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Global Versus Regional Carbon Taxation: Exploring a Natural Experiment

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Abstract: The reduction of global greenhouse gas (GHG) emissions is a priority due to climate change. Scientists across disciplines promote carbon taxation or carbon pricing as an instrument to mitigate the negative externality of fossil energies. We exhibit two insufficiencies of today's regulatory policy by utilizing a novel natural experiment. First, carbon taxation is only effective if it is implemented on a global scale because fossil energy markets and emissions are cross-border and global. Second, carbon taxation is based on an extrinsic mechanism and does not alter intrinsic behavior sustainably. Our applied theory and modeling approach are corroborating these findings. The present regulatory approach is doomed to fail due to overambitious European countries and unambitious (partly realistic) rest of the world. Our interdisciplinary analysis unravels a new agenda to achieve the essential aim. What is needed is a global climate club, as proposed by Nobel Laureate William Nordhaus, with a least but global GHG reduction.

Keywords: carbon taxation, climate change, global markets, intrinsic sustainability, climate club, optimal global action

1. Introduction

The climate crisis is one of the greatest challenges of our times. The global and cumulative nature of greenhouse gas (GHG) emissions in the atmosphere is causing the warming of the earth [1]. Climate change has negative impacts on the planet, including more frequent heatwaves, droughts, and storms, as well as rising sea levels and the loss of biodiversity.

During the coronavirus disease 2019 (COVID-19) pandemic, Galbraith and van den Bergh [2] were arguing for a carbon tax to aid economic recovery and climate. Similar research by Drews et al. [3, 4] studies the perceptions of people's attitudes to carbon taxation. While that research provides valuable insights into the benefits of carbon taxation, it equally reveals two unrecognized flaws. Enforcing tax policies requires an understanding of the workings of global energy markets on the one hand. On the other hand, market-based instruments mainly activate extrinsic incentives and do not facilitate intrinsic impetus. As a consequence, today's policies, such as carbon taxation, do not alter long-term human behavior and the patterns of global energy markets.

We employ both the public goods theory and the theory of externalities in economics. The combustion of fossil fuels for energy production results in the emission of GHGs with far-reaching environmental consequences. Negative externalities cause rising sea levels, extreme weather events, and a loss of biodiversity. These developments are associated with societal costs, including extreme tail events [5]. Those costs are not internalized by fossil fuel consumers and producers. The economic theory, notably championed by Arthur Pigou, posits that the market equilibrium fails to account for these external costs, leading to an overconsumption of fossil energy.

The concept of a carbon tax aligns with Pigouvian principles, proposing a corrective mechanism to internalize the external costs associated with CO_2 emissions. By imposing a tax on fossil fuels, policymakers seek to align private and social costs, encouraging producers and consumers to consider the environmental impact of their choices. This economic incentive, rooted in the Coasian tradition of internalizing externalities through market mechanisms, aims to guide economic agents toward socially optimal outcomes.

This article newly unravels that climate policy hinges on both a global climate club and intrinsic impetus. We find that a Pigouvian CO_2 tax on emissions effectively works if and only if the tax is implemented globally via a large climate club. Internalizing the costs of CO_2 emissions, which is a global negative externality, requires equally a global response. Furthermore, enforcing a CO_2 price (or tax) regionally alone is economically unsuccessful due to its mere external incentive structure and unilateral setting. Effective economic climate policies require both global external and internal incentives in order to change human behavior and markets sustainably. Our paper outlines both the theoretical underpinning and empirical support for a global climate club aligned with intrinsic and extrinsic incentives.

This article is organized as follows. Section 2 provides a literature review. Section 3 illustrates the methodology. In Subsection 3.1, we describe the theoretical foundations and the research design (Subsection 3.2). We exhibit the main findings in Subsection 3.3. Finally, Section 4 contains concluding remarks and Section 5 policy recommendations.

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2. Literature Review

The reports of the [1, 6], the COP27 in Sharm El-Sheikh in 2022 and COP28 in Dubai in 2023, exhibit that regulatory policy and individual day-to-day behavior do not adapt sufficiently or ignore obnoxious scientific evidence in regard to climate change. The sluggish reaction relies, among others, on two unrecognized issues. A general literature review about carbon taxes is provided by Timilsina [7].

2.1. Policy trade-off

First, domestic carbon taxation does not trigger a sustainable change in global market dynamics. GHG emissions are a global negative externality without a price. A carbon tax or carbon price mitigates those externalities according to economic theory [8]. Feld and Nientiedt [9] show that such a policy follows a liberal Hayekian principle. On the contrary, Galbraith and van den Bergh [2, 10], among others, do not study the enforcement of an effective CO_2 price or CO_2 tax in a global market. Indeed, they ignore the cross-border character of fossil emissions and do not consider the trade-off between regional and global institutions in order to protect a global public good. For the first time in the literature, we demonstrate that effective climate policy hinges on a global response and not merely a regional policy framework.

