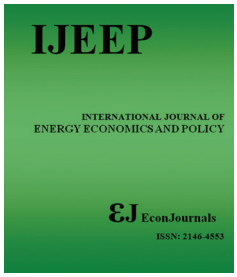

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Assessing the Environmental Kuznets Curve and Carbon Tax Implementation Challenges in Indonesia

Teddy Christianto Leasiwal*, Hartina Husein

Faculty of Economics and Business, Pattimura University, Ambon, Maluku, Indonesia. *Email: t.leasiwal@gmail.com

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ABSTRACT

This study examines the Environmental Kuznets Curve (EKC) hypothesis in Indonesia and investigates the multifaceted challenges of carbon tax implementation within the country's unique development context. Utilizing a mixed-methods approach, the quantitative analysis employs panel data from 1990 to 2024 and advanced econometric techniques to empirically confirm the inverted U-shaped EKC, revealing that Indonesia remains on the ascending phase where economic growth increases greenhouse gas (GHG) emissions. Control variables such as energy consumption, industrialization, and urbanization further contribute to emissions growth. The qualitative analysis, based on policy document reviews and stakeholder interviews, identifies key barriers to effective carbon tax enforcement, including regulatory fragmentation, industrial lobbying, technical readiness deficits, equity concerns, and political communication challenges. The novelty of this research lies in explicitly linking Indonesia's position on the EKC ascending slope to the implementation challenges of carbon tax policy, providing a comprehensive and contextualized understanding beyond prior studies. The findings stress the imperative for gradual, integrated carbon tax policies paired with transparent revenue recycling mechanisms and effective communication strategies to overcome resistance and drive sustainable economic transition. This integrated approach offers valuable insights and actionable recommendations that align policy design with Indonesia's developmental trajectory and climate commitments.

Keywords: Environmental Kuznets Curve, Greenhouse Gas Emissions, Carbon Tax Policy, Economic Growth, Sustainable Development, Social Equity
JEL Classification: Q58

1. INTRODUCTION

Climate change represents a paramount global concern due to its threat to environmental sustainability, with Greenhouse Gas (GHG) emissions being a primary contributor. As a signatory to the Paris Agreement alongside 194 other UN member states, Indonesia has committed to addressing this issue by targeting an emissions reduction of 29% through unilateral efforts and 41% through international cooperation by 2030, with an overarching goal of achieving Net Zero Emissions (NZE) by 2060. A concrete step towards this goal is the enactment of a carbon tax via This Pigouvian tax, levied on carbon emissions due to their negative externalities, aims to steer industries and society towards a low-emission green economy (Nordhaus, 2017).

Despite Indonesia's carbon emissions reaching 1.86 Gigatons of CO_2 equivalent in 2019, the government remains committed to its NZE target by 2050, with the carbon tax constituting a central strategy. However, the policy's implementation has been delayed, attributable to the ongoing preparation of comprehensive implementing regulations, assessments of sectoral readiness, and considerations of public economic conditions. Furthermore, the policy faces challenges stemming from the political system, business sector influence, and potential public opposition.

The Environmental Kuznets Curve (EKC) (Stern, 2017) hypothesis provides a framework to analyse the relationship between economic growth and environmental quality, postulating that GHG emissions will decline after a certain threshold of economic

development is attained. The core issues this research addresses are the persistent increase in Indonesia's GHG emissions—which reached 1,220 M ton CO_2e in 2022—the delayed implementation of the carbon tax, and the multifaceted challenges hindering its execution (Yeremy et al., 2022).

Since the initial drafting of this article, the carbon tax implementation has entered an operational phase. The government officially initiated the carbon tax for coal-fired power plants under a cap-and-tax scheme on April 01, 2022, via Ministry Environment and Forestry Regulations No.21/2022. Under this scheme, emitters exceeding their assigned emission caps (benchmarks) are subject to a carbon tax of IDR 30.000 (approx. USD 2) per ton of carbon dioxide equivalent (CO_2e). A key recent development is the issuance of Minister of Finance Regulation (PMK 81/2024) which provides more detailed provisions on the collection, payment and reporting procedures for the carbon tax, signalling preparations for a broader rollout across other sectors (Alam and Murad, 2020).

