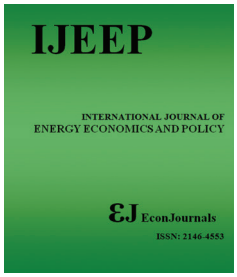

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GHG and Carbon Emission Intensity: Examining Their Impact on Financial Performance

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ABSTRACT

Governments worldwide have implemented various strategies to reduce carbon emissions, with policies targeting high-emission industries such as energy, transportation, and manufacturing. However, developing Southeast Asian countries, including Malaysia, face challenges in balancing economic growth with emission reduction efforts due to financial constraints. Despite these challenges, Malaysia has made notable progress through its National Policy on Climate Change, pledging to reduce carbon intensity by 45% by 2030. In response to growing stakeholder demands for sustainability, companies are increasingly adopting sustainable practices to improve their environmental performance, often measured by Carbon Emission Intensity (CEI). CEI is a crucial indicator that offers a relative measure of environmental impact, considering a company's economic output. The focus on Environmental, Social, and Governance (ESG) criteria has heightened the importance of CEI, particularly as companies with lower CEIs are viewed more favourably by investors. However, the relationship between carbon reduction efforts and financial performance remains inconclusive. This study examines the impact of carbon reduction efforts on the financial performance of Malaysian companies from 2019 to 2023. Using two widely recognized financial performance measures, Return on Assets (ROA) and Tobin's Q, the study investigates the influence of Greenhouse Gas (GHG) emissions and Carbon Disclosure Project (CDP) participation on these metrics. The study utilizes panel data analysis on 1087 listed companies and applies multiple regression analysis using the STATA software package. The findings reveal a positive correlation between GHG emissions and ROA and Tobin's Q, suggesting that companies not actively reducing emissions may still experience short-term financial gains. Conversely, CDP participation negatively impacts both financial indicators, likely due to the increased compliance costs associated with sustainability initiatives. The results underscore the need for a balanced approach that aligns environmental responsibilities with financial performance as Malaysia transitions to a low-carbon economy.

Keywords: Carbon Emission Intensity, Greenhouse Gas Emissions, Carbon Disclosure Project, Financial Performance, Tobin's Q, Economic Sustainability
JEL Classifications: G32, M14, Q54

1. INTRODUCTION

Recently, governments have implemented various strategies to reduce carbon emissions. For instance, the European Union has established a cap-and-trade system, while Japan has implemented carbon taxes (Carl and Fedor, 2016). These policies also target industries with high carbon emissions, such as energy generation, transportation, and manufacturing, reflecting a global trend toward developing more sustainable and low-carbon economies. However, developing countries from Southeast Asia faced significant difficulty in finding a balance between promoting economic growth and decreasing carbon emissions. These countries progressively implement environmentally friendly industrial policies and incorporate carbon reduction methods into their development plans (Binyuan et al., 2023). Nevertheless, the substantial expenses linked to carbon mitigation and insufficient financial resources persist as major obstacles (Clark et al., 2018).

Notwithstanding these obstacles, Malaysia has made significant progress in implementing regulations to decrease carbon emissions. As stated in its National Policy on Climate Change, Malaysia's pledge to decrease carbon intensity by 45% by 2030 displays its unwavering commitment to sustainability (Susskind et al., 2020). The government has implemented a range of incentives and regulatory frameworks to promote enterprises' adoption of carbon-efficient techniques.

Nowadays, many corporations are putting significant effort into becoming more sustainable. As stakeholders demand greater transparency and accountability, these corporations implement sustainable practices to reduce carbon emissions (Comello et al., 2023). These efforts aim to meet specific regulatory requirements and enhance corporate reputation. Carbon Emission Intensity (CEI) is an important indicator for assessing a company's environmental effect. It measures the carbon emissions emitted per unit of total sales revenue (Perera et al., 2023). CEI gives a more comprehensive view of a company's environmental performance by considering its economic output. Unlike absolute emission data, which can be misleading when comparing companies of various sizes, CEI provides a relative measure that allows for more accurate comparisons. As a result, CEI has become an important statistic for assessing the sustainability of businesses, particularly those in carbon-intensive industries like energy, manufacturing, and transportation.

