The Indonesian Accounting Review Vol. 16, No.1, January – June 2026, pages 1 – 14

The Mediating Role of Tax Compliance in the Relationship Between Carbon Tax and Environmental Performance A Public Sector Study

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ARTICLE INFO

Article history:
Received February 11, 2026
Revised March 2, 2026
Accepted April 20, 2026

JEL Classification:
H23, Q58, K34, L51

Keywords:
carbon tax, environmental performance, mediation analysis, public sector, tax compliance

DOI:
10.14414/tiar.v16i1.5566

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ABSTRACT

This study examines the mediating role of tax compliance in the relationship between carbon taxes and environmental performance in the Indonesian public sector. The implementation of a carbon tax, aimed at reducing greenhouse gas emissions, faces challenges in Indonesia due to low tax compliance, potentially undermining its effectiveness. We surveyed 318 participants from public sector organizations in Indonesia using random sampling. Data were collected through an online survey designed to measure tax compliance, carbon taxes, and environmental performance. The findings demonstrate that tax compliance substantially mediates and moderates the relationship between carbon taxes and environmental performance, underscoring the necessity of enhancing tax compliance to improve the efficacy of carbon tax policies. This study provides empirical evidence on the critical role of tax compliance in maximizing the environmental benefits of carbon taxes in developing countries such as Indonesia, where tax culture and enforcement systems are still evolving. The results expand the literature on carbon taxation by emphasizing the need to foster compliance to ensure the success of environmental tax policies.

ABSTRAK

Penelitian ini mengkaji peran mediasi kepatuhan pajak dalam hubungan antara pajak karbon dan kinerja lingkungan di sektor publik Indonesia. Implementasi pajak karbon yang bertujuan untuk mengurangi emisi gas rumah kaca menghadapi tantangan di Indonesia akibat rendahnya tingkat kepatuhan pajak, yang dapat mengurangi efektivitasnya. Sebanyak 318 peserta dari organisasi sektor publik di Indonesia dipilih menggunakan metode sampling acak untuk penelitian ini. Data dikumpulkan melalui survei daring yang dirancang untuk mengukur kepatuhan pajak, pajak karbon, dan kinerja lingkungan. Hasil penelitian menunjukkan bahwa kepatuhan pajak secara signifikan memediasi dan memoderasi hubungan antara pajak karbon dan kinerja lingkungan, menyoroti pentingnya meningkatkan kepatuhan pajak untuk meningkatkan efektivitas kebijakan pajak karbon. Penelitian ini memberikan bukti empiris tentang peran krusial kepatuhan pajak dalam memaksimalkan manfaat lingkungan dari pajak karbon di negara berkembang seperti Indonesia, di mana budaya pajak dan sistem penegakan hukum masih dalam tahap perkembangan. Temuan ini berkontribusi pada literatur tentang pajak karbon dengan menekankan perlunya membangun kepatuhan untuk memastikan keberhasilan kebijakan pajak lingkungan.

INTRODUCTION

The carbon tax, a fiscal instrument designed to reduce greenhouse gas emissions, has increasingly attracted global attention due to the urgency of climate change (Gugler et al., 2023; Tsai, 2020). Although the implementation of the carbon tax is still in its early stages in Indonesia, efforts to reduce carbon emissions and enhance environmental sustainability have become national priorities (Chaudhari et al., 2023). The application of the carbon tax in Indonesia began with policies targeting large sectors of the industry, such as energy and transportation, which are the primary contributors to carbon emissions. The Indonesian government plans to introduce a broader carbon tax,

which is expected to encourage industries to transition to more environmentally friendly technologies and improve the efficiency of carbon emission reductions (Dou & Cao, 2020; Govindan et al., 2023). However, the tax compliance rate of taxpayers, particularly the public sector and large companies subject to the tax, is a key factor influencing the success of carbon tax implementation.

In several countries, the success of carbon tax implementation depends heavily on high tax compliance (Hu et al., 2021a; Liao & Tan, 2023). In Scandinavian countries, such as Sweden and Norway, carbon taxes have been successfully implemented, with high compliance driven by clear policies, transparency in the use of tax funds, and the integration of carbon taxes into broader social systems (Copland, 2020; Dogan et al., 2022). For instance, in Sweden, the carbon tax on fossil fuel emissions has increased national revenues, which are allocated to fund renewable energy projects and emission-reduction efforts (Brown et al., 2020; de Lima et al., 2023; Umit & Schaffer, 2020). Meanwhile, countries such as the United States and Brazil continue to face challenges in achieving high compliance rates with carbon taxes due to political resistance and uncertainty surrounding the allocation of tax revenues (Fu et al., 2021; Mehleb et al., 2021; Sarpong et al., 2023). Although the carbon tax policy is being implemented in Indonesia, its success depends heavily on maintaining and improving tax compliance rates, which is a significant challenge given the still-developing tax culture and the need for stronger tax oversight systems.

