pose and Di Cataldo (2015) is in line with this, arguing that QoG shapes both the incentives and constraints which determine actors' possibilities for technologically innovative performance. The reason is that institutions are central contributors for "[...] regulating learning processes, supporting the formation of mutual trust and facilitating the transmission of knowledge between innovation players" (Rodriguez-Pose & Di Cataldo, 2015: 675). The argument thus builds on the logic that governments with the capacity to both design and implement effective policies that limit moral hazard, increase accountability, and manage to keep corruption levels low, create more room for innovation and entrepreneurship (Rodriguez-Pose & Di Cataldo, 2015: 674; Rothstein, 2011: 36-37).

It is argued that the lack of economic freedom through low levels of private investments and human capital that aligns with corruption hampers innovation, where functioning institutions such as transports, firms and households are being exemplified (Haldar & Sethi, 2021; Masron & Subramaniam, 2018). Murphy (1993) further discusses that corruption hampers innovation by making it expensive to operate due to bribery and illegitimate rent-seeking. Unestablished innovators are especially highlighted as targets of corrupt activities since they are highly dependent on goods supplied by the government, such as permits and licenses. The overall risk for innovation and starting projects in corrupt environments can be explained by the unavoidable outcome that even though the project was to succeed, the returns will be expropriated, and if it fails, the innovator is the one bearing the cost, creating a fruitless situation no matter the outcome (Murphy, 1993: 412-413). Considering the benefits of technological innovation as a result of an environmental tax instrument discussed in the report by Svenskt Näringsliv (2018-06) and Wittneben (2009), could thus be argued to be undermined and fail to initiate behavioral change when introduced in a context with high levels of corruption.

3.7 Alternative explanations for CO_2 emissions

Literature has found that economic growth tends to increase CO_2 emissions, which many times explains the trend of middle to high-income countries being the greatest polluters (Masron & Subramaniam, 2018: 12493). The environmental Kuznets curve (EKC) is a widely supported tool for explaining the link between economic growth and environmental pollution where early stages of economic development tend to increase pollution until development reaches a turning point where pollution starts to decrease (Masron & Subramaniam, 2018: 12493). Mikayilov et al. (2018) however emphasize that this trend does not apply to the same extent in high-income countries that are EU members, where stricter Carbon mitigation policies constitute the main explanation. However, a positive relationship still occurs (Mikayilov et al., 2018: 623). An additional highlighted factor affecting CO_2

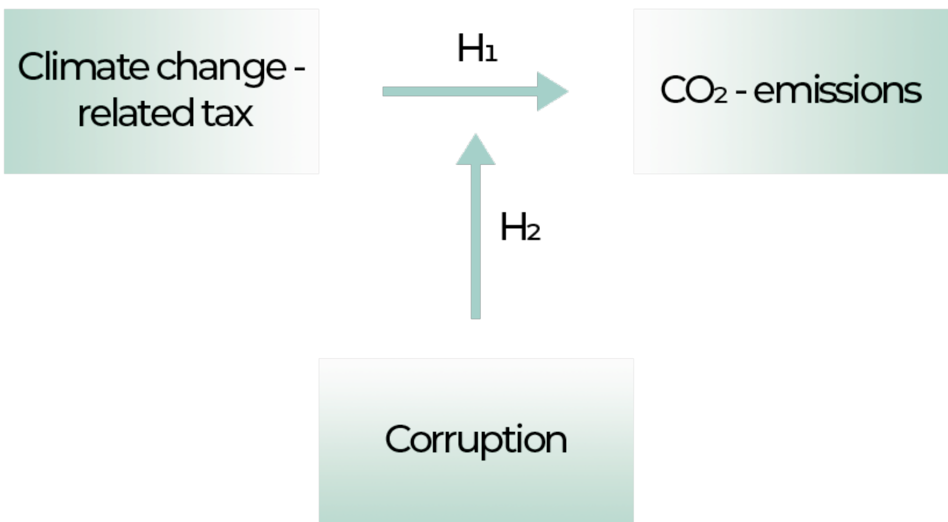
emissions is the size of the urban population in a country. Urban areas are argued to be responsible for at least 70% of the world's total emissions, where traffic, buildings and industries are being described as the main contributors. The effect of urban population on CO_2 emissions is further described to depend on the degree of economic development (Ribeiro et al., 2019: 1-2)

Regime type has additionally been discussed to affect CO_2 emissions. Baloch and Wang (2019) emphasize that democratic governments generally produce environmental regulation systems that are both effective and of high quality, where they accentuate awareness of environmental issues among both citizens and organizations, which in turn leads to support for more environmentally efficient policies, as one reason (Baloch and Wang, 2019: 120). From an African perspective, however, the results of Adom et al. (2018) show that a democratic regime only lowered emissions in some specific sectors and contributed to higher levels of emissions in others (Adom et al., 2018: 525), once again shows signs of varying performance among countries.

