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Challenges and Effectiveness of Carbon Tax in Indonesia's Industrial Sector

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Abstract

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The rise of greenhouse gas (GHG) emissions from the industrial sector significantly contributes to global climate change. In Indonesia, this sector accounts for over 20% of the country's total emissions, largely due to heavy reliance on fossil fuels. To address this, the government has introduced a carbon tax as a fiscal tool to internalize environmental costs and promote the shift toward a low-carbon industry. This study examines the effectiveness of the carbon tax in lowering GHG emissions in the industrial sector and explores challenges in its implementation. A qualitative method based on literature review was employed, using secondary data from journals and official reports. Findings indicate that the carbon tax can strongly encourage energy efficiency, the adoption of green technologies, and behavioral changes among industry actors. Nonetheless, several obstacles persist, including industry resistance, limited understanding of policies, technological constraints, and inadequate emission monitoring. Strengthening policy awareness and technological support is critical to maximize the carbon tax's effectiveness in achieving a low-carbon industrial transition.

1. Introduction

Global climate change has emerged as one of the most pressing challenges for humanity today. The rising emissions of greenhouse gases (GHGs) from human activities, particularly in the energy and industrial sectors, have driven global warming, resulting in extensive impacts on ecosystems, more frequent extreme weather events, rising sea levels, and threats to food security. According to the Intergovernmental Panel on Climate Change (IPCC, 2021), the Earth's surface temperature has increased by approximately 1.1°C compared to pre-industrial levels and is expected to continue rising unless substantial global mitigation measures are implemented. The industrial sector is a major source of GHG emissions at both the global and national levels. In Indonesia, the industrial sector contributes roughly 22% of total national emissions, with its reliance on fossil fuels such as coal and oil being the primary factor behind its high carbon output.

In addition, activities in manufacturing, cement, steel, and petrochemical industries generate emissions that are difficult to reduce without regulatory frameworks or incentives encouraging production changes (Jia & Lin, 2020). To meet its commitments under the Paris Agreement, Indonesia has submitted its Nationally Determined Contribution (NDC), targeting a 29% reduction in GHG emissions independently and up to 41% with international assistance by 2030. Among the strategies to achieve this goal, the government has introduced a carbon tax. The carbon tax functions as a fiscal instrument, imposing a financial obligation on carbon emissions produced by businesses, thereby internalizing the external costs of carbon pollution and incentivizing a transition toward cleaner energy sources and

technologies. Conceptually, the carbon tax possesses substantial potential to curb emissions by creating economic motivation for industries to adopt energy efficiency measures or shift toward renewable energy.

However, the policy's effectiveness largely depends on the implementation context, which includes the design of the policy, the capacity for monitoring, and the readiness of industries subject to taxation (Steenkamp, 2021). In Indonesia, the carbon tax has been applied selectively, initially targeting coal-fired power plants *Pembangkit Listrik Tenaga Uap* (PLTU) at a rate of Rp30 per kilogram of CO_2e (carbon dioxide equivalent). While this represents a positive first step, significant challenges remain, such as the absence of a comprehensive roadmap integrating an emissions trading system, limited verified emissions data, and resistance from industries that perceive the tax as an additional financial burden amid a post-pandemic economic recovery (Metcalf, 2020). Furthermore, Indonesia's industrial sector has yet to respond adaptively to the carbon tax. Many industries continue to depend on fossil fuels due to their lower cost and accessibility, while limited capital and the lack of incentives for green technology slow the transition to low-carbon alternatives. The implementation of the policy is also constrained by inadequate monitoring and evaluation mechanisms, which makes it difficult to measure the actual impact of the tax on emission reductions accurately.