The importance of this research becomes more apparent in the Indonesian context, given the significant role of carbon taxes in reducing carbon emissions and achieving national sustainability targets (Hu & Wang, 2022). However, a major issue is low tax compliance, which can hinder the effectiveness of carbon taxes (Salé et al., 2021; Trifan et al., 2023). Low tax compliance can be caused by various factors, such as a lack of understanding of the benefits of a carbon tax, unclear allocation of tax revenues, and limitations in Indonesia's tax administration and oversight systems (Muharremi et al., 2022). Furthermore, although carbon taxes could be an effective instrument for improving environmental performance, the lack of empirical studies examining tax compliance as a mediator between carbon taxes and environmental performance in Indonesia creates a gap that must be addressed (Alshira'h et al., 2020; Fauzan et al., 2022). Therefore, this study examines how tax compliance mediates the relationship between carbon taxes and environmental performance in Indonesia's public sector. This research will enrich the existing literature by focusing on the Indonesian context, which remains underexplored in research on the relationship between carbon taxes, tax compliance, and environmental performance in developing countries.

While much research has examined the relationship between carbon taxes and environmental performance, most studies have focused on the direct link between them without considering key factors, such as tax compliance (Liu et al., 2024; O'Ryan et al., 2023; Vincent, 2021). Previous studies, especially those from Scandinavian countries, typically presume that the existing system integrates tax compliance. In contrast, in Indonesia, it can serve as a moderating or mediating factor in this relationship. In this context, there is a theoretical gap that needs to be addressed: the lack of studies on the role of tax compliance in the relationship between carbon taxes and environmental performance, particularly in developing countries like Indonesia. A methodological gap also exists, as mediation models are rarely applied to explore this relationship in depth. Previous research often overlooks a more structured approach with mediation models that examine how tax compliance might strengthen the influence of carbon taxes on environmental performance (Hu et al., 2021b; San-José et al., 2024; Yong & Fukofuka, 2023).

Thus, the novelty of this research lies in its attempt to examine tax compliance as a mediator in the relationship between carbon taxes and environmental performance in Indonesia's public sector. Previous studies have not extensively explored this area. This research also employs more quantitative and detailed approaches, such as path analysis and mediation models, to provide a clearer and more comprehensive understanding of the relationships among these three variables and their contributions to the development of theory and the formulation of more appropriate policies in Indonesia. The main objective of this research is to examine the role of tax compliance as a mediator in the relationship between carbon taxes and environmental performance in Indonesia's public sector and to offer commentary on how carbon tax policies can be implemented more effectively by improving tax compliance.

THEORETICAL FRAMEWORK AND HYPOTHESES

Tax Compliance

Tax compliance refers to the extent to which

taxpayers adhere to the rules and regulations established by tax authorities (El-Sayed et al., 2020). It involves both the timely and accurate submission of taxes owed and the full disclosure of taxable activities (LaMothe & Bobek, 2020). Compliance is critical to the effectiveness of any tax system, including the carbon tax system, as it ensures that tax policies contribute to the desired environmental and economic outcomes. A key aspect of tax compliance is taxpayers' voluntary compliance, which is influenced by factors such as trust in the government, the perceived fairness of the tax system, and the presence of tax enforcement mechanisms. Non-compliance can arise from various reasons, including a lack of awareness, complex tax regulations, or perceived injustice in how taxes are levied or used (Fatas et al., 2021).

Indicators of tax compliance typically include the level of on-time payments, the accuracy of reported income, and the degree of underreporting or tax evasion. Research has shown that tax compliance is not only a product of legal enforcement but also the result of psychological and social factors (Fauzan et al., 2022; Thottoli, 2022). Taxpayers' attitudes toward taxation, social norms, and the perceived legitimacy of tax systems play significant roles in determining levels of compliance. In the case of carbon taxes, compliance is particularly influenced by an understanding of the tax's environmental benefits and perceptions of how tax revenues are allocated. Effective communication of these benefits, alongside transparent and accountable use of tax revenues, can enhance compliance rates.

