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Carbon Transparency and Tax Avoidance in Indonesian Energy Companies: The Moderating Role of Audit Quality, 2021–2025

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Abstract

Since sustainability reporting became compulsory for listed firms and Law No. 7 of 2021 introduced a carbon tax, carbon transparency and corporate tax conduct have emerged as connected policy issues in Indonesia. This study investigates whether energy-sector firms that are more transparent about carbon engage in less tax avoidance and whether audit quality reinforces this link. The analysis draws on panel data for 36 energy firms on the Indonesia Stock Exchange from 2021 to 2025 (180 firm-years). Tax avoidance is proxied by the effective tax rate (ETR), carbon transparency by an index of carbon emission disclosure, and audit quality by the engagement of a Big Four auditor. At the 5% level, carbon transparency has no significant effect on ETR in any of the robustness tests, and audit quality does not act as a moderator. The model accounts for less than 3% of the variation in ETR, which implies that tax burdens depend largely on firm attributes and tax factors other than carbon disclosure. Consequently, neither carbon disclosure nor a Big Four auditor can yet be treated as an independent signal of tax compliance, and carbon reporting and tax governance ought to be evaluated as distinct aspects of corporate accountability.

Keywords:
Carbon Transparency; Tax Avoidance; Audit Quality; Effective Tax Rate (ETR); Energy Sector Companies.

1. INTRODUCTION

In the energy sector, where operations, asset structures, and fiscal regimes are complex, tax avoidance is a central corporate governance concern (Benninger et al., 2024). Among the 74 energy firms listed on the IDX, the median effective tax rate (ETR) declined from 23.25% in 2021 to 21.57% in 2025, and the number of firms with an ETR under 10% increased from 3 to 12. A low ETR alone, however, is not proof of tax avoidance, since many accounting and tax factors influence it (Wang et al., 2020). Energy firms are also under mounting pressure to be open about their environmental impact, especially their carbon emissions. Investors are known to price carbon risk (Bolton & Kacperczyk, 2021), and the amount and detail of environmental disclosure have been linked to the performance of Indonesian listed firms (Romandhon et al., 2025); carbon information therefore bears on corporate accountability and on how investors judge firms. Indonesian regulation adds to these pressures. POJK No. 51/POJK.03/2017 obliges issuers and public companies to issue sustainability reports (Otoritas Jasa Keuangan, 2017), and Law No. 7 of 2021 on the Harmonization of Tax Regulations created a carbon tax, tying carbon emissions directly to fiscal policy (Republik Indonesia, 2021). International studies of how carbon-related activity relates to tax behavior do not agree. Firms that start carbon reduction initiatives tend to pay less tax (Feng et al., 2024); environmental regulation may unintentionally raise tax avoidance (Compagnie et al., 2023); and, in contrast to their Australian counterparts, Indonesian mining and energy firms do not seem to use environmental disclosure strategically to offset the legitimacy cost of avoiding tax (Rini et al., 2024). Reviews of CSR and tax likewise report conflicting results (Kovermann & Velte, 2021). A recent meta-regression detects little or no association between ESG and tax avoidance and infers that firms keep their ESG and tax strategies apart (Mitroulia et al., 2025), while evidence across countries indicates that

mandatory ESG disclosure lowers tax avoidance, especially where the mandate includes tax-related provisions (El Ghoul et al., 2026). Furthermore, broad CSR or ESG scores do not isolate carbon transparency (Berg et al., 2022). Environmental disclosure may also preserve legitimacy without signaling real action (Deegan, 2019), and Azisah and Surianto (2026) report no significant effect of carbon emission disclosure on ETR. Agency theory suggests that audit quality can curb managerial opportunism and make corporate information more credible (Kovermann & Velte, 2019; Wang et al., 2020). The engagement of Big Four auditors has been linked to less tax avoidance among listed firms in Indonesia and Malaysia (Rizqia & Lastiati, 2021) yet to more tax avoidance among private clients in the United Kingdom (Chen et al., 2023), and Junaidi et al. (2023) observe no moderating role of audit quality in the link between CSR and tax avoidance. This mixed evidence leaves a gap in understanding how carbon transparency relates to tax behavior and how audit quality enters that relationship. To address it, this study applies an 18-item carbon emission disclosure index adapted from Choi et al. (2013), proxies audit quality by whether the auditor is a Big Four or a non-Big Four firm, and investigates how carbon transparency relates to tax avoidance in Indonesian energy firms.

