



ENVIRONMENTAL TAXATION IN SELECTED ASIAN ECONOMIES: A CONCEPTUAL COMPARATIVE ANALYSIS OF EFFECTIVENESS AND POLICY LESSON FOR INDONESIA

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Abstract

This study evaluates environmental taxation across four dimensions: environmental, economic, governance, and social; in five selected Asian countries. The production and consumption process frequently exclude environmental cost, leaving the society to bear the consequences of damaged nature ecosystem and increasing prevalent of climate crisis. Introduced by Pigou, environmental tax is presented as a fiscal instrument to incorporate these externalities into economics decision making process. Focusing on China, South Korea, India, Vietnam, and Thailand, this study comparatively evaluates the effectiveness of environmental tax implementation across different dimensions. These countries represent important cases given their rapidly expanding economies, significant environmental pressures, and relatively developed environmental taxation frameworks within Asia region. The investigation shows that carbon intensity declined in four countries, although only South Korea recorded a decline in absolute CO₂ emissions. Evidence from China indicates improvements in local pollution, while India illustrates constraints in the use of environmental tax revenues. Yet, broader economic effects and the actual social incidence of environmental taxation remain insufficient to establish comprehensive policy effectiveness. To synthesize these findings, the study develops a promise-design-implementation-response-outcome framework, linking policy effectiveness to the selection of appropriate tax bases, effective tax rates, enforcement capacity, technological alternatives, and revenue use. For Indonesia, the findings highlight the importance of aligning environmental tax instruments with policy objectives, strengthening measurement and verification mechanisms, and integrating revenue accountability and social protection into policy design.

PERPAJAKAN LINGKUNGAN DI SEJUMLAH EKONOMI ASIA: ANALISIS KONSEPTUAL KOMPARATIF TENTANG EFEKTIVITAS DAN PELAJARAN KEBIJAKAN BAGI INDONESIA

Abstrak

*Studi ini mengevaluasi perpajakan lingkungan melalui empat dimensi: lingkungan, ekonomi, tata kelola, dan sosial; di lima negara Asia terpilih. Proses produksi dan konsumsi sering kali mengeksternalisasi biaya lingkungan, sehingga masyarakat harus menanggung konsekuensi dari degradasi ekosistem dan krisis iklim yang semakin meningkat. Berangkat dari gagasan Pigou mengenai internalisasi eksternalitas, perpajakan lingkungan hadir sebagai instrumen fiskal untuk mengintegrasikan biaya lingkungan ke dalam proses pengambilan keputusan ekonomi. Dengan berfokus pada Tiongkok, Korea Selatan, India, Vietnam, dan Thailand, studi ini secara komparatif mengevaluasi efektivitas implementasi pajak lingkungan berdasarkan keempat dimensi tersebut. Kelima negara menjadi kasus yang penting mengingat pertumbuhan ekonomi yang pesat, tekanan lingkungan yang signifikan, dengan kerangka perpajakan lingkungan yang relatif berkembang. Hasil investigasi menunjukkan adanya penurunan intensitas karbon di empat negara, meskipun hanya Korea Selatan yang mencatat penurunan emisi CO₂ secara absolut. Bukti dari Tiongkok memperlihatkan pula perbaikan dalam pengendalian polusi lokal, sementara India menunjukkan adanya keterbatasan dalam pemanfaatan pendapatan dari pajak lingkungan. Namun demikian, dampak ekonomi yang lebih luas dan distribusi beban sosial aktual dari perpajakan lingkungan masih belum memadai untuk menetapkan efektivitas kebijakan secara komprehensif. Untuk mensintesis temuan tersebut, studi ini mengembangkan kerangka *promise-design-implementation-response-outcome*, yang menghubungkan efektivitas kebijakan dengan pemilihan basis pajak yang tepat, tingkat pajak yang efektif, kapasitas penegakan, ketersediaan alternatif teknologi, dan pemanfaatan pendapatan. Bagi Indonesia, temuan ini menekankan pentingnya menyelaraskan instrumen pajak lingkungan dengan tujuan kebijakan, memperkuat mekanisme pengukuran dan verifikasi, serta mengintegrasikan akuntabilitas penggunaan pendapatan dan perlindungan sosial ke dalam desain kebijakan.*

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INTRODUCTION

Environmental taxation addresses a straightforward but persistent problem: market prices often exclude the full costs of pollution borne by society. When health costs, ecosystem damage, and climate risks are absent from production and consumption decisions, polluting activities become relatively inexpensive. Environmental taxes seek to incorporate part of environmental and social costs into prices while raising revenue that can finance the transition, reduce other taxes, or protect vulnerable groups (Heine and Black, 2018; Pigou, 1920). Within the context of today's increasing climate crisis, the need to examine these promises brought by environmental taxation framework is increasingly urgent. The United Nations Environment Programme (UNEP, 2024) states that global greenhouse gas emissions must fall by 42 percent by 2030 and 57 percent by 2035 relative to 2019 to follow a 1.5°C pathway. At the time of its 2024 report, the World Bank (2024) reported that 75 carbon pricing instruments covered approximately 24 percent of global emissions. Less than one percent of global emissions faced a direct price at least equal to the lower bound of the recommended range for keeping warming well below 2°C. The Organization for Economic Co-operation and Development (OECD, 2023a) also found that 58 percent of approximately 40 GtCO₂e of emissions across 72 countries faced no effective price in 2021. Coverage, price levels, and reference years must be distinguished: the existence of an instrument does not establish the adequacy of its incentives.

This study focuses on five Asian economies: China, South Korea, India, Vietnam, and Thailand. These countries differ in income, industrial structure, governance, and policy instruments. China introduced its Environmental Protection Tax in 2018 to address local pollutants rather than carbon emission (Zhang, 2017). In 2015, South Korea combines energy taxes with a national emissions trading system introduced (OECD, 2017), while India linked a coal levy to the National Clean Energy Fund (Abraham, 2014, 2016). On the other hand, Vietnam uses a product-based environmental protection tax (Rodi *et al.*, 2012; World Bank, 2022a) and Thailand uses fiscal instruments for energy and vehicles. This diversity matters because the term environmental tax is frequently used too broadly. Emissions taxes, taxes on polluting products, fuel excises, resource-use charges, and emissions trading systems (ETs) can be considered as part of environmental tax, but they differ in their design and mechanisms. Thus, studies that combine them into a single binary variable risk declaring success or failure without examining instrument objectives, effective rates, exemptions, enforcement, and revenue use.

This study departs from the premise that macroeconomic data alone cannot establish the effectiveness of environmental taxation. Emissions intensity may decline while absolute emissions continue to rise; air quality may improve because of technology standards or facility closures; and growth may change because of a pandemic, commodity cycles, or sectoral transformation. This study therefore uses macroeconomic data to assess the consistency of observed patterns and examines design, implementation, responses, and outcomes through World Bank, OECD, United Nations, and government documents, alongside evaluative academic studies.