Recent research on tax compliance has examined various models that highlight the psychological and behavioral factors influencing taxpayers' decisions (Kasper & Alm, 2022). Studies over the past five years have examined how variables such as income levels, tax complexity, and trust in the government affect compliance rates, particularly with environmental taxes, such as carbon taxes. Battiston et al. (2020) and Muharremi et al. (2022) examined the roles of government trust and social norms in enhancing tax compliance in Southeast Asia, showing that higher levels of trust and social responsibility significantly improve tax compliance with environmental policies. Furthermore, other studies have examined the relationship between tax morale and compliance, suggesting that intrinsic motivations, such as a sense of civic duty, play an essential role in tax compliance (Kim & Lee, 2020). Research over the last five years has highlighted the importance of integrating tax compliance with the Sustainable Development Goals (SDGs), showing that when taxpayers are made aware of how their contributions benefit the environment, compliance rates tend to increase.

Carbon Tax

A carbon tax is a tax on the carbon content of fuels, intended to reduce greenhouse gas emissions by making carbon-intensive products and activities more costly (Umit & Schaffer, 2020). The primary goal of a carbon tax is to incentivize companies and individuals to reduce their carbon emissions by shifting towards cleaner, renewable energy sources (Tsai, 2020). Unlike carbon-trading schemes, which involve the buying and selling of emission allowances, a carbon tax directly prices carbon emissions by charging per ton of carbon emitted, thereby providing a financial incentive for emission reductions. Countries like Sweden and Canada, which already have carbon taxes, have included them in broader plans to fight climate change. This has helped lower overall emissions and protect the environment (Alkaabneh et al., 2021; Gugler et al., 2023).

Indicators of carbon tax effectiveness include reductions in carbon emissions, increased adoption of renewable energy sources, and improvements in energy efficiency (Du et al., 2024; Hu & Wang, 2022). The effectiveness of a carbon tax can also be measured by its impact on the economy, particularly through changes in the price elasticity of demand for carbon-intensive goods and services. Economists frequently analyze the reactions of businesses and consumers to rising carbon costs and assess whether these changes lead to a quantifiable reduction in total emissions. Other indicators might include the level of compliance with the tax, the efficiency in the collection and allocation of tax revenues, and the policy's economic and social equity, ensuring that the tax burden does not disproportionately affect lower-income populations.

Recent research has focused on the economic, environmental, and social impacts of carbon taxes (Fu et al., 2021). Studies over the past five years have examined the role of carbon taxes in meeting international climate goals, with varying results depending on tax design and a country's economic structure. For instance, Williams and Smith (2020) explored the effects of carbon taxes on emission reductions in OECD countries, showing that while carbon taxes have led to a reduction in carbon emissions, the overall effectiveness of these taxes depends heavily on complementary policies, such as subsidies for green technologies or energy efficiency programs (Mehleb et al., 2021; Steenkamp, 2021). Moreover, research has highlighted the challenge of balancing environmental objectives with economic

growth, especially in developing economies. O'Ryan et al. (2023) evaluated the role of carbon taxes in emerging economies. They found that their implementation often faces resistance due to concerns about economic disruption, particularly in energy-intensive industries. This underscores the importance of designing tax policies that minimize economic hardships while achieving environmental targets.

Environmental Performance

Environmental performance refers to the degree to which an organization or sector impacts the environment, including its ability to reduce pollution, conserve resources, and promote sustainable practices (Dogan et al., 2022). In the public sector, environmental performance is often evaluated based on key indicators, such as reductions in carbon emissions, energy consumption, waste management, water conservation, and the adoption of green technologies (Chien et al., 2021; Dou & Cao, 2020). The goal of measuring environmental performance is to ensure that organizations minimize their negative environmental impacts and contribute to broader sustainability goals. Public sector organizations, which often have significant influence over national environmental policy, play a crucial role in driving improvements in environmental performance through regulation, incentives, and strategic planning.

Indicators of environmental performance include reductions in carbon emissions, improvements in waste management practices, the use of renewable energy, and compliance with environmental regulations (Fu et al., 2021). These indicators are often linked to specific environmental targets set by national governments or international organizations, such as the United Nations' Sustainable Development Goals (SDGs). In addition to quantifiable indicators, the adoption of sustainable practices in public administration, such as green procurement policies, energy-efficient buildings, and eco-friendly transportation systems, is also considered part of the broader environmental performance measures (Awan et al., 2022). Governments often use these indicators to monitor progress towards achieving climate-related goals and to ensure accountability in public sector organizations.

Recent research on environmental performance in the public sector has focused on how environmental policies, including carbon taxes, influence organizational behavior and sustainability practices. Studies over the past five years have examined the integration of environmental performance measures into public sector accountability frameworks. For instance, Dogan et al. (2022) examined how governments in Europe and North America have integrated environmental performance indicators into their public procurement processes, leading to a significant shift towards greener technologies. Other studies have examined the impact of carbon taxes on environmental performance across the public and private sectors, showing that they can lead to more efficient resource use and improved environmental outcomes, particularly when paired with complementary policies, such as energy efficiency programs or green investment incentives. Additionally, research has pointed out the challenges faced by public sector organizations in developing countries (Chien et al., 2021; Dou & Cao, 2020), where institutional capacity and political will often hinder the effective implementation of environmental performance measures. These studies suggest that while carbon taxes can improve environmental performance, their success depends on a robust policy framework that supports long-term sustainability.

