

THE EFFECT OF CORPORATE GOVERNANCE BEST PRACTICES ON THE QUALITY OF CARBON DISCLOSURES AMONG MALAYSIAN PUBLIC LISTED COMPANIES

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Abstract: This study aims to assess any changes in the Carbon Disclosure Quality (CDQ) of firms publicly listed on Bursa Malaysia and to examine the effect of adopting the level of the Corporate Governance Best Practices (CGBP) on CDQ from the perspectives of agency and stakeholder theories. The Friedman and Wilcoxon signed-rank tests were conducted to assess if there were any changes in CDQ over the study period. The CGBP is measured by a composite index of a group of variables for board, audit, and Environmental Committees (EC). In addition, CDQ is measured by a comprehensive carbon disclosure checklist in line with well-grounded literature and Malaysian and international guidelines related to climate change disclosures to identify and categorise carbon disclosure. Using a sample of 72 listed carbon-intensive firms in Bursa Malaysia from 2015 to 2019 and multiple regression analysis, the results show that Malaysian firms implementing good practices outlined in the Malaysian Code on Corporate Governance (MCCG) are more likely to provide high-quality carbon information than poorly governed firms. While the overall CDQ of Malaysian firms remains very low, the CDQ has improved in Malaysia. The results imply that carbon disclosure awareness is growing in Malaysia as firms have gradually integrated climate change into their business strategies. The findings may benefit a vast group of regulatory bodies to assess Malaysian firms' response to local and international carbon guidelines.

Keywords: Carbon Disclosure Quality (CDQ), corporate governance, board of directors, audit committee, environmental committee.

Abbreviation	Expansion
CG	Corporate Governance
MCCG	Malaysian Code on Corporate Governance
CGBP	Corporate Governance Best Practices
CDQ	Carbon Disclosure Quality
CDP	Carbon Disclosure Project

Introduction

The increased firms and manufactured production have led the world to face climate change challenges. Companies face many challenges in proving they are responsible and cautious about environmental pollution. The significant Paris Agreement outcome was to minimise Greenhouse Gas Emissions (GHG) so that the temperature will not overshoot more than 2 degrees Celsius compared to before the large-scale manufacturing practices (Fujimori *et al.*, 2016). The disclosure of carbon information and

issues related to global warming are considered an effective way for firms to show the extent of their commitment to this goal. Climate change and its implications, such as global warming and environmental degradation, have become a significant business and political issue that concerns countries worldwide. Consequently, great calls have been made to business, political, and environmental leaders to respond to these implications (Choi *et al.*, 2013).

The world has witnessed increasing attention from regulators, consumers, markets, and analysts about the fear of the effects of climate change risks on company operations and financial outcomes (Peters & Romi, 2014). These risks have put issues related to sustainability high on firms' vital agenda, and firms face tremendous pressure from various stakeholders to provide more useful information about climate change and the carbon emissions generated from their activities (Herold & Lee, 2017). Carbon emitted from fossil fuels such as coal and natural gas represents one of the main contributors to climate change, threatening firms' sustainability (Chariri *et al.*, 2018). As a result, firms must show they are cautious, committed, and responsible for carbon emissions and their environmental implications for climate change disclosures. It is vital for corporations to demonstrate their commitment to these concerns (Ufere *et al.*, 2015).

Several previous studies have investigated carbon reporting practices voluntarily (Liao *et al.*, 2015; Elsayih *et al.*, 2018; Chariri *et al.*, 2018; Charumathi *et al.*, 2019; Kouloukoui *et al.*, 2020; Lahyani, 2022; Goud, 2022) except a few studies (Haque & Deegan, 2010; Comyns & Figge, 2015). Most of these researches have revealed a slight improvement in the Carbon Disclosure Quality (CDQ) and quality in firms' sustainability reports and/or annual reports, including Choi *et al.* (2013), Tauringana and Chithambo (2015), Borghei *et al.* (2016) and Kouloukoui *et al.* (2019). As a result, a specific factor may be responsible for the observed improvement in the proportion of carbon disclosures (quality and quantity) reported by prior studies. To give one concrete example, the release of a precise set of laws, standards, and international agreements for addressing the climate crisis has influenced the reporting practices of businesses (Mateo-Márquez *et al.*, 2019).