3.8 Theoretical model

Based on the theoretical arguments presented above, the following model has been drawn to visualize the relationship between the variables;

Figure 1 - illustration of theoretical model



4. Hypotheses

Based on the discussed theoretical assumptions, I predict that the higher share of environmental tax will affect the levels of CO_2 emissions in a negative direction by the mechanisms of both industrial and individual behavioral change (Svenskt Näringsliv, 2018-06; Lin & Li, 2011; Rafique et al., 2022). The level of CO_2 emissions is expected to decrease foremost as a result of industries developing lower and more efficient carbon productions (Bashir et al., 2021; Wittneben, 2009), and individuals changing their transportation and consumption habits in order to avoid taxation (Grieder et al., 2017). This leads to the following hypothesis;

(H1) *Countries with higher levels of environmental taxes have lower levels of* CO_2 *emissions than countries with low tax levels, which will indicate a negative relationship between the variables.*

I further expect to find that countries with lower levels of corruption will have a stronger negative relationship between the levels of environmental tax and levels of CO_2 emissions, while countries with higher levels of corruption will show a weaker negative relationship due to the earlier established links between corruption, decreased tax revenues, inhibition of innovation, non-compliance and free-riding (Holmberg & Rothstein, 2009; Murphy, 1993; Harring, 2016; Sholz & Lubell, 1998; Tam & Chan, 2018). I expect to find differentiating results between developed and developing countries due to differences in institutional performance, where developed countries are expected to have a more successful outcome of environmental tax as a policy instrument due to lower levels of corruption (Linde, 2009; Bish, 2021; Rafique, 2022). Considering this argument, the second hypothesis has been formulated as follows;

(H2) *Given that corruption acts as a moderating factor, the presence of corruption is expected to weaken the negative relationship between climate change-related tax and* CO_2 *emissions.*

5. Operationalizations

The following section presents the included data and operationalizes the chosen variables before presenting the method and conducting the analysis further down.

5.1 Independent variable

The independent variable "Climate change-related tax revenue (% total tax revenue)" is derived from the QoG Environmental Indicators dataset from 2021 (QoG-EI), where the measurement consists of climate change-related tax revenues as a percentage of the total tax revenue. Besides taxes, these revenues include charges, fees, deposit-refund systems, tradable permits, environmentally motivated subsidies and voluntary approaches related to the domain of climate change (Povitkina et al., 2021). The OECD database "Policy Instruments for the Environment" (PINE) from 2017, where the data originates, points out climate change-related tax as one specific domain related to environmental policy instruments. Moreover, this is explained to involve taxes directly related to the domain of climate change and include fuel taxes, taxes on GHGs, energy taxes, revenue from auctioned permits of emission trading systems for GHGs, taxes on-road use, forestry taxes, etcetera (OECD, 2022-02).

The PINE-rapport (2017) further clarifies that fees and charges are used interchangeably which refers to payments that have a direct purpose to maintain the cost of a service. Where in contrast, the purpose of taxes is to raise revenues for general government services. This could for example involve different revenues related to fossil fuels where payments related to the emissions generated from fossil fuels would be classified as a tax, and payments connected to the volume of consumed fossil fuels would be considered a fee/charge. Moreover, tradable permits refer to the allocation of emissions or resource exploitation rights. Here, the cap-and-trade system can be exemplified where actors are allowed to "trade" emissions amongst each other provided that the emissions of the predefined cap are not exceeded. In a deposit-refund system, a surcharge is placed on a potentially polluting product such as bottles, motor vehicles, lead-acid batteries, or scrapped tires and is refunded if the products in question are returned. Furthermore, a subsidy could be described as a tax cut on something that has been proven to directly or indirectly reduce negative environmental impacts, where VAT exemptions on electric cars or renewable energy can be exemplified (OECD, 2017). Lastly, voluntary approaches refer to the self-initiated commitment by firms or industries to "improve their environmental performance beyond legal obligations" (OECD, 2017: 10).

5.2 Dependent variable

The dependent variable, "CO_2 emissions per capita" is obtained from QoG-EI (2021). With originating data from the Emissions Database for Global Atmospheric Research, the variable measures the total amount of carbon dioxide emissions per country, divided by the population of each country. Tonnes of CO_2 per capita constitutes the unit. By including population size in the measurement, the results will become more comparable between countries. The variable includes every fossil CO_2 source, where the following can be exemplified;

- fossil fuel combustion
- non-metallic mineral processes (e.g., cement production)
- metal (ferrous and non-ferrous) production processes
- urea production
- agricultural liming and solvents use

Due to a highly right-skewed distribution, this variable is logged.

