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Review Article

Carbon Pricing and Green Growth: A Systematic Review of Policy Effectiveness, Design, and Equity

*¹Enoch Nii-Okai, ¹Alfred Yeboah, ²Emmanuel Kwasi Xonu, ³Ayodeji Olayode, ⁴Efe Nkem Osarodion, ⁵Gopal Fosu Oppong Wiafe, ⁵Albert Miezah Ackah, ⁶Benjamin Osaze Enobakhare

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About Author

¹ Department of Geological and Mining Engineering and Sciences, Michigan Technological University, Houghton, USA

² Department of Environment, Geography and Marine Sciences, Southern Connecticut State University, New Haven, CT, USA

³ Department of Civil Engineering, Federal University Oye-Ekiti, Ekiti State, Nigeria

⁴ Department of Economics, Ambrose Alli University, Ekpoma, Nigeria

⁵ Department of Mining and Mineral Engineering, University of Alaska Fairbanks, Fairbanks, AK, USA

⁶ Service Support Engineer, Peterbilt Motors (PACCAR Inc), Denton, Texas, USA

Contact @ Enoch Nii-Okai
niiokaie20@gmail.com

ABSTRACT

Climate change constitutes a major market failure because greenhouse gas emissions are not priced to reflect their social costs. Carbon pricing has become a central policy instrument, yet its effectiveness varies across contexts. This review evaluates the performance of carbon taxes and emissions trading systems by examining their environmental, economic, and equity outcomes. The analysis applies a systematic review framework covering peer-reviewed studies, meta-analyses, and international policy assessments published between 2008 and 2025. Evidence is synthesized across three dimensions: emissions reductions, innovation and structural change, and distributional impacts. The literature consistently shows that carbon pricing reduces emissions when price signals are strong, credible, and increase predictably over time. Jurisdictions with rising tax schedules or progressively tightening emissions caps achieve the most durable mitigation. Carbon pricing also stimulates low-carbon innovation and supports long-term structural change, especially when combined with complementary policies. Distributional outcomes vary, but equity improves significantly when revenues are returned through rebates or tax reductions. Overall effectiveness depends more on design quality and policy coherence than on whether pricing is delivered through taxes or trading systems. Credible long-term price paths, broad sectoral coverage, transparent governance, and equitable revenue use are essential conditions for achieving sustained environmental and socio-economic benefits.

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1. INTRODUCTION

Climate change is the twenty-first century market failure which is most pervasive. The social, ecological, and intergenerational costs of greenhouse gas emissions are not reflected in the market, and this factor contributes to the over-production of carbon dioxide by producers and the consumption of the consequences of climate changes by society in the form of degrading ecosystems, a decrease in the productivity of agricultural activities, and an increase in risks associated with climate change (Stern, 2024). State and Trends of Carbon Pricing 2025 by the World Bank highlights the fact that externalizing climate harm to future generations and to the public sector by emitters through the lack of explicit price provides a continuation of a long-standing mismatch between social and personal interests (World Bank, 2025). The various empirical reviews verify that this distortion is one of the contributors to systematic overproduction of fossil resources and under investments in low-carbon technology (Ahmad *et al.*, 2024; Metcalf, 2009). At the economic level, without a lodged price on carbon, the producers enable the transfer of costs of environmental harm over to the state sphere, establishing a system of incentives that encourages the prevalence of carbon-intensive production, slower adoption of low-emission technologies, and sluggish technological diffusion (Feng *et al.*, 2024).

Comparison with the global literature indicates that economies that lack pricing schemes still stand characterized by a powerful linkage between GDP development and emissions, which supports structural inertia of fossil-fuel dependence (Infante-Amate *et al.*, 2025) and increases the dangers associated with emissions exceeding the set limit (Polewsky *et al.*, 2024). By introducing carbon pricing, either as a carbon tax or through an emissions trading system, the social cost of carbon will be internalized to correct this distortion and to align the choice individuals make with the goals of climate (Köppl & Pichler, 2023). It has been confirmed through meta-analysis that pricing inverts the incentive structure by rendering environments both economically restrictive in terms of emissions and economically beneficial as far as low-carbon innovation is concerned (Döbbeling-Hildebrandt *et al.*, 2024).

The issue of carbon pricing has moved beyond the concept of suggestion to become international policy. According to the reports by the World Bank, over seventy national or subnational jurisdictions currently levy carbon and that carbon cash flows have gone beyond one hundred billion dollars a year, assisting in clean-energy evolutions and societal initiatives (World Bank, 2025). The empirical literature illustrates the instruments have the propensity to lessen nations of emissions when price signals are intense enough, and certain enough predictable. Statistically significant negative emissions reductions are observed by a machine-learning meta-analysis based on over seventeen thousand ex-post policy estimates that are produced by carbon pricing in various sectors and income settings that are accompanied by complementary regulatory measures and exceed levels of price levels (de Perthuis & Trotignon, 2014). Correspondingly, comparative syntheses demonstrate that carbon taxes are linked with decreases in emissions intensity and decreases in the consumption of fossil fuels in case of a steady increase in tax rates over a period, as well as when

policymakers pledge to forego any changes in long-term price paths (Döbbeling-Hildebrandt *et al.*, 2024). These findings are reflected in evidence of emissions trading systems. Assessments of the European Union Emissions Trading System indicate that annual emissions have continued to reduce with the change in allocation of allowances between free permit system and the auction system and tightening of the cap (ERCST, 2025).

Carbon pricing does not only impact emissions but also affects how and what technological change will be. Pricing changes the investment portfolio of firms and raises the relative payoff on the adoption of clean technologies by making carbon intensive activities more costly. Empirical studies indicate that foreseeable schedules related to the prices of carbon increase green R&D expenditure, result in low-carbon-patenting, and enhance implementation of renewable energy methods (Feng *et al.*, 2024). Other research shows that the innovation effect of carbon pricing is reinforced when the price is installed in a set of policies that have specific subsidies to promote clean technologies and state funds to invest in energy infrastructure (Ahlvik *et al.*, 2024). By doing so, carbon pricing can not only be transformative: they bring about economic incentive to lessen the emissions but also drive innovation that would reform the technological edge.