Due to the increasing attention placed on Environmental, Social, and Governance (ESG) criteria, Carbon Emission Intensity (CEI) is becoming a more dependable measure of a company's overall sustainability (Bagh et al., 2024). Specifically, companies with lower CEIs are better equipped to navigate the shift towards a low-carbon economy. Indirectly, these companies are more attractive to investors who prioritize Environmental, Social, and Governance (ESG) factors (Martiny et al., 2024). Although the positive impact of reducing CEI on the environment is well-documented, its effect on financial performance is still under investigation and subject to ongoing dispute. Elevated levels of carbon emissions can pose significant challenges for organizations, such as increased scrutiny from regulatory bodies, potential financial penalties, and harm to their brand reputation (Liu et al., 2023). These characteristics can affect a company's financial performance by increasing operational expenses, reducing profit margins, and undermining investor trust.

The current body of literature presents contradictory findings about the correlation between carbon performance and financial results (Busch and Lewandowski, 2017). A study by Azeem et al. (2024) demonstrated that firms with more robust environmental practices experience improved financial performance because of reduced costs, enhanced brand awareness, and increased attractiveness to investors. On the other hand, Mishra et al. (2024) contended that the costs associated with adopting environmental policies could exceed the financial benefits, particularly in the immediate period. Considering the contrasting perspectives, it is evident that there is a clear requirement for empirical research that specifically examines the impact of CEI on financial achievement.

Thus, this study addresses the lack of research in the field by examining two widely used financial performance measures: ROA, which assesses a company's profitability in relation to its total assets, and Tobin's Q, which reveals a company's market value compared to its replacement cost. Therefore, the first aim of this study will be to examine the influence of GHG on ROA and Tobin's Q. The other objective will be to inspect the effect of CDP on ROA and Tobin's Q. By investigating these relationships. The study hopes to gain vital insights into whether and how initiatives to reduce carbon emissions affect a company's financial health.

2. LITERATURE REVIEW

With global concern over climate change growing, the relationship between a company's carbon emission intensity and financial performance has become a subject of increasing interest for researchers and investors. This study aims to explore the empirical evidence of this relationship and provide insights into how companies can optimize their environmental and financial performance.

Existing literature on the impact of carbon emission reductions represents a mix of findings. Some studies have found a positive correlation between carbon emission reductions and improved financial performance, suggesting that companies benefit financially from adopting environmentally friendly practices (Tuesta et al., 2020; Álvarez et al., 2015; Busch and Lewandowski, 2017). For instance, a study using international data from 89 companies between 2006 and 2009 found that reduced emissions positively impacted financial performance (Ganda and Milondzo, 2018). Similarly, research on the South African market revealed a negative relationship between carbon emissions and corporate financial performance, indicating that companies integrating green investment initiatives to lower emissions can effectively manage their financial performance (Ganda, 2022; Ganda and Milondzo, 2018).

On the other hand, a study on the impact of carbon performance on financial metrics in the South African context found a negative relationship between carbon performance and return on investment and market value added. The researchers suggested that the company's growth rate may influence the relationship between carbon performance and financial performance, with the positive effects being more pronounced for faster-growing firms (Emous et al., 2021).

Corroborating these mixed findings, a comprehensive meta-analysis covering 68 estimates from 32 empirical studies with 101,775 observations found an inverse relationship between carbon emissions and financial performance, indicating that good carbon performance is generally associated with superior financial performance. The meta-analysis also found that relative emissions measures (e.g., emissions intensity) are more likely to produce statistically significant results than absolute emissions (Busch et al., 2020). These findings suggest that companies should carefully consider their carbon emission intensity and integrate green initiatives to improve their financial performance, particularly in a growing economy. Companies that manage their

carbon emissions effectively can reap financial benefits, while those that fail to address their carbon footprint may face financial consequences (Álvarez et al., 2015; Ganda and Milondzo, 2018; Ganda, 2018).