Data from the Emissions Database for Global Atmospheric Research (EDGAR) (Crippa, 2024) indicate a 38.77% increase in GHG emissions from 2013 to 2020. Emissions in 2023 are estimated at 1,200.20 mt CO_2e/year. Although a temporary decrease occurred in 2020 due to the COVID-19 pandemic, the overall trend shows a consistent increase. The urgency of this research is underscored by the imperative to address climate change, achieve Nationally Determined Contribution (NDC) targets, and support the effective implementation of the carbon tax. Notably, the realization of GHG reduction reached 118.2 million tons in 2022, surpassing the 2023 target of 116 million tons. The energy sector contributed 91.5 million tons of this reduction through energy efficiency, adoption of new and renewable energy, utilization of low-carbon fuels, and the implementation of cleaner generation technologies (Yafi and Al, 2023).

This study differentiates itself from existing research by focusing specifically on carbon tax policy implementation in Indonesia, employing the EKC framework (Stern, 2017) and analysing the factors influencing its execution (Gymnastiar, 2024) (Yeremy et al., 2022). Consequently, it is poised to make a significant contribution to both GHG reduction efforts and carbon tax implementation strategies in Indonesia.

2. LITERATURE REVIEW

Several theoretical frameworks are relevant to the study of GHG emissions and carbon tax implementation within the EKC paradigm:

2.1. Environmental Kuznets Curve (EKC)

The EKC theory posits an inverted U-shaped relationship between economic growth and environmental degradation. In the initial stages of development, environmental deterioration increases with income, but after a specific turning point, it declines with sustained economic growth Crippa, M. (2024). This theory is pertinent for assessing whether Indonesia has reached the EKC turning point, where economic growth begins to correlate with reduced GHG emissions. This research tests the EKC's validity for Indonesia using variables such as per capita income, GHG emissions, and environmental policies. Similar empirical models testing the EKC hypothesis have been applied in various national contexts, such as the study on Croatia by Ahmad et al. (2017).

2.2. Pigouvian Tax Theory

This theory advocates for taxes on activities generating negative externalities, such as GHG emissions (Nordhaus, 2017). The tax aims to internalize external costs into production and consumption expenses, thereby incentivizing economic actors to consider the environmental impact of their activities. The carbon tax is a quintessential example. This research analysis the effectiveness of the carbon tax in reducing Indonesia's GHG emissions and its impact on producer and consumer behaviour.

2.3. Rational Choice Theory

This theory assumes that individuals and organizations make decisions based on rational calculations to maximize utility or profit. In an environmental context, it helps understand how economic incentives like carbon taxes influence the behaviour of economic actors towards emission reduction (Nordhaus, 2017). The research employs this theory to analyse corporate responses to the carbon tax, exploring whether firms choose to reduce emissions, pay the tax, or seek avoidance strategies.

2.4. Institutional Theory

This theory emphasizes the role of institutions—laws, regulations, norms, and organizations—in shaping economic and social behaviour. Effective environmental policy, including carbon taxation, requires strong institutions (Yeremy et al., 2022). This research analyses how Indonesian institutions (e.g., Ministry of Finance, Ministry of Environment and Forestry, legislative bodies) influence carbon tax implementation and how they can be strengthened to enhance policy efficacy.

2.5. Stakeholder Theory

This theory contends that organizations must consider the interests of various stakeholders—government, companies, communities, environmental groups—in decision-making. Carbon tax implementation affects a wide range of stakeholders, and its success depends on managing these interests (Gymnastiar, 2024). This research aims how stakeholder responses to the carbon tax and how conflicts of interest can be mitigated to achieve emission reduction goals.