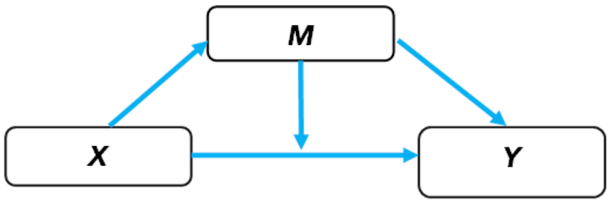
Hypothesis

Given the significant role played by tax compliance in ensuring the effectiveness of tax policies, particularly environmental taxes such as the carbon tax, it is hypothesized that tax compliance may mediate the relationship between the carbon tax and environmental performance in the public sector. The theory behind this hypothesis is that the success of carbon tax implementation depends not only on the tax rate or design but also on how effectively the tax is enforced and adhered to by taxpayers. In Indonesia, improving tax compliance could enhance the overall impact of the carbon tax, ensuring that the revenue generated is used for environmental programs that directly improve environmental performance.

Furthermore, increasing tax compliance could foster a culture of responsibility and awareness among taxpayers, thereby increasing their likelihood of adopting sustainable practices. This, in turn, would lead to improved environmental outcomes, as more funds would be allocated to initiatives that address carbon emissions and other environmental concerns. Therefore, tax compliance is expected to be a critical mediator in the link between carbon taxes and environmental performance, influencing both revenue generation and behavioral changes needed to achieve environmental sustainability goals. A hypothetical visualization is shown in Figure 1.

This study examines the mediating and moderating effects of tax compliance on the relationship between carbon taxes and environmental performance in Indonesia's public sector. The main hypothesis suggests that tax compliance mediates this relationship, thus enhancing the effectiveness of carbon tax policies in improving environmental outcomes.

Figure 1.
Hypothesis of the Study



X: Carbon Tax
M: Tax Compliance
Y: Environmental Performance

It further posits that a carbon tax has a positive effect on environmental performance only when tax compliance is high. Additionally, tax compliance is expected to moderate the relationship, strengthening the impact of the carbon tax on environmental performance. The study also hypothesizes that in developing countries, such as Indonesia, improving tax compliance could have a greater effect on the effectiveness of carbon taxes than in developed countries with higher compliance rates.

Furthermore, external factors, such as education, government perceptions, and policy clarity, are considered moderators of this relationship. In contrast, social and psychological factors, such as attitudes toward sustainability and social norms, are believed to influence tax compliance, thereby enhancing environmental outcomes. These hypotheses aim to shed light on the critical role played by tax compliance in the success of carbon tax policies, especially in emerging economies.

RESEARCH METHOD

Research Design

This study adopts a quantitative research design and uses both mediation and moderation analyses to explore the relationships among carbon taxes, tax compliance, and environmental performance in the public sector (Hair et al., 2019). Specifically, this research investigates whether tax compliance serves as a mediator between a carbon tax and environmental performance and whether moderating effects influence this relationship. The design is based on statistical modeling, in which the independent variable (carbon tax) is hypothesized to affect the dependent variable (environmental performance), with tax compliance serving as a critical mediating variable. The study also tests whether any external or internal variables moderate the relationship between carbon taxes and environmental performance.

In contrast, moderation analysis examines whether tax compliance moderates the relationship between carbon taxes and environmental performance. Combining these two analytical techniques will offer a nuanced view of how tax compliance can be pivotal to the success of carbon tax policies, particularly in achieving their intended environmental goals.

Participant

A total of 318 participants were selected via random sampling to represent a diverse group of individuals from public sector organizations in Indonesia (Krishnaswamy et al., 2012). Based on quantitative research guidelines, we consider this sample size sufficient to ensure statistical power and reliable results. Participants were drawn from a range of public sector entities directly or indirectly involved in carbon tax implementation or environmental performance monitoring, including government agencies, environmental bodies, and regulatory authorities.

Random sampling was employed to reduce bias and ensure that the results could be generalized to a broader population. Participants were invited to complete an online survey designed to collect their responses on the key variables: carbon tax, tax compliance, and environmental performance. The study ensured diversity in the sample by including individuals from various geographical regions, roles, and levels within the public sector, ensuring a balanced representation of the population.

