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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

COMPARATIVE EVALUATION OF EMISSIONS TRADING SYSTEMS AND CARBON TAXES: IMPLEMENTATIONS IN CLIMATE CHANGE MITIGATION THROUGH CARBON PRICING

EMİSYON TİCARET SİSTEMLERİ VE KARBON VERGİLERİNİN KARŞILAŞTIRMALI DEĞERLENDİRMESİ: KARBON FİYATLANDIRMASI YOLUYLA İKLİM DEĞİŞİKLİĞİNİN AZALTILMASINA İLİŞKİN UYGULAMALAR

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Abstract

This article investigates the role of carbon pricing mechanisms, specifically Emissions Trading Systems (ETSs) and carbon taxes, in addressing climate change— which is a critical issue in international environmental politics. With the increasing concentration of greenhouse gases contributing to global warming and its consequential adverse effects, there is a pressing need for well-designed climate change mitigation policies. Utilizing a systematic review of global implementations post-Kyoto Protocol, this research examines both theoretical and empirical perspectives on ETSs and carbon taxes. The study contributes to the literature by proposing a multi-layered evaluation framework to assess the efficacy, political durability, policy consistency, flexibility, adaptability, predictability, and regulatory reliability of carbon pricing instruments. The findings suggest that although carbon taxes are praised for their cost-effectiveness in reducing greenhouse gas emissions, their implementation may be hindered by political resistance and public opposition. Conversely, ETSs, despite their complexity, offer market flexibility and the potential for cost-effective emission reductions. However, their effectiveness is contingent upon stringent cap settings and robust market mechanisms. The study reiterates that neither instrument is superior in isolation but functions best as a complementary tool within a broader policy framework.

Keywords: International Environmental Politics, Policy Design, Climate Change, Emissions Trading Systems, Carbon Taxes

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Öz

Bu makale, karbon fiyatlandırma mekanizmalarının, özellikle de Emisyon Ticaret Sistemleri (ETS'ler) ve karbon vergilerinin, uluslararası çevre politikasında kritik bir konu olan iklim değişikliğiyle mücadeledeki rolünü araştırıyor. Küresel ısınmaya katkıda bulunan sera gazı konsantrasyonlarının artması ve bunun sonucunda ortaya çıkan olumsuz etkiler nedeniyle, iyi tasarlanmış iklim değişikliği azaltım politikalarına acil bir ihtiyaç vardır. Kyoto Protokolü sonrası küresel uygulamaların sistematik bir incelemesinden yararlanan bu araştırma, ETS'ler ve karbon vergilerine ilişkin hem teorik hem de ampirik perspektifleri incelemektedir. Çalışma, karbon fiyatlandırma araçlarının etkinliğini, politik dayanıklılığını, politika tutarlılığını, esnekliğini, uyarlanabilirliğini, öngörülebilirliğini ve çevresel hedefler bakımından düzenlemenin güvenilirliğini değerlendirmek için çok katmanlı bir değerlendirme çerçevesi önererek literatüre katkıda bulunmaktadır. Bulgular, karbon vergilerinin sera gazı emisyonlarını azaltmadaki maliyet etkinliğinin ön plana çıkmasına rağmen, bunların uygulanmasının siyasi direniş ve kamuoyu muhalefeti nedeniyle engellenebileceğini gösteriyor. Bunun tersine, ETS'ler karmaşıklıklarına rağmen piyasa esnekliği ve uygun maliyetli emisyon azaltım potansiyeli sunuyor. Ancak bunların etkinliği sıkı emisyon üst sınırı ayarlarına ve sağlam piyasa mekanizmalarına bağlıdır. Çalışma, her iki aracın da tek başına üstün olmadığını, ancak daha geniş bir politika çerçevesinde tamamlayıcı araçlar olarak en iyi şekilde işlev gördüğünü yinelemektedir.

Anahtar Kelimeler: Uluslararası Çevre Politikası, Siyasa Tasarımı, İklim Değişikliği, Emisyon Ticaret Sistemleri, Karbon Vergisi

1. Introduction

Climate change, attributable to human activities, has emerged as a paramount challenge confronting the world. It now occupies a central position in the study of international environmental politics. The escalating concentration of greenhouse gases (GHGs), such as carbon dioxide (CO_2) and methane (CH_4), has precipitated a notable increase in global temperatures, entailing far-reaching consequences. These consequences encompass elevated sea levels, an increased frequency and intensity of extreme weather events, loss of biodiversity, and the degradation of ecosystems and agricultural productivity (IPCC, 2022). The magnitude and global scale of these impacts underscore the imperative need for concerted efforts to both mitigate climate change and adapt to its repercussions. Consequently, the international struggle against climate change has become a foremost agenda in the field of international environmental politics, necessitating robust international environmental cooperation and the development of effective policy designs.

Various policy tools are being employed to combat climate change caused by human activities, and one such tool is carbon pricing. Carbon pricing seeks to rationalize emission reduction among market participants. It is an economic mechanism that assigns costs to GHG emissions by considering their adverse effects on society and the environment, thereby incentivizing emission reduction. Carbon pricing is implemented through two primary methods: Emissions Trading Systems (ETSs), also known as cap-and-trade, where the carbon price is determined in the market, and carbon tax, where the carbon price is predetermined (Morris, 2022).