The expected relationships rest on two theories. According to legitimacy theory, organizations function under an implicit social contract and must demonstrate that what they do is in line with societal values if they are to keep public acceptance and access to resources. Disclosure is a main tool for managing legitimacy, used either substantively, to report genuine changes in practice, or symbolically, to influence perceptions while behavior stays the same (Deegan, 2019). Because paying a fair amount of tax is increasingly viewed as one of a firm's obligations to society (Mitroulia et al., 2025), a firm pursuing legitimacy through carbon transparency should steer clear of tax practices that would undermine that image, implying that carbon transparency and ETR move together positively. Yet the theory also acknowledges that legitimacy is managed with particular audiences in mind, so environmental disclosure and tax behavior can be decoupled when they are addressed to different stakeholders (Deegan, 2019). Agency theory treats tax avoidance as a choice that managers make on shareholders' behalf. It may raise after-tax cash flows, but it also produces opacity that managers can exploit and exposes the firm to tax and reputational risk; monitoring is therefore required to keep tax planning in line with owners' interests (Kovermann & Velte, 2019; Wang et al., 2020). External audit is one form of such monitoring. Large audit firms have more reputation at stake and more resources for detecting misstatements and challenging aggressive tax positions, which should make corporate disclosures more credible and restrain opportunistic tax behavior (Rizqia & Lastiati, 2021). Because these firms frequently also sell tax advisory services, though, their overall effect on tax avoidance is ambiguous in theory (Chen et al., 2023).

From this discussion, the research gap has three dimensions. Empirically, earlier findings on CSR and carbon emission disclosure leave the link between carbon transparency and tax indicators unresolved. In measurement terms, broad CSR or ESG indices do not single out carbon transparency, which calls for a more targeted measure such as a carbon emission disclosure index. In governance terms, whether audit quality moderates the link between carbon transparency and tax avoidance has not been sufficiently tested. Two research questions follow: (1) Is carbon transparency positively associated with ETR among IDX-listed energy firms in 2021–2025? (2) Does audit quality strengthen the positive association between carbon transparency and ETR? Since ETR serves as the tax avoidance proxy, a higher ETR usually signals less tax avoidance and a lower ETR signals more. On the basis of the theories above, firms that are transparent about carbon are expected to show higher ETRs, and high-quality auditors are expected to reinforce this association by lending credibility to carbon disclosure and limiting opportunistic tax planning. The hypotheses are therefore as follows. H1: Carbon transparency is positively associated with ETR. H2: Audit quality strengthens the positive association between carbon transparency and ETR.

The purpose of this study is to analyze how carbon transparency relates to ETR and to test whether audit quality moderates this relationship for IDX-listed energy firms in 2021–2025. Carbon transparency is captured by an 18-item disclosure index adapted from Choi et al. (2013), audit quality by whether the auditor is affiliated with the Big Four, and ETR by dividing income tax expense by pre-tax income. With these measures, a positive link between carbon transparency and ETR can broadly be read as consistent with less tax avoidance. ETR remains an imperfect proxy, however, as book–tax differences, tax incentives, loss carryforwards, and other factors all influence it. The results are thus interpreted with these caveats and are not taken as direct proof of whether a firm avoids tax.

The study seeks to contribute to the management, accounting, and corporate governance literature in both theoretical and practical ways. On the theoretical side, it broadens the debate on environmental transparency and tax behavior by treating audit quality as an external monitoring mechanism that may condition their relationship. It also combines legitimacy theory, which accounts for the importance of environmental disclosure to a firm's social acceptance, with agency theory, which stresses monitoring that lowers information asymmetry and managerial opportunism. On the measurement side, an index focused specifically on carbon should give a sharper picture than broad CSR or ESG measures. On the practical side, the findings can guide managers designing environmental disclosure policies, auditors judging the credibility of corporate information, and investors and regulators evaluating the transparency and accountability of energy firms.

The rest of the article proceeds as follows. Section 2 sets out the research method, covering the population and sample, the measurement of variables, and the analytical techniques. Section 3 reports the empirical

findings and relates them to theory and earlier studies. Section 4 closes with the implications, limitations, and directions for further research.

2. RESEARCH METHOD

The study adopts a quantitative design based on secondary data drawn from existing documents and sources (Sugiyono, 2019). It investigates how carbon transparency affects tax avoidance and how audit quality moderates this effect in energy firms listed on the Indonesia Stock Exchange (IDX) during 2021–2025. Of the 74 firms in the population, 36 were chosen by purposive sampling using criteria that match the research objectives (Sugiyono, 2019), producing a balanced panel of 180 firm-year observations. The data come from annual reports, financial statements, and sustainability reports published on the IDX website and on company websites. Tax avoidance is proxied by the effective tax rate (ETR), computed as income tax expense over pre-tax income (Wang et al., 2020). A lower ETR points to a stronger tendency to avoid tax, though it is not direct proof, since book–tax differences and other tax factors also influence it. Firms with pre-tax losses were left out because their ETR values have no meaningful interpretation. Carbon transparency is captured by an 18-item carbon emission disclosure (CED) index adapted from Choi et al. (2013), an instrument also used in recent research on Indonesian energy firms (Azisah & Surianto, 2026). Audit quality (AQ) is a dummy coded 1 when the firm's auditor is a public accounting firm affiliated with the Big Four and 0 otherwise.