Instrument

The main instrument for data collection was an online survey, which enabled the efficient distribution and collection of responses from a geographically diverse sample. The survey measured the study's key variables: tax compliance, carbon tax, and environmental performance. The use of an online survey is particularly appropriate given its convenience and wide accessibility to participants. It also facilitates anonymity, which is important when collecting data on sensitive topics, such as tax behavior and environmental

performance. The survey was divided into three main sections, each corresponding to one of the study's key variables. The survey items were adapted from existing validated instruments where possible to ensure that the measures were reliable and valid in the Indonesian context.

Tax Compliance

The instrument for measuring tax compliance was adapted from Salé et al. (2021), who developed a well-known scale examining the psychological, social, and institutional factors that affect how well taxpayers comply with tax laws. The scale has several parts: behavioral compliance, which checks to see if taxpayers are meeting their legal obligations, like paying their taxes on time, reporting their income accurately, and following tax laws; voluntary compliance, which checks to see if taxpayers are willing to pay their taxes even if there are not strict enforcement or audit mechanisms; perceived fairness, which checks to see how taxpayers feel about the fairness of the tax system, including how fairly tax burdens and benefits are distributed; and trust in government, which checks to see how much faith participants have in the government's ability to use tax revenues for public benefits, including environmental goals. These dimensions collectively offer a comprehensive view of the factors influencing tax compliance. Table 1 presents the specific items used to measure these dimensions.

Table 1.

Tax Compliance Scale

No	Dimension	Example
1	Behavioral Compliance	"I ensure that I pay all taxes owed on time."
2	Voluntary Compliance	"I am willing to pay taxes even when I am not audited."
3	Perceived Fairness	"The tax system is fair and just in its distribution of burdens."
4	Trust in Government	"I trust the government to use tax revenues in ways that benefit the environment."

Carbon Tax

The instrument used to measure the carbon tax was adapted from the OECD (2019) framework, which outlines metrics related to carbon taxation, including the tax rate, implementation clarity, revenue allocation, and economic impact. The scale incorporates several dimensions: tax rate, which measures the price per ton of carbon emitted and its adequacy in encouraging emission reductions; implementation clarity, which assesses how clearly and effectively the carbon tax policy has been communicated to the public and industries; revenue allocation, which evaluates the transparency and accountability in how carbon tax revenues are utilized, particularly for environmental programs; and economic impact, which measures the perceived burden or benefit of the carbon tax on businesses and consumers. These dimensions collectively capture the various aspects of the carbon tax policy that can influence its effectiveness. Table 1 presents the items used to measure each dimension.

Table 2.

Carbon Tax Scale

No	Dimension	Example
1	Tax Rate	"The carbon tax rate in Indonesia is adequate for driving emissions reductions."
2	Implementation Clarity	"The government has clearly communicated the goals of the carbon tax policy."
3	Revenue Allocation	"I am confident that the revenue from the carbon tax is used effectively for environmental projects."
4	Economic Impact	"The carbon tax has led to positive changes in the business sector, particularly in sustainability practices."

Environmental Performance

The instrument used to assess environmental performance was adapted from Dou and Cao (2020), who focused on key indicators of environmental sustainability in public sector organizations. The scale includes several dimensions: emission reduction, which measures the extent to which organizations or sectors have achieved reductions in carbon emissions over time; energy efficiency, which assesses improvements in energy consumption and the adoption of renewable energy sources; waste management, which evaluates the effectiveness of waste reduction and recycling practices; and sustainability practices, which measure the adoption of sustainable procurement, green building initiatives, and eco-friendly transportation systems. These dimensions provide a comprehensive understanding of an organization's environmental performance. Table 1 presents the items used to measure these dimensions.

Table 3.

Environmental Performance Scale

No	Dimension	Example
1	Emission Reduction	"My organization has made measurable reductions in carbon emissions."
2	Energy Efficiency	"Our organization uses energy-efficient technologies and practices."
3	Waste Management	"My organization has an effective waste management program."

4	Sustainability Practices	"We integrate sustainability into our procurement and operations."

Data Analysis

Structural equation modeling (SEM) was employed to test both the mediation and moderation effects within the hypothesized model.

Mediation analysis was used to examine whether tax compliance mediated the relationship between carbon taxes and environmental performance, providing insights into how tax compliance influenced the effectiveness of carbon tax policies in achieving environmental outcomes. Moderation analysis assessed whether socioeconomic or institutional factors influenced the strength or direction of the relationship between carbon taxes and environmental performance. This approach enabled a more nuanced understanding of the contextual factors that might alter the impact of carbon taxes on environmental outcomes.