5.3 Moderating variable

The included contextual level variable that moderates the relationship between my independent and dependent variable is corruption. Considering the relationship between corruption and decreased tax revenues (Holmberg & Rothstein, 2009), and how significant impact institutional quality and corruption have on innovation (Murphy, 1993), a variable measuring corruption levels is necessary to understand the varying effects that environmental taxes have on CO_2 emissions. I will use the Bayesian Corruption Indicator (BCI)-variable, which is included in the QoG Standard TS dataset from 2022 provided by the Quality of Government Institute. The data originally derives from Ghent University in Belgium. The indicator is based on an index where the values lie between 0-100, where a higher value implies higher levels of corruption. The measure is based on individual survey data where 0 implies the lowest levels of perceived corruption imaginable and 100 means that it is as bad as it gets. The index is further a composition of 20 different surveys and 80 survey questions with responses collected from inhabitants, companies, NGOs and officials (Teorell et al., 2022).

5.4 Control variables

5.4.1 Real GDP per capita

"Real GDP per capita" in 2011 USD dollars will be included as a control variable from the 2022 QoG Standard dataset. The data is based on the Maddison Project Database from 2018. This paper uses Real GDP per capita to capture the value of relative income across countries with regard to the population trend (Bolt et al., 2018: 2). 'Real' indicates that the series is based on a common set of prices between countries (Bolt et al., 2018: 4). The measure further considers how price levels of export products evolve in relation to the level of import prices, which makes it a good choice when including greater economies with large-scale international trade in the analysis. Although GDP per capita on its own can be a good measure of productivity/economic growth and a precise measure of income differences across countries, it fails to capture the development of a country's consumption patterns and the descending trend of emissions after the tipping point of increased production is reached. Therefore, an additional, squared form of GDP per capita will be included in the analysis in order to capture the effect of the U-shaped Environmental Kuznets Curve (Arminen, 2018; Masron & Subramaniam, 2018; Bolt et al., 2018: 5-6).

Due to the skewness of the values, the variable is logged. However, since some observations in the variable contain a value of "0" it constitutes a problem since the logarithm of zero is undefined. Therefore, a constant (x+1) is added to the data before the log transformation is conducted (Mehmetoglu & Jakobsen, 2016).

5.4.2 Urban population & population density

Due to the higher levels of industrialization, and in turn emissions, that urbanization causes (Ribeiro et al., 2019), the level of urban population in each country will be controlled for. The variable is measured as the percentage of the total population living in urban areas. Additionally, since a larger population naturally results in increased energy consumption and emissions, population density is added to the model. The variable is measured as the yearly quantity of the population in a country divided by land area in square kilometers (Teorell et al., 2022; Acemoglu et al., 2001). This variable is logged due to high skewness.

5.4.3 Fossil fuel energy consumption

Since the burning of fossil fuels constitute the primary source of pollution, it can be considered one of the factors with the most direct impact on a country's CO_2 emission levels. Fossil fuel energy consumption is measured as a percentage of the total energy consumption where the data originates from the World Bank (2020) and the World Development Indicators (obtained from QoG-EI, 2021). The non-renewable sources that are classified as fossil fuels are; coal, oil, petroleum and natural gas products.

5.4.4 Level of democracy

Since democratic governments tend to produce more effective environmental policies of higher quality (Baloch and Wang, 2019), the level of electoral democracy will thus be controlled for in order to exclude any effect regime type has on the levels of CO_2 emissions. The electoral democracy index originated from the V-Dem institute will be used where the measure is based on free and competitive elections and free formations of political and civil organizations. Components such as freedom of speech and politically independent media are included as well (Povitkina et al., 2022).

6. Method & data

To examine the possible effect climate change-related tax has on CO_2 emissions, a quantitative analysis using survey data constitutes the most appropriate choice of method to establish a correlational link between the phenomenons. Furthermore, to investigate the effect a country's corruption levels might have on the theorized relationship, multilevel modeling will be performed using the statistical software program Stata (version 16.1) to analyze the data.

Since earlier research has established a link between carbon taxes and decreased CO_2 emissions in developed countries (Dogan et al., 2022, Rafique et al., 2022, Bashir et al., 2021), I would like to investigate if this pattern is globally persistent, when comparing countries over time. By including data on a large number of countries, the analysis will be based on a good selection of various climate change-related tax rates, as well as countries with varying environmental and institutional performances. The plan is thus to combine data from 196 countries between 1992 and 2020. The time frame is based on the initial introduction of a carbon tax among countries at the beginning of the 1990s (OECD, 2017). Moreover, due to difficulties during the merging process (specifically with the values of Serbia), the years before 1992 have been reduced to obtain a balanced dataset.

The analyzed data originates from OECD, EDGAR, PSR Group, UN Population Division, Groningen Growth and Development Centre, The World Bank Group and the V-Dem Institute and is compiled by the Quality of Government Institute. The independent and dependent variable, as well as one of the control variables, are derived from the QoG Environmental Indicators Dataset from 2021 (Qog-EI) that have been merged together with the moderating variable and the remaining control variables included in the QoG Standard Dataset from 2022. Summary statistics for all included variables can be found in the appendix (Table 1).