Despite extensive research on carbon pricing, there remains a lack of consensus on the optimal design and implementation of these mechanisms that can effectively balance various layers of policy outcomes. This study seeks to contribute to the literature by developing an evaluation framework that encompasses all layers of these policy tools. Thus, it provides an up-to-date policy basis for climate change mitigation, focusing on optimal policy designs and offering a nuanced understanding of the relative merits and drawbacks of ETSs and carbon taxes. The study investigates the relative features of carbon pricing mechanisms in the design of context-appropriate domestic or international policies to combat climate change. Specifically, it compares ETSs and carbon taxes across several layers: Efficiency, political durability, policy consistency, flexibility and adaptability, predictability, and regulatory reliability. The study argues that since the price formation structure differs between the two instruments—with prices being assigned in carbon taxes while market player interactions determine the price in ETSs—this distinction significantly influences the mechanics of the mitigation policy. It markedly impacts the behavior of stakeholders and leads to the emergence of differentiated evaluation layers. Consequently, efficiency, durability, consistency, predictability, and regulatory reliability are the fundamental layers for evaluating these policy instruments. This differentiation highlights the relative advantages and disadvantages of both ETSs and carbon taxes in each context, which should be evaluated through a multi-layered approach, underscoring that these instruments should not be viewed as mutually exclusive but rather as complementary tools in a policy portfolio.

2. Theoretical Framework of Carbon Pricing

The tragedy of the commons illustrates how individual users, having unrestricted access to a common resource, often act in their own self-interest, leading to the depletion or degradation of that resource through collective action. In the context of GHG emissions, the atmosphere can be regarded as a common resource that is collectively utilized without any individual ownership. GHGs, generated from activities such as fossil fuel combustion, deforestation, and industrial processes, are absorbed by the atmosphere. However, those responsible for emitting GHGs do not bear the complete cost of the environmental damage caused by these emissions. This situation aligns with Pigou's concept of negative externality, where the negative impacts of individual actions are not adequately accounted for by the parties involved (Pigou, 1920; Sandmo, 2016).

Each emitter may perceive their individual emissions as a negligible contribution to the overall total, thus perceiving them as inconsequential in terms of harm caused. From an individual standpoint, they may derive benefits from GHG emission activities, while the costs, such as the impacts of climate change, are distributed among the collective. Consequently, there exists a rationale for emitters to release as much GHG as desired for their self-interested gain. However, if everyone adopts this perspective, it leads to elevated emission levels and the subsequent onset of climate change, exemplifying a classic manifestation of Hardin's concept of the tragedy of the commons (Hardin, 1968). Hardin's proposed solutions also involve addressing this problem through taxation or privatization. In other words, creating a cost and establishing a price form the foundation of these proposed solutions (Hardin, 1968, pp. 1245–1247).

Addressing the tragedy of the commons in the context of climate change necessitates mechanisms that can effectively translate shared environmental costs into individual accountability. Carbon pricing involves establishing a monetary value for GHG emissions, achievable through either a carbon tax or an ETS (Morris, 2022). This economic valuation not only reflects the environmental impact of these emissions but also integrates these costs into the decision-making processes of businesses and individuals. A carbon tax imposes a levy on each unit of GHG emitted, while an ETS sets a cap or quota on total emissions and enables the trading of emission permits. The underlying concept is to internalize the external costs associated with emissions, compelling market participants responsible for GHG emissions to bear the environmental damages they create (Aldy & Stavins, 2012, p. 153). Such mechanisms incentivize market actors to enhance energy efficiency, transition to cleaner energy sources, and, in certain instances, modify behavior or production processes to curtail emissions. By doing so, carbon pricing attempts to shift economic behavior from an exploitative use of the common resource — the atmosphere — towards more sustainable practices and, theoretically, resolves the tragedy of the commons.

ETSs have emerged as a mechanism for pricing carbon, offering market players the opportunity to trade carbon allowances or offset certificates and thereby incentivizing emission reductions. The development of ETSs traces back to the early 1990s when the United States implemented the first cap and trade system for sulfur dioxide emissions, successfully addressing acid rain issues and serving as a model for subsequent carbon markets (van Asselt, 2016). The Kyoto Protocol, a significant milestone in international climate change negotiations accepted in 1997, played a vital role in the global expansion of carbon markets. Through mechanisms like the Clean Development Mechanism and Common Practice, the Protocol allowed developed nations to invest in emission reduction projects in developing countries and receive carbon credits in return (Chuang et al., 2019; 'Kyoto Protocol to the United Nations Framework Convention on Climate Change', 1997). Noteworthy among the carbon markets is the European Union ETS (EU ETS), launched in 2005, which stands as the largest and most prominent carbon market encompassing diverse sectors in member states. Research on the EU ETS has demonstrated its effectiveness in reducing emissions and driving the adoption of cleaner technologies within covered sectors (Martin et al., 2016, p. 16; Valdivia, 2014, p. 126). Similar positive outcomes have been observed in other carbon markets, such as the Regional GHG Initiative (RGGI) in the Northeastern United States. Furthermore, several regional and national carbon markets have emerged, including the California Cap and Trade Program in the United States and the New Zealand Emissions Trading Program. The Paris Agreement of 2015 further solidified the role of carbon markets by incorporating provisions for voluntary international cooperation, including emissions trading, to achieve emission reduction targets (Gulbrandsen & Wettestad, 2022, p. 231).

