THE EFFECT OF CARBON TAX ON INDUSTRIAL EMISSIONS: INTERNATIONAL EVIDENCE AND IMPLICATIONS FOR INDONESIA

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Abstract

Industrial emissions contribute substantially to climate change, and carbon pricing is widely used to create a financial incentive for reducing greenhouse-gas emissions. This paper reviews selected empirical studies of carbon taxation and carbon pricing, with emphasis on evidence relevant to industrial emissions and the implications for Indonesia. A targeted narrative review was undertaken using peer-reviewed empirical studies and official policy sources identified from the original manuscript and supplementary searches. The review is not a systematic review, and no pooled effect estimate is calculated. Evidence from Sweden indicates that carbon pricing was associated with lower emissions intensity in manufacturing; a firm-level study estimates that Swedish manufacturing CO_2 emissions in 2015 would have been approximately 30% higher without carbon pricing. In the United Kingdom, a study of the Carbon Price Support mechanism estimates a 26% reduction in power-sector CO_2 emissions over three years, largely through substitution of coal by gas. These findings are sector- and policy-specific and should not be interpreted as universal reduction rates. In Indonesia, Law No. 7 of 2021 established a legal basis for a carbon tax, while Presidential Regulation No. 110 of 2025 replaced Presidential Regulation No. 98 of 2021 as the framework for national carbon-economic-value instruments. The legal basis should not be confused with evidence that a carbon tax has been fully implemented or has generated projected revenues. Carbon taxation may support industrial decarbonization when accompanied by credible emissions monitoring, predictable policy design, access to cleaner technologies, and transparent revenue use. The review concludes that Indonesia needs verifiable implementation data and sector-specific impact evaluation before firm conclusions can be made about the tax's effectiveness.

Keywords: *carbon tax, carbon pricing, industrial emissions, emissions intensity, Indonesia.*

Introduction

Climate change is driven by the accumulation of greenhouse gases in the atmosphere, with carbon dioxide (CO_2) emissions from fossil-fuel use and industrial processes being important contributors (Yoro & Daramola, 2020). Industrial production contributes to emissions directly through fuel combustion and process-related sources, and indirectly through electricity and heat consumption. Reducing these emissions requires a combination of energy efficiency, cleaner production, fuel switching, technological innovation, and policy instruments that account for the environmental costs of carbon-intensive activity (Munsif et al., 2021).

A carbon tax places a price on greenhouse-gas emissions or on the carbon content of fuels (Nong et al., 2021). By increasing the relative cost of carbon-intensive production, it can encourage firms to improve energy efficiency, change fuel or technology choices, and invest in

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lower-carbon processes. Carbon pricing can also generate public revenue, but its environmental and economic effects depend on the tax rate, coverage, exemptions, availability of alternatives, and the way revenues are used (Klenert et al., 2018). A tax does not automatically produce the same outcome in every country or sector.

Empirical research provides more informative evidence than broad national emission trends alone. For Sweden, firm-level research has estimated a negative relationship between the marginal cost of emissions and manufacturing emission intensity, while a quasi-experimental study of transport emissions found a reduction following the introduction of carbon and fuel taxes (Andersson, 2019; Martinsson et al., 2024). In the United Kingdom, research on the Carbon Price Support mechanism found a substantial decline in power-sector emissions after tax increases, with fuel switching from coal to gas playing a major role (Gugler et al., 2023). These examples concern different sectors and policy designs; therefore, their estimates should not be treated as directly interchangeable.

Indonesia has established a statutory basis for a carbon tax through Law No. 7 of 2021 on the Harmonization of Tax Regulations. The national carbon-pricing framework has also evolved: Presidential Regulation No. 110 of 2025 replaced Presidential Regulation No. 98 of 2021 on the implementation of carbon economic value instruments and national greenhouse-gas emission control (Republic of Indonesia, 2021, 2025). A distinction is necessary between establishing a legal framework, operational implementation, and measurable emission reductions. This paper therefore reviews selected international evidence and discusses the conditions required for an effective and accountable application of carbon pricing in Indonesia.

The objective of this paper is to critically examine selected evidence on the relationship between carbon taxation and emissions, assess the limits of cross-country comparisons, and identify implementation considerations for industrial environmental management in Indonesia.

Research Methodology

This paper uses a targeted narrative literature review. It draws on the references cited in the original manuscript and supplementary searches for peer-reviewed empirical studies and authoritative policy documents relevant to carbon taxation, industrial emissions, and Indonesia's carbon-pricing framework. Search concepts included combinations of "carbon tax," "carbon pricing," "industrial emissions," "manufacturing," "emission intensity," "United Kingdom Carbon Price Support," "Sweden CO_2 tax," and "Indonesia carbon tax." Sources were prioritized when they provided empirical estimates, described a policy mechanism, or stated the applicable legal framework.