Linear, cross-sectional panel data will be analyzed to test the hypothesis using fixed effects model[1]. When running the Woolridge test, a significant result show signs of autocorrelation and heteroscedasticity. The method used to detect autocorrelation in panel data is based on Durbin-Watson (Mehmetoglu & Jakobsen, 2016: 150-151). In order to account for autocorrelation and heteroscedasticity and avoiding false correlations between the variables, clustered standard

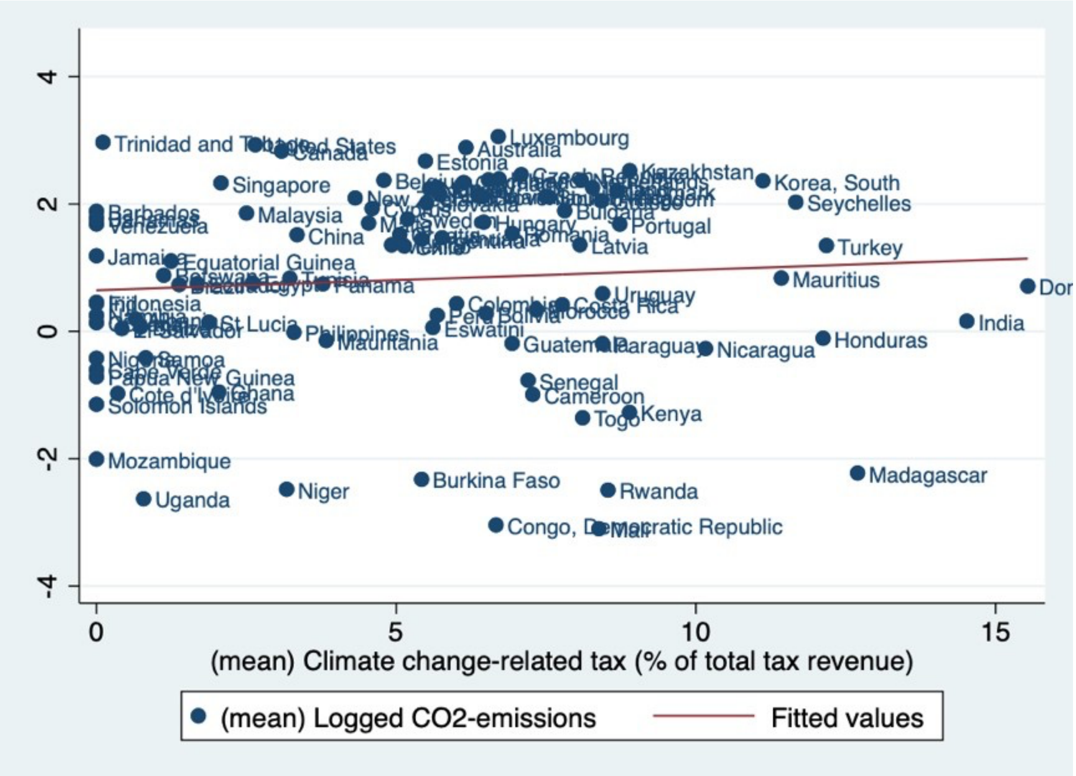
[1] A significant Hausman test clearly indicated that fixed-effects was the most suitable model to use (Mehmetoglu & Jakobsen, 2016: 240).

errors will be added to the regression (Mehmetoglu & Jakobsen, 2016: 260). The correlation matrix (Table 2 in Appendix) along with further tests such as the Variance Inflation Factor (Table 3 in Appendix) indicate no major problems with multicollinearity.

The main reason for testing a model with panel data is to take possible time-related changes in the main independent variable into consideration. In this case, it involves changes in the climate change-related tax rate, which in many countries have increased over the decades while simultaneously changing depending on the ruling government. Positive and negative changes in other variables that potentially influence the model are additionally accounted for by including a year variable. In the attempt of solving the problem of reversed causality, all independent variables will be lagged for one to four years (Mehmetoglu & Jakobsen, 2016: 253-254). This implies that the value of X (climate change-related tax) and its effect on Y (CO_2 emissions) in one year's time are based on X's value from the previous year. In short, for X to have a causal effect on the present value of Y, X has to occur before. Including one to four years lags in the model thus gives me a broader outlook on the relationship and enables me to explore how many years it takes for changes in climate change-related tax to influence CO_2 emissions (Mehmetoglu & Jakobsen, 2016). Additionally, using panel data automatically increases the number of observations which increases the robustness of the model.

The analytical strategy of my non-additive model will be divided into four steps. Firstly, I will be testing the relationship between the share of climate change-related tax (independent variable) and CO_2 emissions (dependent variable) separately in a bivariate model (H1). Thereafter, a number of control variables will be added in a second model in order to enhance the validity of the focal relationship by excluding the influence of other exogenous variables. Thirdly, (H2) will be tested by investigating the moderating effect of corruption in a third model where the interaction variable is added to the focal relationship by using a product-term approach (Mehmetoglu & Jakobsen, 2016). In a fourth model, all variables including the moderator and additional control variables, will be tested simultaneously. These steps will be repeated four times in total, with one to four years lags.