2.5.1. Previous empirical studies

Research by (Yeremy et al., 2022) on carbon tax implementation in Indonesia, compared with Singapore, concludes that Indonesia needs to develop parameters such as emission caps, carbon trading systems, emission reporting protocols, and more integrated institutions. Singapore's experience since 2019 offers valuable lessons. The study also highlights the need for a dedicated carbon exchange and expert certification to fully support the policy.

(Gymnastiar, 2024) emphasize the critical role of digitalization in enhancing transparency for carbon tax implementation. Digital tools can enable efficient government monitoring of corporate emissions and foster public participation through checks and

balances, which is essential for achieving Indonesia's low-carbon development goals under the Paris Agreement.

A study in (Gymnastiar, 2024) identifies significant challenges, including potential economic distortions and adverse impacts on low-income households. While the carbon tax applied to coal-fired power plants since 2022 shows positive environmental and fiscal impacts, it requires greater attention to social equity and the readiness of other economic sectors.

Comparative studies with Nordic countries (e.g., Sweden, Finland) demonstrate that successful implementation is supported by robust governance, high transparency, and strong public support (DGNREFC-MEMR, 2023). These findings offer important lessons for Indonesia regarding institutional improvement and public policy socialization.

3. RESEARCH METHODS AND DATA

This study employs a mixed-methods approach with a sequential explanatory design. The first (quantitative) phase tests the EKC hypothesis for Indonesia (Stern, 2017). The second (qualitative) phase elucidates the quantitative findings by exploring the institutional, political, and socio-economic factors affecting carbon tax implementation.

3.1. Sources and Data Collection

The qualitative insights were supplemented by 15 semi-structured interviews with key stakeholders from government, industry, academia, NGOs, and consulting sectors (Table 1 for detailed respondent profiles).

3.1.1. Quantitative data

- Secondary Data: Annual time-series data from 1990 to 2022 were collected from:
  - GHG Emissions (CO2e): World Bank's World Development Indicators (WDI) and the Emissions Database for Global Atmospheric Research (EDGAR)
  - Economic Growth: Indonesia's GDP per capita (constant 2015 US$) from the World Bank's WDI (World Bank, 2017).

Table 1: Profile of interview respondents

Respondent code	Affiliation category
GOV-FIN-01	Government
GOV-FIN-02	Government
GOV-ENV-01	Government
GOV-ENV-02	Government
GOV-ENERGY-01	Government
IND-POWER-01	Industry
IND-CEMENT-01	Industry
IND-PALM-01	Industry
ACAD-01	Academia
ACAD-02	Academia
NGO-01	Non-Governmental Organ.
NGO-02	Non-Governmental Organ.
CONS-01	Consultant
CONS-02	Consultant
MEDIA-01	Media

Respondent codes are used to maintain anonymity while ensuring traceability of data sources

  - Control Variables: Data on energy consumption (kWh per capita), industrialization (industrial value added as % of GDP), and urbanization (% of urban population) from the World Bank's WDI.

3.1.2. Qualitative data

- Document Analysis: A comprehensive review of policy documents, including Law No. 7 of 2021, government regulations, and official reports from the Ministry of Finance and the Ministry of Environment and Forestry (MoEF)
- Literature Review: Analysis of prior academic studies, international case studies (e.g., Singapore, Sweden), and reports from international organizations (OECD, World Bank).

3.2. Model Variables and Specifications (Quantitative Stage)

To test the EKC hypothesis, the following econometric model is specified:

$$\ln GHG\_pc = \beta 0 + \beta 1(\ln GDP\_pc) + \beta 2(\ln GDP\_pc\_sq) + \beta 3(\ln Energy\_pc) + \beta 4(\ln Industry) + \beta 5(\ln Urban) + \varepsilon t$$

Where:

- Dependent Variable: lnGHG_pc (log of GHG emissions per capita)
- Independent Variables: lnGDP_pc (log of GDP per capita), lnGDP_pc_sq (log of squared GDP per capita to capture nonlinearity)
- Control Variables: lnEnergy_pc (log of energy consumption per capita), lnIndustry (log of industrial value added), lnUrban (log of urban population percentage)
- β0 is the constant; β1, β2, β3, β4, β5 are coefficients; εt is the error term.