Table 1. Sample Selection Criteria

No	Sample Selection Criteria	Number
1	Energy firms listed on the Indonesia Stock Exchange in 2021–2025	74
2	Firms that did not publish annual and sustainability reports consistently in 2021–2025	(20)
3	Firms reporting a pre-tax loss in any year of the study period	(18)
	Number of sample companies	36
	Total observations (36 companies × 5 years)	180

Table 1 shows that the population consists of 74 energy firms listed on the IDX in 2021–2025. Of these, 20 were removed for not publishing annual and sustainability reports consistently over the period, and another 18 were removed for recording a pre-tax loss in at least one year, leaving 36 firms that satisfy all criteria. Across the five years, these firms provide 180 firm-year observations for analyzing the effect of carbon transparency on ETR and the moderating role of audit quality.

Each of the three criteria has a specific purpose and also affects how the findings should be interpreted. The first establishes an industry setting with broadly similar carbon intensity and fiscal regimes. The second allows CED to be measured consistently every year, but because it keeps only firms with established reporting practices, the sample may be weighted toward firms with more mature disclosure; this narrows the differences in carbon transparency and can make an effect harder to detect. The third drops firms with a pre-tax loss in any year, since the ETR of a loss-making firm is negative or undefined and does not represent a tax burden. As a consequence, the sample is limited to consistently profitable taxpayers, excludes firms whose tax positions depend most on loss carryforwards, and forms a balanced panel that supports within-firm comparisons over the whole period. The findings therefore pertain to consistently profitable energy firms that report on sustainability regularly and should not be extended to loss-making firms or to firms with irregular reporting.

Following Choi et al. (2013), the CED index comprises 18 items in five categories, namely climate change risks and opportunities (2 items), greenhouse gas (GHG) emissions (7 items), energy consumption (3 items), GHG reduction and costs (4 items), and accountability for carbon emissions (2 items), as shown in Table 2. An item receives a score of 1 when it is disclosed in the annual or sustainability report and 0 when it is not; the index is the number of disclosed items divided by 18 and thus lies between 0 and 1. Because no weights are applied, every item counts equally. The index thus reflects how broadly a firm discloses carbon information, not how much it emits or how good its carbon performance is, a point that matters when its link with tax behavior is interpreted.

Table 2. Carbon Emission Disclosure (CED) Index Items

Category	Code	Disclosure item
Climate change risks and opportunities	CC1	Assessment or description of climate change–related risks (regulatory, physical, or general) and of the measures taken to manage them
	CC2	Assessment or description of the present and future financial and business implications and opportunities arising from climate change
GHG emissions	GHG1	Description of the method used to calculate GHG emissions (e.g., GHG Protocol or ISO)
	GHG2	Whether the quantity of GHG emissions has been externally verified
	GHG3	Total GHG emissions (metric tonnes of CO2-equivalent)

	GHG4	Disclosure of Scope 1 and Scope 2, or Scope 3, GHG emissions
	GHG5	GHG emissions disclosed by source (e.g., coal, electricity)
	GHG6	Disclosure of GHG emissions by facility or segment
	GHG7	Comparison of GHG emissions with previous years
Energy consumption	EC1	Total energy consumed
	EC2	Quantification of energy used from renewable sources
	EC3	Energy consumption disclosed by type, facility, or segment
GHG reduction and costs	RC1	Details of plans or strategies to reduce GHG emissions
	RC2	Stated GHG emission reduction target, including the target level and year
	RC3	Emission reductions achieved to date and the related costs or savings
	RC4	Future emission costs taken into account in capital expenditure planning
Accountability for carbon emissions	AEC1	Identification of the board committee or other executive body holding overall responsibility for climate change actions
	AEC2	Description of how the board or executive body reviews the company's progress on climate change actions

Source: adapted from Choi et al. (2013).

Data analysis was carried out in Stata and comprised descriptive statistics, correlation analysis, and panel data regression. The Chow test, the Breusch–Pagan Lagrange Multiplier (LM) test, and the Hausman test were used to choose the estimator, and on their basis the random effects model (REM) was adopted. Two models were estimated: Model 1 examines the effect of carbon transparency on ETR, while Model 2 adds audit quality and the carbon transparency × audit quality interaction (CED × AQ):

$$\text{Model 1: } ETR_{it} = \beta_0 + \beta_1 CED_{it} + u_i + \varepsilon_{it}$$
$$\text{Model 2: } ETR_{it} = \beta_0 + \beta_1 CED_{it} + \beta_2 AQ_{it} + \beta_3 (CED \times AQ)_{it} + u_i + \varepsilon_{it}$$

Where ui denotes the firm-specific random effect and εit the idiosyncratic error term. To allow for correlated errors across observations of the same firm, standard errors are clustered by firm (cluster-robust). In Model 2, β1 measures the effect of CED for firms with non-Big Four auditors, whereas β1 + β3 measures the effect for firms with Big Four auditors; H2 is supported when β3 is positive and significant. Since a higher ETR means a heavier effective tax burden, a positive coefficient signals less, not more, tax avoidance.