From an academic perspective, research on carbon taxes in Indonesia remains scarce, particularly regarding empirical assessments of their effectiveness in reducing industrial emissions. Most existing studies are theoretical or focus on case studies from developed countries. For instance, Koval et al. (2022) argue that carbon taxes

are most effective when accompanied by strong monitoring systems and flexible pricing structures. Similarly, Jin et al. (2018) studied carbon taxes in Europe and found that revenues could be reinvested as environmental incentives to reduce resistance from industries. However, Indonesia, as a developing country with a distinct economic structure, has not been studied extensively in terms of policy implementation and economic impacts on local industries. Putra et al. (2021) examined the fiscal potential of carbon taxes but did not address their real effects on emission reductions. Borodin et al. (2022) focused on industry perceptions of cost burdens without evaluating the effectiveness of emissions control measures.

Consequently, there remains a clear research gap concerning the extent to which carbon tax policies can effectively alter industrial behavior and directly lower GHG emissions in Indonesia. Against this backdrop, the present study seeks to analyze the effectiveness of carbon tax policies in controlling GHG emissions within Indonesia's industrial sector. Specifically, the study will assess how the carbon tax incentivizes emission reductions through changes in production behavior, adoption of energy-efficient practices, or implementation of environmentally friendly technologies. Additionally, the study aims to identify the challenges and barriers encountered during policy implementation, including regulatory constraints, industry preparedness, and the availability of supportive infrastructure.

2. Methods

This study utilizes a qualitative research approach, specifically through a literature review method. This method was selected because it enables a

comprehensive and detailed examination of concepts, policies, and empirical evidence related to the implementation of the carbon tax and its effects on greenhouse gas (GHG) emissions in the industrial sector. Conducting a qualitative literature review is considered appropriate for exploring the connections between key concepts and understanding diverse perspectives developed within academic research and public policy discussions. The study relies on, gathered from various credible and relevant sources. These include academic books, peer-reviewed national and international journals, policy articles, reports from government agencies and international organizations, and other publications that provide insights into the topic of carbon taxation and industrial emissions. The selection of these sources was carried out purposively, focusing on their relevance to the research objectives and the credibility of the information presented.

This research specifically investigates the relationship between carbon tax implementation and GHG emissions in the industrial sector. The main objective is to assess how the carbon tax policy contributes to efforts to reduce emissions in this sector. The analysis is conducted by reviewing and synthesizing findings from prior studies, comparing the policy implementation frameworks and outcomes in different countries, and relating these insights to the current context and policy measures in Indonesia. By examining both theoretical perspectives and empirical evidence, the study aims to provide a thorough understanding of how fiscal instruments such as carbon taxes can influence industrial behavior, promote energy efficiency, and support the adoption of environmentally friendly technologies. This qualitative literature review approach allows for an in-depth evaluation of policy effectiveness,

challenges, and best practices, providing a foundation for drawing meaningful conclusions and recommendations for enhancing carbon tax implementation in Indonesia's industrial sector. The study's findings are expected to inform policymakers and stakeholders about strategies to improve policy design, monitoring, and industry adaptation, ultimately contributing to GHG emission reduction goals.

3. Results

3.1. The Role of Carbon Tax in Promoting Low-Carbon Industrial Transformation

The carbon tax is a fiscal policy tool intended to mitigate the environmental impacts of greenhouse gas (GHG) emissions, particularly within the industrial sector. This policy imposes extra costs on activities or products that produce carbon emissions, including the consumption of fossil fuels such as coal, gasoline, and natural gas, which remain central to many industrial processes. Its main purpose is to internalize the environmental costs, or externalities, associated with GHG emissions (Jin et al., 2018). By factoring carbon emissions into operational expenses, the carbon tax incentivizes industries to lower emissions through behavioral adjustments, investment in low-carbon technologies, or enhancements in energy efficiency. This mechanism provides economic motivation for industries to adopt greener practices while signaling a strong market shift toward a sustainable economy. The operational principle of the carbon tax is grounded in environmental economics, where businesses producing higher emissions incur additional costs

proportional to the environmental harm they generate. By raising the expenses of carbon-intensive operations, the tax encourages companies to explore sustainable alternatives, such as deploying low-carbon technologies, increasing energy efficiency, or transitioning to renewable energy sources like solar, wind, or hydrogen.