Ultimately, the impact of carbon emission intensity on financial performance appears complex, with various factors such as company growth, measurement approaches, and market conditions influencing the relationship. This complexity underscores the need for further research to understand this relationship's mechanisms fully. The call for more research is necessary and an opportunity to delve deeper into this intriguing topic and provide more definitive guidance for companies seeking to optimize their environmental and financial performance.

2.1. Effect of Environmental Disclosure on Q Ratio

Tobin's q is one of the most valuable approaches to evaluate the firm value and the efficiency of investments, which is a financial ratio that facilitates an evaluation of the company's market value per its possible cost of obtaining the same type of assets (Dimand, 2019; Setiyawati et al., 2017). Initiated by James Tobin, this theory postulates that investment corresponds to the proportion of the share of equity market value to the cost of capital or replacement cost; Monetary policy and expectations make an impact on investment through asset values (Dimand, 2019). Scholars apply Tobin Q widely to analyse an organisation's and firm's performance or value. The study conducted in this research has identified that the factors related to corporate governance have an impact on Tobin's Q erroneously; of course, the board size, number of committees, and concentration of ownership have a positive effect on Tobin's Q but the board independence and CEO duality have a negative effect on Tobin's Q (Singh et al., 2018). Nonetheless, it may be a challenge to establish the correlation between the dependent variable, firm performance and the independent variable, Tobin's Q. In the underperforming manufacturing firms of Pakistan uncovered that under investment either has no impact or increases Tobin Q, going against the premise of increased efficiency and Tobin Q (Ishaq et al., 2021). In addition, internal factors such as business bankruptcy risks, the Altman Z-score that can be used to measure the business's probability of bankruptcy will also lead to an increased Tobin's Q (Khoo, 2019). Therefore, these results give insights of the various aspects of Tobin's Q performance measure and they also elaborate the need to put into consideration some aspects in the evaluation of such values.

2.2. Effect of Environmental Disclosure on ROA

Reseracher's define ROA as one of the things that holds the ability to compare the income statement of a certain company to the structural assets. As mentioned by Cai et al., Maulana (2020) and others that is (Cai et al., 2019). Scholars calculate it with the net income total assets formula and express it in percentages (Maulana, 2020). Management employs ROA to compare the efficiency of its operations in utilizing assets to generate revenues whereby ideal ROA is higher than actual ROA (Maulana, 2020; Oktavia and Titiek, 2022). There are different elements of ROA including liquidity, activity, leverage and firm size (Oktavia and Titiek, 2022). In accordance with prior studies providing details as to the relationship between the predictor variables and ROA, the results elicited are that liquidity, activity and size are positively significant with ROA and leverage has a negative significant relationship with it (Oktavia and Titiek, 2022). ROA is compared to Return on Equity (ROE) which provides additional insight for investment analysis and business execution (Qosim and Latoki, 2024).

Based on previous research, there are no any articles focused on the related between Return on Assets (ROA), Tobin's Q, and stock trading volume. Saputra (2018) also affirmed that Tobin's Q is related with the trading volume while the result showed that ROA does not affect the trading flow on the stock. Similarly, Reny et al. (2019) was able to observe significant positive association between ROA and Tobin's Q and the stock trading volume in the banking companies. In another empirical work, Dasmaran and Yulaeli (2020) found ROA and EPS have a significant and positive association with Tobin's Q for manufacturing firms jointly explaining 59 per cent of the variation in Tobin's Q Among others, Ismawati et al. (2019) examined the impact of institutional ownership on firm value measured by Tobin's Q with Return on Investment (ROA) as a moderator variable. They discovered that institutional ownership positively correlates with Tobin's Q while the firms' return on assets (ROA) profoundly impacts firm value. Specifically, ROA was found not to moderate the relationship between institutional ownership and firm value. These studies show much interaction between financial performance and market valuation measures.