2.2. Incentive schemes

Second, similar to the literature above, we exhibit that a carbon tax is merely based on extrinsic rather than intrinsic motivation. Yet, long-term behavioral change requires both [11, 12].

Unraveling the working of intrinsic sustainability explains why the green transition is partially stuck. Standard economic analysis suggests that extrinsic instruments increase, not decrease the willingness of behavioral adaption. However, economic theory is blind to the commercialization effect. Various experimental studies by Falk and Szech [13], Heyman and Ariely [14], Holmås et al. [15], Ekelund and Bergquist [16], and Falk et al. [17] exhibit the flaws of extrinsic schemes and reveal the importance of intrinsic impetus on human behavior.

Empirical evidence suggests that extrinsic incentives corrode intrinsic motivation [12]. For instance, Frey et al. [18] and Frey and Oberholzer-Gee [19] point out that the extrinsic price effect is sometimes confounded by moral considerations. The prospect of paying a carbon tax to eligibly emit carbon transforms a civic duty into a pecuniary problem. The intrusion of only extrinsic market principles crowds out the sense of individual responsibility. The authors conclude, "using price incentives to muster support for the construction of a socially desirable, but locally unwanted, facility comes at a higher price than suggested by standard economic theory because these incentives tend to crowd out civic duty". This confirms that extrinsic mechanisms alone might corrupt or degrade societal wishful behavior.

Indeed, domestic carbon taxation as a policy solution does not sufficiently focus on long-term behavioral adaption. In principle, it triggers a one-sided commercialization effect. A long-term and effective solution should activate both extrinsic and intrinsic motivation. While extrinsic motivation is necessary, intrinsic is pertinent for sustainable change according to the literature. Consequently, public policy has to redesign the existing environmental regulation following behavioral and psychological sciences.

2.3. Carbon taxation

The theoretical underpinning of this literature is rooted in Pigouvian economics, emphasizing the internalization of externalities associated with GHG emissions. There exists seminal research by Weitzman [5], Stern [20], and Rode et al. [21]. This research provides foundational insights into the economic rationale for taxing carbon, considering the market failures inherent in unpriced carbon emissions. The efficiency and effectiveness of carbon taxation are further explored through the lenses of economic models, including the seminal contribution by Nordhaus [22].

Empirical studies further exhibit the role of carbon taxation. They are providing insights into the real-world impacts of policy implementation. Recent contributions by Pretis [23] and Pan et al. [24–28] delve into the specificities of carbon tax design and its implications for emissions reduction in general. Similarly, there is a range of case studies, including experiences from Sweden and British Columbia, to elucidate the tangible outcomes and challenges associated with carbon taxation.

As climate change inherently is a global challenge, the literature is pertaining to an international perspective. Contributions by Baylis et al. [29] and Xu et al. [30] explore the potential for global coordination through mechanisms such as cross-border carbon adjustments. The analysis incorporates insights from the Paris Agreement [31] and assesses the challenges and opportunities associated with harmonizing carbon taxation policies across diverse economies, drawing on insights from [32].

While carbon taxation is praised for its potential, there is a literature addressing its challenges and criticisms [33]. Scholars such as Klenert et al. [34], Gokhale [35], Jakob [36], and Bertoldi [37] investigate issues ranging from regressive impacts on vulnerable populations to concerns about competitiveness and carbon leakage. They are examining the proposed mitigating strategies and policy adjustments.

In synthesizing the literature review on carbon taxation and policy instruments, our study contributes to the literature by addressing critical gaps and advancing the understanding of effective climate policy. Existing research, as exemplified by the IPCC reports, highlights the inadequacies of current regulatory policies and behavioral responses in tackling climate change. Notably, our study complements prior literature by unraveling two hitherto unacknowledged issues. First, we contend that the conventional approach to carbon taxation, as evidenced by Feld and Nientiedt [9], lacks a nuanced consideration of the global goods character of fossil emissions. Our perspective underscores the necessity of a global response rather than relying on domestic instruments. Second, building on the literature on incentive schemes, we delve into the intrinsic and extrinsic motivations driving behavioral change. While economic instruments like carbon pricing are extrinsic motivators, our study emphasizes the significance of intrinsic motivation for fostering enduring behavioral adaptation. The literature analysis draws on empirical evidence and experimental studies to underscore the limitations of extrinsic mechanisms alone. By shedding light on these gaps, our paper advances the literature and provides a new balance for effective climate policy in the future.

3. Research Methodology

3.1. Theoretical background

Our empirical modeling approach is based on public goods theory and complexity sciences. Indeed, human behavior is nonlinear, dynamic, and complex. The relationship between behavior and carbon mitigation has been a topic of interest within the field of climate science and economics for years [22, 38, 39]. Several theories within this subject evolved in order to understand the impact of carbon taxation.