Carbon pricing policies are, however, faced by political and distributional issues. Increased prices of fuel, electricity, etc. tend to heavily tax lower-income households. Research indicates that carbon tax may lead to retrogressive effects, especially in situations where household incomes are used on energy at a significant percentage (Goulder & Stavins, 2011). However, it is always determined in studies that revenue recycling via lump-sum rebates or income taxes payroll due to households can undo this retrogressiveness and enhance household wellbeing (Shang *et al.*, 2023). When the policies are implemented in a transparent way and rebates can be seen and cut across board, it is likely that it will get public acceptance because its effect becomes more acceptable (Carattini *et al.*, 2019). It is found that prices alone do not define policy durability, instead design decisions in regard to price level, price path credibility, revenue use, and sectoral coverage define policy duration (Köppl & Pichler, 2023).

The carbon pricing debate cuts across the wider issue of green growth which is whether an economy can grow decarbonizing it. An example of relatively decoupled emissions with GDP growth can be observed in multiple industrialized economies, with the cases being mainly associated with carbon pricing in combination with extensive renewable energy development and incentives on innovation (Goulder & Stavins, 2011; Infante-Amate *et al.*, 2025). According to other researchers, global decoupling is still restricted and reductions, which are realized in a certain country, can be compensated through international trade and global supply chain emissions (Polewsky *et al.*, 2024). These two opposing conclusions show that, although carbon pricing can help in such a process of decoupling, it does not do so across sectors or economies that lack such changes in investments and structure.

Since the carbon pricing initiatives are increasingly growing fast and the results of the empirical studies are varied, an integral synthesis is required. Whereas the individual studies



indicate that carbon pricing can lead to a decrease in emissions in the case of application using strong price signals (de Perthuis & Trotignon, 2014), and that carbon pricing can raise the level of policy acceptance as long as revenues are redistributed (Mardones *et al.*, 2024; Shang *et al.*, 2023), and innovation effects in the case of pricing as part of a larger policy mix are observed (Ahlvik *et al.*, 2024), the literature is still divided along disciplinary and methodological lines.

Thus, this review aims to address a critical gap in the existing literature. Previous meta-analyses and reviews have typically examined either the environmental effectiveness of carbon pricing or its economic and distributional effects in isolation. Few have integrated evidence across emissions outcomes, innovation dynamics, and equity considerations within a single analytical framework, and even fewer have evaluated how design features condition performance across these domains. This review therefore pursues three objectives. First, it evaluates the efficacy of carbon pricing instruments in reducing emissions at both national and sectoral levels, drawing on evidence from carbon taxes and emissions trading schemes (Carattini *et al.*, 2019; World Bank, 2025). Second, it analyzes the relationship between carbon pricing and green growth by assessing how pricing interacts with innovation, structural economic change, and long-term productivity (Infante-Amate *et al.*, 2025; Feng *et al.*, 2024; Polewsky *et al.*, 2024). Third, it examines how specific design features, including price trajectories, revenue recycling mechanisms, and sectoral coverage, shape equity outcomes, political durability, and policy resilience (Shang *et al.*, 2023; Köppl and Pichler, 2023). By synthesizing these dimensions in a unified review, this study clarifies what carbon pricing can achieve, identifies the conditions under which it is most effective, and highlights areas where further empirical evidence is needed.

2. LITERATURE REVIEW

Carbon pricing is based in the classical welfare economics which considers climate change as a negative externality that cannot be fixed automatically by the market. The release of carbon dioxide by the firms leads to expenditure on the society as environmental deterioration and adverse climatic impacts. These expenditures are not reflected in market prices, and hence a gap between the private and social good. The purpose of the climate policy is to reset these incentives accordingly through internalization of such external costs (Köppl & Pichler, 2023). The absence of such intervention will cause markets to produce more emission-intensive products and insufficiently invest in low-carbon products which will deepen structural dependence on fossil-based fuels (Metcalf, 2009).

2.1. Pigouvian logic and the social cost of carbon

The essence of Pigouvian taxation justifies carbon taxation in the first place. In an attempt to internalize an externality, pigou advocated that when the activities of the privates caused harm to others, the governments should levy a tax which is equal to the marginal social harm. In the modern climate economics, the social cost of carbon applies this principle by having an economic price of the damages of a single extra ton of greenhouse gas emissions. The results of empirical reviews

indicate that Pigouvian taxes can be the most effective when the carbon price paths can be predicted and gradually rise over time (Köppl & Pichler, 2023). The same report by the World bank (2025) goes on to record that jurisdiction implementing rising price schedules and unambiguous long-term taxation trajectories record high reduction in emissions when compared to those applying fixed price levels. The increasing amount of ex-post evidence advocates a Pigouvian logic. In a machine-learning meta-analysis on global pricing policies on carbon pricing, the authors find that carbon taxes always lead to a decrease in carbon emissions that exceed threshold prices (Doebeling-Hildebrandt *et al.*, 2024). Alternatively, small increases in the price at an early stage will have a considerable impact on the expectations of the firms and cause changes in the long run planning of investments. The results are in line with the sectoral research that states that increased carbon prices decrease the intensity of emissions in the electricity and industry sector (Ahmad *et al.*, 2024).

2.2. Emissions trading systems and the coasean perspective

The ET Systems are a manifestation of Coasean theory and climate regulation. Coase suggested that the issue of externalities could be solved effectively in the situation when property rights are clear and actors are able to negotiate. The ETS implements this rationale by transferring property rights of the emissions as tradable rights. To control the emission level, governments establish a limit to emissions by a binding cap and assign a number of finite allowances, which companies can utilize or book. Within the context of such a scenario the institution of scarcity will turn out to be the tool that controls emissions (Ahmad *et al.*, 2024).

At the initial stages of European Union Emissions Trading System (EU ETS) there was substantial allocation of free allowances which repressed the shortage and stifled carbon market prices. Further reforms enhanced the auctioning over free allocation and market stability Reserve was introduced to eliminate excess allowance. These changes enhanced shortage of allowances, price stabilization and faster cuts in emissions in the electrical and industrial industries (Metcalf, 2009). The World Bank (2025) also notes that ETS systems in which the caps decrease and auctioning regulations are transparent in their rules have better speed in realizing the reduction of emissions compared to ones in which a lot of reliance is given to free allocation.