The research gap concerns the insufficiently explicit distinction between policy promises and evidence of outcomes. Many studies discuss Pigouvian theory or changes in emissions, but fewer integrate environmental, economic, governance, and social dimensions into an explanatory framework for comparing developing-country experiences. The gap of the existing research is addressed through a promise-design-implementation-response-outcome framework and evidence criteria that distinguish supported improvement, mixed outcomes, unmet expectations, and outcomes that cannot yet be assessed. This study examines the extent to which evidence from environmental taxation supports the promise of environmental, economic, governance, and social improvements in five Asian economies, and identifies the conditions that explain gaps between policy expectations and observed outcomes. The analysis examines instrument design, environmental changes, economic and fiscal consequences, implementation capacity, and the distribution of benefits and burdens. The comparison provides a basis for deriving policy lessons for Indonesia. In doing so, the study also extends the discussion of Pigouvian taxation by treating implementation quality, behavioral responses, revenue use, and social acceptance as conditions connecting policy design to outcomes. Its conceptual contribution is a framework that explains these relationships across four evaluation dimensions. By identifying conditions that enable or obstruct each relationship, the framework helps explain differences in national experiences.

Conceptual Foundation and Four Dimensions of Evaluation

Environmental taxes are identified by tax bases associated with environmental pressures, rather than solely by their names or the stated purposes of their revenues. Energy and transport taxes must therefore be distinguished from taxes on measured emissions. The OECD (2017, 2023a) discusses energy taxes, transport taxes, and carbon pricing instruments as distinct components of the policy mix. This study assesses

the environmental price signal through the relationship between the tax base and the targeted damage, the effective rate, and opportunities for behavioral change.

This taxonomy determines which outcome indicators are appropriate. China's air pollution tax should primarily be assessed through targeted pollutants and air quality; Vietnam's product taxes through product consumption, effective prices, and associated pollutants; and Thailand's vehicle excises through fleet composition and transport emissions. National CO₂ emissions remain useful contextual indicators, but may fall outside an instrument's tax base (OECD, 2017, 2023a; World Bank, 2022a; Zhang, 2017). In the Pigouvian framework, the ideal tax rate equals marginal social damage at the efficient level of activity. A tax raises private costs and encourages firms and consumers to reduce activity, substitute inputs, improve efficiency, or adopt cleaner technology. This mechanism requires a response to prices. When demand is highly inelastic, technological alternatives are unavailable, or subsidies constrain energy prices, higher taxes may generate revenue without substantially reducing pollution (Aldy and Stavins, 2012; Pigou, 1920).

The double-dividend hypothesis holds that environmental taxes can deliver environmental and fiscal benefits when revenues reduce distortionary taxes, finance productive investment, or strengthen social protection. Goulder (1995) shows that the second dividend does not arise automatically because environmental taxes interact with existing tax distortions. How revenue is used may matter more for political and economic outcomes than the tax's environmental label. Heine and Black (2018) emphasize that environmental tax reform in developing countries must be designed alongside the fiscal system, administrative capacity, and development objectives. Earmarking may build support when revenue clearly finances the transition, but can also create rigidity and weak accountability when the connection between revenue and expenditure cannot be audited. India's coal fund illustrates why revenue mobilization does not necessarily imply effective expenditure.

Porter and van der Linde (1995) argue that well-designed environmental regulation can stimulate process and product innovation. The weak version of the Porter hypothesis, under which regulation encourages innovation, has received broader support than the strong version, under which innovation benefits always exceed compliance costs. Ambec et al. (2013) conclude that outcomes depend heavily on instrument flexibility, policy certainty, competitive conditions, and technological opportunities. Stable, gradual, and predictable taxation is more likely to influence long-term investment than small, frequently changing rates.

Legal design also becomes an effective signal only when emissions or tax bases can be measured, liabilities verified, and violations penalized. Measurement, reporting, and verification (MRV), integration of fiscal and environmental data, coordination across levels of government, independent enforcement, and appeal procedures determine whether a nominal rate translates into an effective price. Tang and Yang (2023a) provide relevant evidence: following China's environmental tax reform, the air quality index (AQI) was on average 2.36 points lower in cities authorized to raise rates, with stronger effects where tax enforcement was stricter and fiscal pressure lower. This finding supports the proposition that governance capacity mediates impacts. Identical rates can produce different outcomes when measurement, enforcement, and local government incentives differ. The Worldwide Governance Indicators (WGI) provide information about this general institutional capacity, but cannot replace evidence on audits, compliance, arrears, or an instrument's administrative costs (Tang and Yang, 2023a; World Bank, 2025a).

Energy and carbon taxes may burden low-income households when energy absorbs a larger share of their budgets or access to alternative vehicles, electricity, and technologies is limited. However, incidence is not uniformly regressive: wealthier households often have larger absolute carbon footprints, while consumption patterns, informality, geography, and electricity tariffs can alter distributional outcomes. Pizer and Sexton (2019) emphasize the need to distinguish direct burdens, indirect burdens through goods prices, changes in factor incomes, and environmental benefits. While the study by Klenert et al. (2018) show that visible and fair revenue use, including per-capita transfers, targeted compensation, or reductions in other taxes, can improve public acceptance. Social considerations therefore belong within initial policy design. They help sustain the tax trajectory, compliance, and policy continuity.

Empirical research supports neither the claim that taxes always succeed nor the claim that they are always symbolic. A substantial reduction in transport emissions attributable to Sweden's carbon tax has been identified relative to a counterfactual trajectory, with cross-country comparisons also showing patterns consistent with slower emissions growth (Andersson, 2019; Best *et al.*, 2020). By contrast, Bruvoll and Larsen (2004) show that changes in the energy mix and other factors played a greater role than carbon taxation in Norway during the period they examined.

The OECD (2023a) identifies one source of heterogeneity: effective prices differ sharply across sectors. In 2021, approximately 93 percent of road transport emissions faced positive prices, compared with only around four percent of non-CO₂ emissions.

Free permit allocations and exemptions also reduce average prices paid. The World Bank (2024) concludes that coverage and prices remain insufficient for the Paris goals, despite carbon pricing revenues reaching USD104 billion in 2023.

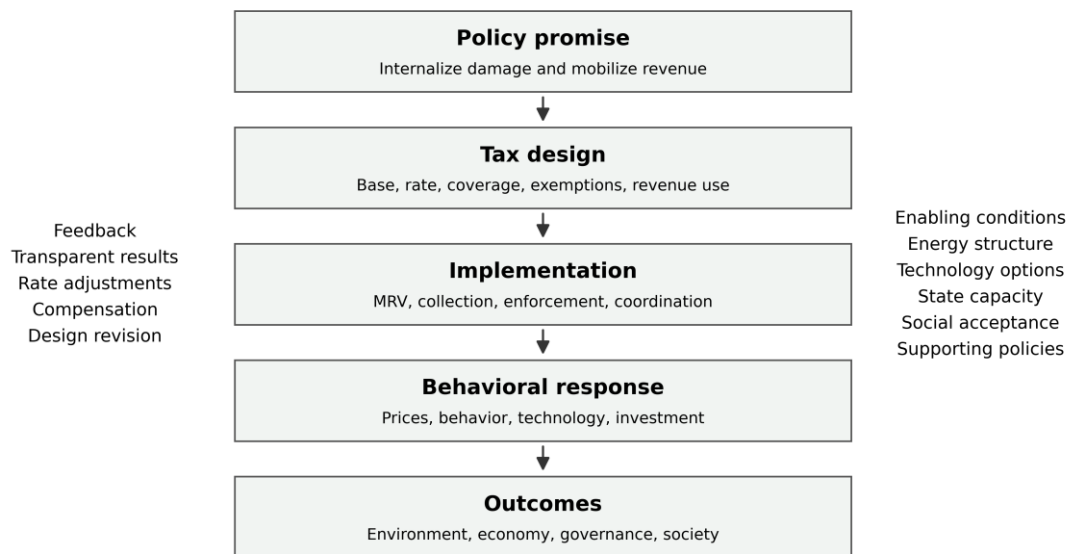
Table 1. Four dimensions of effectiveness

Dimension	Main question	Evidence required
Environmental	Has the targeted damage declined?	Target emissions or pollutants; behavioral, technological, and intensity changes.
Economic	What are the fiscal benefits and adjustment costs?	Instrument-specific revenue, fund use, business costs, investment, and employment.
Governance	Are obligations implemented in practice?	Collection, verification, compliance, audits, exemptions, and administrative capacity.
Social	Who bears the burdens and receives the benefits?	Incidence by income or region, compensation, environmental benefits, and access to alternatives.