Two aspects of the specification need clarification. First, the models omit control variables commonly used in tax avoidance studies, such as firm size, profitability, leverage, capital intensity, and tax loss carryforwards (Mitroulia et al., 2025; Wang et al., 2020). This omission is a limitation, especially with regard to firm size: larger firms usually disclose more carbon information and are more likely to hire Big Four auditors, and size can push ETR up through political costs or down through greater resources for tax planning. Since firm size changes slowly, the firm-specific effect in the panel model absorbs much of its influence, and the fixed effects robustness test, which eliminates all time-invariant firm characteristics, yields the same conclusion. Even so, the coefficients should be read as associations that omitted time-varying factors may still bias. Second, audit quality is represented by a binary Big Four indicator because this information is available for every firm-year and allows comparison with earlier Indonesian studies (Junaidi et al., 2023; Rizqia & Lastiati, 2021). The indicator reflects auditor reputation and resources but leaves out other aspects of audit quality, including industry specialization, audit fees, audit tenure, and assurance of sustainability reports; the moderation test therefore concerns one particular facet of audit quality rather than audit quality in its entirety.

To check how sensitive the results are, Model 2 was re-estimated in three alternative forms: (1) a random effects model in which ETR is winsorized at the 5th and 95th percentiles to reduce the influence of outliers; (2) a random effects model including year dummies to capture common shocks such as commodity price cycles and changes in tax policy; and (3) a fixed effects model that eliminates all time-invariant firm characteristics, including largely stable differences in firm size and subsector. As in the main analysis, all models use standard errors clustered by firm, and the Hausman test was run again for the alternative random effects specifications.

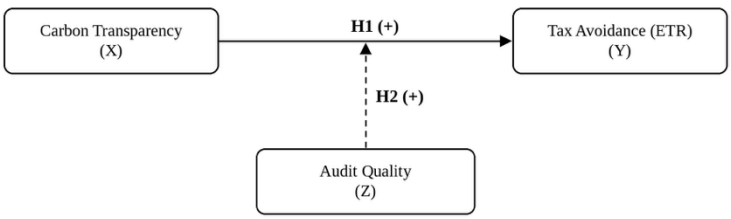


Figure 1. Research Model

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistics

Table 3. Descriptive Statistics

Variable	Mean	Median	Std. Dev.	Min	Max
ETR	0.2614	0.2223	0.1725	0.0054	0.8388
CED	0.5225	0.5556	0.2568	0.0000	1.0000
AQ	0.4222	0.0000	0.4953	0.0000	1.0000
CED × AQ	0.2806	0.0000	0.3583	0.0000	1.0000

Source: processed research data. ETR = effective tax rate; CED = carbon emission disclosure index; AQ = Big Four audit firm dummy; CED × AQ = interaction term. N = 180.

Average ETR is 26.14% (median 22.23%), near the statutory corporate income tax rate of 22%, and ranges from 0.54% to 83.88%, which points to substantial heterogeneity. The CED index has a mean of 0.5225 (range 0.00–1.00), and Big Four firms audited 42.2% of the observations (76 of 180).

The descriptive statistics also reveal the spread of the data. The coefficient of variation of ETR is roughly 66% (0.1725/0.2614), and the mean lies above the median, pointing to right skewness: a small number of firm-years with very high ETRs—as high as 83.88%, far above the 22% statutory rate—pull the average up. Such high values usually stem from non-deductible expenses, tax adjustments, or deferred tax effects rather than from deliberate tax decisions, whereas ETRs near zero (minimum 0.54%) correspond to firm-years with very little recognized tax expense. CED is likewise widely spread (coefficient of variation of roughly 49%), from firms disclosing none of the 18 items to firms disclosing every item. Mean CED climbed from 0.4012 in 2021 to 0.6096 in 2025, a rise of roughly 52%, but ETR shows no similar trend. Carbon transparency also varies with the type of auditor: mean CED is 0.664 for firms with Big Four auditors and 0.419 for firms with non-Big Four auditors, and only 2 of the 36 firms moved between auditor groups over the period. Variation in AQ therefore arises mostly between firms rather than over time, a feature that matters for interpreting the moderation results.

3.2. Correlation Analysis

Table 4. Correlation Matrix

Variable	ETR	CED	AQ	CED × AQ
ETR	1.000			
CED	0.143 (0.055)	1.000		
AQ	−0.011 (0.880)	0.474 (<0.001)	1.000	
CED × AQ	0.041 (0.584)	0.654 (<0.001)	0.918 (<0.001)	1.000

Source: processed research data. p-values in parentheses. N = 180.