Consistent evidence also shows that in numerous cases carbon taxes yield initial impacts in terms of reducing emissions since their signal is immediate in price, and ETS work better as time progresses as a scarce allowance drives up price (Ahmad *et al.*, 2024). Another impact of the ETS design on the results in the innovation process is also seen. Companies in the ETS jurisdictions are also likely to shift investment in carbon-intensive processes towards low-carbon innovation, especially in cases where shortage becomes a source of probable financial punishment (Ahlvik *et al.*, 2024). The Innovation Fund financed by revenues of the auctioning within the EU ETS provide incentives to the clean technology projects and actively contribute to the generation of spill-over effects (Feng *et al.*, 2024).



ETS is becoming increasingly popular throughout the world. The banking systems of emerging economies like China and South Korea are headed towards scaling their trading systems, countries like Canada and various EU nations are discussing inter-jurisdictional linking in an attempt to bring larger allowance markets and lessen fluctuations (World Bank, 2025). Market connection brings forth market liquidity, minimization of costs on transaction, and increase in the overall efficiency of the market. The longitudinal analyses reveal that the efficacy of ETFs is significantly predetermined by the stringency in caps: hangar caps or politically-focused surpluses offer a delay in one's cuts and increase the credibility (Polewsky *et al.*, 2024). The current meta-analysis study validates that the performance of ETS is linked to a lack of allowance, believable cap paths, and open market policies (Döbbling-Hildebrandt *et al.*, 2024).

2.3. Marginal abatement cost theory and investment efficiency

One of the most solid theoretical merits of carbon pricing is the opportunity to minimize the emissions at the minimal cost in general. The marginal abatement cost (MAC) theory demonstrates that the firms have varying costs to abate emissions. Carbon pricing enables companies that incur low costs of abatement to emit low volumes of emissions as companies with high cost of abatement pay the price or purchase allowances. This flexibility makes sure that the reductions are made where they will be the most cost-efficient and to take advantage of heterogeneity instead of forcing the same technological standards. Empirical data show that the least-cost abatement strategies in the market regime always self-equilibrium, which is significantly more effective compared to control via command and control regulation (Ahmad *et al.*, 2024). That is the reason why economists of all ideological traditions see carbon pricing as the core of the design of climate policies (World Bank, 2025).

2.4. Policy mix theory and induced innovation

In addition to fixing market failure, carbon prices also define technological paths. The theory of policy mix supports policy mix and believes that pricing mechanisms will be most effective with the assistance of technology supporting policies such as subsidies, grants and renewable portfolio standards. It has been empirically demonstrated that green innovation is the most robust in the presence of carbon pricing in a favorable policy environment (Ahlvik *et al.*, 2024). Foreseeable price trends promote the process of green patenting and hasten the result of deploying renewable energy (Feng *et al.*, 2024). Longitudinal studies also indicate that closer relations between GDP and emissions are more likely to be decoupled when the pricing policies coexist with innovation policy (Infante-Amate *et al.*, 2025). Within this framework, the issue of pricing is not just an economic correction, but it also triggers a systematic transformation.

2.5. Equity and political feasibility

Carbon pricing is economical; however, the political sustainability of this measure is subject to equity and popular acceptance. In the absence of redistribution, carbon taxes will

overburden low-income households since the interpretation of energy expenditures hits a higher part of their income (Mardones *et al.*, 2024). Under empirical evidence, the drop in regressivity when revenues are redistributed using lump-sum rebates or reduced income tax [as a benefit] is offset, with net benefits of the vulnerable groups (Shang *et al.*, 2023). When households can observe the tangible benefits, including the appearance of dividends, or the payment of electricity bills (Ahmad *et al.*, 2024). These lessons indicate that carbon pricing is not only a financial instrument but also a political entity that would have to be more transparent, gain trust, and be just to become sustainable over time (World Bank, 2025; Polewsky *et al.*, 2024).

3. METHODOLOGY

3.1. Literature identification and scope

The literature search was conducted across major academic databases, including Scopus, Web of Science, ScienceDirect, SpringerLink, and Google Scholar. The review focused on publications from 2008 to 2025 to capture both the foundational theoretical work following Metcalf (2009) and the most recent empirical studies and meta-analyses such as Döbbling-Hildebrandt *et al.* (2024) and the World Bank's State and Trends of Carbon Pricing 2025. The search targeted peer-reviewed journal articles, meta-analyses, policy evaluations, and official reports, and was limited to English-language sources. Studies were included if they provided empirical evidence on carbon pricing instruments at the national or subnational level. Editorials, commentaries, purely theoretical models, and studies without identifiable methodological grounding were excluded. To ensure transparency and reproducibility, Boolean search strings were developed using combinations of economic, policy, and technology-related terms. The core Boolean query applied across databases was:

*("carbon pricing" OR "carbon tax" OR "emissions trading system" OR ETS OR "carbon market") AND ("policy effectiveness" OR emissions OR mitigation OR innovation OR "green growth" OR equity OR distributional) AND (economy OR sector OR national OR subnational)**.

Database-specific syntax was adapted as required. These Boolean strings ensured a comprehensive and systematic identification of studies relevant to carbon pricing effectiveness, innovation impacts, and equity outcomes.

3.2. Data extraction and analytical strategy

A coding of selected studies by policy instrument, region and analysis focus was done. The econometric analysis, simulation models, and meta-analytical synthesis were considered as the quantitative evaluation. There was a review of qualitative and mixed-method studies based on how they approached policy design and governance as well as social outcomes. Effect estimates were also harvested on three fundamental dimensions of policy effectiveness in order to allow comparability:

- i. The result of emissions cut which is the environmental performance.
- ii. Economic efficiency and technological advancement in form of innovations and structural change.
- iii. Social sustainability is represented by equity and political



feasibility.

The results were then divided in the type of instrument (carbon tax or ETS) and looked into through cross-case synthesis. This enabled the incorporation of empirical results in regions, sectors, and design of the methods used to detect patterns of consistent causal and design principles.

3.3. Thematic synthesis and framework development

A narrative and thematic method was used in the synthesis to connect theoretical knowledge and empirical research. Several major concepts identified in the literature were then chosen to build thematic clusters (1) Pigouvian taxation and the social cost of carbon, (2) Coasean market design in emissions trading, (3) marginal abatement cost efficiency, (4) innovation and policy-mix theory, and (5) distributional equity. It analyses the results assembled altogether in these domains to determine the impact of design parameters like price dynamics, capwooden, and revenue reuse on effectiveness and durable viability. In a bid to avoid foul play, all sources used are mentioned under the reference list. The data regarding policies based on institutional reports (the European Roundtable on Climate Change and Sustainable Transition are organized therein, ERCST 2025, 2025) and the World Bank (2025) served as a way of putting context to the progress toward pricing and performance in carbon pricing.