Note. Synthesized by author from Goulder (1995); Heine and Black (2018); Klenert et al. (2018); Pizer and Sexton (2019); and Tang and Yang (2023a).

The four dimensions are assessed jointly. Environmental improvement accompanied by uncompensated social burdens constitutes a mixed outcome. High fiscal revenue without a change in the pollution base does not establish environmental effectiveness. Strong governance likewise cannot guarantee results when rates are too low or technological alternatives are unavailable.

The framework interprets policy as a five-stage chain. Policy promises specify the externality and fiscal objectives. Design establishes the base, rate, coverage, exemptions, and revenue use. Implementation shapes the effective price through MRV and enforcement. Firms and households respond through prices, behavior, technology, and investment. Outcomes are then assessed across the four dimensions. Gaps can arise at every connection: unsuccessful outcomes do not necessarily invalidate price theory, while favorable macroeconomic trends do not establish that tax design was effective as illustrates the following framework.

Figure 1. The promise–design–implementation–response–outcome framework

Six propositions follow. The proximity of the tax base to environmental damage determines the relevance of behavioral responses. Effective rates, coverage, and a credible escalation path determine the strength of price incentives. MRV, enforcement, and fiscal-environmental coordination connects formal design to outcomes. Technological alternatives and complementary policies shape producer and consumer responses. Transparent and progressive revenue use influences economic and social consequences and political acceptance. Macroeconomic data can assess consistency with these mechanisms, but cannot establish causal attribution on their own.

RESEARCH METHODS

The study uses a conceptual comparative design based on structured synthesis. Following Jaakkola (2020), this conceptual contribution rests on explicit concept selection, traceable relationships between concepts, and transparent links between claims, evidence, and reasoning. No new regression is estimated. Quantitative evidence is used to examine the consistency of patterns, while policy documents and evaluative studies explain mechanisms. The five cases were selected for maximum-variation strategy, rather than to provide statistically representative sample of Asian economies. The population consists of Asian economies that had implemented identifiable environmental taxation or closely related fiscal environmental instrument. The cases were selected based on two dimension that corresponds directly to the proposed *promise-design-implementation-response-outcome framework*.

First, instrument type and tax base dimension. Rather than treating environmental tax as a homogenous policy category, the case selected represent 5 five variation of environmental taxation and related fiscal environmental instruments: (1) pollution-oriented tax in China; (2) product-based environmental tax in Vietnam; (3) coal-based environmental levy in India; (4) combination of energy and transportation taxation in South Korea; and (5) energy and vehicle-related fiscal instrument in Thailand. This variation permits the analysis to distinguish instruments according to the environmental pressure and economic activity they directly target. *Second*, institutional and implementation setting dimension. Each country selected differ in how environmental fiscal instruments are administered, enforced, coordinated with other policies, and linked to revenue use. These differences are relevant because formal tax rates do not necessarily translate into equivalent effective incentives when measurement, enforcement, administrative capacity, exemptions, or revenue governance differ. *Third*, economic and environmental context dimension. The five countries have varied income level, industrial structure and energy use to show how same fiscal environmental instrument could have different outcome in different contextual condition, while avoiding the assumption that income level or aggregate emissions by themselves determine environmental-tax effectiveness. The cases therefore provide variation in the mechanisms through which environmental taxation is expected to operate, rather than constituting a ranking of national performance. It also worth noting that five countries selected should not be read as cases that surpassing other relevant Asian experiences. The purpose of the five-case design is analytical generalization: to identify mechanisms and conditions that may help explain differences across contrasting policy configurations.

This study used macroeconomic data come from World Development Indicators (WDI)/DataBank that cover 21 source indicators for 2010–2024. Five countries, 15 years, and 21 indicators produce 1,575 target cells. Of these, 1,506 contain numerical observations, equivalent to 95.62 percent coverage. The 69 missing values remain missing and are not interpolated. Data were retrieved on September 10, 2026, with a stated source update of July 13, 2026. This vintage must be retained because historical series may be revised (World Bank, 2026). Sources were selected according to their evidentiary function which are: (1) legislation and government documents establish design and effective dates; (2) evaluative articles inform impact assessment when their identification strategies support it; (3) reports from the World Bank, OECD, UNEP, and other organizations provide context, synthesis, or simulations according to the type of

analysis; and (4) institutional reputation does not replace methodological scrutiny. Documents published after 2024 are not treated as policy interventions within the 2010-2024 panel. The Thailand draft dated April 18, 2025, is used in this research only as reform context, not as evidence of realized implementation or impacts (World Bank, 2025b).

The search focused on combinations of environmental tax, carbon tax, pollution tax, energy excise, implementation, enforcement, incidence, revenue recycling, and country names. Sources were included when they explained design or implementation dates, provided outcomes aligned with the instrument's objectives, described governance or revenue-use mechanisms, or addressed incidence and public acceptance. Sources were excluded when they merely repeated announcements, failed to distinguish taxation from emissions trading, or asserted impacts without traceable evidence. Analysis proceeded in five steps. Instruments were first classified by their bases and objectives. Policy promises were then reconstructed as mechanisms that could be evaluated. Country evidence was coded for design, implementation, responses, and outcomes. Macroeconomic trends were compared with microeconomic and sectoral evidence to identify consistency or contradiction. Finally, cross-country patterns were synthesized into conditions that enable or constrain effectiveness.

Table 2. Criteria for assessing evidence

Category	Assessment rule
Evidence-supported improvement	Indicators match the objective and evaluative studies show progress; the strength of attribution is reported separately.
Limited or mixed improvement	Progress is confined to particular dimensions, sectors, or periods, or accompanies other costs and weaknesses.
Expectations or targets not met	Evidence must match the objective. Claims about official targets require an explicit target, baseline year, and deadline.
Not yet assessable	Evidence is unavailable, mismatched to the tax base, or insufficient to connect the instrument to outcomes.

Note. Criteria developed by the author. Rising national CO₂ emissions alone do not establish the failure of a local pollution tax; an absence of evidence is not evidence of failure.

These criteria are applied in accordance with the scope and strength of the evidence. Data limitations are not classified as policy failure. The suggestion that environmental taxation might be merely aspirational is treated as a critical research question, not a predetermined conclusion.