Descriptive statistics were first applied to summarize the data and provide an overview of the key variables. Subsequently, reliability tests, including Cronbach's alpha, were conducted for all survey instruments to evaluate the internal consistency and reliability of the measurement scales used to assess tax compliance, carbon taxes, and environmental performance. Path analysis was subsequently performed to test the hypothesized relationships among the variables, thereby identifying direct, indirect, and moderating effects. This comprehensive approach provided a solid foundation for understanding the complex relationships among the study's key factors.

DATA ANALYSIS AND DISCUSSION

Pre-Analysis

Before conducting the main analysis, normality tests were performed to assess whether the data on tax compliance, carbon taxes, and environmental performance were normally distributed. The results of the Kolmogorov–Smirnov test showed that all three variables—tax compliance ($p = 0.340$), carbon tax ($p = 0.307$), and environmental performance ($p = 0.417$)—had p-values greater than 0.05, suggesting that the data for all variables were normally distributed. These results satisfied the assumption of normality required for further statistical analyses. Table 4 presents the results of the normality test, including the test statistics, degrees of freedom (df), and significance values for each variable.

Table 4.

Normality Test

Tests of Normality

	Kolmogorov-Smirnov[a]		
	Statistic	Df	Sig.
Tax Compliance	.052	318	.340
Carbon Tax	.060	318	.307
Environmental Performance	.097	318	.417

a. Lilliefors Significance Correction

The Kolmogorov-Smirnov test results indicate that all three variables—tax compliance, carbon tax, and environmental performance—are normally distributed, as their p-values exceed 0.05. This satisfies the assumption of normality, which is essential for conducting parametric tests in the subsequent analyses. Next, a correlation analysis was conducted to examine the relationships between tax compliance, carbon taxes, and environmental performance. Table 5 presents the results of the correlation analysis, including Pearson's correlation coefficients and significance values.

The correlation analysis reveals significant relationships between tax compliance and both carbon taxes and environmental performance. Specifically, there is a strong positive correlation between tax compliance and carbon taxes ($r = 0.654$), suggesting that higher compliance with tax policies is associated with the more effective implementation of carbon taxes. Additionally, a moderate positive correlation between tax compliance and environmental performance ($r = 0.331$) suggests that improved tax compliance is associated with better environmental outcomes. However, the weaker correlation between carbon taxes and environmental performance ($r = 0.146$) indicates that carbon taxes alone may not directly lead to significant improvements in environmental performance without other influencing factors, such as tax compliance.

Direct Effect

To explore the direct effect of carbon tax on environmental performance, an analysis of variance (ANOVA) was conducted. Table 6 presents the ANOVA results, including the regression and residual sums of squares, mean squares, F-values, and significance levels.

The ANOVA results indicate that the direct effect of the carbon tax on environmental performance is not statistically significant ($p = 0.331$). Although the relationship between the

carbon tax and environmental performance is positive, this result suggests that the carbon tax alone is insufficient to produce significant environmental improvements. Other factors, such as tax compliance, may be necessary to strengthen the effectiveness of carbon tax policies in achieving environmental goals.

Indirect Effect

A mediation test was conducted to examine whether tax compliance serves as a mediator in the relationship between carbon taxes and environmental performance. Table 7 summarizes the results of the mediation analysis, including the coefficients, standard errors, t-values, and significance values for both the mediating and outcome variables.

Table 5
Correlation Test

Correlations

		Tax Compliance	Carbon Tax	Environmental Performance
Tax Compliance	Pearson Correlation	1	.654**	.331**
	Sig. (2-tailed)		.000	.000
	N	318	318	318
Carbon Tax	Pearson Correlation	.654**	1	.146**
	Sig. (2-tailed)	.000		.000
	N	318	318	318
Environmental Performance	Pearson Correlation	.331**	.146**	1
	Sig. (2-tailed)	.000	.000	
	N	318	318	318

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6.
ANOVA Test

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13573.727	1	13573.727	18.497	.331
	Residual	54642.487	316	172.919		
	Total	68216.214	317			

a. Dependent Variable: Environmental Performance
b. Predictors: (Constant), Carbon Tax

Table 7.
Mediation Test

Outcome Tax Compliance				
Model	**Coeff**	**Se**	**t**	**Sig.**
Content	39.3995	3.3013	11.9346	.0000
Carbon Tax	.5048	.0328	15.3827	.0000
Outcome Environmental Performance				
Model	**Coeff**	**Se**	**t**	**Sig.**
Content	19.511	3.8667	5.0461	.0000
Carbon Tax	.0989	.0953	1.0378	.3302
Tax Compliance	.4428	.0735	6.0214	.0000