4. RESULTS AND DISCUSSION

4.1. Carbon taxes

The carbon tax is an immediate charge on carbon emission or the carbons content of fossil fuels. On the economic level, it uses the Pigouvian logic according to which environmental damages must be reflected by the prices. When taxes are applied to price emissions, they will give a clear and predictable message to companies and households to move onto alternatives with lower carbon content. Comparative studies indicate that the carbon tax has the highest effectiveness when the tax rate is administered in a slow manner and policymakers are willing to have commitments to the long-term price trends (Köppl & Pichler, 2023). The examples of jurisdictions, including Sweden and British Columbia, show that price schedules that remain unchanged assist in decarbonization, without declining the economic growth. World Bank, State and Trends of Carbon Pricing 2025 reports that economic growths subject to increasing carbon taxes made more significant reduction to the emissions than those of the decomposable taxes that followed flat or transitory price packages (World Bank, 2025).

A characteristic of the topic of carbon tax is revenue use. Research indicates that once revenues are returned to households via lump-sums or payroll tax cuts the tax becomes more equitable and receives greater political acceptance (Shang *et al.*, 2023). Through evidence provided by Mardones *et al.* (2024), it is demonstrated that carbon tax regressive effect can be reversed by substituting it with targeted redistribution. These empirical data show that carbon tax is not only a means of market failure correction, but also a redistributive measure whose effectiveness is predetermined by an objective and socially just allocation of revenues. New studies also indicate that carbon taxes do affect the decision-making of investors.

Under multisector, the carbon-tax-treated area firms are moving toward the production technology that is cleaner and allocating more funds on its energy efficiency than the firms in the non-priced areas (Ahmad *et al.*, 2024). Carbon taxes thus impact on the short-term emission behavior and the long term technological orientation.

4.1.2. Emissions trading systems

Emission trading systems (ETS) operate on the basis of a set cap on licensed emissions and allowances that are given to the companies. Contrary to carbon taxes which control the price of any given product, ETS programs control the amount of emission that is permitted and leave the market forces to control the price of allowance. ETS effectiveness is associated with cap stringency, incremental increase in emissions limits and regulation on how the allowances will be distributed. Early iterations of the European Union ETS had free allowances that were generous and this muffled the prices and minimized the emissions reduction. The subsequent reforms turned more toward the auction and introduced the Market Stability Reserve made allowance scarcity and enhanced the price signal (ERCST, 2025). Consequently, the EU ETS has resulted in annual emissions trading off in the electricity and industrial process, and this illustrates how the emissions decrease when there is a scarcity of the same and the prediction is certain.

There are also ETS systems with effects of innovation. Research indicates that companies that are exposed to the ETS caps spend more on low-carbon technologies and shift capital in the gas-intensive operations to renewable technologies (Ahlvik *et al.*, 2024). Price of allowances has impacts on direction of R&D because it changes relative returns of clean technologies. Now, in the EU ETS, methane trade revenues are used to finance the Innovation Fund and, in this manner, a feedback loop was constructed between carbon prices and innovation, which, in turn, reduces abatement costs (Feng *et al.*, 2024). World Bank (2025) observes that the ETS implementation is increasing at a high rate in the emerging markets such as China and South Korea and several regions are looking into market linking to enhance liquidity and stabilize prices.

4.1.3. Comparing carbon taxes and ETS: price certainty vs. quantity certainty

Where carbon taxes ensure price, ETS ensures the result of the emissions. Empirical comparisons of the two instruments reveal that carbon taxes are more likely to generate faster decreases due to the timetables of taxes with existing price security, whereas the ETS works better as time progresses as the lack of allowance occurs, and the cap gets stricter (Ahmad *et al.*, 2024). Recently, a machine learning meta-study has verified that carbon taxes as well as ETS are effective in lowering emissions but that the strength of the impact relies on the design of the policy than the type of the instrument (Döbbling-Hildebrandt *et al.*, 2024). Using either of the tools is more effective when applied as a policy mix. Carbon pricing in combination with renewable energy requirements or even specific subsidies on certain areas of innovation intensifies the use of green technology (Ahlvik *et al.*, 2024) and leads to the faster decoupling of growth in GDP and emissions



(Infante-Amate *et al.*, 2025). On the other hand, weak pricing information or ineffective allowances are causes of policy failure especially when there are political concessions resulting in the extreme case of free allocation (Polewsky *et al.*, 2024). Concisely, carbon taxes and ETS have the same capacity to control the emission, and one is not necessarily better than the other. Its effectiveness is hinged on price levels, clarity of the policy, consideration of equity and long term credibility.

Table 1. Comparative overview of carbon pricing instruments

Policy Instrument	Jurisdictions (Examples)	Core Design Features	Emissions Outcome	Innovation Effects	Equity/Revenue Use	Key Sources
Carbon Tax	Sweden, British Columbia, Chile	Gradually rising price path; predictable rate schedule	Early and stable reductions	Strong incentives for energy efficiency and clean R&D	Progressive with revenue recycling (lump-sum rebates, tax swaps)	Köppl & Pichler (2023); Shang <i>et al.</i> (2023); World Bank (2025)
Emissions Trading System (ETS)	EU ETS, China, South Korea	Declining emissions cap; allowance auctioning; market stability reserve	Gradual, accelerating reductions as scarcity tightens	Innovation via scarcity mechanism and reinvestment of auction revenues	Neutral to mildly progressive; risk of regressivity if free allocation persists	ERCST (2025); Ahlvik <i>et al.</i> (2024); Feng <i>et al.</i> (2024)

Note: Table 1 summarizes design features, equity implications, and performance outcomes across carbon pricing instruments.

4.2. Policy effectiveness

Effectiveness of carbon pricing is not just in the ability of emissions to decrease after adoption of the policy but also in the ability of pricing to restructure economic incentives, investment choices as well as long run technological paths. This multidimensional concept of effectiveness has been echoed in the newer body of scholarly work, which highlights that pricing tools work in the context of a more intricate political, institutional, as well as a technological environment, not in a discrete market mechanism. Consequently, scholars look into policy impacts more often in three areas that are closely connected, namely, emissions cut, innovation and structural change, equity, and political sustainability (Köppl & Pichler, 2023; Ahmad *et al.*, 2024; World Bank, 2025). Collectively these studies go beyond the initial belief that pricing was to be used as a sole abatement optimization. On the contrary, the newly acquired consensus provides that the effectiveness is related to the strength of the price, the design policy, and the complementary strategy (Infante-Amate *et al.*, 2024; Ahlvik *et al.*, 2024).