The review focuses on studies with identifiable sectors, study periods, and reported emission outcomes, alongside primary legal and government sources for Indonesia. The selected evidence was compared qualitatively according to policy instrument, sectoral coverage, outcome measure, and limitations. No statistical meta-analysis was conducted, and no common effect size was calculated because the studies use different sectors, periods, outcome definitions, and identification strategies. This is a narrative review rather than a systematic review: the search was purposive, a complete database-by-database search log was not maintained, and the paper does not claim exhaustive coverage of all published evidence.

To reduce the risk of over-attribution, the review distinguishes observed emission trends from estimates that attempt to identify a causal or counterfactual effect. Numerical estimates are

reported with their relevant sector and time period wherever available. Legal claims about Indonesia are based on the cited legislation and official government sources; revenue projections are not treated as realized revenue unless verified by implementation data.

Results and Discussion

How Carbon Taxation May Affect Emissions

The central mechanism of a carbon tax is a change in relative prices. When emissions or carbon-intensive fuels become more expensive, firms have an incentive to reduce energy use, improve process efficiency, substitute lower-carbon energy, or alter production. The strength of this response depends on the price signal and on the availability and cost of alternatives. In the short term, firms with fixed equipment and limited financing may have fewer options to reduce emissions; in the longer term, investment and technology choices can increase their capacity to respond.

Tax design matters; a high statutory tax rate may not create a strong marginal incentive if major emitters receive exemptions or face lower effective rates (Bovenberg et al., 2017). Conversely, a moderate price signal can affect dispatch decisions in electricity generation when competing fuels have different emissions intensities. A carbon tax can also interact with emissions trading, energy taxes, performance standards, and subsidies. Evaluation should therefore examine the effective marginal carbon cost and the wider policy package rather than the headline tax rate alone.

Selected International Empirical Evidence

Evidence from Sweden indicates that carbon pricing can affect industrial emissions, but also that responses differ among firms and subsectors. Martinsson et al. (2024) analyzed approximately 4,000 manufacturing firms over 1990–2015 and found a negative relationship between marginal emissions costs and firm-level CO_2 emission intensity. Their analysis reports that Swedish manufacturing CO_2 emissions declined by about 31% over the period and estimates, using a calibration based on their model, that 2015 manufacturing emissions would have been roughly 30% higher in the absence of carbon pricing. The latter is a model-based counterfactual, not a directly observed reduction attributable exclusively to the tax. The study also identifies heterogeneity in responses, including weaker responses among some high-emitting firms facing lower marginal incentives or higher abatement costs.

Evidence from the United Kingdom relates primarily to electricity generation rather than manufacturing. Gugler et al. (2023) estimate that the Carbon Price Support mechanism and its increases between 2013 and 2015 reduced power-sector CO_2 emissions by approximately 26%, or 38.6 million tonnes, over three years. The mechanism increased the relative operating cost of coal-fired generation, contributing to substitution toward gas. The authors also discuss limitations, including possible emissions embodied in imported electricity and interactions with the wider emissions-trading system. This result should not be described as a 38.6-million-tonne reduction in all UK industrial emissions.

Transport evidence further illustrates why sectoral boundaries matter. Andersson (2019) used a quasi-experimental approach to study Sweden's carbon tax and value-added tax on transport fuel and estimated that transport CO_2 emissions declined by nearly 11% relative to a synthetic control. This is evidence about transport, not industrial production, and the combined policy context must be considered when interpreting the estimate. Taken together, these studies support the proposition that carbon pricing can reduce emissions under particular conditions, but they do not establish a universal reduction percentage applicable to every country or sector.

Table 1. Selected empirical evidence on carbon pricing and emissions

Country / study	Policy and sector	Period	Reported finding	Interpretation / limitation
Sweden (Martinsson et al., 2024)	Carbon pricing; manufacturing firms	1990–2015	Manufacturing CO_2 emissions declined about 31%; calibrated counterfactual suggests 2015 emissions would have been about 30% higher without carbon pricing.	Long-run firm-level analysis; counterfactual estimate depends on model assumptions; effects vary across firms.
United Kingdom (Gugler et al., 2023)	Carbon Price Support; electricity generation	2013–2015	Estimated reduction of about 26%, or 38.6 Mt CO_2, in power-sector emissions over three years.	Power sector, not all industry; fuel switching and interactions with other policies matter.
Sweden (Andersson, 2019)	Carbon tax and fuel VAT; transport	Following early-1990s introduction	Transport CO_2 emissions declined nearly 11% relative to a synthetic control.	Transport-specific result; combined tax context means it should not be used as an industrial estimate.

Economic and Environmental Trade-Offs

Carbon taxation can encourage emissions reduction while creating adjustment costs. Firms may face higher energy and production costs, particularly where energy is a large share of operating expenditure or low-carbon alternatives are unavailable. If trading partners face materially lower carbon costs, some production may relocate, creating a risk of carbon leakage rather than global emissions reduction. The distribution of costs may also be uneven: small and medium-sized enterprises can have less access to capital for efficiency upgrades, while consumers may face indirect price increases.