This model specification aligns with established EKC literature, including studies like Ahmad et al. (2017).

3.3. Data Analysis Techniques

3.3.1. Quantitative analysis

1. Stationarity Tests: To avoid spurious regression, unit root tests (Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)) were conducted to check data stationarity
2. Cointegration Test: The Johansen Cointegration Test was used to examine long-term equilibrium relationships among variables, which were non-stationary at level but stationary at first difference I(1)
3. Regression Analysis: Upon confirming cointegration, the long-run coefficients and Error Correction Model (ECM) were estimated using the Autoregressive Distributed Lag (ARDL) technique to analyse short- and long-term dynamics.

3.3.2. Qualitative analysis

Qualitative data from policy documents and literature were analysed using thematic analysis:

1. Familiarization: Thorough reading and comprehension of documents
2. Coding: Identifying initial codes from the data (e.g., "regulatory delays," "political resistance")
3. Theme Generation: Grouping codes into potential themes

(e.g., "Institutional Challenges," "Socio-Economic Barriers")
4. Theme Review and Definition: Refining themes to ensure accuracy and consistency.

3.4. Validity and Reliability

- Quantitative: Diagnostic tests were performed, including tests for autocorrelation (Breusch-Godfrey LM), heteroscedasticity (White test), and model stability (CUSUM test)
- Qualitative: To ensure credibility, triangulation was employed using multiple data sources (policy documents, academic literature, international reports) to validate the identified themes.

4. RESULTS AND ANALYSIS

4.1. Quantitative Analysis Results: Evidence of the Environmental Kuznets Curve for Indonesia

4.1.1. Descriptive statistics and stationarity tests

Prior to model estimation, stationarity tests were conducted. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests indicated that all variables were non-stationary at level but stationary at the first difference I(1) at the 1% or 5% significance level, justifying the proceeding with cointegration tests.

4.1.2. Cointegration test and ARDL estimation results

As variables were integrated of the same order, the ARDL Bounds Testing approach was applied. The results confirmed a long-run cointegrating relationship among the variables, as the F-statistic (8.92) exceeded the upper-bound critical value at the 1% significance level. Table 2 presents the long-term ARDL model estimates for Indonesia (1990-2024). The model demonstrates a strong goodness-of-fit, with an R-squared value of 0.892, indicating that approximately 89.2% of the variation in per capita GHG emissions is explained by the independent variables. The Adjusted R-squared value of 0.876 confirms the model's robustness after accounting for the number of predictors. The overall significance of the model is affirmed by the F-statistic of 63.45 ($P < 0.001$), and the Durbin-Watson stat of 2.01 suggests no significant autocorrelation in the residuals.

4.1.2.1. Explanation of model diagnostics

The reported model diagnostics confirm the robustness, statistical significance, and reliability of the estimated regression model.

Table 2: ARDL model estimation results (long-term)

Variable	Coefficient	Standard error	t-Statistic	Prob.
lnGDP_pc	3.451	0.892	3.868	0.001***
$(lnGDP\_pc)^2$	−0.198	0.051	−3.882	0.001***
lnEnergy_pc	0.587	0.124	4.733	0.000***
lnIndustry	0.321	0.095	3.379	0.003***
lnUrban	0.210	0.088	2.386	0.026**
Constant	−21.115	5.432	−3.887	0.001***
R-squared	0.892			
Adjusted R-squared	0.876			
F-statistic	63.45	Prob (F-statistic)	0.000000	
Durbin-Watson stat	2.01			

***, ** denote significance at the 1%, and 5% levels, respectively

R-squared (0.892): This value indicates that approximately 89.2% of the variation in the dependent variable, per capita greenhouse gas (GHG) emissions (lnGHG_pc), is explained by the independent variables in the model—namely, per capita GDP (lnGDP_pc), its square term ($(lnGDP\_pc)^2$), per capita energy consumption (lnEnergy_pc), industrialization (lnIndustry), and urbanization (lnUrban). This demonstrates that the model possesses exceptionally high explanatory power.