Another approach to carbon pricing is through the implementation of "Pigouvian" taxation. When a market activity generates negative externalities, it means that the total cost to society, known as social cost, exceeds the private cost borne by the individual or firm conducting the activity. Because these external costs are not factored into the market price, the allocation of resources may become inefficient, resulting in market failure. The purpose of a "Pigouvian" tax is to address this market failure by setting the tax equal to the per-unit external costs associated with the activity. This adjustment aligns the private cost with the social cost, thereby incentivizing individuals or firms to reduce their activity to a socially optimal level. In the context of climate change, a carbon tax serves as a type of "Pigouvian" tax (Metcalf & Weisbach, 2013, p. 9). By levying taxes on the carbon content of fossil fuels, the carbon tax internalizes the external costs linked to climate change, presenting a market-based solution for reducing GHG emissions.

The introduction of carbon taxes has seen considerable progress in various countries around the world. Finland took the lead in 1990 by implementing a carbon tax, initially targeting fossil fuels used for heat and electricity generation. Following suit, Sweden introduced its own carbon tax in 1991 covering a broad range of fossil fuels. Sweden's carbon tax stands among the highest globally and has proven effective in reducing the country's carbon emissions. In the same year, Norway also introduced a carbon tax, encompassing petroleum products, coal, and natural gas. While it includes certain exemptions, the tax has predominantly driven a shift towards the utilization of hydroelectric power. In 2001, the United Kingdom introduced the Climate Change Levy (CCL), an energy tax applicable to non-domestic users (Sumner et al., 2011, p. 922). British Columbia became the first jurisdiction in North America to adopt a carbon tax in 2008. Employing a phased approach, the tax commenced at a low rate and incrementally increased over time, allowing businesses and households to adjust gradually (Bumpus, 2015, p. 481). Ireland introduced a carbon tax in 2010, encompassing most fossil fuels, with its rate steadily rising since its inception (Conefrey et al., 2013, p. 934). In 2012, Australia implemented a carbon pricing mechanism as a carbon tax. However, it was subsequently repealed in 2014 (Crowley, 2017, p. 1). Mexico became the first developing country to impose a carbon tax in 2013, focusing on fossil fuel sales and imports based on their carbon content. Chile followed suit in 2014, enacting a carbon tax law that took effect in 2017, primarily targeting large, fixed emitters, particularly within the energy sector (Flores & Mardones, 2017, p. 334). Portugal joined the ranks in 2015, implementing a carbon tax on fossil fuel combustion in the energy and industrial sectors, alongside reforms to the energy tax system (Pereira et al., 2016, p. 110). These diverse examples highlight the global momentum surrounding the implementation of carbon taxes to address climate change and mitigate GHG emissions.

The implementation of carbon pricing mechanisms, however, presents its own set of challenges and opportunities. It requires careful balancing of economic impacts, social equity, and environmental effectiveness. The success of these mechanisms is contingent on their design, the political and economic context in which they are implemented, and their ability to adapt to evolving environmental and technological realities.

3. Methodology

This study employed a systematic review approach focusing on the global implementations of ETSs and carbon taxes. The literature included peer-reviewed academic journals, authoritative reports, and case studies published focusing on the period after the Kyoto Protocol, which promoted market-based instruments for mitigating climate change. The inclusion and exclusion criteria were applied to Google Scholar, Web of Science, and Scopus searches using terms such as "carbon pricing," "carbon taxes," "emissions trading systems," and related variants and combinations. This ensured a high-quality concentration on contemporary and relevant data and discussions in the field of carbon pricing. The scope of the literature review encompassed both empirical and theoretical analyses, with an emphasis on studies that provided insights into the practical applications and theoretical underpinnings of carbon pricing mechanisms. The evaluation was structured to systematically assess each layer of policy evaluation, drawing on the identified literature to support or challenge the theoretical and empirical findings related to ETSs and carbon taxes. Various case studies were used to provide practical examples and insights. The multi-layered approach is inspired by similar frameworks utilized in Narassimhan (2018), Haites (2018), Aldy and Stavins (2012), Doda (2016), Green (2021) which are all review theories and experiences of carbon pricing mechanisms. Therefore, the study has identified several layers for evaluation. Each of these layers is supported by theoretical and empirical studies that justify their existence: Efficiency, political durability, policy consistency, flexibility, adaptability, predictability, and regulatory reliability are major layers of evaluation.