Figure 2: Scatterplot over independent and dependent variables (mean value)



The scatter plot above (figure 2) shows tendencies of a positive relationship between climate change-related tax and Co2 emissions on a country-level. However, we still don't know if one is causing the other without including other factors that could potentially influence the relationship. By including control variables in the regression later, we will see if the trend changes.

7. Results

The following section starts with a regression analysis on hypothesis one, concerning the relationship between the independent variable and dependent variable. After that, hypothesis two is addressed, suggesting that the effect of climate change related-tax on CO_2 emissions is moderated by the level of corruption. Both hypotheses include separate models, with and without control variables. The regression results are visualized in four tables and 16 models in total (four models for each lag) that can be found in the Appendix.

Table 4: Regression table with one year lag

CO_2 emissions (logged)	Model 1	Model 2	Model 3	Model 4
Climate tax (% of total)	-0.00215 (0.00477)	0.00153 (0.00350)	0.0218 (0.0209)	0.0172 (0.0265)
Real GDP per capita (logged, squared)		0.0114** (0.00407)		0.0114** (0.00405)
Democracy index		0.00154 (0.0865)		0.00596 (0.0853)
Urban population		0.0000621 (0.00563)		0.000146 (0.00558)
Fossil energy (% of total)		0.0156*** (0.00311)		0.0154*** (0.00305)
Population density (logged)		0.242 (0.175)		0.243 (0.177)
Corruption		0.00000989 (0.00469)	0.00107 (0.00527)	0.00135 (0.00530)
Climate tax*corruption			-0.000460 (0.000379)	-0.000293 (0.000464)
_cons	0.981*** (0.0259)	-1.826** (0.585)	0.905*** (0.243)	-1.903** (0.621)
N	2078	1470	2002	1470
adj. R-sq	-0.000	0.318	0.003	0.319
AIC	-823.0	-2265.0	-942.5	-2268.0
BIC	-817.4	-2228.0	-925.7	-2225.7

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

In the table above, Model 1 and 2 represent hypothesis one, while Model 3 and 4 represent hypothesis two. The coefficient for the bivariate relationship stays negative with both one respectively two-year lags (see Model 1 above respectively Model 5, Table 5 in Appendix), but changes to positive with three and four years (Table 6, Model 9 and Table 7, Model 13 in Appendix). However, the relationship is weak, and since non of the values are statistically significant, we cannot draw any conclusions regarding the effect on climate change-related tax on CO_2 emissions alone. Although a considerable increase in robustness (which can be interpreted through the increased value of the adjusted R-square), this trend seems to continue even when control variables are added. Moreover, the value of the coefficient seems to turn positive in Model 2 and remains so in the same models with two-four-year lags.

One reason for the shift in direction of the coefficient of the bivariate relationship in Model 2 when adding the confounding variables, could be the strong influence of Real GDP per capita. Results show that a one percent increase in economic growth over a period of one-year results in approximately 0.01 % increase in CO_2 emissions (similar results with a significant p-value can be found in Model 6, Table 5 with two-year lags). No other control variables except fossil fuel consumption turn out to be statistically significant in the same model. The significance of the variable further represents its predicted influence on the dependent variable, and thus succeeds to control for the effect that the burning of fossil fuels has on a country's level of CO_2 emissions. A one-unit increase in fossil fuel consumption seems to increase levels of CO_2 emissions by 0,015 %, indicating a quite weak but highly significant relationship between the control variable and the dependent variable.

The interaction term is added to see if it enhances the fit of the model. In the absence of an interaction term, the focal relationship is assumed to be the same across all values of the moderator. The inclusion of the interaction term further allows the focal relationship to vary across these values (Aneshensel, 2012). When observing the slope of the interaction term it appears to be negative in both models, meaning that for a one-unit increase in corruption levels, the effect of climate change-related tax on the dependent variable is expected to decrease by -0.00046 % (Model 3) and -0.00029 % (Model 4). However, when looking at the effect of the interaction term in Model 3 and 4, no significant results can be found (which also applies to the models with two-to-four-year lags). Although weak and non-significant, it is worth noting that the relationship is the opposite of what hypothesis two predicted. Furthermore, similarly to

Model 1 and 2, the only significant results among the control variables in Model 4 are Real GDP per capita and fossil fuel consumption (which also remains in Model 8 in Table 5 in Appendix, with two-year lags).

The bivariate relationship shows to be non-significant even when the interaction term is included, however with a slightly more positive slope compared to Model 2. This trend seems to remain when adding two-to-four-year lags. The inclusion of corruption as an individual-level control variable does not seem to have any effect on the dependent variable in any of the models either.

8. Discussion

Now let us discuss the empirical findings in relation to the hypotheses. The results of the first two models are mixed where a negative relationship is displayed for Model 1 while a positive relationship occurs when adding control variables in Model 2. However, since there are no signs of statistical significance in either of them, we cannot draw any conclusions about the focal relationship and thus not confirm (or dismiss) hypothesis one. When adding corruption as a moderator in Model 3 and 4, the focal relationship remains positive but non-significant. The same goes for the interaction term where the coefficient turns out to be negative. Therefore, we will also retain the null hypothesis that includes the moderating effect.