The correlation between CED and ETR is weak and positive ($r = 0.143$; $p = 0.055$) and reaches significance only at the 10% level, while ETR is not significantly correlated with either AQ ($r = −0.011$; $p = 0.880$) or CED × AQ ($r = 0.041$; $p = 0.584$). CED and AQ are significantly correlated ($r = 0.474$; $p < 0.001$). The strong correlation between AQ and CED × AQ ($r = 0.918$) is to be expected, since AQ is used to build the interaction term.

3.3. Panel Data Model Selection

Table 5. Panel Data Model Selection Tests

Test	Null hypothesis	Model 1 (CED)	Model 2 (CED, AQ, CED × AQ)	Decision
Chow (F)	Pooled OLS is adequate	$F(35, 143) = 4.773$; $p < 0.001$	$F(35, 141) = 4.633$; $p < 0.001$	Reject H_0: firm effects present
Breusch–Pagan LM (χ^2)	Variance of individual effects = 0	$\chi^2(1) = 62.77$; $p < 0.001$	$\chi^2(1) = 59.14$; $p < 0.001$	Reject H_0: firm effects present
Hausman (χ^2)	Random effects estimator is consistent	$\chi^2(1) = 0.987$; $p = 0.320$	$\chi^2(3) = 2.084$; $p = 0.555$	Fail to reject H_0: random effects

Source: processed research data.

Both the Chow test and the Breusch–Pagan LM test are significant ($p < 0.001$), showing that firm effects need to be included in the model. The Hausman test is insignificant ($p = 0.320$ for Model 1; $p = 0.555$ for Model 2), so REM is chosen, with firm-clustered standard errors.

3.4. Panel Data Regression Results

Table 6. Random Effects Regression Results (Dependent Variable: ETR)

Variable	Model 1 Coef. (SE)	p-value	Model 2 Coef. (SE)	p-value
CED	0.0513 (0.0637)	0.421	0.0389 (0.0723)	0.591
AQ			−0.0360 (0.0742)	0.628
CED × AQ			0.0393 (0.1194)	0.742
Constant	0.2346*** (0.0379)	<0.001	0.2453*** (0.0476)	<0.001
Observations	180		180	
Companies	36		36	
R^2 within	0.0001		0.0003	
R^2 between	0.0488		0.0820	
R^2 overall	0.0205		0.0288	
Wald χ^2	0.648 (1 df)	0.421	1.165 (3 df)	0.762
σu / σe	0.1139 / 0.1297		0.1154 / 0.1306	
ρ (share of variance between firms)	0.4353		0.4384	

Source: processed research data. Dependent variable: ETR. Figures in parentheses are standard errors clustered by firm (36 clusters). *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$. In Model 2, the CED coefficient represents the effect of CED when AQ = 0.

3.4.1. Effect of Carbon Transparency on ETR (Model 1)

Model 1 yields a positive but insignificant CED coefficient of 0.0513 (SE = 0.0637; $p = 0.421$), and the model overall is not significant either (Wald $\chi^2(1) = 0.648$; $p = 0.421$). Hence, H1 is not supported.

This insignificant result does not demonstrate that carbon transparency has no effect. The 95% confidence interval of the CED coefficient runs from −0.0735 to 0.1761 (0.0513 ± 1.96 × 0.0637). Economically, a rise of one standard deviation in CED (0.2568) corresponds to an ETR roughly 1.3 percentage points higher, yet the interval for this effect stretches from about −1.9 to +4.5 percentage points. The data are thus consistent with a zero effect as well as with small effects in either direction, and with 36 firms and limited within-firm variation the study is not precise enough to tell these apart. The finding is best understood as a lack of evidence for a systematic relationship in this sample, not as evidence that no relationship exists.

3.4.2. Moderating Role of Audit Quality (Model 2)

In Model 2, the CED × AQ interaction has a positive but insignificant coefficient of 0.0393 (SE = 0.1194; $p = 0.742$). CED ($p = 0.591$) and AQ ($p = 0.628$) are each insignificant as well. Likewise, neither the marginal effect of CED for firms with Big Four auditors ($\beta1 + \beta3 = 0.0782$; $p = 0.431$) nor the joint Wald test of AQ and CED × AQ ($\chi^2(2) = 0.295$; $p = 0.863$) is significant. Consequently, H2 is not supported.

The interaction coefficient has a wide 95% confidence interval (−0.1947 to 0.2733), so the data exclude neither a strengthening nor a weakening role for audit quality. As AQ changes for just 2 of the 36 firms, the interaction is identified almost wholly from between-firm differences, which reduces the precision of the moderation test.