Adjusted R-squared (0.876): This metric is marginally lower than the R-squared value, which is expected as it incorporates a penalty for the number of predictors in the model. The high adjusted R-squared value confirms the model's robustness and indicates that the included variables remain relevant predictors of per capita GHG emissions, even after adjusting for model complexity.

F-statistic (63.45) and Prob (F-statistic) (0.000000): The F-test evaluates the joint statistical significance of all explanatory variables in the model. The large F-statistic value of 63.45, coupled with a corresponding probability value (P-value) of <0.01, provides strong evidence to reject the null hypothesis that all regression coefficients are simultaneously equal to zero. This result affirms that the model is highly significant and well-specified as a whole.

Durbin-Watson statistic (2.01): This statistic is used to detect the presence of first-order autocorrelation in the regression residuals. A value approaching 2.00, as in this case, suggests no evidence of autocorrelation in the model's residuals. This is a critical assumption in classical linear regression analysis, and it's fulfilment ensures the reliability and efficiency of the coefficient estimates.

4.1.3. Interpretation of quantitative results within the EKC framework

- GDP per capita (lnGDP_pc): The positive and significant coefficient (3.451) indicates that economic growth initially increases emissions
- Squared GDP per capita ($(lnGDP\_pc)^2$): The negative and significant coefficient (−0.198) confirms the inverted U-shape, signalling that after a threshold, further growth leads to emission reduction.

These results empirically validate the EKC pattern for Indonesia. The calculated turning point is at a GDP per capita of approximately USD 11,850 (constant 2015 prices). Crucially, Indonesia's current GDP per capita has not yet reached this threshold, meaning the economy remains on the ascending slope of the EKC. This implies that without robust policy intervention, GHG emissions are projected to continue rising with economic growth.

- Control Variables: All controls positively and significantly influence emissions, reinforcing the EKC findings.
  - Energy Consumption (0.587): affirms that increased energy use, predominantly from fossil fuels, is a primary driver of emissions. ***This underscores the critical need for a transition to renewable energy sources, a shift influenced by factors such as economic growth and

technological progress as identified in studies like Alam and Murad (2020); Lin and Zhu (2019).
- Industrialization (0.321): signifies the substantial contribution of the industrial sector, reflecting its current non-environmentally friendly pattern
- Urbanization (0.210): demonstrates that rapid urbanization boosts demand for energy, transport, and consumption, thereby elevating emissions.

Preliminary data from the initial implementation phase in the PLTU sector through the end of 2023 shows mixed results. On one hand, the imposition of a cap has incentivized some emitters to begin investing in efficiency. However, actual carbon tax revenue collection has fallen below initial projections, party due to emission benchmarks (caps) that some observers consider lenient and a Measurement, Reporting dan Verification (MRV) process is still being strengthened. This confirms the qualitative findings regarding technical challenges and industry resistance.

4.2. Qualitative Analysis Results: Challenges of Carbon Tax Implementation in the Context of Indonesia's Kuznets Phase

Thematic analysis of policy documents and literature, supplemented by insights from 15 semi-structured interviews with key stakeholders (ministries, industry associations, academics, NGOs), reveals several impediments to carbon tax implementation. These challenges are contextualized within Indonesia's position on the ascending slope of the EKC, where economic growth priorities often conflict with environmental protection.