Public goods theory, conceptualized by Samuelson [40] in his seminal paper "The Pure Theory of Public Expenditure," has been instrumental in understanding the nature of goods that defy traditional market mechanisms. Samuelson [40] identified two defining characteristics of public goods: non-excludability and non-rivalrous consumption. The former implies that individuals cannot be excluded from the benefits of the good, while the latter suggests that one person's consumption does not diminish its availability to others.

Samuelson's contributions sparked an extensive debate and refinements in theory, including the development of club goods and common-pool resources [41, 42]. While public goods theory has been influential in shaping policy discussions, challenges persist in the practical implementation of appropriate mechanisms, such as carbon taxation or carbon pricing.

The theory is equally aligned with the well-known theory of externalities [43, 44]. The theory of negative externalities, often associated with Pigou [45], addresses the repercussions of economic activities that spill over onto third parties. Pigou [45] argued for the imposition of corrective taxes to internalize external costs to bring about optimal outcomes. Thus, in order to mitigate the negative externality of GHG emissions, one needs to price or tax the emissions from fossil energies. Yet, if the emissions are global, the public intervention must be on the same level – that is, global. Otherwise, public policy might be ineffective.

Coase [46] challenged this perspective in his groundbreaking work "The Problem of Social Cost," proposing that parties could negotiate and reach efficient solutions without government intervention under certain conditions. The debate between Pigouvian and Coasian approaches has endured, with contemporary scholars exploring the applicability of each framework in diverse contexts. We continue this debate in this research work and apply it to carbon taxation in the real world.

Additionally, the advent of behavioral economics has introduced nuances to the understanding of how individuals perceive and respond to externalities [19]. This paper includes state-of-the-art theoretical considerations in order to implement effective transboundary climate policies.

While carbon taxation aligns with economic theory, its implementation and potential consequences warrant careful consideration. Criticisms include concerns about regressive impacts on lower-income households, behavioral biases, and the potential for carbon leakage, wherein emissions-intensive activities relocate to jurisdictions with lax regulations. The policy design of the tax structure, revenue allocation, and complementary policies play a crucial role in mitigating these concerns.

Nonetheless, by internalizing external costs, a carbon tax or carbon price seeks to align private incentives with societal welfare, fostering a transition toward sustainable energies. As governments grapple with the imperative to address climate change, ongoing research and policy experimentation will refine our understanding of carbon taxation in mitigating negative externalities associated with fossil energy.

3.2. Research design

This study employs a time series approach in order to study the impact of domestic versus global carbon taxation (Figure 1). We use annual data from the mid-1960s to 2021. Our data consist of worldwide CO_2 emission per year in tons, world oil supply and demand in barrels, and the oil price (WTI) in dollars.

We utilize a list of global events, which signify natural experiments in the literature. We add the COVID-19 pandemic of 2020 to this list, given the pandemic is per definition a global incidence and can be utilized as a novel natural experiment. To our knowledge, there exists no study utilizing this methodology and data.

We are discussing and estimating several regression models. The time series regression model is defined by the following equation:

$$CO_{2,t} = \alpha + \beta_1 Supply_t + \beta_2 OilPrice_t + \beta_3 Dummy_t - Interaction + \beta_4 Controls_{t-1} + \varepsilon_t, \quad (1)$$

where t denotes time or year, respectively, and ε_t is an independent, identically distributed error term, according to $N(0, \sigma_\varepsilon^2)$. The dependent variable is global CO_2 emissions. The independent variables are the global oil supply, the world oil price (WTI), the interaction dummy identifying the global events (or natural experiments), and control variables accounting for autocorrelation patterns.

This empirical approach provides insights into the impacts of carbon taxation on GHG emissions. The unique data, which newly includes the COVID-19 pandemic, among three earlier global natural experiments, complements the time series methodology. This approach is strengthening the causal inference and scientific evidence on the impact of carbon taxation in case of domestic versus global policy interventions.

We utilize this methodology because it is based on the Nobel Prize in 2021, shared by Joshua Angrist, Guido Imbens, and David Card. They developed this idea in order to identify cause and effect with natural experiments [48].