Macroeconomic indicators provide context and a consistency check. When a source claims success, relevant indicators help assess whether national conditions are moving in a compatible direction. Previous studies and implementation documents then

help explain the pattern. Success must be measured against the instrument's objective: a tax targeting water pollution requires evidence on water pollution, whereas GDP growth or national CO₂ emissions alone are insufficient. Changes in macroeconomic indicators do not establish that taxation caused them. The comparison separates the existence of rules, implementation, responses, and outcomes. Data are interpreted alongside evidence on environmental tax revenue, behavioral or technological changes, enforcement, and the distribution of benefits and burdens.

Table 3. Roles and limitations of macroeconomic indicators

Group	Indicators	Role and limits
Environmental	Total and per-capita CO ₂ ; intensity; PM _{2.5} ; renewable energy.	Context for environmental pressure; must match the tax objective.
Economic	GDP, inflation, employment, trade, FDI, and industry.	Growth context; not estimates of tax costs or benefits.
Fiscal	Total tax revenue / GDP.	General fiscal capacity, not environmental tax revenue.
Governance	WGI government effectiveness, regulatory quality, and control of corruption.	General institutional context, not an instrument-specific audit.
Social	Gini index.	Inequality context, not tax incidence.

Note. Indicators retrieved from World Bank (2026). Limitations of WGI use follow World Bank (2025b). CO₂ intensity is a derived variable, not an additional source indicator.

Validity is strengthened through source triangulation, matching indicators to policy objectives, separating tax and non-tax instruments, and reporting missing values. Principal threats include confounding by growth, the 2020-2021 pandemic, energy prices, electricity mix changes, technology standards, and industrial policy. Differences in revenue definitions and fiscal years also limit comparability. The study offers analytical generalization about mechanisms rather than statistical generalization about average effect sizes.

FINDING AND DISCUSSION

Data Quality and Macroeconomic Conditions in the Five Selected Economies

Overall data coverage of 95.62 percent supports examination of broad patterns, but missing observations are unevenly distributed. Renewable energy shares are unavailable for 2022–2024 in all five countries, and PM_{2.5} observations are unavailable for 2024. The Gini series contains 29 missing values; total tax revenue has five missing values for India and all 15 missing for Vietnam. Out of 315 target cells per country, China has 309 observations (98.10 percent), South Korea 305 (96.83 percent), India 293 (93.02

percent), Vietnam 288 (91.43 percent), and Thailand 311 (98.73 percent). In addition to the common renewable-energy and PM_{2.5} gaps, Gini observations are missing for two years in China, six in South Korea, 13 in India, and eight in Vietnam; Thailand has no Gini gaps. Missing values are not replaced with zero. Table 4 records these details.

Table 4. WDI panel completeness for 2010–2024

Country	Available	Coverage (%)	Missing observations
China	309/315	98.10	Renewables: 3; PM _{2.5} : 1; Gini: 2.
South Korea	305/315	96.83	Renewables: 3; PM _{2.5} : 1; Gini: 6.
India	293/315	93.02	Renewables: 3; PM _{2.5} : 1; Gini: 13; total tax revenue: 5.
Vietnam	288/315	91.43	Renewables: 3; PM _{2.5} : 1; Gini: 8; total tax revenue: 15.
Thailand	311/315	98.73	Renewables: 3; PM _{2.5} : 1.

Note. Synthesized and calculated by author. The data set were retrieved from World Bank (2026), on September 10, 2026; author's calculations. Each country has 315 target cells (15 years × 21 indicators). Renewables are missing for 2022–2024 and PM_{2.5} for 2024. Missing observations remain missing.

The substantive limitations matter more than the count of missing observations. The panel contains neither annual effective tax rates nor revenue specific to environmental taxes. Accordingly, the analysis does not construct an unsupported numerical effectiveness score. Each assessment identifies which domains have evidence and which remain unassessed.

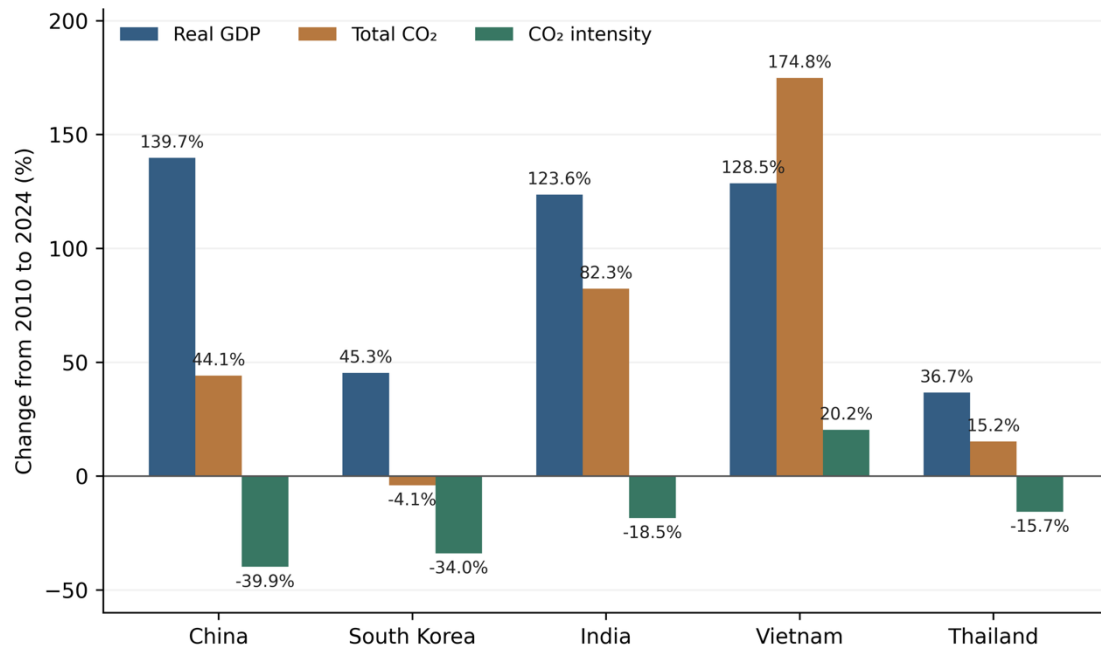
The World Bank (2024) reports global carbon pricing revenue of USD104 billion in 2023, yet less than one percent of global emissions faced direct prices sufficient relative to the report's reference range. The OECD (2023a) finds that 58 percent of emissions in its 72-country sample remained unpriced. These findings change the standard of assessment: revenue growth or a larger number of instruments is insufficient evidence of effectiveness. Coverage, prices, responses, and outcomes aligned with policy objectives must also be examined. UNEP (2024) calls for a whole-of-government approach and at least a sixfold increase in mitigation investment. This supports treating taxation as one component of a policy mix where taxes are introduced without cleaner electricity, public transport, access to credit, or technology standards may raise costs before viable substitutes become available.