Efficiency layer evaluates how effectively each system allocates resources to reduce emissions cost-effectively. The efficiency of carbon pricing mechanisms is underscored by Aldy & Stavins (2012) and Metcalf & Weisbach (2013), who discuss the economic rationales for using market-based tools to address greenhouse gas emissions.

Political durability dimension assesses the resilience of ETS and carbon taxes to political changes. The concept of political durability draws from Jordan & Moore (2023), Rabe (2016) emphasizing the importance of policy resilience in fluctuating political landscapes.

The policy consistency layer examines the ability of each system to integrate with international climate change mitigation efforts. The flexibility and adaptability aspect evaluates the ability of each system to adjust to technological advancements and changing economic conditions. Policy consistency, flexibility, and adaptability are derived from the dynamic nature of climate change mitigation efforts, as articulated by Aldy et al. (2003), Rhodes (2021), and (Evans et al., 2023).

Predictability and regulatory reliability layers compare the predictability of each system for businesses and their effectiveness in ensuring environmental outcomes. Predictability and regulatory reliability resonate with the literature as a commonly mentioned themes, focusing on the importance of clear policy signals to drive market participants towards sustainable outcomes (Green, 2021, pp. 3–4; Johnstone et al., 2010, pp. 9–13). These layers of evaluation are applied to assess the strengths and limitations of each carbon pricing mechanism, supported by up-to-date examples for each.

4. Evaluation of Carbon Pricing Instruments

Efficiency

Efficiency in carbon pricing mechanisms is defined by their cost-effectiveness in achieving emissions reduction targets (Rousseau & Proost, 2009, p. 25). This entails minimizing the economic costs of reducing GHG emissions, and avoiding undue burdens on businesses and consumers (Rousseau & Proost, 2009, p. 40). Furthermore, an efficient system should be straightforward to implement and manage, characterized by clear guidelines and procedures and minimal complex rules. Such simplicity reduces bureaucratic overhead and compliance costs, facilitating streamlined processes for both government and regulated entities, leading to reduced monitoring, enforcement, and paperwork for governments and lower compliance costs for businesses and industries (Flues & Dender, 2020, p. 45).

In ETSs efficiency revolves around the notion that market forces possess the capacity to allocate resources optimally and economically when unrestricted. Grounded in the fundamental principles of supply and demand, this concept highlights the role of price determination through the dynamic interplay between buyers and sellers within a market. By allowing these market dynamics to operate freely, efficiency can be achieved as resources are allocated in the most effective and cost-efficient manner. Market efficiency may even improve as market phases progress, as seen in the EU ETS example (Mirzaee Ghazani & Jafari, 2021, p. 61093).

The ETSs play a crucial role in facilitating cost-effective emission reduction by establishing an emissions allowances market. This framework incentivizes participants to reduce emissions where it is most cost-effective and to sell surplus allowances to those with higher abatement costs. For example, a company that reduces emissions at a low cost through enhanced energy efficiency or renewable energy adoption can trade excess allowances with companies facing more expensive reduction options. This encourages efficient resource utilization and stimulates investment in emission-reducing technologies and innovative business processes, furthering emissions reductions. The ETS model also fosters innovation by enabling income generation from the sale of excess allowances for participants achieving lower-cost emissions reductions (Martin et al., 2016, p. 13). Participants facing higher abatement costs can offset their expenses by purchasing these allowances, encouraging investment in innovative emission reduction technologies (Narassimhan et al., 2018).

The case of Danish energy company Ørsted provides a compelling example of how innovation can be fostered within the framework of an ETS. Ørsted has achieved a transformation, transitioning from one of Europe's most coal-intensive enterprises to a global leader in renewable energy (Abraham-Dukuma, 2021; Madsen & Ulhøi, 2021). The EU ETS has played a pivotal role in facilitating this transition by offering Ørsted a strong financial incentive to invest in renewable energy technologies. By making substantial reductions in its carbon emissions, Ørsted has been able to capitalize on its green transition by selling excess allowances on the ETS market, leading to significant economic benefits (European Commission, 2020). It is worth noting that Ørsted's experience is not an isolated one. The ETS framework has effectively stimulated a surge in innovations related to clean technologies across diverse industries in China (Cui et al., 2018, p. 453). Within the ETS framework, companies have successfully leveraged innovation to mitigate emissions through various means, such as improving energy efficiency, adopting cleaner fuels, embracing carbon capture and storage technologies, and more.