3.4.3. Coefficient of Determination (R^2)

Table 7. Coefficient of Determination

Measure	Model 1 (CED)	Model 2 (CED, AQ, CED × AQ)
R^2 within	0.0001	0.0003
R^2 between	0.0488	0.0820
R^2 overall	0.0205	0.0288
R^2 overall (%)	2.05%	2.88%
Adjusted R^2 (based on R^2 overall)	0.0150	0.0122

Source: processed research data. Within = variation over time within firms; between = variation across firms; overall = total variation. Adjusted R^2 is computed from R^2 overall as $1 - (1 - R^2)(N - 1)/(N - k - 1)$, where $N = 180$ and k is the number of regressors.

For Model 2, the overall R^2 is 0.0288 (2.88%) and the adjusted R^2 is 0.0122, meaning that the model's variables account for only a small portion of the variation in ETR. The between R^2 (0.0820) far exceeds the within R^2 (0.0003), so the model captures differences between firms better than changes within firms over time.

Three implications follow from the low R^2. First, although it does not undermine the coefficient estimates, it shows that carbon transparency and audit quality explain only a small fraction of the differences in tax burden; on their own, these variables are therefore unsuitable for predicting or screening the tax behavior of energy firms. Second, the within R^2 close to zero means that annual increases in a firm's CED are not matched by corresponding movements in its ETR, despite the considerable rise in CED over the period. Third, the variance shares due to persistent firm effects ($\rho = 0.44$) and the remaining idiosyncratic variation ($\sigma e = 0.13$) imply that ETR depends on stable firm characteristics—profitability, leverage, capital intensity, subsector tax regimes, and fiscal incentives—and on transitory tax items, none of which the model contains. A fuller specification is thus required to assess the relationship more precisely.

3.4.4. Robustness Checks

Table 8 presents the Model 2 coefficients for the three alternative specifications alongside the baseline estimates in Table 6.

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Table 8. Robustness Checks (Model 2; Coefficients and Cluster-Robust Standard Errors)

Specification	CED	AQ	CED × AQ
Baseline model (RE)	0.0389 (0.0723)	−0.0360 (0.0742)	0.0393 (0.1194)
ETR winsorized at 5%–95% (RE)	0.0426 (0.0655)	−0.0186 (0.0652)	0.0118 (0.1038)
With year dummies (RE)	0.1146* (0.0694)	−0.0689 (0.0830)	0.0553 (0.1316)
Fixed effects	−0.0191 (0.0975)	−0.0296 (0.1064)	0.0514 (0.1454)

Source: processed research data. Dependent variable: ETR. Standard errors clustered by firm appear in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$. The Hausman test gives $p = 0.520$ for the winsorized specification and $p > 0.99$ for the year-dummy specification, so random effects remain the appropriate estimator.

In none of the specifications is the interaction coefficient significant ($p = 0.674$–0.910), so no alternative supports H2. When year dummies are added, the CED coefficient increases to 0.1146 and nears the 10% significance threshold ($p = 0.099$); since it is not significant at 5%, it is regarded only as an exploratory result. The increase stems from common movements over time: mean ETR was higher in 2021 (0.305) than in 2022–2025 (0.243–0.258) while CED was increasing, so removing year effects makes the positive association slightly more visible. In the fixed effects specification, which uses only within-firm changes, the CED coefficient becomes negative (−0.0191) and stays insignificant. The relationship between CED and ETR is therefore not consistent across specifications, reinforcing the conclusion that H1 is not supported.

3.5. Discussion

3.5.1. Carbon Transparency and Tax Avoidance

The findings indicate that carbon transparency does not significantly affect ETR in Model 1 ($\beta = 0.0513$; $p = 0.421$) or in Model 2 ($\beta = 0.0389$; $p = 0.591$). The positive sign fits the legitimacy argument behind H1, namely that firms which are open about their environmental impact also safeguard their social legitimacy by complying with their tax obligations. Given the small coefficients and comparatively large standard errors, however, this sample provides no empirical support for the argument.

A number of explanations are possible. First, even though sustainability reporting is compulsory, what Indonesian firms disclose about carbon emissions is still largely left to management and is often symbolic; wider disclosure thus need not signal an ethical commitment that also guides tax decisions. Viewed through legitimacy theory, disclosure can serve as an image-management strategy detached from operational and financial conduct (Deegan, 2019). Second, many technical factors outside the model drive tax avoidance, including profitability, leverage, tax loss carryforwards, capital intensity, and the specific tax regimes of the mining, oil and gas, and supporting services subsectors. The low R^2 and the large between-firm share of variance ($\rho = 0.44$) are in line with the view that time-invariant firm characteristics weigh more heavily on ETR than does the level of carbon transparency. Third, the rise in CED over the period (a mean of 0.4012 in 2021 versus 0.6096 in 2025) probably reflects regulatory requirements and sustainability reporting standards applying to all firms simultaneously, so differences in CED say more about compliance with reporting obligations than about differences in firms' ethical positions. Fourth, large swings in ETR at some firms (from 0.5% to 83.9%) introduce measurement noise.