A study that aimed to show a link between carbon emissions and financial performance, namely Return on Assets (ROA), was found to be inconsistent. Some previous studies have found both insignificant and negative correlations between carbon emission reduction and ROA (Octaceria and Rahardja, 2020; Larasati et al., 2020); however, Rahmawati (2020) and Syahdanti and Marietza (2024) have found a positive and significant relationship. Capital intensity refers to emission reduction investment ratios (Octaceria and Rahardja, 2020), and industry characteristics could explain the gap. Other factors influencing carbon emission disclosure are corporate size and media coverage (Syahdanti and Marietza, 2024). The relationship between leverage and carbon emission disclosure remains inconclusive, with some studies finding no significant influence (Syahdanti and Marietza, 2024). Thus, these findings suggest that further research into the dynamics of carbon emissions and financial performance is needed not only because of the inconsistencies discovered by the previous study but also because of the presence of underlying mechanisms and industry-specific variables.

Researchers have conducted several studies to understand the relationship between carbon emissions and the value of operations, as defined by Tobin's Q, with results varying based on context. Carbon emission disclosure is positively related to firm value in Indonesia, implying that firms disclosing carbon emissions will have a competitive advantage (Kurnia et al., 2021). However, a cross-country investigation reveals that carbon content has a weak negative relationship with financial outcomes (Mazzarano, 2024). In India, Desai and Raval (2022) observed a strong and negative relationship between CO2 emissions and firm value, indicating

that shareholders dislike increased carbon dioxide emissions. A Korean study reveals that firms that make organized efforts to decrease carbon output tend to have smaller market capitalization, likely because they are associated with high-emission industries. However, organizations that cut carbon emissions also had higher financial value than those that followed government directives (Lee & Jeon, 2019). These results shed light on the nature of carbon emission, disclosure, and firm value interactions while stressing the role of regional and regulation factors when analyzing the financial earned effect of carbon-ranked actions.

Prior research work has analyzed the effects of CARs both in the context of policy and disclosure relating to carbon emissions. Even though Purwanti et al. (2022) found that disclosing carbon emissions through the websites of state-owned enterprises in Indonesia negatively impacts the extent of disclosure, it remains an important practice. Liu et al. (2023) have proven that establishing carbon emission policies in China positively affects the financial performance of target companies, resulting in decreased expenses and increased asset utilization efficiency. Reshetnikova et al. (2023) found that carbon firms in Russia demonstrate higher expected returns, showing a statistically significant carbon premium, although carbon risk does not affect this carbon premium. A cross-country analysis, building on the Fama-French five-factor framework, demonstrated the presence of the carbon risk premium in the North American, European, and Asia Pacific markets and found that small-size firms are more sensitive to the carbon dioxide emissions (Akbar et al., 2021). Thus, the results provide an understanding of the CH and ERC and their connection between carbon emissions, financial performance, and stock returns in diverse markets.

3. RESEARCH METHODOLOGY

The study employed quantitative research to obtain numerical data for statistical analysis and formulate precise conclusions via secondary data collection. Researchers used the collected numerical data to conduct various analysis methodologies and model estimations using statistical techniques. Past studies emphasized content analysis to determine the environmental disclosure variable per the Global Reporting Initiative (GRI). However, this study relies solely on data obtained from the Bloomberg platform. By investigating deeper carbon emission factors, this study aims to provide informative insights into the performance of Malaysia's publicly listed companies over 5 years.

Total sales, rather than total assets, represent firm size to prevent multicollinearity problems. Firm size is employed to control the effect of scale economies. Additionally, the natural logarithm of total sales reduces the significant differences between firms with negligible sales and those with substantial sales figures, ensuring a normal distribution of firm size. Researchers conducted the panel data study based on census sampling techniques (Sutherland, 2006) for Malaysian listed companies, continuously collecting all available data from 2019 to 2023. The total number of Malaysian companies listed as per the Bloomberg platform as of August 2024 is 1087 companies at the point of data collection. Then, the researcher will conduct the analysis using the STATA Software Package. They will perform diagnostic tests, descriptive analysis, correlation analysis, and multiple regression analysis (MRA).