The endpoint comparison for 2010–2024 reveals relative decoupling in China, India, and Thailand: real GDP and emissions increased, but CO₂ intensity declined. China’s real GDP rose by 139.7 percent and total CO₂ by 44.1 percent, while intensity fell by 39.9 percent. India recorded increases of 123.6 percent in real GDP and 82.3 percent in CO₂, with an 18.5 percent decline in intensity. Thailand’s corresponding changes were a 36.7 percent rise in GDP, a 15.2 percent rise in CO₂, and a 15.7 percent decline in intensity. South Korea exhibited absolute decoupling: real GDP increased by 45.3 percent while CO₂ fell by 4.1 percent and intensity by 34.0 percent. Vietnam’s emissions outpaced economic growth: GDP rose by 128.5 percent, CO₂ by 174.8 percent, and intensity by 20.2 percent. These changes are calculated as $(2024 \text{ value} / 2010 \text{ value} - 1) \times 100$. Real GDP is measured in constant 2015 US dollars; emissions exclude land use, land-use change, and forestry (LULUCF); and intensity equals total CO₂ divided by real GDP. The figures describe trends rather than tax impacts. Renewable energy’s share of final consumption includes biomass, so a decline does not itself imply reduced solar or wind capacity. The summary of endpoint changes can be found in Table 5 and while Figures 2-4 as follows.

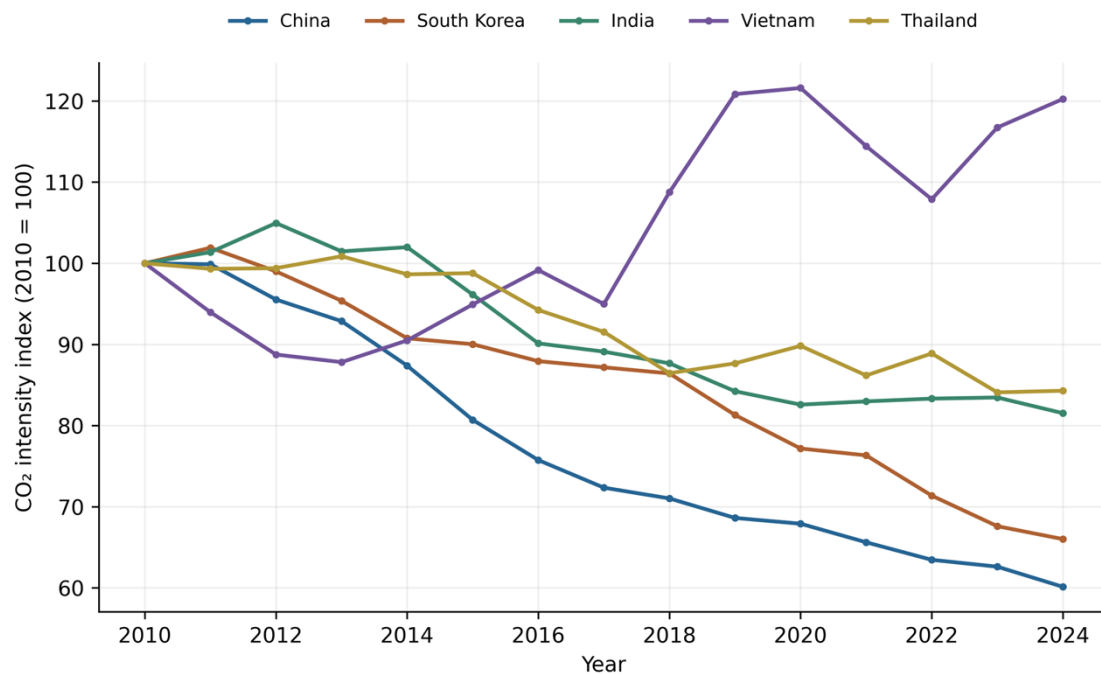
Table 5. Changes in real GDP and CO₂ emissions from 2010 to 2024

Country	Real GDP (%)	Total CO ₂ (%)	CO ₂ intensity (%)
China	139.7	44.1	–39.9
South Korea	45.3	–4.1	–34.0
India	123.6	82.3	–18.5
Vietnam	128.5	174.8	20.2
Thailand	36.7	15.2	–15.7

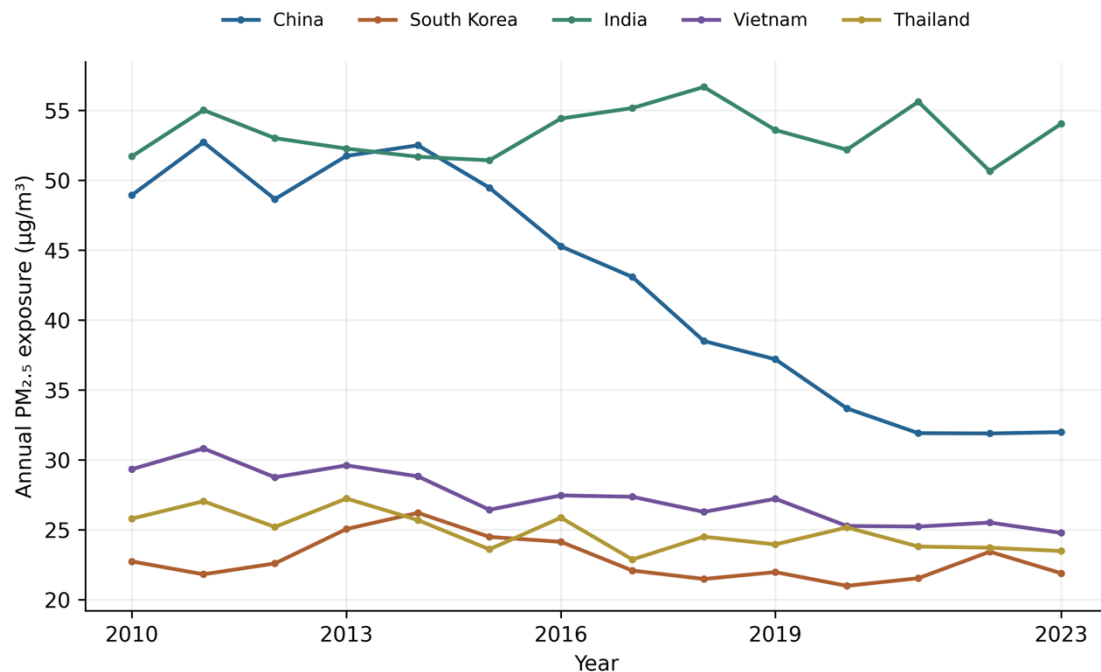
Note. Synthesized and calculated by author. The data set were retrieved from World Bank (2026). Change = $(2024 \text{ value} / 2010 \text{ value} - 1) \times 100$. GDP uses constant 2015 US dollars. Emissions exclude LULUCF. Intensity = total CO₂ / real GDP. These are descriptive changes, not tax effects.

Figure 2. Changes in real GDP, total CO₂, and CO₂ intensity from 2010 to 2024

Note. Synthesized and calculated by author. The data set were retrieved from World Bank (2026). Changes are descriptive and do not estimate tax impacts. Real GDP uses constant 2015 US dollars; emissions exclude LULUCF.

Figure 3. CO₂ intensity index from 2010 to 2024

Note. Synthesized and calculated by author. The data set were retrieved from World Bank (2026). CO₂ intensity = total CO₂ excluding LULUCF / real GDP in constant 2015 US dollars; each country is rebased to 2010 = 100.