4.2.1. Measuring policy effectiveness

The effectiveness of the policies is measured by determining whether carbon pricing will lead to any measurable and enduring effects on the economic behaviour of firms and households. Although earlier assessment was carried out based on short-term differences in emissions before and after the introduction of the policy, modern assessment is carried out based on the use of econometric counterfactuals, machine-learning syntheses, and the analysis of multi-country panels so that the causal effects could be identified (Döbbeling-Hildebrandt *et al.*, 2024). The concept of effectiveness is consequently discussed as a result of the behavioral and structural change as opposed to a mere capture of the emissions. The scholars believe that policy is working when it changes the pattern of investments, risk-processing, and communicates starting a belief in the long-term

commitment to decarbonization which is credible (Köppl & Pichler, 2023; World Bank, 2025). By doing so, carbon pricing is not necessarily an intervention but rather a kind of authoritative organization that can adjust the incentives, expectations, and social discourses to fit to cleaner development lines. Figure 1 depicts the conceptual pathway in which carbon pricing functions, in which the price signals will impact on firm behavior, technological innovation as well as equity outcomes that mutually support long-term decarbonization.

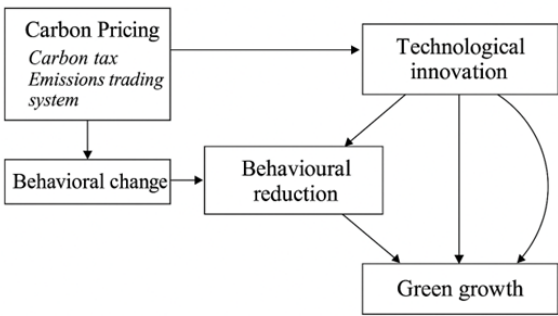


Figure 1. Conceptual pathway of carbon pricing effectiveness. *Note. The arrows are the causal relationships between the carbon pricing instruments, behavior change, innovation, emissions reduction, and the outcomes of green growth. Feedback loops refer to the way in which innovation and equity processes strengthen policy performance.*

4.2.3. Emissions outcomes

There is currently a solid literature attesting to the role of carbon pricing in achieving statistically significant emission declines in various contexts involved in the national setting. Döbbeling-Hildebrandt *et al.* (2024) used over seventeen thousand and One effect estimates in its most comprehensive synthesis of carbon pricing outcomes by the authors and found that consistent effects were reduced in terms of emission scales and when

price signals are above threshold values. The same conclusions are supported by Ahmad *et al.* (2024), who also prove that the emission decreases in even energy-intensive industries when policymakers are determined to increase price movements. The experience of emissions trading systems demonstrates that the reduction is higher with the increase in scarce allowances. The European Union Emissions Trading System saw the emissions in power and industries gradually cut as the free allowances gradually declined and were replaced by auctions as the general mechanism of allocation (ERCST, 2025). This trend is supported by the World Bank (2025); it indicates that the jurisdiction declining emission cap and having a clear signal of price over time will lower rates of emission more compared to that with politically unstable or weak price curves. Structural impacts of policy, through policy mediated by the structure of national economies is also emerging. In an economy with a transition to service-based production, Quaye (2025) identifies that the increase in emission reductions that can be connected to pricing is more sustainable; it is possible that carbon pricing affects a structural change in these economies, rather than operating independently. This is consistent with Infante-Amate *et al.* (2024), who believe that the result of mitigation is discussed in terms of policy strength and the economic composition behind.

4.3.4. Innovation and technology diffusion

Carbon pricing brings about innovation as it changes the relative profitability of low-carbon and high-carbon technologies. The reaction of firms to rising the cost of carbon involves diversion to clean energy and energy efficiency in order to prevent future rise in costs. This theoretical mechanism is always supported by research. Poisonous to jurisdiction-specific findings, Lim and Prakash (2023) their study shows that carbon-pricing jurisdictions have much higher rates of green patenting and that reducing emissions increases the quality of innovation by directing innovation to technologies that are more likely to reduce emissions. Ahlvik *et al.* (2024) also indicate that carbon pricing is an innovation selection tool that rewards less costly emission-cutting technologies and kills off low-efficiency technologies. According to Feng *et al.* (2024) the price signals hasten the adoption of renewable generation through the minimization of investment risk where there is a contentment with the scheme of planning of infrastructures of the government. Effects of innovation are enhanced by pricing when mingling with complementary policies. Infante-Amate *et al.* (2025) report that in areas that would have carbon price in combination with clean-energy requirements and research payments, meaningful decoupling of GDP and emissions happens. These findings highlight the conclusion that innovation has a path-dependent aspect: pricing drives companies out of intensive carbon production, but the right policies offer the support system needed to grow low-carbon technological systems.

4.3.5. Distributional and equity impacts

Effectiveness of a policy is not only related to reduction of emissions, but to how the people perceive the fairness of the policy. The empirical evidence provides that revenue redistribution-free carbon pricing may be retrogressive because households with lower incomes allocate a greater portion of

their assets on energy (Mardones *et al.*, 2024). Nevertheless, regressivity can be turned into progressivity through redistribution. Shang *et al.* (2023) provide evidence that lump-sum rebates and payroll taxes decreases outweigh costs related to the low-income households. Carbon pricing becomes much more popular among the population when these households explicitly get climate dividends or when the government has a clear description of where the revenue goes (Ahmad *et al.*, 2024). This observation can be attributed to a larger truth that a good pricing policy is the one that is not only economically but also socially acceptable.

4.3.6. Long-term durability and policy coherence

The durability is the determinant of long-term effectiveness. Carbon pricing does not work when the policy signals are erratic, low prices do not change decision, or when allowances are large in number and they undermine the idea of scarcity (Polewsky *et al.*, 2024). The enhancement of durability can be achieved when pricing is a part of a policy mix comprising of renewable investment, infrastructure planning, and focused industrial policy (Ahlvik *et al.*, 2024). According to the World Bank (2025), pricing is better understood as a type of coordinating tool rather than an independent tool, and as such, pricing should align innovation, fiscal spending, and other forms of regulations towards the same decarbonization goal. That is, pricing determines the route to be taken, and supporting policies propel operations.