These risks do not demonstrate that carbon taxation is ineffective; rather, they indicate that outcomes depend on policy design and complementary measures. Predictable tax schedules can improve investment planning. Targeted, time-limited support for verified decarbonization investments may help firms adjust, provided it does not eliminate the marginal incentive to reduce emissions. Revenue recycling can support energy-efficiency programs, low-carbon infrastructure, worker transition, or carefully designed transfers to households. Any such allocation should be transparent and evaluated for additional emission reductions rather than assumed to produce them automatically.

Evaluation should include both environmental and economic indicators. Relevant environmental indicators include absolute emissions, emissions intensity per unit of output, fuel mix, and energy consumption. Economic indicators may include output, productivity, employment, energy costs, investment, and effects on smaller firms. Absolute emissions can fall because production contracts, whereas emissions intensity may improve through efficiency or technology. Reporting both indicators helps distinguish genuine process improvement from changes in industrial activity.

Implications for Indonesia

Law No. 7 of 2021 provides the statutory basis for a carbon tax and sets a minimum rate of IDR 30 per kilogram of CO_2-equivalent where the relevant carbon-market price is below that level. The original implementation plan identified coal-fired power generation as an initial target. However, a statutory provision and an announced implementation schedule do not themselves demonstrate that a tax has been fully operationalized or that a particular level of revenue has been collected. The implementation status and applicable secondary regulations must be checked against the latest official announcements before a current claim is made.

Presidential Regulation No. 110 of 2025 replaced Presidential Regulation No. 98 of 2021

and now provides the national framework for carbon economic-value instruments and greenhouse-gas emission control. This regulatory change should be reflected in any current discussion of Indonesia's carbon-pricing architecture. Carbon trading and a carbon tax are related but distinct instruments: trading establishes a market for eligible emissions units, whereas a tax imposes a financial liability under specified legal rules. Their interaction requires clear rules on coverage, emissions measurement, reporting and verification, tax liability, and avoidance of double counting.

The figure of IDR 23.65 trillion cited in the original manuscript should not be presented as actual 2025 state revenue unless an official realization report verifies it. It should either be removed or identified explicitly as a projection, with its original source, assumptions, expected coverage, and calculation method. In the absence of a verified realization figure, the defensible conclusion is that potential revenue is uncertain and depends on the effective tax base, rate, compliance, exemptions, and timing of implementation.

For industrial environmental management, Indonesia should prioritize reliable facility-level greenhouse-gas inventories and consistent monitoring, reporting and verification (MRV). Sector-specific baselines are necessary to evaluate whether policy changes lead to lower absolute emissions or emissions intensity. An impact evaluation should account for energy prices, output changes, energy-efficiency programs, renewable-energy availability, emissions trading, and other regulations. Where feasible, evaluations could compare covered facilities with comparable facilities not yet covered, while documenting differences in production and policy exposure. The resulting evidence would support decisions about tax coverage, rate trajectories, support for cleaner technology, and the transparent use of revenue.

Limitations of This Review

This review is limited by its narrative and purposive approach. It does not provide an exhaustive inventory of carbon-tax studies, a formal risk-of-bias assessment, or a pooled quantitative estimate. The studies discussed differ in sector, time period, policy design, and empirical method, so their estimates cannot be compared as if they measured the same outcome. In addition, Indonesia's policy status and revenue data can change; legal and implementation statements should therefore be checked against current primary sources at the time of publication. These limitations mean the findings should be interpreted as a critical synthesis of selected evidence rather than a definitive estimate of the effect of carbon taxation worldwide.

Conclusions

Selected empirical studies indicate that carbon taxation and related carbon-pricing mechanisms can contribute to emissions reductions, but the magnitude and distribution of effects depend on policy design, sectoral characteristics, effective marginal prices, and the availability of lower-carbon alternatives. Evidence from Sweden supports an association between carbon pricing and reduced manufacturing emission intensity, while evidence from the United Kingdom demonstrates a substantial response in electricity generation following increases in the Carbon Price Support mechanism. These sector-specific results should not be generalized to all industries or countries.

For Indonesia, Law No. 7 of 2021 establishes a legal basis for a carbon tax, and Presidential Regulation No. 110 of 2025 updates the framework for carbon economic-value instruments and national greenhouse-gas emission control. Nevertheless, legal authorization, projected revenue, implementation, and verified environmental outcomes are distinct matters. Claims about

revenue or emission reductions should be supported by official realization data and transparent evaluation. A credible policy assessment will require robust MRV systems, clear sectoral coverage, predictable rules, attention to competitiveness and distributional effects, and transparent use of any revenue to support a just and effective transition. Future research should evaluate facility-level emissions and economic outcomes in Indonesia once sufficiently detailed implementation data are available.

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