Additionally, revenue generated from the carbon tax can be reinvested into climate mitigation initiatives, including renewable energy infrastructure development, reforestation programs, and research in green technologies. This reinvestment forms a positive feedback loop, where reduced emissions are supported through funding environmentally beneficial projects. Experts in environmental economics and policy underscore the carbon tax's potential to curb GHG emissions in the industrial sector. Parry et al. (2022) note that the carbon tax drives businesses toward a green economy by reducing dependence on fossil fuels and encouraging adoption of new and renewable energy sources (EBT). Beyond serving as a regulatory tool, the carbon tax acts as a catalyst for structural transformation toward sustainable business models (Lin & Jia, 2020). With the tax in effect, industries are motivated to embed sustainability into their strategies, such as investing in low-carbon technologies like carbon capture and storage (CCS) or switching to alternative fuels, including hydrogen.

Tsai (2020) emphasizes that the carbon tax is pivotal in regulating the use of environmentally damaging energy sources. By influencing the behavior of economic actors, including industrial players, the tax fosters the adoption of sustainable practices, including enhanced energy efficiency and better waste management. Furthermore, revenues from the carbon tax can support climate mitigation projects,

such as developing low-carbon public transport systems or reforestation efforts (Putra et al., 2021). This policy establishes a synergistic relationship between fiscal measures and environmental objectives, where industries are encouraged not only to reduce emissions but also to contribute to climate solutions through financing green initiatives.

Borodin et al. (2022) affirm that the carbon tax strengthens Indonesia's commitment under the Paris Agreement to lower GHG emissions. Through strict emission measurement protocols, such as ISO 14080 standards, the carbon tax ensures industrial compliance with established reduction targets. These standards allow for transparent and accurate reporting, providing a reliable basis for evaluating policy effectiveness. Kristianto also highlights that the carbon tax stimulates technological innovation, exemplified by the development of CCS technology, which is deemed crucial for achieving the Net Zero Emission (NZE) target by 2060 or sooner. Carbon tax not only functions as a mechanism for controlling emissions but also serves as a strategic instrument to promote sustainable industrial practices, technological advancement, and fiscal reinvestment into environmental initiatives. By integrating economic incentives with environmental accountability, the carbon tax fosters a comprehensive approach toward reducing industrial GHG emissions and advancing Indonesia's green economy agenda.

3.2. Effectiveness of Carbon Tax Policies in Reducing Industrial Greenhouse Gas Emissions in Indonesia

Empirical studies provide concrete evidence that carbon taxes are effective in reducing greenhouse gas (GHG) emissions in the industrial sector. World Bank report noted that 37 countries implementing carbon taxes achieved significant reductions in carbon emissions. In countries such as Sweden, Canada, and the United Kingdom, carbon taxes have driven a shift from fossil fuels to renewable energy and improved energy efficiency in the industrial sector. In Indonesia, the implementation of a carbon tax on coal-fired power plants (PLTU) since April 2022, with a rate of Rp30 per kg CO_2e, has shown promising results. Through the cap-and-tax mechanism, which combines emission limits with taxes for exceeding those limits, the PLTU sector has demonstrated significant potential for emission reductions. Data from the Directorate General of Climate Change Control indicates that the energy sector, including industry, is a major contributor to GHG emissions in Indonesia.

However, the realized emission reduction in that year reached 118.2 million tons of CO_2, surpassing the target of 116 million tons of CO_2, partly due to policies such as the carbon tax and fiscal incentives for renewable energy. Research by Dewi and Dewi (2022) shows that carbon emission reduction activities driven by policies like the carbon tax have a positive impact on the financial performance of industrial companies. The study found that companies proactively reducing emissions, either through energy efficiency or investments in green technologies, experienced improvements in operational and market performance. Additionally, disclosing

carbon emissions in sustainability reports enhances corporate accountability toward environmental, social, and governance (ESG) targets, which are increasingly important to global investors. This indicates that carbon taxes not only benefit the environment but also provide economic advantages for companies that successfully adapt to the policy.