4.4. Green growth and decoupling

The issue of the ability or inability of the economies to expand and at the same time to minimize the emissions is at the core of the modern climate change economics. The green growth theory posits that it is possible to achieve economic growth and minimum emissions at the same time in the event the economy slowly shifts to low-carbon intensive technologies, energy efficiency, and knowledge intensive industries (Emeka-Okoli *et al.*, 2024). This argument presupposes that climate change is not a simple environmental issue, it is a chance of reorganizing the growth patterns via carbon pricing and innovation to redirect investment into those spheres that can produce high productivity and have minimal impact on the ecology (Emeka-Okoli *et al.*, 2024). This optimism is disputed in nature by experts such as critics who believe that pricing can diminish competitiveness or inject emissions in other jurisdictions whose own regulations on the environment are less stringent. Empirical findings of recent years, however, are more and more opposing the assumed trade off. The research indicates that effective carbon pricing may lead to the possibility of absolute decoupling where emissions decrease despite the growing GDP, especially when the price is undertaken in a consistent, protracted policy framework (Infante-Amate *et al.*, 2025; Polewsky *et al.*, 2024). The purpose of carbon pricing in this regard is not merely to cut the level of emissions, but to transform the system of growth as a whole and to re-orient the investment towards a low-carbon economy.

4.4.1. The green growth hypothesis

Green growth theory places carbon pricing as a remedial



institution to reposition the economies away towards carbon intensive activity. It operates by adjusting the cost structures and rewarding the firms who innovate, invest in efficiency or launch low-carbon products. It has been proven that carbon pricing allows the development of new economic domains in the field of renewable energy, clean mobility, the circulation of production, and retrofits of buildings (Feng *et al.*, 2024). These industries have become the major sources of jobs in the developed economies, they are sought after industries superseding the old industries that used to extract fossil fuels. Such tendencies are strengthened with cross-national comparisons. Carbon pricing in countries allows them to grow much faster with green exports and low carbon investment inflows, and countries that keep fossil fuel subsidies imprison themselves in high emission trajectories (Ahmad *et al.*, 2024). The World Bank (2025) notes that carbon pricing asserts financial streams to the climate by enhancing predictability of costs as well as indicating the commitment to regulation. The consequence of this crowding-in of its own privately-owned investment is to turn price on carbon into an economic modernizer. Further, the research findings have demonstrated that the cost of carbon boosts clean technology patent quantities and qualities (Lim & Prakash, 2023) when price signals are credible and increasing. Pricing thus does not tend to drive away the emissions but also fully transforms technological competition.

4.4.2. Evidence of decoupling

Decoupling is the empirical evidence of green growth theory. It demands that the level of emission must decrease even with an expanding economy. Sustained decoupling is noted in the European economies, which have both a renewable investment policy and an efficiency policy in conjunction with carbon pricing (Infante-Amate *et al.*, 2025). These are consistent with reports by ERCST (2025) when emissions included in the EU ETS came down drastically with regulators restricting the number of emissions by point of cap tightening, auctioning more number of allowances and eliminating additional permits. In its analysis of the outcomes of regulation of global carbon prices, Döbbling-Hildebrandt *et al.* (2024) call on machine-learning to support this conclusion. They find that best instances of decoupling can work in jurisdictions in which organizations establish clear and foreseeable long-term patterns of prices so that firms can predict costs in the future and invest in emissions abatement in a strategic manner. Quaye (2025) also adds that the best decoupling is seen in the economies that are transforming into the services and the knowledge economy which means that the pricing of items drives the structural economic change faster by rendering the profitability of the carbon-intensive industry less lucrative. Decoupling is, however, no just an emissions trend. Carbon pricing is an indicator that it starts reforming economic structures.

4.4.3. Carbon pricing, competitiveness, and trade exposure

The issue of decreased competitiveness and the emission leakage still remain on the agenda of the policies. Opponents observe that pricing would contribute to unregulated places to produce their goods, or would disadvantage domestic industries. But there is more to empirical evidence. As Ahmad

et al. (2024) demonstrate, leakage is caused by governments reusing revenues within the state to fund innovation, upgrade on productivity, and low-carbon implementation. According to what the World bank (2025) establishes, companies tend to use the carbon revenues to fund efficiency gains that would eventually reduce the cost of production to counter initial competitive actions.

Systemic leakages are handled by transitional design properties of emissions trading systems like output based allocation or gradual free allowances (Köppl & Pichler, 2023). According to the ERCST (2025) measures allowed avoiding critical competitive handicapping during the initial stages of the EU ETS without undermining the price signal. In the long term, when low-carbon technologies are increasingly cost-competitive, it is possible to gradually remove allowance and increase the auction (Ahlvik *et al.*, 2024). This sequencing renders pricing politically sustainable and enables industry to make adjustments over time instead of making a drastic change. Succinctly, weakening carbon pricing does not help avoid leakage but, together with pricing and innovation support, sequenced allocation rules.

4.4.4. Green growth limitations and the policy mix

Green growth can not be ensured just by pricing carbon. Although this sends a strong market signal, it has limited impacts where other supporting infrastructure or innovations are lacking. Polewsky *et al.* (2024) warn that pricing carbon earnings but leaving it to the people to invest may trigger an immediate portion of efficiency, which will stand even after the low-abatement choices have been depleted. The authors discover that the effects of innovation are the most significant when the price is considered a part of the policy mix that includes technology subsidies, R&D grants, investments in infrastructure, and renewable energy standards (Ahlvik *et al.*, 2024). As demonstrated by Feng *et al.* (2024), combining pricing with industrial policy results in a fast diffusion of the low-carbon technologies than in a setting with pricing. Therefore, the concept of carbon pricing is to be considered as coordinating institution not as a single tool. It explains the economic direction in which he is going but has supportive policies to speed up the process.

4.5. Synthesis and future research directions

A review of the evidence provided in Sections 2 to 5 shows that well-designed carbon pricing can be effective in reducing emissions, creating technological innovation and, as such, providing economic growth. However, the literature also brings out the fact that carbon pricing is not a vacuum. It operates on institutions, regulatory systems and political landscapes that influence its performance in the long-term. Carbon pricing does not change the incentive dynamics, but supplementary policies and governance framework put in place whether the incentives lead to structural change.