Table 8.
Moderation Test

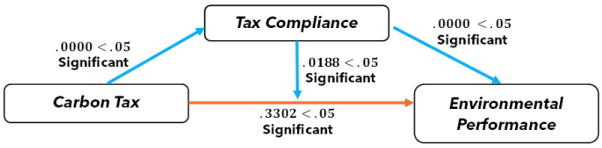
Outcome Environmental Performance				
Model	**Coeff**	**Se**	**t**	**Sig.**
Content	55.6392	45.7492	1.2162	.2248
Carbon Tax	1.2906	.5133	2.5143	.2124
Tax Compliance	1.4860	.4477	3.3195	.0010
Int_1	.0115	.0049	2.3621	.0188

This highlights the importance of fostering tax compliance to maximize the impact of carbon taxes on environmental performance. The lack of a significant direct effect of carbon taxes on environmental performance (p = 0.3302) further supports the critical role of tax compliance in this process.

The moderation test examined whether tax compliance moderates the relationship between carbon taxes and environmental performance. Table 8 presents the results of the moderation test, including the coefficients, standard errors, t-values, and significance values for the main effects of carbon taxes, tax compliance, and their interaction (Int_1).

The results from the moderation analysis demonstrate that tax compliance significantly moderates the relationship between carbon taxes and environmental performance. Specifically, the interaction between carbon taxes and tax compliance (coeff = 1.4860, p = 0.0010) enhances the effect of carbon taxes on environmental performance. This indicates that improving tax compliance can increase the effectiveness of carbon tax policies, reinforcing the importance of fostering compliance to achieve better environmental outcomes. Figure 2 visually presents the hypothesized test results, showing the direct, indirect, and moderating effects of the variables involved.

Figure 2.
Hypothetical Test Results



These results indicate that tax compliance plays a key role in mediating and moderating the relationship between carbon taxes and environmental performance, highlighting the importance of fostering compliance to enhance the impact of carbon tax policies on environmental outcomes.

Discussion

The results of this study provide valuable insights into the relationships among carbon taxes, tax compliance, and environmental performance in the public sector, particularly in the context of Indonesia. The study found that tax compliance plays a significant role in mediating and moderating the relationship between carbon taxes and environmental performance, emphasizing the

crucial role of compliance in enhancing the effectiveness of carbon tax policies. These findings align with previous research highlighting the importance of compliance for the success of environmental policies, suggesting that tax compliance is an essential factor for achieving desired environmental outcomes.

The first key finding is the strong correlation between tax compliance and both carbon taxes (r = 0.654) and environmental performance (r = 0.331). This suggests that as tax compliance increases, the implementation of carbon taxes and environmental performance both tend to improve. These results align with previous studies that have emphasized the importance of tax compliance for the success of environmental policies. For example, Fauzan et al. (2022) and Muharremi et al. (2022) suggest that higher tax compliance is often associated with better environmental policy outcomes, as greater compliance leads to more revenue directed toward implementing green initiatives. In Indonesia, where tax compliance has traditionally been low, these findings highlight the importance of improving compliance to ensure that carbon tax policies are effective. Alshira'h et al. (2020), Fatas et al. (2021), and Thottoli (2022) argue that fostering a culture of tax compliance through transparent revenue allocation and public trust in government is key to ensuring that the tax system contributes positively to environmental sustainability.

However, the correlation between carbon taxes and environmental performance was relatively weak (r = 0.146). This finding suggests that while there is a relationship between carbon taxes and environmental outcomes, the direct impact of carbon taxes on environmental performance is less pronounced than expected. The lack of a significant direct effect, as revealed by the ANOVA test (F = 18.497, p = 0.331), further supports this argument. This is consistent with the studies by El-Sayed et al. (2020) and Yong and Fukofuka (2023), who show that while carbon taxes can reduce emissions, their effectiveness is often moderated by other factors, such as policy design, enforcement, and public participation. In Indonesia, where the institutional framework and enforcement mechanisms are still developing, the direct impact of carbon taxes may be weaker without complementary measures, such as tax compliance.

The second key finding is the significant role of tax compliance as a mediator between carbon taxes and environmental performance. The results from the mediation analysis showed that tax compliance significantly strengthened the relationship between carbon taxes and environmental performance (coeff = 0.4428, $p < 0.01$). This finding suggests that when taxpayers comply with carbon tax policies, the revenue generated by these taxes can be used more effectively for environmental programs, thereby improving outcomes. This finding is consistent with the work of LaMothe and Bobek (2020), Salé et al. (2021), and Vincent (2021), who indicated that enhancing tax compliance increases the overall effectiveness of carbon taxes in reducing emissions and funding environmental initiatives.