The insignificant result may also reflect mechanisms pulling in opposite directions. Legitimacy theory expects more transparent firms to defend their legitimacy by complying with tax rules, which would push ETR up. Recent international studies, in contrast, find that firms undertaking carbon reduction pay less tax, especially in countries with a carbon tax, because carbon strategies can win legitimacy with tax authorities and bring tax advantages (Feng et al., 2024), and that environmental regulation may raise tax avoidance as a side effect (Compagnie et al., 2023). Where both forces operate among Indonesian energy firms, they may offset

each other overall. The finding also agrees with evidence that Indonesian mining and energy firms do not deploy environmental disclosure strategically to compensate for the legitimacy cost of tax avoidance (Rini et al., 2024), and with the null effect of carbon emission disclosure on ETR found for the same sector and period (Azisah & Surianto, 2026). In theoretical terms, the results back calls for refining legitimacy theory (Deegan, 2019): disclosure directed at environmental audiences and tax conduct directed at fiscal authorities may answer to separate legitimacy pressures and can thus be decoupled. Once the carbon tax under Law No. 7 of 2021 is implemented, this relationship may shift, as carbon information will then feed directly into tax liabilities.

Characteristics of the measures and the institutional setting offer additional explanations. First, CED and ETR are matched within the same year, whereas disclosure may affect tax decisions only after a delay, since tax planning and adjustments to tax positions take time. Second, annual ETR is noisy; a recent meta-regression finds that results on the ESG–tax relationship hinge on the choice of tax avoidance proxy and advises using long-run, multi-year measures (Mitroulia et al., 2025). Third, the CED index captures how broadly firms disclose, not how they perform on emissions, so firms with comparable scores can behave very differently in terms of carbon. Fourth, the Indonesian disclosure requirement in POJK No. 51/POJK.03/2017 includes no tax-related provisions, while international evidence suggests that ESG disclosure mandates curb tax avoidance mainly when such provisions are present (El Ghoul et al., 2026). Fifth, mining firms contribute to the state largely through royalties and other non-tax revenues that do not appear in income tax expense, so ETR reflects only part of the fiscal burden borne by energy firms.

Conditions outside the firm during the study period may also have influenced the findings. Prices of coal and other energy commodities surged in 2022 and fell thereafter, altering profitability and hence ETR across firms and years regardless of disclosure practices. The period further includes the post-pandemic recovery of 2021, the choice under Law No. 7 of 2021 to hold the corporate income tax rate at 22% rather than lower it further, the delay of the carbon tax beyond its scheduled 2022 start, and the gradual evolution of sustainability reporting standards. Because these external factors were not modeled, they may have introduced variation in ETR that has nothing to do with carbon transparency or audit quality.

This interpretation is supported by the robustness checks. Once year dummies remove common movements in ETR—mean ETR dropped from 0.305 in 2021 to roughly 0.25 in subsequent years as CED increased—the CED coefficient grows to 0.1146 and nears the 10% significance level ($p = 0.099$). Within firms, by contrast, the fixed effects estimate is negative and insignificant, showing that annual gains in a firm's own carbon disclosure are not followed by a higher ETR. Shared time shocks thus partly obscure a weak positive association between firms, but nothing suggests that a firm alters its tax behavior by becoming more transparent; future studies should therefore control for macroeconomic and policy conditions.

3.5.2. Moderating Role of Audit Quality

The relationship between CED and ETR is not moderated by audit quality. The CED × AQ interaction is positive but insignificant ($\beta = 0.0393$; $p = 0.742$), and this holds in every robustness check. In principle, Big Four auditors should raise the credibility of information and limit managerial opportunism. A financial statement audit, however, mainly evaluates whether the statements are presented fairly, and auditors do not automatically restrain aggressive tax planning that stays within the law. Big Four firms also routinely offer tax advisory services, which makes their stance toward tax avoidance ambiguous: they may serve as monitors, but also as facilitators of tax planning. In addition, carbon emission disclosure is typically published in sustainability reports, which are not audited to the standards applied to financial statements, so a high-quality financial statement auditor does not necessarily ensure high-quality carbon information.

Two limitations concerning measurement and identification deserve attention. First, AQ is a binary variable (Big Four vs. non-Big Four) and thus a rough proxy that ignores industry specialization, audit fees, and audit tenure. Second, audit quality hardly varies within firms (just 2 of the 36 firms changed auditor group), so in practice the moderating effect can be estimated only from between-firm differences. At the same time, Big Four–audited firms report much higher CED scores (0.664 vs. 0.419), making it difficult to disentangle the effect of AQ from related firm characteristics such as size and stakeholder pressure. In light of these limitations, the results should be taken as a lack of evidence of moderation in this sample and with these measures, not as proof that audit quality is irrelevant.