3.3. Results

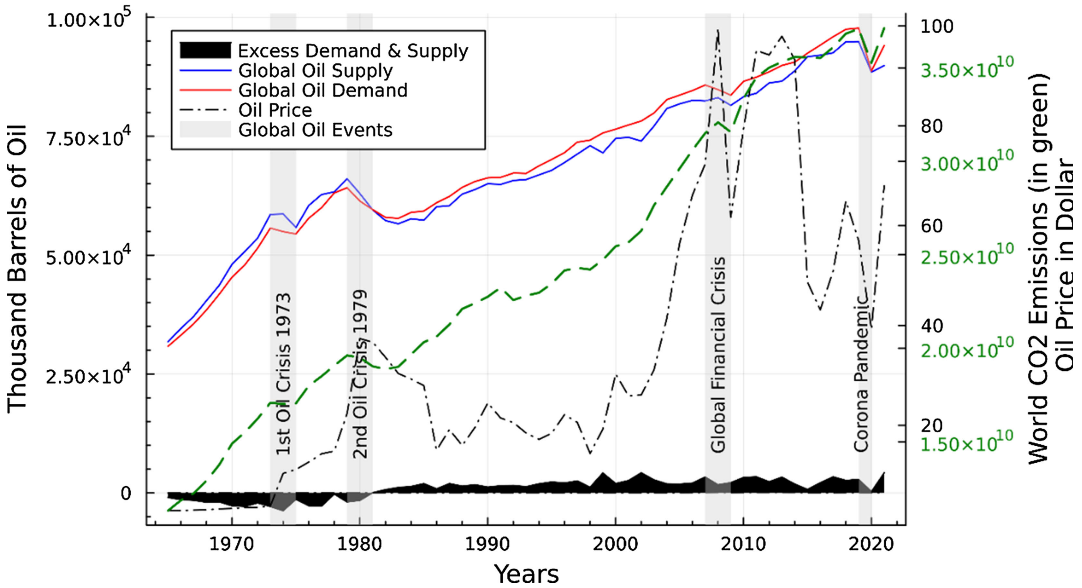
Let us assume, somewhere in the world, a country, let us pick Germany, cut all CO_2 emissions, which is roughly 2% globally. How large will be the CO_2 reduction globally?

First, fossil energy markets are global markets. Figure 1 illustrates global oil supply and demand over the past 60 years. We find that the oil supply is steadily growing with the exception of four global events. One observes the first and second oil price shocks in the 1970s. Previously to both oil price shocks, supply was above demand (Figure 1). In hindsight, both events have triggered higher prices and lower oil demand as well as cuts in oil supply by Organization of the Petroleum Exporting Countries. The third and fourth events are the global financial crisis in 2008 and the COVID-19 pandemic in 2020.

These four instances, particularly the COVID-19 pandemic in 2020, are an excellent natural experiment because oil supply and emissions declined globally. In Figure 1, we mark those four events with gray bars. The reduction in oil supply and CO_2 emissions are visible by the blue line (left axis) and green dashed curve (right axis). Of course, global oil demand equally dropped during the four global events (red line).

The unrecognized issue is the underestimated impact of global market dynamics. Climate change is a global issue, and clean air is a global public good. Nordhaus [22], among others, convincingly proposes a climate club as an optimal policy solution. Thus, a tax on GHG emissions has to be enforced on a global scale. We find new evidence for this policy proposal by utilizing our natural experiment methodology for the first time in this literature (Figure 1 and Table 1).

Figure 1
Global oil supply and demand



Notes: The red (blue) line denotes oil demand (supply) on the left-hand scale [47]. The green dashed curve represents global CO_2 emissions (right scale). Oil prices are denoted by a black dash-dotted curve (right scale). The gray areas highlight the four global oil events. On the x-axis, the area plot in black illustrates the difference between oil supply and demand. Negative numbers show excess supply (until the 1980s) and positive numbers excess demand (until today). Data and codes are available upon request by the author.

Table 1
Regression output*

CO_2 emissions	Model 1	Model 2	Model 3	Model 4
Intercept	−4214317102***	−4215382388***	−4131807493***	−4260466982***
	(−4.001)	(−4.105)	(−3.965)	(−4.090)
Supply	387536***	389134***	385574***	390799
	(−20.538)	(−21.131)	(−20.630)	(−20.509)
Oil price	59240922***	61109706***	64249855***	59102328***
	(−5.499)	(−5.794)	(−5.765)	(−4.998)
Dummy × supply	–	−12347	–	−17007
		(−1.951)		(−1.250)
Dummy × supply	–	–	−14721719	7972460
			(−1.519)	(−0.388)
Estimator	OLS	OLS	OLS	OLS
N	57	57	57	57
Adj. R-squared	0.967	0.970	0.969	0.970

*The regression models in order to test our hypothesis. The significance is denoted by * = 5%, ** = 1%, and *** = 0.1%.

The data in Figure 1 confirm a steady supply- and demand-side growth otherwise, despite economic fluctuations in stand-alone countries over the past 60 years. The volatile oil price is reflecting the regional fluctuations in economic and business activity. Yet, a higher oil price has neither reduced global oil demand nor global CO_2 emissions in "normal" times (Figure 1).

Notably, global oil supply and global CO_2 emissions have been declining in parallel only in the four global events. This finding is supported by a positive correlation of 0.84 between the oil price and global CO_2 emissions. Definitely, a positive relationship violates the general assumption that a carbon tax almost automatically reduces GHG emissions. Moreover, there is a positive correlation between oil price and oil supply (demand) of 0.78 (0.78). Consequently, a higher price for fossil energy, for instance, due to a domestic carbon tax, does not reduce global emissions. On the contrary, the data exhibit that an effective regulatory policy on GHG emissions requires global action. Indeed, a global carbon tax might unfold a scenario, which is uniquely highlighted by the four global events, particularly the COVID-19 pandemic in 2020–2021 (Figure 1).