4. FINDINGS

At the point of data collection and analysis, the sample size of 40 companies has a complete dataset for five years, which derives 200 observations of the panel dataset. First, the researchers assessed the dataset's suitability through a diagnostic test. The results indicate that the data is normally distributed, exhibits a linear relationship, and has no multicollinearity issues. However, the Breusch-Pagan/Cook-Weisberg test indicates the heteroskedasticity issues. Thus, on top of MRA, the generalized method of moment (GMM) estimator employed as ordinary least squares assumption homoskedasticity fails to estimate the multiple moments. The robust variance-covariance estimator presents findings by excluding data contaminated with influential observations. As the primary order, the correlation coefficient results in Tables 2 and 3 demonstrate results based on robust least square regression, fixed effect analysis, and 2-step-GMM analysis.

Pearson's correlation analysis conducted for this study indicates a significant relationship between GHG and ROA and CDP and ROA. However, the correlation analysis does not reflect a significant relationship between the variables and Q ratios.

Table 3 uncovers that environmental disclosure factors have a significant effect on ROA and Q Ratio based on GMM results, where the robust OLS doesn't indicate any significant impact on the firm's performance and only CDP have a positive significant effect on firm performance under fixed-effect analysis. However, none of the models indicate a significant impact of SIZE on firm performance.

5. DISCUSSION AND CONCLUSION

The first aim of this study is to examine the influence of greenhouse gas emission (GHG) on return on assets (ROA) and Tobin's Q. The

Table 1: List of variable measurements

Variables		Measurement
GHG	Greenhouse gas intensity	Total greenhouse gases in carbon dioxide equivalent (C02e) emitted per million of EBITDA
CDP	Carbon disclosure project	Discloses the firm's environmental impacts on the global system. Score 1=disclose, Score 0=non-disclosure
ROA	Return on Assets	Net income/average total asset
Q Ratio	Tobin's Q ratio	Market Value/Total asset
Size	Firm's size	Natural log of total sales

Source: Bloomberg (2024)

Table 2: Pearson correlation analysis

Variables	GHG	CDP	Size	ROA	Q Ratio
GHG	1.000				
CDP	−0.0773	1.000			
Size	0.0045	−0.0289	1.000		
ROA	0.0193*	0.1374*	0.1201	1.000	
Q Ratio	−0.0640	0.0354	0.1606	0.0590	1.000

ROA: Return on Asset, Q Ratio: Tobin's Q Ratio, GHG: Greenhouse gas emission, CDP: Carbon disclosure projects, Size: Firm size

Table 3: Effect of CHG and CDP on ROA and Q ratio

Dependent variables	ROA			Q Ratio		
	OLS	Fixed effect	GMM	OLS	Fixed effect	GMM
GHG	0.910 (−0.011)	0.066 (0.004)	0.003 (0.435)	0.392 (−0.012)	0.078 (0.051)	0.000 (0.592)
CDP	0.048 (0.050)	0.005 (0.084)	0.000 (0.082)	0.650 (0.580)	0.062 (−0.069)	0.015 (−0.002)
SIZE	0.079 (0.004)	0.671 (0.009)	0.163 (0.052)	0.402 (0.019)	0.632 (0.701)	0.380 (−0.008)

N: 200, ROA: Return on Asset, Q Ratio: Tobin's Q Ratio, GHG: Greenhouse gas emission, CDP: Carbon disclosure projects, Size: Firm size