Figure 4. Annual PM_{2.5} exposure from 2010 to 2023

Note. World Bank (2026). Mean annual population-weighted exposure, in micrograms per cubic metre. The 2024 observations are missing and are not extrapolated.

China and the reform of local pollution taxation

The Environmental Protection Tax Law took effect on January 1, 2018, replacing the pollution discharge fee. Its base includes air and water pollutants, solid waste, and noise, but excludes CO₂. Local governments have the capacity and authority to set rates within prescribed ranges, replacing an administrative fee with a tax sought to strengthen legal certainty and enforcement by involving tax authorities (Zhang, 2017). The most direct evidence comes from Tang and Yang (2023a), who treat the reform as a quasi-experiment. Cities authorized to raise rates experienced an AQI that was 2.36 points lower after the reform. Effects were stronger where enforcement was stricter, fiscal pressure lower, initial pollution higher, and public participation greater. The findings support a local taxation mechanism for air pollution and show that results depend on implementation capacity.

The macroeconomic series also showing consistency that support this finding where air quality is improving: PM_{2.5} exposure declined by approximately 34.6 percent between 2010 and 2023. CO₂ intensity also fell by 39.9 percent. However, it worth noting that total CO₂ emissions rose by 44.1 percent and per-capita emissions by 36.8 percent. Because CO₂ lies outside the Environmental Protection Tax base, this increase does not

contradict effects on local pollutants; it indicates that pollution tax reform alone is insufficient to establish absolute carbon reductions. China has also operated a national ETS since 2021 alongside numerous energy and industrial policies, preventing attribution of aggregate trends to taxation alone (World Bank, 2022a, 2026).

Economically, real GDP continued to grow rapidly, but the data do not isolate compliance costs or environmental tax revenue. In governance, the variation of effects with enforcement provides direct evidence that administration mediates outcomes. Socially, the Gini index declined from 43.7 in 2010 to 36.0 in 2022, but that change does not establish tax incidence. China is therefore assessed as showing evidence-supported improvement in local air pollution, mixed aggregate carbon outcomes, and insufficient evidence to assess social incidence (Tang and Yang, 2023a; World Bank, 2026).

South Korea and the combination of energy taxes and emissions trading

South Korea combines energy and transport taxes with the Korea Emissions Trading System (K-ETS), introduced in 2015. The ETS sets an emissions cap and permits allowance trading; it is not a tax. The OECD (2017) and International Carbon Action Partnership (ICAP, 2026) describe its design and implementation. The continuously updated ICAP webpage is used only for relevant historical features; coverage expansion after 2024 is not used to explain the study panel. South Korea is the only case with lower total CO₂ emissions between 2010 and 2024: emissions fell by 4.1 percent, while real GDP increased by 45.3 percent and intensity declined by 34.0 percent. Per-capita emissions nevertheless remained high, at 11.36 tCO₂e in 2024 in the WDI series. This pattern indicates absolute decoupling, but the emissions peak and subsequent decline occurred alongside changes in the electricity mix, efficiency improvements, the pandemic, and K-ETS (World Bank, 2026).

The OECD (2017) assesses South Korea's green growth policies, carbon pricing, energy taxation, and compliance. In the WDI panel, South Korea had the highest 2024 government effectiveness and regulatory quality estimates among the five cases, but these indicators do not measure the administration of a particular tax (World Bank, 2025a, 2026). K-ETS combines free allocation and auctions (ICAP, 2026). Free allocation reduces average payments by firms but does not automatically remove the marginal opportunity cost of emitting. Auction revenue must also be separated from tax revenue in fiscal evaluation (OECD, 2023a). South Korea also shows descriptive environmental improvement, but the contribution of taxation cannot be separated from emissions trading and other policies. Institutional indicators provide context for relatively strong capacity rather than proof of uniformly effective implementation. The panel cannot

establish cost consequences for heavy industry or household incidence. As a result, assessment of tax effectiveness remains limited despite more favorable aggregate carbon outcomes (OECD, 2017; World Bank, 2026).

India and the use of coal levy revenue

India established the National Clean Energy Fund (NCEF) in 2010–2011 to support clean energy research and projects (Abraham, 2014). The Clean Energy Cess applied to domestic and imported coal, lignite, and peat. Its effective rate started at INR50 per ton in 2010, rising to INR100 in 2014, INR200 in 2015, and INR400 in 2016, when it was renamed as the Clean Environment Cess (Abraham, 2016). Although the government webpage describes it as a carbon tax, a charge per ton of fuel is not equivalent to a uniform rate per ton of CO₂. Analysis of NCEF revenues is restricted to the phases and years actually discussed in the sources and is not assumed to apply uniformly throughout 2010–2024. Pandey et al. (2013), in a study published by the National Institute of Public Finance and Policy, identify low fund utilization and the need for clearer priorities, project selection, and outcome monitoring. Seemann (2014) discusses NCEF's early experience in a case study available through the UNESCAP SDG Help Desk. These policy studies are not treated as independent audits or causal evaluations of emissions. They help distinguish successful revenue collection from successful deployment into clean energy investment.

India's real GDP increased by 123.6 percent and total CO₂ emissions by 82.3 percent between 2010 and 2024. Emissions intensity fell by 18.5 percent, while per-capita emissions increased by 56.2 percent. PM_{2.5} exposure in 2023 was approximately 4.5 percent higher than in 2010 (World Bank, 2026). This pattern indicates efficiency improvement without lower absolute environmental pressure. It does not measure the elasticity of responses to the cess or the cess's contribution to emissions changes. India is assessed as showing relative improvement in carbon efficiency without reductions in absolute emissions or PM_{2.5} at the comparison endpoints. This does not automatically establish failure against an official tax target, because the study has not identified comparable targets with explicit baselines and deadlines. NCEF studies reveal weaknesses in revenue use during the early phase, while household incidence remains unassessed. For Indonesia, the lesson is to establish allocation rules, transfer reporting, project registers, and auditable outcome indicators (Pandey et al., 2013; World Bank, 2026).

Vietnam and differences in effective carbon prices

Vietnam has applied a product-based Environmental Protection Tax (EPT) since 2012, covering fuels, coal, plastic bags, and selected chemicals (Rodi et al., 2012; World Bank, 2022b, 2022c). The World Bank (2022a, p. 12) reports carbon-equivalent EPT prices of approximately USD0.50/tCO₂e for coal, USD77.60 for gasoline, and USD32.90 for diesel. These values are a snapshot in the 2022 report, not fixed rates throughout 2010–2024 or current rates. The differences demonstrate that an environmental tax label does not produce a uniform carbon price across fuels. The macroeconomic series presents the most pronounced carbon challenge among the five cases: real GDP rose by 128.5 percent, total CO₂ by 174.8 percent, and intensity by 20.2 percent. Per-capita emissions increased by approximately 138 percent. Meanwhile, PM_{2.5} exposure fell by 15.5 percent. This combination can arise when taxes and regulations affect particular pollutants or products while electricity generation and industry become more carbon-intensive (World Bank, 2026).