In Indonesia, this result is highly relevant, as the country has faced challenges with low tax compliance (Bashir et al., 2021). According to the World Bank, Indonesia's tax-to-GDP ratio is among the lowest in Southeast Asia, hindering the government's ability to generate sufficient revenue for public projects, including environmental initiatives (Harahap et al., 2025; Zhang et al., 2022). By improving tax compliance, Indonesia could better leverage carbon tax revenue to fund climate change mitigation efforts, such as renewable energy investments and sustainable infrastructure. The significant role of tax compliance in mediating the relationship between carbon taxes and environmental performance underscores the need for policy reforms that promote compliance, such as improved tax education, transparent revenue allocation, and strengthened enforcement mechanisms.

The third key finding is the significant moderating role of tax compliance in the relationship between carbon taxes and environmental performance. The moderation analysis revealed that the effect of carbon taxes on environmental performance was stronger when tax compliance levels were higher (Coeff = 1.4860, p = 0.0010). This result highlights the critical role of tax compliance in amplifying the impact of carbon tax policies on environmental outcomes. As Y. Zhang et al. (2022) suggest, high tax compliance creates a positive feedback loop in which increased tax revenues are reinvested in environmental programs that further improve public perception and compliance. The moderation effect observed in this study aligns with findings from Sarpong et al. (2023), Tsai (2020), and G. Zhang et al. (2021), who argue that when individuals perceive that their taxes are being used effectively, they are more likely to comply with tax policies, creating a virtuous cycle that enhances environmental performance.

In Indonesia, the findings of this study are particularly significant given the country's unique challenges. Indonesia has been struggling with relatively low tax compliance, and its nascent carbon tax policy, introduced in 2022, is still in its early stages. According to the Indonesian Ministry of Finance (Fauzan et al., 2022), Indonesia's carbon tax

is expected to play a key role in achieving its climate goals. However, their success hinges on increasing their tax compliance. The results of this study suggest that without substantial improvements in compliance, the carbon tax alone may not be sufficient to drive significant environmental changes. Therefore, Indonesia must not only focus on implementing carbon taxes but also on strengthening compliance mechanisms through public awareness campaigns, incentives for voluntary compliance, and stringent enforcement measures.

This study highlights the need for a comprehensive approach to carbon taxation in Indonesia that integrates effective tax policy design and enhanced tax compliance strategies. It also underscores the importance of building public trust in the government's ability to use carbon tax revenue for environmental sustainability, as trust in the government is a key determinant of tax compliance, as emphasized by Muharremi et al. (2022).

CONCLUSION, IMPLICATION, SUGGESTION, AND LIMITATIONS

This study provides valuable insights into the complex relationships among carbon taxes, tax compliance, and environmental performance, particularly in the Indonesian context. The key findings suggest that tax compliance plays a significant role in both mediating and moderating the relationship between carbon taxes and environmental performance. The results emphasize that improving tax compliance is essential for maximizing the effectiveness of carbon tax policies in achieving environmental sustainability goals. In Indonesia, where tax compliance has traditionally been low, fostering compliance will be critical to ensuring that revenue from carbon taxes is effectively used for environmental programs and that carbon tax policies deliver their intended environmental outcomes.

Although the findings are promising, this study has several limitations. First, it relies on cross-sectional data, which limits the ability to draw causal inferences. Future research could benefit from longitudinal data to examine the long-term effects of tax compliance on the effectiveness of carbon tax policies. Additionally, this study focuses on the public sector, and future studies could explore the role of tax compliance in the private sector and its influence on overall environmental performance. Despite these limitations, this research contributes to the growing literature on the role of tax compliance in enhancing the effectiveness of environmental taxation, particularly in emerging economies such as Indonesia.

Hence, improving tax compliance is essential not only for the successful implementation of carbon tax policies but also for ensuring that these policies lead to significant improvements in environmental performance. By strengthening tax compliance mechanisms and ensuring transparency in the use of tax revenue, Indonesia can better leverage its carbon tax to achieve its environmental sustainability goals and contribute to global efforts to combat climate change.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to all those who contributed to this research, both directly and indirectly. Special thanks are due to my advisors, colleagues, and all those who provided support with resources, time, and valuable insights, which were essential to the success of this study. Without their contributions, this research would not have been possible.

Conflict of Interest

I declare that I have no conflicts of interest in this research, whether financial, professional, personal, or related to organizational membership, associations with relevant entities, or personal beliefs related to the research topic.

Use of Artificial Intelligence Technology

I confirm that artificial intelligence technology was used solely for translation in this research. It was not used for data analysis or any other decision-making process related to the research content.

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