results revealed that greenhouse gases (GHG) have a significant positive influence on both ROA and Tobin's Q ratio. The positive significant relationship between GHG and ROA suggests that a firm's carbon emission increases the profit a company can generate from its assets. Thus, the findings of this study indicate that firms in Malaysia that are not actively reducing greenhouse gas emissions may achieve higher financial performance. These results align with the findings of Rahmawati (2020) and Syahdanti and Marietza (2024), which revealed a positive and significant relationship between carbon emissions and financial performance, particularly in terms of Return on Assets (ROA). A possible explanation for this finding is that Malaysian companies are not actively mitigating their greenhouse gas emissions. These companies prioritize cost-reduction strategies and efficiency enhancements that boost their short-term financial performance. Besides that, investment in sustainable technology, infrastructure, and processes often requires vast funds, potentially increasing operational costs. Companies that circumvent these costs may attain a transient financial benefit, especially regarding profitability metrics such as Return on Assets (ROA). Moreover, in markets with lax regulatory frameworks for emissions or insufficient enforcement, corporations may evade immediate financial repercussions for their environmental impact, enabling them to reallocate resources to enhance profitability.

Besides that, this study revealed a positive and significant relationship between GHG and Tobin's Q ratio. Thus, the findings of this study proposed that for a firm in Malaysia, an increase in greenhouse gas emission may increase the market values of this firm greater than its asset cost, denoting higher growth and profit potential that will foster additional investment. This positive relationship between GHG and Tobin's Q ratio aligns with the findings of Le and Nguyen-Phung (2024), who analyzed the relationship between GHG and corporate financial performance at the firm level in Africa. The potential explanation is that Malaysian companies that emit higher levels of greenhouse gases do not face solid regulations or market pressures to reduce their emissions. As a result, these companies have more opportunities to focus on production and growth.

Consequently, as reflected in Tobin's Q ratio, their market value may increase since investors perceive them as having more significant profit potential. These results are especially true for industries prioritizing growth and output over environmental sustainability. Furthermore, companies that do not invest in emission reduction or sustainable practices can allocate the additional capital toward expanding their business, which boosts their market value relative to the replacement cost of their assets. Investors may interpret this as a sign of higher future returns, leading to a higher valuation for the firm.

Meanwhile, the second research objective of this study was to investigate the impact of Carbon Disclosure Projects (CDP) on ROA and Tobin's Q. This study showed a negative and significant relationship between these two variables. This result means that Malaysian companies that reduce the carbon disclosure project may be experiencing an increase in the company's profitability. This result is consistent with Desai and Raval (2022) and Purwanti et al. (2022), who disclosed that CO2 emissions have a negative and significant relationship with the firm value. Besides that, this study revealed that Malaysian companies that increase the carbon disclosure projects may be experiencing a reduced market value. This result is consistent with Mazzarano (2024) study, which disclosed that carbon content had a negative relationship with the financial outcome. A potential reason behind these findings is that Malaysian companies participating in Carbon Disclosure Projects (CDP) may face increased costs associated with environmental compliance, reporting, and implementing sustainable practices. These additional costs can negatively impact short-term profitability.

Regarding the negative relationship between CDP and Tobin's Q, investors might perceive companies with higher carbon disclosures as facing more significant operational risks. This perception could result in a lower market valuation relative to the cost of the firm's assets. Additionally, some investors may prioritize short-term financial performance over long-term sustainability, which could explain the drop in market value as companies increase their carbon disclosures.

Therefore, GHG and CDP play a crucial role in determining ROA and Tobin's Q ratio among firms operating in Malaysia. Focusing on GHG and CDP when measuring a firm's financial performance is essential, as Malaysia is moving towards a green economy. Such monitoring will improve the firm's performance and ensure alignment with environmental, social, and governance criteria. Meeting these criteria will lead to more sustainable business practices and help avoid unwanted greenwashing issues.

In conclusion, this study sheds light on the complex relationship between environmental factors and the financial performance of Malaysian companies. The findings indicate that GHG emissions positively impact both Return on Assets (ROA) and Tobin's Q. These results suggest that companies not actively reducing emissions may still experience short-term financial gains. In contrast, CDP negatively affects both ROA and Tobin's Q. These results indicate that CDP may increase compliance costs and sustainability efforts. Thus, there is a need for a balanced approach, where firms must consider both their environmental responsibilities and financial performance as Malaysia transitions towards a green economy.

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