Even though both the focal-and moderating relationship lacks significance in all models displayed in the table above and in the Appendix, the unexpected directions of the slopes are still interesting and worth discussing. The hypothesized link of the focal relationship implied that climate change-related tax would have a negative effect on CO_2 emissions, i.e., that the presence of climate tax would lead to decreased CO_2 emissions due to mechanisms of green innovation and behavioral change. The second hypothesis suggested that the climate change-related tax would lose its steering effect in conjunction with adding corruption as a moderator. The assumption was that the presence of corruption would weaken the negative relationship by the mechanisms of embezzlement, free-riding, non-compliance, and general hampering of innovation that would result in climate change-related tax losing some of its decreasing effect on CO_2 emissions. However, since the results in Model 2 and 3 showed the opposite (although not being statistically significant), it raises some interesting questions about the findings and the study's design.

Considering the positive (and significant) effect of Real GDP per capita on CO_2 emissions, which overall aligns well with general theoretical assumptions (Masron & Subramaniam, 2018), one must consider what this impact means for the rest of the model. Could it simply have to do with the contextual explanation regarding the size of a country's economy? For example, in developed countries which generally have lower corruption levels, tax revenues are expected to be more successful than in countries with higher levels of corruption (Povitkina (2018; Haldar & Sethi 2021). However, since developed countries also have higher economic growth (which is regarded as one of the primary causes of high CO2 emissions), this could potentially mean that the effect of corruption on climate tax efficiency is being overshadowed and undermined by the presence of GDP per capita. Although we cannot be entirely sure about this, especially due to the non-significant results, some approximations can be made for future research. Since GDP appears to be such a strong driver given the findings, it is hard to overlook the effect economic growth has on CO_2 emissions in this particular case. Henceforth, a more detailed and precise model would have to be conducted to capture the true effects of corruption. This requires a design accounting for the assumed decelerating effect that a climate tax has on emissions, or in other words the "decrease of the increasing effect" in a context where emission levels will continue to rise even though a carbon tax is present (Haldar & Sethi, 2021). However, this type of project is beyond the scope of this study.

As mentioned, it is still crucial to report the findings of a non-significant result and to point out that the inclusion of other factors could have led to different findings. Considering that this thesis aims to look at the effect of climate change-related taxes on CO_2 emissions, a tax that directly targets pollution is to be considered a valid operationalization of the concept by itself. However, there is one validity problem concerning the measure that can be detected. Since the share of general taxes within each country is what determines the percentage of climate change-related tax, it runs the risk of disguising the true effect of the climate tax per se (OECD, 2010: 33-35). This means that the specific rate can be due to changes in tax levels in general and not solely to changes in the level of the climate tax. Drawing valid conclusions about the relationship based on the results only with the inclusion of the climate change-related tax can thus be considered a limitation. Although the QoG Standard dataset provides a variable concerning the share of direct taxes on a country level, it was deliberately removed from the model since it affected the total number of observations in Model 2 and 4 substantially. Even though it succeeded to capture some omitted effects (it appeared to be significant), adding the variable to the model could thus lead to false results since a much smaller number of countries are included. Which in turn could risk driving the findings in a different direction. The variable turned out to have an impact on the significance of GDP per capita, but not on the main relationship.

To exemplify a few cases where the omitted effect of general taxes and GDP per capita leads to questionable results, one can look at the scatterplot of the bivariate relationship illustrated in 6.0 Method (page 24). For example, the position of countries like Togo, Congo and Rwanda in the graph tells us that relatively high climate change-related tax leads to low CO_2 emissions. Although when browsing the data, these countries also seem to have relatively high levels of corruption and low GDP per capita compared to other countries with similar percentages of climate tax such as Finland, Australia and Belgium (Teorell et al., 2022). Firstly, this demonstrates the strong effect of GDP per capita on CO_2 emissions levels. Secondly, the positions visualize the likelihood that some countries' high climate tax rates in fact are due to a lower percentage of general tax, since the position of the Scandinavian countries (who are generally known to have among the highest climate tax in the world, FM coalition, 2022-04: 9), does not stand out from the crowd and appear to have lower climate tax than the mentioned countries when observing the scatterplot. Meaning that even though their climate taxes are high, they do not appear to be as high in relation to the general tax rate in the country. The validity problem in question seems to apply to the data in its entirety since the results remained with no major changes when running the model with ”Cook's Distance”-calculations (> 4/n), to detect the possible effect of outliers in the regression model (Mehmetoglu & Jakobsen, 2016: 156).