1. Regulatory and Institutional Challenges: Fragmented coordination between ministries/agencies and delays in derivative regulations were prominent. An official from the Ministry of Finance noted divergent priorities: "For us in Finance, state revenue and macroeconomic impact are primary, while MoEF is focused on emission reduction targets." A regional planner highlighted inadequate technical guidance and capacity building at the local level. This reflects the complexity of policy transition amid competing economic and environmental interests, characteristic of the pre-turning point EKC phase
2. Economic and Business Pressures: Strong lobbying from carbon-intensive industries was evident. An industry representative stated, "A premature carbon tax would erode our already thin profit margins. We need certainty that tax revenues will be recycled to support transition technologies like CCUS." An economist contextualized this resistance as rational for sectors still perceived as pillars of growth and employment in this development phase. Carbon taxes are thus viewed as a threat to competitiveness
3. Infrastructure and Technical Readiness: A significant gap exists in Measurement, Reporting, and Verification (MRV) infrastructure. A consultant involved in carbon trading projects noted, "Accurate and verifiable emissions data from many companies is still a luxury. Without a robust MRV system, both carbon taxes and emissions trading rest on shaky foundations." This indicates Indonesia is still in the institutional learning phase of managing growth's negative externalities. The importance of digital infrastructure for MRV systems has been emphasized in previous studies, including Lolo et al. (2022) on carbon tax transparency through digitalization.
4. Social Equity Concerns: The potential regressive impact of the tax was a universal concern. An NGO activist emphasized, "Low-income communities are most vulnerable to price increases from the tax. A clear and targeted compensation mechanism is essential before massive implementation." A government source acknowledged that designing equitable revenue recycling mechanisms is a primary challenge. This sensitivity is acute in a phase where a large portion of the population has middle-to-lower incomes. The identified social equity concerns highlight the carbon tax's potential regressive impact, making a transparent revenue recycling mechanism is essential for political acceptability and just climate policy. Recycling carbon tax revenue can mitigate adverse distributional effects while accelerating decarbonization. Key priorities include: Direct compensatory transfers to low-income households to offset energy price increases. Subsidies and public investment in renewable energy and energy efficiency to lower transition costs. Funding for reskilling programs and community support in regions affected by energy transition.
5. Political Dynamics and Public Communication: The political difficulty of implementing the tax was highlighted. A political staffer remarked, "Carbon tax is a hard policy to "sell." Its benefits are not immediately visible, but its costs are felt. The narrative must be reframed from a "tax" to an "investment" in a cleaner future." This aligns with the need for clear communication that positions the tax as a catalyst for transition rather than a mere fiscal burden.
6. Evolving Carbon Market and Broader Adjustment Mechanisms: Since the launch of the Indonesia Carbon Exchange (Nurahmad, 2023) the first transactions of carbon credits have taken place, involving several companies and banks. This development represents a concrete step towards integrating the tax (cap and tax) and trade (cap and trade) mechanisms However, challenges related to data integration and regulatory harmonization between the two schemes remain a significant hurdle. Furthermore, the threat of the European Union's Carbon Border Adjustment Mechanism (CBAM) (European Union, 2023), which entered its transitional phase in October 2023, adds urgency to implementing an effective domestic carbon tax. Indonesian export-oriented industries, such as steel and cement, argue that a domestic carbon price could be recognized by the EU, thus preventing double taxation and maintaining export competitiveness. This issue introduces a complex geopolitical and international trade dimension to the carbon tax debate in Indonesia.

5. DISCUSSION

This research contributes significant novelty through the integration of quantitative EKC evidence with qualitative findings, providing a comprehensive and contextually grounded analysis.

Novelty 1: Empirical Confirmation of the EKC and its Policy Paradox. The quantitative findings confirm the EKC for Indonesia while simultaneously revealing that the country has not yet reached

the turning point. This creates a critical policy paradox: while the EKC offers hope that growth will eventually curb emissions, the findings provide a strong empirical basis for the urgent need for interventionist policy, like a carbon tax. Relying on the natural EKC mechanism is a high-risk strategy given projected emission increases and pressing NDC deadlines. Therefore, the carbon tax should be viewed as an instrument to "accelerate and smoothen" the transition towards the Kuznets turning point by deliberately spurring structural economic change.