While market-based instruments have advantages, they also have various disadvantages. ETS are subject to market dynamics and can experience price volatility (Feng et al., 2011, p. 591). Carbon taxes do not have this issue, ensuring a more stable cost for carbon emissions. Furthermore, ETSs are more complex, requiring greater bureaucratic and administrative capabilities. It requires a robust infrastructure for tracking and trading emissions allowances, plus regular adjustments to the cap and oversight of the carbon market, while carbon taxes are simpler to implement and manage. In certain contexts, it may be more feasible and efficient to implement carbon taxes rather than ETSs as a policy instrument due to their relative simplicity. Additionally, carbon taxes can provide a clear and consistent revenue stream for governments. This revenue can be used to fund climate mitigation and adaptation projects or be redistributed to citizens to offset the increased costs of energy. Another risk associated with market-based mechanisms is that ETS can suffer from over-allocation of allowances or market manipulation, which can undermine their environmental integrity. A carbon tax avoids these issues by setting a clear price on emissions. While the tax imposes recurring costs for carbon emissions, it lacks a clear financial reward system for companies that surpass a specific threshold for emission reduction. Determining an appropriate tax rate that effectively achieves emission reduction targets without burdening specific industries or sectors can pose challenges (Haites, 2018, p. 961). Consequently, while companies are motivated to minimize their emissions to avoid taxes, they may not be equally encouraged to innovate as they would be under an ETS, where they can directly profit by selling excess allowances.

Political Durability

In the context of climate policy, political durability refers to the ability of a policy or regulatory framework to endure over time (Jordan & Moore, 2023, p. 425), regardless of shifts in political leadership, public sentiment, or economic conditions. Durable policies have the capacity to withstand political changes and maintain their core objectives and mechanisms, even when governments transition. When a policy demonstrates political resilience, it suggests that it has garnered bipartisan or extensive stakeholder support and has integrated itself into the political landscape and institutional frameworks in a manner that makes it resistant to repeal or substantial modification.

In terms of political durability, the carbon tax has encountered several challenges, primarily due to the direct impact of the tax burden on voters in democracies. In carbon tax systems, emitters bear the responsibility of paying the tax, which provides them with a more predictable and stable price signal (Compernolle et al., 2022). However, this may also result in a higher pass-through of costs for society. Consequently, the costs are immediately imposed on voters in the short term, while the benefits of the revenue generated may materialize in the longer term. As a result of this gap, there can be political pressure to abolish such taxes, as exemplified by the Australian experience with carbon tax.

From the introduction of a carbon pricing mechanism to its subsequent repeal, Australia has undergone a contentious process in formulating and implementing policies aimed at reducing carbon emissions. In 2012, under the leadership of Prime Minister Julia Gillard and the Labor Party, the Australian government enacted the Clean Energy Act, which established a carbon pricing mechanism imposing a flat price on carbon emissions (Perry et al., 2013, p. 104). However, the implementation of this mechanism has been accompanied by significant controversy. Industry groups, conservative politicians, and segments of society voiced opposition to the carbon tax, asserting that it would lead to higher energy prices, economic harm, and job losses (Grubel, 2012). The political discourse surrounding the carbon tax became a central focus during elections. Subsequently, in 2014, the carbon pricing mechanism was repealed following the election victory of the Liberal Party. The new government contended that the carbon tax was ineffective, burdensome for businesses, and resulted in increased household costs (Taylor, 2014). The Australian carbon tax has been criticized as poorly conceived, inadequately executed, and lacking substantial public support even prior to its implementation (Robson, 2014, p. 35).

In contrast, exemplary practices in terms of political durability can be observed in various ETS examples. Notably, the EU ETS stands as the world's largest and longest-running ETS, having been successfully implemented since 2005. This system has demonstrated resistance to political pressures and has gained acceptance from stakeholders (Jordan & Moore, 2023, p. 437). Such achievements have contributed significantly to political stability and the sustained efforts for long-term emissions reduction. Moreover, the EU ETS has proven efficient in achieving a noteworthy reduction in emissions within its covered sectors, while also encouraging investments in low-carbon technologies (Calel & Dechezleprêtre, 2016; Colmer et al., 2020).

Another notable illustration is the California Cap-and-Trade Program. California, with its position as the state possessing the largest economic power in the United States and its pioneering role in the fight against climate change, successfully implemented its ETS in 2013. The California Emissions Trading System is founded on a robust legal and administrative framework that ensures political continuity. It has garnered political support, public acceptance, and has expanded over time, highlighting its political durability (Rabe, 2016, p. 118).

In terms of durability, it is important to emphasize that the decisive factor lies in the formation of a coalition seeking the repeal of a policy. The carbon tax, due to its imposition of a uniform cost on all, is more likely to create a shared interest among those seeking its abolition as seen in the Australian case. The presence or absence of such a coalition directly impacts the durability of environmental policies. An illustrative example in this regard can be found in the case of the Montreal Protocol.

One factor influencing the policies of the United States, a significant participant in the Montreal Protocol, was the dissolution of an industry coalition opposing CFC regulations. The Alliance of Responsible CFC Policy was formed to address demand-driven controls, which had the potential to harm both producers and users. However, the impact of supply-oriented controls varied based on specific details. While the top three major CFC producers accepted the Alliance's new policy, the other two smaller producers did not agree with the situation. This exemplifies that large producers recognize the potential for market consolidation and more favorable conditions resulting from CFC regulations. Conversely, for small producers, such consolidation would spell the end of their existence (Parson, 2003, p. 127). Notably, the competition between major manufacturers and European and Japanese firms necessitated international coordination of CFC regulations for significant actors. As a result, the interests of large producers within the Alliance for Responsible CFC Policy began to diverge from those of their smaller counterparts by 1986 (Falkner, 2001, p. 165). Additionally, the relatively substantial research and development budgets of large manufacturers provided them with an advantage (Falkner, 2005, p. 110). This suggests that major manufacturers strategically shifted their anti-regulation stance and concluded that influencing the process in their own interests would be more favorable than outright opposing CFC regulations. The situation described here serves as an example of how differences in interests can hinder coalition formation or cause an existing coalition to disintegrate. On the other hand, a fixed additional tax cost imposed on all market players is more likely to generate a convergence of interests against it. Conversely, in ETSs, market actors have diverse options depending on their specific circumstances. This reduces the clustering of interests, thereby inhibiting the formation of strong coalitions against regulatory policies. The existence and status of such coalitions are crucial for the future of regulatory policy.