The World Bank (2022a) assesses prevailing prices as insufficient to support large-scale decarbonization. Its plastic bag policy review also finds that the charge on producers and importers has not appeared effective in reducing plastic bag consumption (World Bank, 2022a, p. 5). This product-specific evidence matches the tax base, but does not estimate the causal effect of the entire EPT. Economic growth remains high, yet no consistent environmental tax revenue series is available. Upstream collection is an administrative design choice rather than evidence of effective compliance. Actual social impacts cannot be inferred from the transition simulations in the Country Climate and Development Report (CCDR). Vietnam shows neither an absolute carbon reduction nor lower carbon intensity over the macroeconomic period, despite improving PM_{2.5} exposure. These findings constrain claims of national carbon success, but neither isolate tax impacts nor demonstrate failure against all EPT objectives. Indonesia should calculate equivalent rates per unit of environmental damage or tCO₂e and then assess responses for products that actually fall within the tax base (World Bank, 2022a, 2026).

Thailand and sectoral fiscal instruments

The draft Thailand CCDR discusses energy excises and fiscal support for lower-emission vehicles. Its account of the 2024–2027 electric vehicle package, for example, includes reduced electric car excise rates (World Bank, 2025b, p. 50). Retrospective information in this draft is used to understand sectoral instrument design, not to confirm the full regulatory history or measure impacts. The study has no causal evaluation of fleet changes that can be directly attributed to excises. Thailand's real GDP increased by 36.7 percent and total CO₂ emissions by 15.2 percent, while intensity fell by 15.7

percent. $PM_{2.5}$ exposure declined by approximately 9.0 percent between 2010 and 2023. Renewable energy's share of final consumption fell from 22.8 percent in 2010 to 19.0 percent in 2021. These results indicate moderate relative decoupling, without a decline in absolute emissions (World Bank, 2026). The April 18, 2025, QER draft of the Thailand CCDD describes a THB200/tCO₂e carbon component integrated into oil excises in 2025 without changing retail prices (World Bank, 2025b, p. 50). This is used as reform-design context, not confirmation of current law or an explanation for 2010–2024 trends. The draft also contains distributional simulations, but ex ante simulations do not establish realized incidence. Within the study period, Thailand shows limited descriptive improvements in intensity and $PM_{2.5}$; the causal effects of excises and actual incidence remain unassessed.

Comparison across four dimensions and gaps in outcomes

Across the environmental and economic dimensions, the country patterns diverge. China combines evidence of improved local AQI with rising national CO₂, while compliance costs and instrument-specific revenues remain un-isolated. South Korea combines falling absolute CO₂ with uncertainty about the separate contributions of taxation, emissions trading, and other policies to costs and competitiveness. India combines lower carbon intensity with higher absolute CO₂ and $PM_{2.5}$, alongside revenue mobilization but weak early fund utilization. Vietnam combines lower $PM_{2.5}$ with rising CO₂ and intensity, limited evidence of plastic bag tax effectiveness, and uneven fuel prices despite strong growth. Thailand combines lower intensity and $PM_{2.5}$ with unresolved causal effects of excises and unisolated sectoral fiscal benefits and costs. Table 6 preserves this comparison (OECD, 2017; Pandey *et al.*, 2013; Tang and Yang, 2023b; World Bank, 2022a, 2022b, 2025b, 2026).

Table 6. Synthesis of environmental and economic evidence

Country	Environmental	Economic
China	Reform studies support improved local AQI; national CO ₂ still rises.	Growth continues; compliance costs and specific revenues are not isolated.
South Korea	Absolute CO ₂ falls; the tax contribution is not separated from the ETS and other policies.	Tax effects on costs and competitiveness are not isolated from the policy mix.
India	Intensity falls, but absolute CO ₂ and PM _{2.5} rise.	Funds were raised; early studies find weak utilization.
Vietnam	PM _{2.5} falls; CO ₂ and intensity rise; plastic bag tax evidence is also limited.	Strong growth; effective prices differ sharply across fuels.
Thailand	Intensity and PM _{2.5} fall; causal excise effects remain unknown.	Sectoral costs and fiscal benefits are not isolated.

Note. Synthesized by author. WDI trends are descriptive; this is not a causal ranking.

Governance evidence concerns different mechanisms in each case. China's reform effects vary with enforcement and local fiscal conditions. South Korea's relatively strong institutional context requires a distinction between ETS monitoring and allowance allocation and tax administration. Early NCEF studies identify weaknesses in priorities, disbursement, and utilization in India. Vietnam's upstream collection is a design feature whose effective compliance is not measured by the panel. Thailand's sectoral instruments and reform proposals must be separated from realized implementation (ICAP, 2026; OECD, 2017; Pandey *et al.*, 2013; Tang and Yang, 2023b; World Bank, 2022a, 2025a, 2026; World Bank Group, 2025). On the other hand, social incidence cannot be adequately assessed for any of the five cases from the selected sources. China's observed Gini improvement does not identify tax burdens, and South Korea's aggregate inequality indicators do not reveal which households pay. The corpus lacks adequate household incidence evidence for India. Transition simulations for Vietnam and the draft Thailand CCDD are prospective assessments rather than measurements of realized tax impacts. The following Table 7 records these limitations. *"Not yet assessable"* describes the evidence available in this study, not a claim that no other studies exist (Pizer and Sexton, 2019; World Bank, 2022b, 2026; World Bank Group, 2025).

Table 7. Synthesis of governance and social evidence

Country	Governance	Social
China	Reform effects vary with enforcement and local fiscal conditions.	Actual tax incidence cannot be assessed from the selected sources.
South Korea	Relatively strong capacity context; MRV and allowance allocation must be distinguished from tax administration.	Aggregate Gini values do not identify who bears tax burdens.
India	NCEF studies identify early weaknesses in priorities, disbursement, and utilization.	The corpus lacks adequate evidence of household incidence.
Vietnam	Upstream collection is a design feature; the panel does not measure effective compliance.	Transition simulations are not evidence of realized tax impacts.
Thailand	Sectoral instruments and reform plans must be distinguished from actual implementation.	The draft CCDR provides simulations; ex post incidence evidence is insufficient.

Note. Synthesized by author. Unassessed outcomes reflect the selected sources, not the absence of all possible research.

The reviewed evidence is insufficient to conclude that any one country succeeded across all four dimensions. South Korea has the most favorable aggregate carbon outcome, but attribution to taxation remains limited. China provides direct evaluative evidence on local pollution tax reform. India illustrates early weaknesses in fund utilization. Vietnam shows uneven fuel prices and limitations in plastic bag taxation. Thailand demonstrates the need to distinguish sectoral design and reform simulations from observed impacts. This is an analytical synthesis, not a causal ranking of countries (OECD, 2017; Pandey *et al.*, 2013; Tang and Yang, 2023b; World Bank, 2022a, 2022b, 2025b, 2026). Five sources of divergence emerge. A gap between the tax base and the evaluated outcome arises when an instrument targets different products or pollutants; national CO₂ is not interchangeable with China's EPT pollutants or Thailand's vehicle-policy objectives. A rate and coverage gap arises when prices are too low or inconsistent across fuels, as illustrated by Vietnam's carbon-equivalent rates. These problems require indicators aligned with the tax base and comparison of rates in common units of damage or carbon (Heine and Black, 2018; World Bank Group, 2025).