However, the implementation of carbon taxes is not without challenges. A study by Dyarto and Setyawan (2021) highlights that, despite the effectiveness of carbon taxes in reducing emissions, several obstacles can diminish their impact. Limited public awareness and understanding of carbon taxes often lead to resistance, particularly from industries concerned about rising operational costs. Furthermore, the potential for tax leakage, such as inaccurate emission reporting, poses a significant challenge to ensuring policy effectiveness. To address this, stringent oversight and strengthened emission reporting standards, such as those outlined in ISO 14080, are necessary. Transparency in emission reporting is critical to ensuring that carbon taxes are applied fairly and effectively. Heavy industries, such as cement, steel, and power generation, are the primary focus of carbon taxes due to their significant contribution to GHG emissions. In Indonesia, the coal-fired PLTU sector accounts for over 80% of emissions from the energy sector, making it a priority target for carbon tax policies.

The tax encourages companies in this sector to transition to low-carbon technologies or alternative fuels, such as renewable energy or hydrogen. Additionally, the carbon tax prompts companies to integrate green investment concepts into their business strategies. Many companies are now adopting

sustainability reporting and utilizing green funds to finance environmentally friendly projects, aligning with the Net Zero Emission (NZE) target by 2060. Despite the benefits of carbon taxes, some industries face challenges in the form of increased operational costs. Low-carbon technologies, such as carbon capture and storage (CCS) or renewable energy, often require significant upfront investments, which may be difficult for small or medium-sized enterprises to afford.

To address this, the Indonesian government has adopted a phased approach to implementing the carbon tax. This approach aims to ensure a fair and affordable transition, providing industries with time to adapt and access more environmentally friendly technologies. Additionally, the government offers fiscal incentives, such as tax holidays or value-added tax (VAT) exemptions, to encourage investment in green technologies (Dyarto & Setyawan, 2021). The success of carbon taxes heavily depends on comprehensive supporting policies. The development of renewable energy infrastructure, such as solar or wind power plants, is crucial for reducing reliance on fossil fuels. Additionally, the development of low-carbon public transportation, such as electric trains or buses, can help reduce emissions from industries dependent on logistics. Strict oversight of emission reporting is also essential to prevent tax leakage and ensure fair application of the carbon tax. Emission reporting standards like ISO 14080 can play a vital role in ensuring data transparency and accuracy, ultimately enhancing public trust in the policy

4. Conclusion

The carbon tax is a fiscal policy instrument aimed at internalizing the environmental impact of greenhouse gas (GHG) emissions, particularly from the industrial sector, which is the largest emitter in Indonesia. By imposing financial costs on carbon-intensive activities, the tax provides economic incentives for industries to adopt low-carbon technologies, improve energy efficiency, and utilize renewable energy sources. This mechanism encourages behavioral changes in industries while sending strong market signals supporting the transition to a green economy. Both theoretical and empirical studies indicate that carbon taxes are effective in reducing emissions, enhancing environmental performance, and delivering economic advantages to companies that adapt proactively. Experiences from developed countries show significant emission reductions, and in Indonesia, although the policy is still at an early stage, early implementation has demonstrated promising results, with emission reductions exceeding initial targets.

Nevertheless, challenges remain, including limited public understanding and socialization of the policy, potential inaccuracies in emission reporting, and restricted access to clean technologies for industries. High initial costs also pose barriers, particularly for small and medium-sized enterprises. To overcome these challenges, comprehensive policy support is required, including fiscal incentives, robust emission reporting systems such as ISO 14080, and the development of renewable energy infrastructure. Properly implemented, the carbon tax can promote energy efficiency, technological innovation, and sustainable business practices. It is a key instrument for achieving Indonesia's emission reduction goals of 31.9%

independently and 43.2% with international support by 2030, while also advancing the country toward Net Zero Emissions by 2060 or earlier. Beyond controlling emissions, the carbon tax serves as a catalyst for sustainable economic transformation, benefiting the environment, society, and business actors in the long term.

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