According to Stanny (2013), many businesses began disclosing their accounting methodology and emissions after introducing mandatory US GHG reporting requirements.

Particularly, between 2006 and 2008, the percentage of enterprises responding to the Carbon Disclosure Project (CDP) questionnaire increased from 47 to 70%. Meanwhile, the percentages declaring emissions increased from 19 to 41% to 12 to 30%. Tauringana and Chithambo (2015) discovered that after the Department for Environment, Food and Rural Affairs (DEFRA) implemented GHG reporting guidelines, there was a significant improvement in GHG disclosures in the UK from 2008 to 2011. Other than that, Borghei *et al.* (2016) stated that the average level of GHG disclosure in 2011 was higher compared to 2009, indicating a significant increase in the level of GHG disclosure after the introduction of the National Greenhouse and Energy Reporting (NGER) Act 2007 and before the introduction of the Australia emissions trading scheme. According to Ooi and Amran (2018), because the maximum value is one and the average level of climate change reporting in Malaysia is 0.1972, the level of climate change information disseminated by Malaysian businesses remains relatively low, implying that a significant number of businesses only disclosed very basic climate change-related information in their corporate reports. Consequently, it is quite intriguing and motivating to evaluate whether there have been any changes in the quality of the carbon disclosures provided by Malaysian listed companies throughout the five-year study period. This is particularly in light of the introduction of several domestic-related carbon emissions initiatives and guidelines, such as the national corporate GHG reporting program or MYCarbon in the year 2013 and the sustainability framework in the year 2015 (Ministry of Natural Resources and Environment, 2013; Bursa Malaysia, 2015).

Despite the significance of carbon disclosures on firms' sustainability, there is growing evidence showing that the current carbon disclosures are still insufficient to meet the needs of investors and the comparability, quality, content, and level of such disclosures remain relatively low (de Faria *et al.*, 2018; Zhang & Liu, 2020). In addition, carbon

disclosure awareness is relatively low (Allam & Diyanty, 2020). Accordingly, such evidence emphasises the critical demand to gain more insight and a deeper understanding of the reasons behind the low carbon disclosures, in addition to assessing the determinant factors of the failure of firms to provide high-quality carbon disclosure. The Malaysian Code of Corporate Governance (MCCG) emphasises the board of directors' responsibility to formalise corporate strategies for promoting sustainability and ensuring the disclosure of related information within annual reports and websites (Securities Commission Malaysia, 2012). However, since then, the carbon information provided by Malaysian firms has remained relatively low (Alrazi, 2014). Indeed, Malaysian firms are not well prepared to face climate change risks (Alrazi & Husin, 2016). Firms operating in Malaysia have mainly focused on disclosing more information regarding economic aspects rather than other sustainability aspects, such as environmental ones (Nurim *et al.*, 2020).

Thus, the current study links the CGBP, defined as an effective board, audit, and Environmental Committee (EC), to the extent to which Malaysian publicly listed firms provide higher quality information related to their carbon emissions. Using 360 observations for 72 publicly listed firms in Bursa Malaysia, the findings document positive and significant associations between the level of CGBP of CGBP and the CDQ provided by Malaysian firms. The current study contributes to the literature regarding Corporate Governance (CG) mechanisms in many ways. Firstly, carbon disclosures are still an emerging area, and the number of studies investigating issues related to carbon disclosures is quite limited. Besides, most of these studies were mainly conducted in developed countries (Choi *et al.*, 2013; Luo & Tang, 2014; Ben & McIlkenny, 2015; Tang & Demerit, 2018; Borghei, 2021; Velte *et al.*, 2020; Gulluscio *et al.*, 2020). Accordingly, there is a lack of empirical evidence regarding the relation between CG mechanisms and carbon disclosures from developing countries.