Policy Consistency

Policy consistency within the scope of this study refers to policy coherence and policy integration (Evans et al., 2023, pp. 9–10) which brings standardization and consistency of regulatory frameworks across different geographic regions or jurisdictions. This entails the establishment of similar rules, standards, and practices concerning carbon emissions. Policy consistency minimizes inconsistencies between regulatory jurisdictions, reduces complexity, and facilitates the operation of businesses across borders, thereby enabling multinational companies to comply easily with these regulations across the various countries in which they operate. Moreover, promoting a synchronized global effort to mitigate climate change, it enhances the effectiveness of policies that are implemented and enforced in a standardized manner worldwide. This is a subject that has been extensively discussed in literature (Haites, 2015; Müller & Slominski, 2016; Vöhringer, 2012).

In terms of policy consistency, the possibility of trading emissions allowances between countries through the ETS should be underscored. Under the ETS framework, countries are able to engage in cross-border emissions allowance trading by establishing harmonized ETSs. This enables international climate cooperation in efforts to reduce emissions and provides a framework for linking different regional or national systems. Second, the ETS facilitates regional integration. It serves as a suitable mechanism for combining ETSs across different regions. By establishing coherent systems, emissions allowances from various regions can be interconnected. A prime example is the European Union's ETS, which enables emissions allowance trading among member states, creating a common market for emissions reduction across the EU and ensuring regional coherence. Lastly, ETSs can be better aligned with a possible global framework for emissions reduction.

The primary example of policy consistency is the linking of ETSs such as the EU ETS and the Swiss ETS or the linking of the California and Québec cap-and-trade programs, which expanded the scope of the two systems (Isser, 2016, p. 59). In 2020, the EU and Switzerland established a linkage between their respective ETSs, allowing companies operating in both regions to utilize allowances from both systems for compliance purposes. This integration created a larger and more liquid market, reduced compliance costs, and facilitated easier planning and operations for multi-jurisdictional companies (Verde & Borghesi, 2022, pp. 32–33). Prior to the integration of the EU ETS and the Swiss ETS, a Swiss-based multinational with operations across the EU had to manage two separate allocation sets, each with its own price dynamics and eligibility rules. However, after the integration, these allocations became interchangeable, streamlining compliance procedures and planning processes. The company can now adopt a comprehensive approach to emissions reduction in its European operations, maximizing efficiency and cost-effectiveness. There was also an intention to establish a link between the EU ETS and the Australian ETS. However, following the debate over the carbon tax in Australia, the ETS legislation was also abolished (Verde & Borghesi, 2022, p. 33).

Unlike an ETS, which necessitates the creation of a complex market for trading emissions allowances, a carbon tax is a straightforward levy on the carbon content of fossil fuels. Carbon taxes are typically implemented at the national level and can vary significantly between countries. Implementing and managing a carbon tax system is generally simpler than an ETS Carbon taxes can be applied broadly across all sectors, avoiding the need for sector-specific cap-setting as in ETS. While this simplicity renders the system less complicated, it also presents challenges in achieving international coherence and coordination. For example, different countries may impose different tax rates, leading to trade and competitive imbalances, and hindering the harmonization of international efforts towards emissions reduction. For instance, Sweden has implemented a higher carbon tax per ton of CO_2, whereas neighboring Finland imposes a considerably lower tax rate on carbon (Sumner et al., 2011, p. 924). For companies operating in both countries, managing distinct tax systems introduces complexity and potential inconsistency to their emissions reduction strategies, making it challenging to achieve an international policy effort. Sharp disparities in carbon pricing can also distort competition, placing businesses in high-tax areas at a disadvantage. This could lead to the migration of companies towards regions with no or relatively lower taxation. In a sense, it might result in the creation of havens in the context of climate.

Flexibility and Adaptability

Flexibility and adaptability pertain to the ability of a policy or regulatory framework to adjust and accommodate changing conditions, including economic fluctuations, technological advancements, new scientific discoveries, or evolving societal needs. A policy framework characterized by a high degree of flexibility and adaptability can ensure the continued effectiveness and relevance of its regulations as time progresses (Aldy et al., 2003, p. 378; Doda, 2016, p. 138). It can effectively respond to unforeseen challenges or opportunities and incorporate diverse strategies to accomplish its objectives. This attribute holds particular significance in complex and rapidly evolving domains such as climate change mitigation.