One should have in mind though, that the examples above are only meant to envision how omitted factors might affect our model. By using the fixed-effects approach we still account for a lot of the variation regarding GDP per capita and climate tax rates in our model, since most of the factors concerning within-country variation are controlled for (Mehmetoglu & Jakobsen, 2016: 242). However, there is still a risk of some endogeneity problems inside the within-variation that the fixed effects model fails to account for, which might give us inaccurate results. For example, since institutional quality and corruption are known for being a highly persistent phenomenon taking decades to change (Rothstein, 2018; Prasad et al., 2018), the variable might include too little variation over time for our fixed-effects model to capture. This is due to the limitations of the fixed-effects model when it comes to accounting for factors that change slowly over time. In turn, this might mean that the current model is undermining the true effect of corruption (Mehmetoglu & Jakobsen, 2016: 249). And since corruption further affects the capacity for innovative solutions (which constitute the key mechanism between climate tax and levels of CO_2 emissions), it could mean that the links between the variables are too vague for the model to detect.

Although a cross-sectional study could be a better option when considering corruption as a relatively persistent variable, it would be difficult to capture the true effect of the climate tax since it is assumed to take time for the key mechanisms to "kick in" before an actual change in the levels of CO_2 emissions can be detected as an indirect effect of the policy instrument implementation. It would also be hard to avoid the problem of reversed causality by not using panel data with one or more lags (Mehmetoglu & Jakobsen, 2016: 253-254).

9. Conclusion

This paper has aimed to examine if institutional quality, and more specifically corruption, has a moderating effect on the efficiency of environmental policy instruments in terms of CO_2 emissions. By focusing specifically on climate change-related tax revenues, the thesis hypothesized that higher tax levels would lead to a decrease in CO_2 emission levels due to mechanisms of green innovation and behavioral change (H1), and subsequently that the presence of corruption would weaken this decreasing relationship due to embezzlement, inhibition of innovation, noncompliance etcetera. Influencing the tax to lose some of its effectiveness in decreasing CO_2 emissions (H2). A time-series analysis with panel data on 196 countries between 1992 and 2020 was conducted using fixed-effects models. Regarding the empirical findings, no support was found for either of the hypotheses, meaning that we cannot confirm the moderating effect of corruption on climate change-related tax and CO_2 emission levels based on the results from this study.

Despite the lack of support for the hypotheses, the results still lead up to some interesting points while displaying a few potential weaknesses of the models. Since the relationship between climate change-related tax and CO_2 emissions turned out to be positive (although not statistically significant), in contrast to what was expected, it raised questions regarding the impact of some control variables that turned out to have a great influence on the model. This may be because developed countries, which tend to have lower levels of corruption, simultaneously has higher GDP per capita than developing countries, that in general suffers from higher levels of corruption (Mehmetoglu & Jakobsen, 2016). The strong empirical links between GDP and CO_2 emissions can thus be argued to have overshadowed the impact of corruption and climate change-related tax in this case. Although there are examples, such as Sweden, where the emissions have fallen simultaneously as GDP per capita has risen (FM Coalition, 2022-04: 9). The exclusion of a general tax-variable did also most likely affect the model since the percentage of the climate change-related tax is dependent on the general tax rate in the country. Although the diagnostic tests strongly indicated that a fixed-effects approach was the best fit for the model, its inefficiency in capturing within-variation effects of consistent factors may have affected our corruption variable, since it is known for being persistent and tend to change slowly over time (Rothstein, 2018; Prasad et al., 2018). In turn, this complicates the ability to perform time-series, especially using a fixed-effects model.

These encountered issues further represent new paths for future research to take on, where future models must be able to capture the true effect of climate tax without undermining the moderating effect of corruption. Since we know for a fact that climate tax incites green innovation (Bish, 2021; Rafique 2022), it is of high importance to consider corruption when studying environmental instrument efficiency, which hampers innovation through (i.a) illegitimate rent-seeking and bribery (Haldar & Sethi, 2021; Murphy, 1993). All things considered, the effect of institutional quality on environmental policy instruments in terms of efficiency clearly needs further exploring, especially to solve the problem of bad environmental performance within developing countries (Povitkina, 2018). A better understanding of the subject will thus allow for more adapted policy recommendations for governments that want to improve their environmental quality while also dealing with high levels of corruption, which will allow a larger share of countries to successfully participate in multilateral cooperation that will improve the chances of achieving long-term climate goals.

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Appendix

Table 1: summary statistics, independent and dependent variables

Variable	Obs	Mean	Std. Dev.	Min	Max
CO_2 emissions (log)	4933	.525	1.693	-3.906	5.157
Climate tax (% of total)	2208	5.408	3.941	-12.254	20.504
Corruption	4663	47.331	15.94	6.45	74.963
Real GDP per capita (log)	4371	8.914	1.223	0	11.96
Urban population	5524	55.112	23.446	6.288	100
Population density (log)	5522	4.196	1.44	.367	9.871
Democracy index	4954	.516	.267	.013	.919
Fossil energy (% of total)	3175	64.914	30.358	0	100