The lack of moderation also fits the mixed evidence on Big Four auditors and tax behavior. Big Four affiliation has been linked to less tax avoidance among listed firms in Indonesia and Malaysia (Rizqia & Lastiati, 2021) but to more tax avoidance among private Big Four clients in the United Kingdom (Chen et al., 2023), and reviews conclude that the influence of governance mechanisms, external audit included, on tax avoidance depends on institutional context and incentives (Kovermann & Velte, 2019). From an agency perspective, external audit is therefore not a uniform check on tax planning; its effect hinges on whether auditors primarily monitor or advise on tax and on the scope of their verification. Since the financial statement audit usually does not extend to carbon information in sustainability reports, independent assurance of those reports may be a more fitting moderator than auditor size.

3.5.3. Implications

The findings carry practical implications for several parties. The Directorate General of Taxes should not read the extent of carbon emission disclosure as a sign of low tax risk and should keep basing tax risk assessments of energy firms on tax-specific indicators. For the Financial Services Authority (OJK) and the bodies implementing the carbon tax, the weak connection between disclosure and tax behavior points to a need for carbon reporting that is more standardized, quantitative, and independently assured, so that it can eventually be tied to carbon tax obligations. Managers should handle carbon transparency and tax governance as separate yet coherent accountability commitments, as stakeholders may increasingly compare them. Investors and other stakeholders should assess carbon disclosure scores and auditor reputation together with tax-specific information instead of using them as replacements for it. For researchers, the results underscore the need for fuller model specifications and finer measures of audit quality in testing this relationship.

4. CONCLUSION

Using a random effects panel regression with firm-level cluster-robust standard errors, this study examines how carbon transparency affects tax avoidance, with audit quality as a moderator, in 36 Indonesian energy firms over 2021–2025 (180 firm-year observations). Carbon transparency does not significantly affect the effective tax rate (ETR) ($\beta = 0.0513$; $p = 0.421$), so H1 is not supported, and audit quality does not moderate the link between carbon transparency and ETR ($\beta = 0.0393$; $p = 0.742$), so H2 is not supported either. Robustness tests with ETR winsorized at 5%–95%, year dummies, and firm fixed effects confirm the absence of moderation; the CED coefficient nears significance at the 10% level only with year dummies ($p = 0.099$) and becomes negative under fixed effects, so no consistent relationship between carbon transparency and ETR emerges across specifications. Given the model's low explanatory power (overall R^2 of 2.88%) and wide confidence intervals, the results indicate a lack of evidence for a systematic relationship rather than proof that no relationship exists. Carbon disclosure by energy firms rose steadily over the period while ETR showed no systematic change, suggesting that carbon reporting and tax behavior are at present decoupled in this sector.

Several practical implications follow. Tax authorities should not treat carbon disclosure as a marker of low tax risk, and those preparing to implement the carbon tax should improve the standardization and assurance of carbon reporting so that carbon information is verifiable and can be tied to tax obligations. Managers and investors should regard carbon transparency and tax governance as separate dimensions of accountability. For the audit profession, there is no evidence that Big Four affiliation by itself strengthens this relationship; auditor independence, the scope of non-audit tax services, and the assurance of sustainability reports therefore remain important issues.

The study is subject to several limitations. First, control variables such as firm size, profitability, leverage, capital intensity, and tax loss carryforwards are not included in the models. Second, audit quality is proxied by a binary Big Four indicator that changes little over time. Third, tax avoidance is measured solely by ETR, which fluctuates annually and does not reflect royalties or other non-tax levies. Fourth, loss-making firms and firms lacking consistent sustainability reports are excluded, and the observation window is fairly short. Fifth, external influences such as commodity price cycles, post-pandemic recovery, tax policy changes, and the delay of the carbon tax were not modeled. Lastly, the residuals are non-normal, and heteroskedasticity and endogeneity, including potential reverse causality between carbon disclosure and tax behavior, cannot be excluded.

Subsequent studies could address these limitations by (1) adding control variables, particularly firm size, profitability, leverage, capital intensity, and tax loss carryforwards, along with year effects for common shocks; (2) employing a broader set of tax avoidance proxies, such as cash ETR, long-run (three- to five-year) cash ETR, book–tax differences, and permanent or discretionary book–tax differences, and comparing results across them; (3) measuring audit quality more fully through auditor industry specialization, audit fees, audit tenure, and independent assurance of sustainability reports; (4) distinguishing quantitative from qualitative carbon disclosure and using emission intensity data to separate substantive from symbolic transparency, as well as examining tax disclosure in sustainability reports, for instance under the GRI 207 tax standard; (5) treating the introduction of the carbon tax as a policy shock to see whether the relationship changes once carbon information is tied to tax liabilities, and testing lagged effects of disclosure; and (6) lengthening the observation period, including loss-making firms with suitable measures, widening the sample to other sectors and countries, and using methods that deal with endogeneity, such as instrumental variables or dynamic generalized method of moments (GMM).

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