While ETSs and carbon taxes are assessed based on their flexibility, the most notable differences between them arise from their distinct carbon pricing mechanisms. In ETSs, prices are determined by the market, which allows changing conditions to be dynamically reflected in the pricing. Within ETSs, modifying the overall emissions quota to reflect new targets is relatively straightforward. With access to updated information, the central authority may adjust its strategy for acquiring emissions permits, thereby ensuring significant policy flexibility and adaptability (Aldy et al., 2003, p. 387). In such cases, industries may benefit from the flexibility of the policy to adjust their emission levels according to their unique circumstances and business requirements. For example, if a market participant invests in cleaner technologies and successfully reduces emissions below the allocated quotas, it can sell the excess allowances to other companies facing higher abatement costs. On the other hand, carbon taxes typically rely on fixed pricing mechanisms. Although tax rates can be adjusted, such modifications often require time-consuming legislative processes and political negotiations, limiting the responsiveness of the system to changing conditions or the inclusion of new sectors and gases within the tax framework.

Secondly, the ETSs facilitate cross-border trading of emissions allowances, fostering regional and international integration. RGGI serves as an example of an ETS that showcases flexibility and adaptability. The program was initially launched in the U.S. with ten states in 2009 and has since expanded to include Virginia in 2021. Furthermore, RGGI has demonstrated its ability to adjust and evolve by tightening emission caps and incorporating additional types of emissions, reflecting its resilience to changing conditions and progress in emissions reduction. Since its inception, over time, RGGI has demonstrated its flexibility through various actions, including the addition of new states, reduction of the upper emissions limit, expansion of the program's scope, and effective price management. Regarding the addition of new states, RGGI has progressively expanded its reach since its inception. Initially consisting of ten northeastern states, the program saw the official inclusion of Virginia in 2021, marking the first southern state to join the initiative (RGGI, 2020). This expansion underscores RGGI's ability to foster collaboration and engagement across diverse regions. In terms of reducing the upper emissions limit, RGGI states have collectively agreed to lower their emissions caps by 2.5% annually until 2030, resulting in an additional 30% reduction in emissions (International Carbon Action Partnership, 2021). This commitment demonstrates the program's capacity to adjust and tighten its regulations in response to evolving environmental goals and scientific data. Furthermore, the scope of the RGGI program has expanded over time. While initially focusing solely on CO_2 emissions, recent discussions among participating states have indicated the potential for the program's extension to include emissions from transportation fuels (Shemkus, 2019). This expansion reflects the adaptability of the initiative and its commitment to addressing emerging challenges and priorities. RGGI has also exhibited flexibility in managing allowance prices. The program incorporates a Cost Containment Reserve that releases additional allowances if prices surpass a certain threshold (RGGI, 2023). This mechanism ensures that compliance costs for businesses remain controlled, preventing sudden and significant price fluctuations. To sum up, RGGI's expansion, adjustments to caps, and incorporation of additional emission types demonstrate its ability to respond to evolving conditions and drive progress in emissions reduction efforts with its flexibility and adaptability.

Predictability

Policy predictability refers to the degree to which future regulatory conditions can be anticipated based on current policy frameworks. This means that over a period, businesses can expect a stable set of rules and regulations, which allows them to make strategic decisions and plan with a comprehensive understanding of the operating environment. A predictable policy environment mitigates the business risks associated with regulatory changes and empowers companies to confidently commit to long-term sustainable practices (Doda, 2016, p. 139).

Carbon taxes may offer a predictable and stable carbon price, aiding in long-term business and investment planning. This predictability is vital for companies transitioning to low-carbon operations. However, carbon taxes may also introduce uncertainty. For instance, Canada's federal carbon pricing started at \$20 per ton of CO_2 in 2019, with planned annual increases, but later revisions projected it to reach \$170 per ton by 2030 (Environment and Climate Change Canada, 2021). Such policy changes can disrupt long-term planning and alter cost projections for businesses. In contrast, the EU ETS establishes a clear, decreasing cap on emissions for key sectors, reducing by 2.2% annually in the Phase IV period (2021-2030) (European Commission, 2023b). This provides businesses a clear policy trajectory, aiding in long-term investment planning. Yet, the market-driven nature of ETS pricing, while dynamic, poses predictability challenges due to potential price fluctuations, complicating long-term strategic planning.

Regulatory Reliability

Regulatory reliability is a theme often considered in carbon pricing research. It is observed that many studies discuss this topic without explicitly using this term (Andersson, 2019; Green, 2021; Metcalf, 2021). Therefore, regulatory reliability pertains to the assurance that specific environmental outcomes or targets will be achieved. It underscores the capability of a regulatory system to yield a specific environmental outcome—specifically, emission reductions—in accordance with climate change mitigation goals. This establishes it as an important layer for assessment.