An integrated study of the empirical literature has found clear evidence of three convergent conclusions. To start with, in instances of the credibility, strength and escalation of price signals, carbon pricing will decrease emissions. Both World Bank (2025) and Döbbling-Hildebrandt *et al.* (2024) stated in their meta-analysis that carbon pricing generates significant



operational emissions reductions in a wide range of settings, and more importantly, when prices exceed a critical level and the price curve trajectory in the long term is predictable. The European Union ETS evidence supports this observation; the decrease in emissions occurs when the regulators do not provide extra allowances and when free allocation does not take place and is replaced by auctioning (ERCST, 2025). Second, the pricing process spur not only efficiency but innovation as well. The research reports that increased and more foreseeable carbon prices are related to an augmented number of low-carbon patenting, green investment, and faster technological infiltration (Lim *et al.*, 2023; Ahlvik *et al.*, 2024; Feng *et al.*, 2024). Such effects of innovations are enhanced in a place where pricing combines with a larger policy ecosystem such as renewable energy succession, subsidies, and funding of research. Third, with complementary policies, carbon pricing would be able to assist in economic growth and allow decoupling of GDP and emissions. It is recorded in longitudinal evidence in the European economies of instances of absolute decoupling where emission declines coupled with GDP growth, particularly in economies that are under structural change to a service and knowledge-intensive sector (Infante-Amate *et al.*, 2025; Quaye, 2025; Polewsky *et al.*, 2024). Positive results notwithstanding, the literature indicates that there are major gaps that need to be addressed through research.

4.5.1. Understanding distributional justice and social legitimacy

Numerous works recognize the role of distributional concerns yet fail to exhaust variations of the equity in terms of influencing the long-term policy sustainability. Despite the evidence that the regressive effects can be reversed by revenue recycling (residents receive the rebates or tax reduction) (Shang *et al.*, 2023; Mardones *et al.*, 2024), very little is discovered on the impact of political rhetoric, government trust, or transparency of institutions on acceptance. The next round of research needs to explore sources of citizen-approved legitimacy of carbon pricing and the impact of communication, trust, and social norms on policy sustainability (Ahmad *et al.*, 2024).

4.5.2. Carbon pricing in the global south

The concentration of the literature is mostly in Europe, North America and few economies in Asia. Very little empirical research has studied the role of carbon pricing in low- and middle-income nations, where institutional capacity and informality, and energy poverty, can shift the policy dynamic. The question remains as to whether carbon pricing can remain a feature of green growth where fossil fuels are still being subsidized or where the energy sources that generate the greatest amounts of emissions are agricultural or land use activities or distributed sources of energy. According to the World Bank (2025), emerging economies have different political and infrastructural challenges, which indicates that the outcome of carbon pricing does not depend on carbon pricing only but rather on institutional design.

4.5.2. Long-term structural change and industry transition

Although it is evident that technological innovation is brought

about by price, little has been known concerning the long-term restructuring of industry due to price. Empirical information on large scale industrial transformation is limited and studies have just started to investigate whether pricing can lead to firms diversifying into new business and/or can compel them to get out of carbon-intensive production altogether (Koppel & Pichler, 2023) as prices nudge their firms to diversify or exit the production altogether. The way of pricing that interacts with global value chain, green industrial policy, and regional labour markets ought to be studied in future.

4.5.3. The limits of pricing as a standalone solution

One of the findings that can be viewed as constant in the literature is the fact that carbon pricing is best done as part of a bigger transformation agenda. As witnessed in policy-mix research, carbon pricing is leading to optimal outcomes when governments invest in infrastructure and research at the same time and in energy system planning (Ahlvik *et al.*, 2024; Feng *et al.*, 2024). Research on pricing needs to be factored in with strategic planning and industrial policy in the future and in particular as nations strive towards net-zero. Conclusively, in the literature, it has been demonstrated that carbon pricing is not just a system to internalize externalities, but it can be an institutional framework capable of reorganizing the path of economic progress. A decarbonization economic rationale is now given through pricing, whereas transformation or not is established through innovation policy, state financing and social approval.

5. CONCLUSION

The literature studied in this paper indicates that the carbon pricing has become one of the most empirically verified tools in climate change economics. Its power is not necessarily in putting a price upon emissions but in upsetting the economic logic according to which fundamental dependence on fossil fuels is continued. With the introduction of a transparent and increasing cost on emission-related activities by price, firms and households change their actions. This is because it results in emissions that are lower since it becomes costlier to pollute and it is more lucrative to innovate. The experience of various nations indicates that the rate of reduction of emissions is the greatest when pricing strategies use plausible price paths, extensive designation of the sector, and a clear administration (DoeblingHildebrandt *et al.*, 2024 World Bank, 2025). In such situations, the design architecture is more important as compared to whether the policy is in a form of tax or as an emissions trading system. The review also demonstrates that the effect of carbon price is not limited to the reduction of emissions. Pricing has the effect of determining the way the technology changes. Companies tend to put more capital into efficiency and low-carbon development, the pace of patenting is growing, and the move to renewable and clean energy markets is increasing (Lim & Prakash, 2023 Ahlvik *et al.*, 2024 Feng *et al.*, 2024). Carbon pricing is thus a coordinating institution that helps to bring market incentives in line with the social climate goals. Significant impacts are realized when pricing is combined with other complementary policy actions like renewable portfolio standards, public R and D funding or even a special



treat to the industrial sector. In such policy ecosystems, it does not only facilitate innovation, but hastens it.

Notably, the existence of carbon pricing can be able to facilitate the macroeconomic performance. Empirical research on the concept of green growth and decoupling demonstrates that the reduction of emissions is possible even with an increase in GDP, especially in economies that are experiencing structural changes towards the service and technological industry (Infante-Amate *et al.*, 2025 Polewsky *et al.*, 2024). Recent empirical evidence is not in line with the notion that climate policy requires an artificial limitation of growth. Carbon pricing, instead, seems to focus investment on industries that are oriented towards the future, enhance competitiveness, and mobilize the private capital asset, particularly when the capital gathered is reinstated internally (Ahmad *et al.*, 2024). Economic development and decarbonization go hand in hand in such instances. During the same time, carbon pricing is not a refuge in political reality. Pricing schemes may overburden the low-income households without directed redistribution of revenues so that the cost of heating, transportation, and electricity becomes more expensive (Mardones *et al.*, 2024). Nevertheless, the same research studies indicate that in case revenues are restored to households, whether in the form of rebates or breakages to payroll and income taxes carbon pricing is just and can even add disposable income to vulnerable population (Shang *et al.*, 2023). Pricing is sturdy also then not merely a matter of economic design but also a matter of perceived fairness. Climate policy is supported by the citizens in cases where the benefits are perceived to be tangible than abstract.