To support our hypothesis, we estimate a time series regression with CO_2 emissions per year as the dependent variable based on the oil price and oil demand-supply dynamics. In addition, we construct a dummy variable that has value one during the four global events, otherwise zero. The interaction dummy controls for the identified four natural experiments in Figure 1.

We find a robust and significant positive nexus between global CO_2 emissions and oil supply in all years (p-value < 0.001 in Table 1). Additionally, we exhibit a significant positive linkage between global emissions and oil prices (p-value < 0.001 in Table 1). This evidence is contrary to economic theory and political thinking. In a nutshell, our regression analysis supports the evidence in Figure 1.

Indeed, in normal times, higher oil prices due to a carbon tax do not decrease global oil demand and CO_2 emissions. Only during the identified four global events, the expected mechanism is at work since our two interaction dummy variables are insignificant (p-values > 0.05) (Table 1). The estimation of the models with the first differences obtains the same outcome. Thus, our econometric analysis is robust, and it is supporting the hypothesis: climate policy is effective in global markets if it is enforced globally.

A unilateral reduction of fossil energy by a domestic carbon tax triggers rather carbon leakage and supply-side shifts in market shares to other countries, and it is neither causal nor significantly affecting global emissions. In conclusion, cutting oil demand in a country or region alone, such as Germany, does reduce global GHG emissions rather little – if at all. Local policy actions have a negligible impact on global energy markets.

The lockdowns of the COVID-19 pandemic, when examined alongside three other events as a natural experiment, unveil a straightforward pattern: GHG emissions decline if and only if there is a global policy intervention. Indeed, a pandemic is a global and not a regional incident. Making climate policy work requires a global climate club and inclusive policy with extrinsic and intrinsic incentives. In doing so, we obtain sustainable market reactions and long-term behavioral adaption.

Finally, we exhibit future research directions and research gaps. Our findings help to guide research to the avenues for future inquiry. As the field of carbon taxation and carbon pricing evolves, it is crucial to address the emerging global and behavioral challenges in the real world and refine policy recommendations accordingly. Further investigations ought to study the role of innovation, the impact of technological advancements, and the integration of carbon taxation into broader environmental and economic policy frameworks. Research might help to provide insights into the potential impact of technological advancements on the effectiveness of carbon taxation while exploring the transboundary nature and the cross-border effects of environmental issues.

4. Concluding Remark

Steps to avert climate change are a challenge in the 21st century. This interdisciplinary research article unravels two unrecognized forces in environmental regulation. Carbon taxation is an effective market-based instrument to mitigate GHG emissions only under certain assumptions. It is important to acknowledge that the assumptions made in economic theory do not perfectly align with the intricacies of the real world. Therefore, in the context of socioeconomic complexity, it is crucial to give greater attention to factors such as intrinsic behavior and global market dynamics.

The theoretical and empirical foundations support a global regulation of climate change as it is rooted in the transboundary nature of its externalities and the behavioral notions. As a global negative externality, climate change necessitates collective action to internalize its costs and mitigate its far-reaching impacts. The new perspective drawn from our research methodology underscores the imperative for coordinated, behaviorally founded, and international efforts to address climate change effectively and ensure the sustainability of the global environment.

In order to affect human behavior, public policy ought to design market interventions based on extrinsic and intrinsic forces simultaneously. Correspondingly, shifting global market dynamics requires a level playing field, among others, a global climate club. The compelling methodology of the natural experiment reveals an optimal policy solution: act globally. In doing so, fossil energy markets adjust globally, and human behavior adapts sustainably alike.

5. Policy Conclusion

Our analysis reveals a striking pattern: GHG emissions experience a discernible decline if and only if there is a global policy intervention. The findings underscore the imperative for a unified global approach to climate policy, recognizing the inherently global nature of environmental challenges. In the context of our results, the severe acute respiratory syndrome coronavirus-2 pandemic serves as a compelling illustration of a global incident that prompted a reduction in emissions due to widespread (global) lockdown policies. This reinforces the notion that effective climate policy necessitates the least collaborative effort on a global scale and it does not require high CO_2 taxes in a few countries, such as of today.

5.1. Need for a global climate club

Our study advocates for the establishment of a global climate club – a collaborative coalition of nations committed to enacting and enforcing stringent climate policies. By fostering a collective and inclusive approach, such a club could amplify the impact of individual nations' efforts and create a cohesive global response to climate change. The success of climate policies is contingent on the coordination of diverse and large countries, recognizing that environmental challenges transcend national boundaries.