Table 2: Matrix of correlations

Variables	CO_{2-} emissions	Climate tax (% of total)	Corruption	Real GDP per capita	Urban population	Population density	Democracy index
CO_2 emissions	1.000						
Climate tax (% of total)	-0.0484	1.000					
Corruption	-0.5856	-0.0015	1.000				
Real GDP per capita	0.7490	-0.0056	-0.8017	1.000			
Urban population	0.4806	0.291	-0.5477	0.6273	1.000		
Population density	0.0850	-0.0742	-0.1838	0.2314	0.1993	1.000	
Democracy index	0.4609	0.0865	-0.5357	0.5500	0.5302	-0.0881	1.000
Fossil energy (% of total)	0.3986	-0.0021	-0.1770	0.2943	0.3890	0.1624	0.2103

Table 3: Variance Inflation Factor (VIF)

	VIF	1/VIF
Corruption	2.972	.337
Real GDP per capita	3.453	.29
Democracy index	1.78	.562
Fossil energy (% of total)	1.216	.822
Climate tax (% of total)	1.015	.986
Population density	1.3	.769
Urban population	1.98	.505
Mean VIF	1.942	.

Table 5: Regression table with two-year lags

CO_2 emissions (logged)	Model 5	Model 6	Model 7	Model 8
Climate tax (% of total)	-0.00122	0.00264	0.0236	0.0209
	(0.00456)	(0.00333)	(0.0202)	(0.0256)
Real GDP per capita logged, squared)		0.00890*		0.00891*
		(0.00377)		(0.00373)
Democracy index		-0.0281		-0.0230
		(0.103)		(0.101)
Urban population		0.000866		0.000963
		(0.00536)		(0.00530)
Fossil energy (% of total)		0.0143***		0.0141***
		(0.00305)		(0.00300)
Population density		0.240		0.241
		(0.170)		(0.173)
Corruption		-0.000261	0.000902	0.00131
		(0.00486)	(0.00526)	(0.00546)
Climate tax*corruption			-0.000476	-0.000343
			(0.000364)	(0.000446)
_cons	0.973***	-1.520**	0.915***	-1.610**
	(0.0247)	(0.563)	(0.242)	(0.599)
N	2019	1470	2002	1470
adj. R-sq	-0.000	0.253	0.003	0.256
AIC	-838.0	-2128.8	-959.7	-2133.0
BIC	-832.4	-2091.7	-942.9	-2090.7

Standard errors in parentheses
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 6: Regression table with three-year lags

CO_2 emissions (logged)	Model 9	Model 10	Model 11	Model 12
Climate tax (% of total)	0.000999	0.00483	0.0186	0.0242
	(0.00427)	(0.00314)	(0.0193)	(0.0251)
Real GDP per capita (logged, squared)		0.00675		0.00676
		(0.00347)		(0.00343)
Democracy index		-0.0261		-0.0207
		(0.126)		(0.124)
Urban population		0.000733		0.000836
		(0.00508)		(0.00502)
Fossil energy (% of total)		0.0130***		0.0128***
		0.00296)		(0.00289)
Population density		0.251		0.253
		(0.168)		(0.171)
Corruption		-0.00147	-0.000702	0.000187
		(0.00518)	(0.00524)	(0.00576)
Climate tax*corruption			-0.000337	-0.000363
			(0.000347)	(0.000436)
_cons	0.975***	-1.232*	0.994***	-1.328*
	(0.0232)	(0.563)	(0.241)	(0.598)
N	1932	1470	1915	1470
adj. R-sq	-0.000	0.203	0.001	0.206
AIC	-906.5	-2033.1	-1021.9	-2037.6
BIC	-901.0	-1996.0	-1005.2	-1995.3

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 7: Regression table with four-year lags

CO_2 emissions (logged)	Model 13	Model 14	Model 15	Model 16
Climate tax (% of total)	0.00188	0.00497	0.0178	0.0263
	(0.00413)	(0.00305)	(0.0192)	(0.0240)
Real GDP per capita logged, squared)		0.00376		0.00378
		(0.00325)		(0.00320)
Democracy index		-0.0283		-0.0222
		(0.146)		(0.145)
Urban population		0.00114		0.00125
		(0.00494)		(0.00486)
Fossil energy (% of total)		0.0119***		0.0116***
		(0.00295)		(0.00287)
Population density		0.286		0.288
		(0.171)		(0.173)
Corruption		-0.00202	-0.00139	-0.000190
		(0.00547)	(0.00553)	(0.00605)
Climate tax*corruption			-0.000306	-0.000399
			(0.000346)	(0.000417)
_cons	0.982***	-1.023	1.033***	-1.128
	(0.0225)	(0.589)	(0.253)	(0.624)
N	1842	1470	1825	1470
adj. R-sq	-0.000	0.163	0.001	0.167
AIC	-940.3	-1938.2	-1064.9	-1943.7
BIC	-934.8	-1901.2	-1048.4	-1901.3

Standard errors in parentheses
* $p<0.05$, ** $p<0.01$, *** $p<0.001$