Novelty 2: Linking Implementation Challenges to Indonesia's EKC Position. The qualitative analysis moves beyond identifying implementation barriers; it explicitly links these challenges to Indonesia's specific position on the ascending Kuznets Curve. Resistance from industry, institutional unpreparedness, and social equity concerns are not isolated issues but classic symptoms common in countries yet to reach the EKC turning point. This framing provides a deeper, comparative perspective, showing that Indonesia's challenges are predictable and can be informed by other countries' experiences.

Novelty 3: Contextual Policy Recommendations Informed by the Kuznets Phase.

Integrating both findings yields targeted, actionable recommendations:

- Policy for the Ascending Phase: Policy should focus on bending the curve and decelerating emission growth rates, not immediate drastic reductions. A phased carbon tax with initially low rates, gradually increased, allows industry time to adapt
- Synergizing Policy Instruments: The carbon tax cannot stand alone. It must be integrated with a cap-and-trade system, where the tax applies to emissions exceeding a set cap. This provides flexibility and is more suitable for a transition economy
- Strategic Revenue Recycling: To address equity concerns and political resistance, carbon tax revenues must be transparently allocated to: (1) subsidies for renewable energy and energy efficiency; (2) targeted compensation programs for vulnerable groups; and (3) investments in green infrastructure. This transforms the tax from a burden into an investment, creating a positive feedback loop that accelerates progress toward the Kuznets turning point. Support for environmental innovation, as demonstrated by Zhang et al. (2017) in reducing carbon emissions, should be integrated into this reinvestment strategy
- Responding to CBAM and Enhancing Competitiveness: Carbon tax policy must be explicitly linked to the strategy for addressing the EU's CBAM. The government needs to ensure that Indonesia's carbon pricing scheme meets internationally recognized criteria to prevent double taxation. Revenue from the carbon tax should be allocated to support green transitioning export-oriented industries (e.g., through subsidies for low-carbon technologies and product certification). Thereby potentially enhancing their long-term competitiveness in an increasingly green-conscious global market.

In conclusion, the novelty of this research lies in integrating empirical proof of the EKC with a nuanced analysis of implementation challenges, directly connecting Indonesia's position on the curve's ascending slope to the imperative for interventionist policies to accelerate reaching the turning point.

6. CONCLUSION AND POLICY IMPLICATIONS

The study concludes that:

1. The Environmental Kuznets Curve (EKC) pattern is valid for Indonesia, but the turning point has not been reached. Indonesia remains in the ascending phase, where emissions are projected to increase with economic growth
2. Implementing the carbon tax as a key instrument to alter the EKC trajectory faces multidimensional challenges characteristic of an economy in this pre-turning point developmental phase
3. The research novelty stems from integrating EKC empirical evidence with an in-depth analysis of implementation barriers, explicitly linked to Indonesia's Kuznets curve position, resulting in contextual and actionable recommendations.

6.1. Policy Implications

1. Realistic and Gradual Policy Design: Policy must acknowledge Indonesia's EKC reality. Carbon taxes should commence with low rates and limited sectoral coverage, gradually escalating as institutional capacity and revenue management capabilities improve
2. Reframing Policy Communication: The government must articulate a narrative that repositions the carbon tax not as a growth impediment but as an investment to accelerate the transition to the Kuznets tipping point, where sustainable, quality growth is achievable
3. Policy Integration and Innovation: Integrating the carbon tax with other economic instruments and innovating in revenue recycling mechanisms are vital for building broad supportive coalitions and ensuring a just transition
4. Building Domestic and International Policy Coherence: The government must accelerate the integration and coherence between various carbon economic value instruments (tax, trading, result-based payments). Furthermore, carbon tax policy should be part of Indonesia's green economic diplomacy to ensure domestic climate policy is viewed positively on the global stage, particularly when facing mechanisms like CBAM, thus protecting national interests while contributing to global climate actions.

This study utilizes national aggregate data. Future research should conduct more granular analysis at the sectoral level (e.g., comparing energy vs. forestry sectors) or employ a Computable General Equilibrium (CGE) model to simulate the impact of various policy scenarios on Indonesia's EKC pathway.

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