5.2. Intrinsic and extrinsic incentives

To ensure the effectiveness and sustainability of climate policies, our findings underscore the importance of integrating both extrinsic and intrinsic incentives. Extrinsic incentives, such as economic mechanisms like carbon pricing, provide tangible rewards for emissions reduction. Simultaneously, intrinsic incentives, including fostering a sense of environmental stewardship and responsibility, play a crucial role in driving long-term behavioral adaptation. Policymakers should craft strategies that appeal to both dimensions, recognizing the complementary roles they play in achieving lasting change.

5.3. Facilitating market reactions

The formulation of climate policies should not only focus on immediate reductions but also on fostering sustainable market reactions in the future. A well-designed climate club can induce positive market responses, encouraging businesses and industries to adopt environmentally conscious practices. This, in turn, can contribute to the development of a more sustainable and resilient global economy.

5.4. Long-term behavioral adaptation

Climate policies should extend beyond short-term interventions and aim for long-term behavioral adaptation. By incorporating mechanisms that encourage sustained reductions in emissions, policymakers can lay the foundation for enduring change. This necessitates continuous evaluation and innovation in policy design to address evolving global and behavioral dynamics.

In conclusion, our study advocates for a balanced and comprehensive approach to climate policy, emphasizing the necessity of global collaboration, inclusive incentives, sustainable market reactions, and enduring behavioral adaptation. As we navigate the evolving landscape of carbon taxation and carbon pricing, it is crucial to address emerging challenges and refine policy recommendations accordingly.

5.5. Future research directions

Building on our findings, we identify several avenues for future research in contemporary environmental and climate studies. Investigating the role of innovation, the impact of technological advancements, and the integration of carbon taxation into broader environmental and economic policy frameworks are critical areas that merit further exploration. Drawing on insights from researchers such as Abrell et al. [38], Böhringer et al. [49], Többen et al. [50], Mandaroux et al. [51], and Acemoglu and Rafey [52] shapes future studies in the field.

Overall, holistic research deepens our understanding of the potential influence of technological advancements on the efficacy of carbon taxation, while also exploring the transboundary nature of carbon taxation and its cross-border environmental implications. Additionally, research in behavioral game theory and the dynamics of international political economy will contribute to a more comprehensive understanding of the complexities inherent in addressing global policy challenges. Our findings offer a roadmap for future inquiry, encouraging scholars to delve into these crucial aspects and shaping the future of nature, our economy, and society.

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Ethical Statement

This study does not contain any studies with human or animal subjects performed by the author.

Conflicts of Interest

The author declares that he has no conflicts of interest to this work.

Data Availability Statement

The data that support the findings of this study are openly available. WTI oil price data are from FRED.org at https://fred.stlouisfed.org/ Data about global oil supply/demand are available by bp Statistical Review of World Energy June 2022 at https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf Global CO_2 emissions are from World in Data at https://ourworldindata.org/co2-emissions

Author Contribution Statement

Bodo Herzog: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration.

References

[1] Intergovernmental Panel on Climate Change. (2022). *Climate change 2022 – Impacts, adaptation and vulnerability: Working group II contribution to the sixth assessment report of the intergovernmental panel on climate change*. UK: Cambridge University Press.

[2] Galbraith, E., & van den Bergh, J. (2020). Tax carbon to aid economic recovery. *Nature*, *581*, 262. https://doi.org/10.1038/d41586-020-01500-8

[3] Drews, S., Savin, I., & Van Den Bergh, J. C. (2022). Biased perceptions of other people's attitudes to carbon taxation. *Energy Policy*, *167*, 113051. https://doi.org/10.1016/j.enpol.2022.113051

[4] Shapiro, A. F., & Metcalf, G. E. (2023). The macroeconomic effects of a carbon tax to meet the US Paris agreement target: The role of firm creation and technology adoption. *Journal of Public Economics*, *218*, 104800. https://doi.org/10.1016/j.jpubeco.2022.104800

[5] Weitzman, M. L. (2009). On modeling and interpreting the economics of catastrophic climate change. *Review of Economics and Statistics*, *91*(1), 1–19. https://doi.org/10.1162/rest.91.1.1

[6] Intergovernmental Panel on Climate Change. (2023). *Synthesis report of the IPCC sixth assessment report (AR6)*. Retrieved from: https://www.ipcc.ch/report/ar6/syr/

[7] Timilsina, G. R. (2022). Carbon taxes. *Journal of Economic Literature*, *60*(4), 1456–1502. https://doi.org/10.1257/jel.20211560

[8] Xu, H., Pan, X., Li, J., Feng, S., & Guo, S. (2023). Comparing the impacts of carbon tax and carbon emission trading, which regulation is more effective? *Journal of Environmental Management*, *330*, 117156. https://doi.org/10.1016/j.jenvman.2022.117156

[9] Feld, L. P., & Nientiedt, D. (2022). Hayekian economic policy. *Journal of Economic Behavior & Organization*, *204*, 457–465. https://doi.org/10.1016/j.jebo.2022.10.019