REFERENCES

- Ahlvik, L., van den Bijgaart, I. J. H., Borghesi, S., Carattini, S., Jagers, S. C., Shrimali, G., & van den Bergh, J. C. J. M. (2024). Assessing criticisms of carbon pricing. *Journal of Environmental Economics and Management*, 117, 103733. <https://doi.org/10.1016/j.jeem.2023.103733>
- Ahmad, M., Li, X.-F., & Wu, Q. (2024). Carbon taxes and emission trading systems: Which one is more effective in reducing carbon emissions? A meta-analysis. *Journal of Cleaner Production*, 476, 143761. <https://doi.org/10.1016/j.jclepro.2024.143761>
- Carattini, S., Kallbekken, S., & Orlov, A. (2019). How to win public support for a global carbon tax. *Nature*, 565(7739), 289–291. <https://doi.org/10.1038/d41586-019-00124-x>
- De Perthuis, C., & Trotignon, R. (2014). Governance of CO₂ markets: Lessons from the EU ETS. *Energy Policy*, 75, 100–106.
- Döbbeling-Hildebrandt, N., Miersch, K., Khanna, T. M., Bachelet, M., Bruns, S. B., Callaghan, M., Edenhofer, O., Flachsland, C., Forster, P. M., Kalkuhl, M., Koch, N., Lamb, W. F., Ohlendorf, N., Steckel, J. C., & Minx, J. C. (2024). Systematic review and meta-analysis of ex-post evaluations on the effectiveness of carbon pricing. *Nature Communications*, 15, 4147. <https://doi.org/10.1038/s41467-024-48512-w>
- Emeka-Okoli, S., Otonnah, C. A., Nwankwo, T. C., & Nwankwo, E. (2024). Review of carbon pricing mechanisms: Effectiveness and policy implications. *International Journal of Applied Research in Social Sciences*, 6(3), 337–347. <https://doi.org/10.51594/ijarss.v6i3.891>
- ERCST (European Roundtable on Climate Change and Sustainable Transition), ICIS, I4CE, & Wegener Center. (2025). State of the EU ETS Report 2025. <https://ercst.org/publication/state-of-the-eu-ets-2025/>
- Feng, T., Wang, X., Shi, Y., & Tu, Q. (2024). The role of carbon price signal in green innovation: Evidence from OECD countries. *Journal of Environmental Management*, 370, 122787. <https://doi.org/10.1016/j.jenvman.2024.122787>
- Feng, X., Guo, R., Shi, R., & Cui, B. (2024). Carbon pricing and innovation: Evidence from global markets. *Journal of Environmental Management*, 359, 120756. <https://doi.org/10.1016/j.jenvman.2024.120756>
- Goulder, L. H., & Stavins, R. N. (2011). Challenges from state–federal interactions in U.S. climate change policy. *American Economic Review*, 101(3), 253–257. <https://doi.org/10.1257/aer.101.3.253>
- Infante-Amate, J., Aguilera, E., de Molina, M. G., & Neira, D. (2024). When can carbon pricing policies reduce emissions? *World Development*, 181, 106426. <https://doi.org/10.1016/j.worlddev.2024.106426>
- Infante-Amate, J., Neira, D., de Molina, M. G., & González de Molina, M. (2025). Intelligent decoupling: Measuring the detachment of GHG emissions from economic activity in advanced countries. *Sustainability*, 17(11), 5054. <https://doi.org/10.3390/su17115054>
- Köpl, A., & Schratzenstaller, M. (2023). Carbon taxation: A review of the empirical literature. *Journal of Economic Surveys*, 37(4), 1353–1388. <https://doi.org/10.1111/joes.12531>
- Lim, H., & Prakash, A. (2023). Carbon pricing and green innovation: Evidence from patenting. *Journal of Cleaner Production*, 395, 136459. <https://doi.org/10.1016/j.jclepro.2023.136459>
- Mardones, C. (2024). Improving the estimation of the distributional impacts of carbon pricing and targeted transfers to reduce its regressivity in Latin American countries. *Ecological Economics*, 225, 108336. <https://doi.org/10.1016/j.ecolecon.2024.108336>
- Metcalf, G. E. (2009). Designing a carbon tax to reduce U.S. greenhouse gas emissions. *Review of Environmental Economics and Policy*, 3(1), 63–83. <https://doi.org/10.1093/reep/ren015>
- Polewsky, M., Hankammer, S., Kleer, R., & Antons, D. (2024). Degrowth vs. green growth: A computational review and interdisciplinary research agenda. *Ecological Economics*, 217, 108067. <https://doi.org/10.1016/j.ecolecon.2023.108067>



- Polewsky, M., Lamb, W. F., & Minx, J. C. (2024). Degrowth vs. green growth: A computational review and interdisciplinary research agenda. *Ecological Economics*, 217, 108075. <https://doi.org/10.1016/j.ecolecon.2023.108075>
- Shang, B. (2023). The poverty and distributional impacts of carbon pricing: Channels and policy implications. *Review of Environmental Economics and Policy*, 17(1), 64–85. <https://doi.org/10.1086/723899>
- Sterner, T. (2024). Carbon pricing reduces emissions. *Nature*, 632(8023), Article d41586-024-02293-w. <https://doi.org/10.1038/d41586-024-02293-w>
- van den Bergh, J. C. J. M., Botzen, W. W. J., Carattini, S., Pahle, M., & Tavoni, M. (2024). Assessing criticisms of carbon pricing. *International Review of Environmental and Resource Economics*, 18, 315–384. <https://doi.org/10.1561/101.00000172>
- World Bank. (2025). *State and trends of carbon pricing 2025*. World Bank. <https://www.worldbank.org/en/research/brief/state-and-trends-of-carbon-pricing-2025>