Implementation gaps arise when MRV, enforcement, and coordination weaken the effective price or revenue use. China's enforcement differences and early NCEF

utilization problems in India support stronger verification, audits, coordination, and public fund reporting. Substitution gaps arise when cleaner energy, transport, technology, or finance is unavailable; taxation then requires complementary infrastructure and transition finance. Accountability and fairness gaps arise when revenue use and the distribution of burdens are unclear or distrusted, making compensation and incidence evaluation necessary from the design stage. These mechanisms, summarized in Table 8, are a conceptual synthesis rather than newly estimated effects (Heine and Black, 2018; Klenert *et al.*, 2018; Pandey *et al.*, 2013; Tang and Yang, 2023b; World Bank, 2023, 2025a).

Table 8. Sources of gaps between policy design and outcomes

Gap	Symptoms and case context	Design implication
Base and objective	National CO ₂ differs from China's EPT pollutants and Thailand's vehicle-policy objectives.	Define indicators aligned with the tax base before judging results.
Rates and coverage	Carbon-equivalent prices differ sharply across fuels in Vietnam.	Compare rates in common units of damage or carbon.
Implementation	Enforcement varies in China; early NCEF fund utilization was weak in India.	Strengthen verification, audits, coordination, and fund reporting.
Available alternatives	Price responses require alternative technologies, energy, and transport.	Combine taxation with infrastructure and transition finance.
Accountability and fairness	Revenue use and the distribution of burdens require separate evidence.	Plan compensation and incidence evaluation from the outset.

Note. Conceptual synthesis rather than a new empirical test.

The answer to whether environmental taxation delivers improvement or remains aspirational is conditional. The reviewed evidence supports improvement when tax bases align with objectives, rates provide meaningful incentives, enforcement is credible, alternatives are available, and revenue is managed transparently. Without these conditions, taxes may function mainly as revenue instruments or policy symbols. The evidence supports neither rejecting environmental taxation altogether nor assuming that formal adoption necessarily improves environmental outcomes.

Policy lessons for Indonesia

Indonesia's legal basis for carbon taxation is set out in Article 13 of Law No. 7 of 2021 on Harmonization of Tax Regulations (Undang-Undang Republik Indonesia Nomor 7 Tahun 2021 tentang Harmonisasi Peraturan Perpajakan, 2021). The existence of that

legal basis does not establish full implementation or impacts. The World Bank (2023) places carbon pricing and energy subsidy reform within fiscal reforms for a low-carbon economy. It identifies the need to connect carbon pricing with the coal transition, PLN's revenue model, grid investment, and the investment climate for renewable energy. This discussion refers to the framework in the 2023 report rather than asserting current legal status. The first lesson is to define objectives and tax bases narrowly at the outset. Bases closely related to measured emissions provide clearer signals. Where emissions administration is not yet ready, upstream taxation based on carbon content can serve as an interim approach, supported by transparent conversion factors. Local pollution taxes and carbon taxes should be distinguished so that air-quality and health outcomes are not conflated with climate outcomes (Aldy and Stavins, 2012; Heine and Black, 2018).

The second lesson is to establish a credible, gradual rate trajectory. Initial rates may be low while systems are developed, but need an escalation schedule, evaluation, and adjustment criteria. Vietnam's experience illustrates how very low coal rates weaken decarbonization incentives. South Korea's experience highlights the development of MRV before broader coverage, a sequence relevant to Indonesia (OECD, 2017; World Bank, 2022a). The third lesson is to plan revenue use from the outset. Revenue can support targeted transfers, cleaner electricity and transport, and transition assistance for workers and coal-dependent regions. Funds require additionality rules, outcome indicators, beneficiary registers, and public audits. India's experience warns that green labels without disciplined transfers and project evaluation undermine credibility (Klenert *et al.*, 2018; Pandey *et al.*, 2013; Pizer and Sexton, 2019).

The fourth lesson is to manage interactions with emissions trading and subsidies. Carbon pricing must be assessed alongside electricity-sector emissions trading, coal domestic market obligations, fuel subsidies, electricity tariffs, and industrial policy. Effective net prices need to account for subsidies, exemptions, and free allowances. When one instrument raises prices while another lowers them, the net signal can approach zero (OECD, 2023b; World Bank, 2023). The fifth lesson is to make policy evaluable. Governments need annual series on effective rates, tax bases, covered emissions, liabilities, payments, arrears, administrative costs, revenue use, technological changes, and household incidence. Phased implementation or documented facility thresholds may help create credible difference-in-differences designs, while respecting ethical considerations and equitable treatment across regions.

CONCLUSION AND POLICY RECOMMENDATION

Environmental taxation can deliver improvements, but effectiveness is conditional and must be assessed against the tax base. China's experience provides evidence of improved local air pollution following reform, while India's NCEF reveals problems in revenue use. Aggregate outcomes in South Korea, India, Vietnam, and Thailand must be separated from attribution to taxation. The evidence therefore supports neither the claim that environmental taxes are merely symbolic nor the conclusion that their adoption necessarily improves every dimension (Pandey *et al.*, 2013; Tang and Yang, 2023b; World Bank, 2026). Environmentally, CO₂ intensity and PM_{2.5} exposure declined in four of the five countries, while only South Korea recorded a point-to-point decline in absolute CO₂ emissions. These findings are descriptive according to author's calculation (World Bank Group, 2025). Economically, the panel does not isolate environmental taxes' effects on costs, employment, competitiveness, or fiscal benefits. For governance, the reviewed studies identify enforcement and revenue use as important mechanisms. Socially, evidence of realized impacts remains limited within this research corpus; aggregate Gini indices and ex ante simulations cannot replace ex post incidence studies.

The main conceptual contribution is the *promise-design-implementation-response-outcome* framework. It shows that implementation gaps can arise between rules and collection, between collection and behavioral responses, and between responses and outcomes. The four evaluation dimensions prevent a single judgment from concealing trade-offs. The evidence criteria also prevent missing information from being classified as failure or descriptive trends from being presented as causal findings. For Indonesia, priorities include separate reporting for carbon taxes, local pollution taxes, energy excises, and emissions trading; predictable rate trajectories; and readiness in MRV, data integration, audits, and sanctions before coverage expands. Revenue use should connect compensation for vulnerable households with support for workers and regions in transition and investment in lower-carbon alternatives. Annual reporting should support evaluation across all four dimensions, while causal evaluation is designed from the outset through phased implementation or documented policy variation.

The study has several limitations that should be considered when interpreting the result. The purposive five-country design is intended to provide maximum analytical variation rather than statistical representation of Asian economies; therefore, the findings should not be generalized as representative of all Asian countries. It also does not establish causal effects of environmental taxation on environmental or economic

outcomes, as changes in emissions, air pollution, economic growth, and energy use occur alongside other factors, including energy prices, changes in the electricity mix, technological development, industrial policy, environmental regulation, subsidies, and the 2020–2021 pandemic. Future research should combine household microdata, facility data, and revenue by instrument. Incidence analysis should account for direct and indirect burdens, environmental benefits, and revenue use. Firm-level analysis should measure technological investment, productivity, price pass-through, and leakage. For Indonesia, input-output analysis or microsimulation can provide ex ante estimates that are subsequently compared with administrative data after implementation. Further comparisons could include Japan, Singapore, or subnational jurisdictions to increase variation in rates and design. Expanding the number of cases should not compromise alignment between indicators and instrument objectives. Traceable evidence on mechanisms and outcomes remains the priority.

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