[10] Hong, Q., Cui, L., & Hong, P. (2022). The impact of carbon emissions trading on energy efficiency: Evidence from quasi-experiment in China's carbon emissions trading pilot. *Energy Economics*, *110*, 106025. https://doi.org/10.1016/j.eneco.2022.106025

[11] Herzog, B., & Schnee, S. (2022). Exploring a dualism of human rationality: Experimental study of a cheating contest game. *International Journal of Environmental Research and Public Health*, *19*(13), 7675. https://doi.org/10.3390/ijerph19137675

[12] Sandel, M. J. (2013). Market reasoning as moral reasoning: Why economists should re-engage with political philosophy. *Journal of Economic Perspectives*, *27*(4), 121–140. https://doi.org/10.1257/jep.27.4.121

[13] Falk, A., & Szech, N. (2013). Morals and markets. *Science*, *340*(6133), 707–711. https://doi.org/10.1126/science.1231566

[14] Heyman, J., & Ariely, D. (2004). Effort for payment: A tale of two markets. *Psychological Science*, *15*(11), 787–793. https://doi.org/10.1111/j.0956-7976.2004.00757.x

[15] Holmås, T. H., Kjerstad, E., Lurås, H., & Straume, O. R. (2010). Does monetary punishment crowd out pro-social motivation? A natural experiment on hospital length of stay. *Journal of Economic Behavior & Organization*, *75*(2), 261–267. https://doi.org/10.1016/j.jebo.2010.03.024

[16] Ekelund, M., & Bergquist, M. (2023). Hotels re-explored: Experience and influence of reciprocity and social normative appeals. *Plos one*, *18*(12), e0289602. https://doi.org/10.1371/journal.pone.0289602

[17] Falk, A., Neuber, T., & Szech, N. (2020). Diffusion of being pivotal and immoral outcomes. *The Review of Economic Studies*, *87*(5), 2205–2229. https://doi.org/10.1093/restud/rdz064

[18] Frey, B. S., Oberholzer-Gee, F., & Eichenberger, R. (1996). The old lady visits your backyard: A tale of morals and markets. *Journal of Political Economy*, *104*(6), 1297–1313. https://doi.org/10.1086/262060

[19] Frey, B. S., & Oberholzer-Gee, F. (1997). The cost of price incentives: An empirical analysis of motivation crowding-out. *American Economic Review*, *87*(4), 746–755. https://www.jstor.org/stable/2951373

[20] Stern, N. (2007). *The economics of climate change: The Stern review*. UK: Cambridge University Press.

[21] Rode, A., Carleton, T., Delgado, M., Greenstone, M., Houser, T., Hsiang, S., . . . , & Yuan, J. (2021). Estimating a social cost of carbon for global energy consumption. *Nature*, *598*(7880), 308–314. https://doi.org/10.1038/s41586-021-03883-8

[22] Nordhaus, W. (2015). Climate clubs: Overcoming free-riding in international climate policy. *American Economic Review*, *105*(4), 1339–1370. https://doi.org/10.1257/aer.15000001

[23] Pretis, F. (2022). Does a carbon tax reduce CO_2 emissions? Evidence from British Columbia. *Environmental and Resource Economics*, *83*(1), 115–144. https://doi.org/10.1007/s10640-022-00679-w

[24] Pan, J., Du, L., Wu, H., & Liu, X. (2024). Does environmental law enforcement supervision improve corporate carbon reduction performance? Evidence from environmental protection interview. *Energy Economics*, *132*, 107441. https://doi.org/10.1016/j.eneco.2024.107441

[25] Andersson, J. J. (2019). Carbon taxes and CO_2 emissions: Sweden as a case study. *American Economic Journal: Economic Policy*, *11*(4), 1–30. https://doi.org/10.1257/pol.20170144

[26] Liu, W., Li, Y., Liu, T., Liu, M., & Wei, H. (2021). How to promote low-carbon economic development? A comprehensive assessment of carbon tax policy in China. *International Journal of Environmental Research and Public Health*, *18*(20), 10699. https://doi.org/10.3390/ijerph182010699

[27] Metcalf, G. E. (2019). On the economics of a carbon tax for the United States. *Brookings Papers on Economic Activity*, *2019*(1), 405–484. https://doi.org/10.1353/eca.2019.0005

[28] Ptak, M., Neneman, J., & Roszkowska, S. (2024). The impact of petrol and diesel oil taxes in EU member states on CO_2 emissions from passenger cars. *Scientific Reports*, *14*(1), 52. https://doi.org/10.1038/s41598-023-50456-y

[29] Baylis, K., Fullerton, D., & Karney, D. H. (2013). Leakage, welfare, and cost-effectiveness of carbon policy. *American Economic Review*, *103*(3), 332–337. https://doi.org/10.1257/aer.103.3.332

[30] Xu, L., Fan, M., Yang, L., & Shao, S. (2021). Heterogeneous green innovations and carbon emission performance: Evidence at China's city level. *Energy Economics*, *99*, 105269. https://doi.org/10.1016/j.eneco.2021.105269