In ETSs, a maximum limit is set on GHG emissions for covered sectors, enforced by a stringent and progressively decreasing cap on total emissions. This approach, ensuring emissions do not exceed the cap regardless of allocation distribution or trading, contrasts with carbon taxes, which influence the cost of emissions but do not strictly limit their volume. For instance, the EU ETS establishes a decreasing limit on emissions, with a 1.74% annual reduction for power plants and industrial facilities during Phase III (2013-2020) (European Commission, 2023a). Similarly, the Regional Greenhouse Gas Initiative (RGGI) sets a diminishing CO_2 cap for the energy sector, providing a clear trajectory for environmental target achievement.

While carbon taxes do not set a specific emissions reduction target, empirical evidence suggests they are effective in reducing emissions (Andersson, 2019, p. 27; Green, 2021, p. 9; Metcalf, 2021, p. 255). Therefore, despite the absence of a defined upper limit for emissions, it cannot be concluded that carbon taxes are ineffective in providing regulatory reliability.

5. Discussion

Carbon taxes are generally acknowledged as the most cost-effective means for reducing GHG emissions. However, these policies encounter significant opposition due to their conspicuous costs and adverse public opinion. Consequently, few regions implement carbon taxes at levels sufficient to meet the decarbonization targets outlined in the Paris Agreement. In instances where regulatory measures are adopted, policymakers frequently favor market-oriented or flexible regulations. Diverging from traditional command-and-control regulations that specify compliance methods, these flexible regulations grant regulated bodies the discretion to meet performance standards in various ways. They also permit the trading of compliance credits, enabling entities that do not meet the standards to purchase excess credits from those exceeding them, provided the overall requirements of the regulation are met. Consequently, flexible regulations offer a dual advantage: they are both effective in curbing emissions and politically viable (Rhodes et al., 2021, p. 1).

Evidence indicates that carbon taxes and ETSs should be considered elements of a broader array of mitigation strategies rather than as mutually exclusive optimal solutions. In practice, jurisdictions implementing a carbon tax often concurrently operate an ETS, and those with either a tax or an ETS invariably employ additional measures targeting emissions from sources covered by the tax/ETS. The rationale for this multifaceted approach, grounded in both theoretical and practical considerations, is to employ a combination of price-based and non-price mechanisms to mitigate GHG emissions. However, this approach of utilizing multiple instruments not only escalates compliance costs but also gives rise to complex interactions and distributional impacts (Haites, 2018, p. 963).

It should be emphasized that the relative advantages and disadvantages highlighted in certain dimensions of assessment cannot be simply aggregated or subtracted to determine their overall impact on the balance. In other words, the prominence of an instrument in many dimensions does not necessarily imply its superiority over other. Indeed, an instrument that appears disadvantaged in numerous dimensions might operate more effectively in unique contexts due to its relative advantages in certain aspects.

6. Conclusion

The existing literature elucidates the layers of evaluation in this study, which include efficiency, political durability, policy consistency, flexibility, adaptability, predictability, and regulatory reliability. Based on these layers, the study assesses various carbon pricing instruments, with experiences illuminating the relative merits and drawbacks of ETSs and carbon taxes. This facilitates informed decision-making in the domain of carbon pricing. By providing insights into the design of effective emission reduction policies, the study contributes to informed and sustainable policy decisions on climate change. Both ETS and carbon taxes can serve as effective components within a mitigation policy portfolio, functioning as complementary tools.

ETS, offers the advantage of setting a clear limit on emissions, providing certainty about environmental outcomes if the cap is set appropriately. It allows for market flexibility, as companies can trade emissions allowances, potentially leading to cost-effective emissions reductions. ETS can be complex to design and implement, requiring a robust monitoring and enforcement framework. It can also be subject to market volatility, which might lead to unpredictable costs for businesses. Over-allocation of permits or a lack of stringent caps can undermine the system's effectiveness.

Carbon taxes are simpler to administer and provide relatively predictable prices for carbon emissions, facilitating easier long-term planning for businesses. They generate government revenue, which can be used for climate initiatives or offsetting the tax burden elsewhere. Carbon taxes are transparent and straightforward, making them potentially more palatable to the public and easier to implement. The effectiveness of a carbon tax depends heavily on the tax rate; if set too low, it may not sufficiently incentivize emissions reductions. There is also the political challenge of setting and potentially raising the tax over time. Unlike ETS, carbon taxes do not provide a hard cap on emissions, potentially leading to uncertainty about environmental outcomes.

Future research should focus on expanding the comparative analysis of ETS and carbon taxes within diverse economic and geopolitical contexts. There is a particular need for empirical studies assessing the effectiveness of these mechanisms in developing countries, where economic constraints and different policy priorities may influence outcomes. Furthermore, longitudinal studies examining the long-term impacts of ETS and carbon taxes on innovation in green technologies would provide valuable insights. This could include analyzing how different industries adapt to these mechanisms and the subsequent effects on sustainable economic growth. Another critical area of exploration is the intersection of carbon pricing mechanisms with broader socio-political dynamics, including public acceptance, political feasibility, and the role of international cooperation and agreements in shaping these policies. Research in these areas guide more nuanced and effective policy formulations in the ongoing global effort to mitigate climate change.

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