[31] The United Nations Framework Convention on Climate Change. (2015). *Paris agreement*. Retrieved from: https://unfccc.int/sites/default/files/english_paris_agreement.pdf

[32] Aldy, J. E. (2020). Carbon tax review and updating: Institutionalizing an Act-Learn-Act approach to U.S. climate policy. *Review of Environmental Economics and Policy*, *14*(1), 76–94. https://doi.org/10.1093/reep/rez019

[33] Mintz-Woo, K. (2024). Carbon tax ethics. *Wiley Interdisciplinary Reviews: Climate Change*, *15*(1), e858. https://doi.org/10.1002/wcc.858

[34] Klenert, D., Funke, F., Mattauch, L., & O'Callaghan, B. (2020). Five lessons from COVID-19 for advancing climate change mitigation. *Environmental and Resource Economics*, *76*, 751–778. https://doi.org/10.1007/s10640-020-00453-w

[35] Gokhale, H. (2021). Japan's carbon tax policy: Limitations and policy suggestions. *Current Research in Environmental Sustainability*, *3*, 100082. https://doi.org/10.1016/j.crsust.2021.100082

[36] Jakob, M. (2021). Climate policy and international trade–A critical appraisal of the literature. *Energy Policy*, *156*, 112399. https://doi.org/10.1016/j.enpol.2021.112399

[37] Bertoldi, P. (2022). Policies for energy conservation and sufficiency: Review of existing policies and recommendations for new and effective policies in OECD countries. *Energy and Buildings*, *264*, 112075. https://doi.org/10.1016/j.enbuild.2022.112075

[38] Abrell, J., Bilici, S., Blesl, M., Fahl, U., Kattelmann, F., Kittel, L., & Siegle, J. (2024). Optimal allocation of the EU carbon budget: A multi-model assessment. *Energy Strategy Reviews*, *51*, 101271. https://doi.org/10.1016/j.esr.2023.101271

[39] Metcalf, G. E., & Stock, J. H. (2020). Measuring the macroeconomic impact of carbon taxes. *AEA Papers and Proceedings*, *110*, 101–106. https://doi.org/10.1257/pandp.20201081

[40] Samuelson, P. (1954). Diagrammatic: The pure theory of public expenditure. *Review of Economics and Statistics*, *37*(4), 387–389. https://doi.org/10.2307/1925849

[41] Sun, Y., & Razzaq, A. (2022). Composite fiscal decentralisation and green innovation: Imperative strategy for institutional reforms and sustainable development in OECD countries. *Sustainable Development*, *30*(5), 944–957. https://doi.org/10.1002/sd.2292

[42] Miskin, E. S. (2008). Mechanism design: How to implement social goals. *American Economic Review*, *98*(2), 567–576. https://doi.org/10.1257/aer.98.3.567

[43] Buchanan, J. M. (1965). An economic theory of clubs. *Economica*, *32*(125), 1–14. https://doi.org/10.2307/2552442

[44] Seo, S. N. (2020). *The economics of globally shared and public goods*. Netherlands: Elsevier Science.

[45] Pigou, A. C. (1920). Co-operative societies and income tax. *Economic Journal*, *30*(118), 156–162. https://doi.org/10.2307/2223009

[46] Coase, R. H. (1960). The problem of social cost. *The Journal of Law and Economics*, *3*, 1–44.

[47] The International Energy Agency. (2024). *CO_2 emissions in 2023*. Retrieved from: https://www.iea.org/reports/co2-emissions-in-2023

[48] Ball, P. (2021). *Nobel-winning 'natural experiments' approach made economics more robust*. https://doi.org/10.1038/d41586-021-02799-7

[49] Böhringer, C., Fischer, C., Rosendahl, K. E., & Rutherford, T. F. (2022). Potential impacts and challenges of border carbon adjustments. *Nature Climate Change*, *12*(1), 22–29. https://doi.org/10.1038/s41558-021-01250-z

[50] Többen, J., Pichler, P. P., Jaccard, I. S., Kratena, K., Moran, D., Zheng, H., & Weisz, H. (2023). Unequal carbon tax impacts on 38 million German households: Assessing spatial and socio-economic hotspots. *Environmental Research: Climate*, *2*(4), 045006. https://doi.org/10.1088/2752-5295/aceea0

[51] Mandaroux, R., Schindelhauer, K., & Mama, H. B. (2023). How to reinforce the effectiveness of the EU emissions trading system in stimulating low-carbon technological change? Taking stock and future directions. *Energy Policy*, *181*, 113697. https://doi.org/10.1016/j.enpol.2023.113697

[52] Acemoglu, D., & Rafey, W. (2023). Mirage on the horizon: Geoengineering and carbon taxation without commitment. *Journal of Public Economics*, *219*, 104802. https://doi.org/10.1016/j.jpubeco.2022.104802

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