Furthermore, due to differences in settings, policies, and environmental factors between developed and developing states, findings obtained from developed countries cannot be generalised to developing countries (Belal *et al.*, 2010; Sudibyo, 2018).

Malaysia is classified as a unique, developing country with a high proportion of GHG emissions. Besides that, the Malaysian government has committed to carbon emissions reduction, notably a 40% mitigation by the year 2020 and a 45% reduction (compared to 2005 levels) by 2030 (Susskind *et al.*, 2020). Being one of the fast-developing Asian states, Malaysia may gradually face the tension between ethical consciousness and economic incentives regarding environmental accounting. There is a growth in the demand to understand the regional environmental position and its economic reliance in explaining Malaysian motivational factors for reporting environmental impacts (Sulaiman *et al.*, 2014). Thus, conducting this study in a developing state in Malaysia provides a significant opportunity to assess if there are any changes in CDQ over the study period and assess the effect of adopting Corporate Governance Best Practices (CGBP) on CDQ.

Secondly, researchers have always had uncertainty about the impact of multiple factors on carbon disclosures. Several prior studies have succeeded in identifying certain factors that have a strong influence on carbon disclosures, such as ownership structure, carbon emission intensity, firms' features, stakeholder pressure, and CG (Guenther *et al.*, 2016; Kılıç & Kuzey, 2018; Luo, 2019; Yu *et al.*, 2020). However, the various factors affecting the board, audit, and EC remain contentious among researchers. The knowledge about their effect on climate change-related disclosure is weak (Galbreath, 2010), and the findings obtained reveal no consensus on their influence (Helfaya & Moussa, 2017; Hamdan & Al Mubarak, 2017). In other words, the effect of the board, audit, and EC on CDQ remains largely unexplored (Tingbani *et al.*, 2020). In response, the current study attempts to assess if there are any changes in CDQ over the

study period, in addition to assessing the effect of CGBP on CDQ in Malaysia, specifically among the companies operating in the carbon-intensive industry.

Due to the voluntary nature of carbon disclosures, there was no uniformity or standardisation regarding subject matter, type, and quantity of information reported in the corporate annual reports to shareholders. Furthermore, the scepticism and criticism of CDQ are primarily due to the discretion of management to selectively report mostly encouraging information to maintain a good position and image (Noor Raida *et al.*, 2019). Most conducted carbon disclosure studies relied on a CDP questionnaire to classify, collect, and measure information related to a firm's carbon emissions (Depoers *et al.*, 2016; Faisal *et al.*, 2018). The questionnaires are a voluntary initiative wherein firms are requested to answer a group of questions. They usually employ previous researchers' most commonly used sources to collect information about carbon emissions (Depoers *et al.*, 2016; Herold & Lee, 2017; Tang & Demeritt, 2018). However, due to the voluntary nature of CDP, certain companies participate while others do not (Kim & Lyon, 2011). Unlike other studies and for more completeness, reliability, and generalizability, this study addresses such concerns by constructing a carbon reporting index as a proxy for CDQ considering the Malaysian context requirements, in addition to considering multiple international frameworks, guidelines, and well-grounded previous studies relevant to carbon disclosures. Hence, this index is expected to provide additional evidence about the completeness, reliability, and generalizability of using different measurement sources to classify, collect, and measure carbon information, contributing to the literature gap related to carbon disclosure measurement.

The remainder of the paper is organised as follows: In Section 2, the literature review is discussed. In Section 3, the study hypothesis is discussed and developed. The research design, comprising data and sample selection

in addition to variables measurement and model specification is presented in Section 4. Section 5 introduces the empirical findings and sensitivity analysis, and Section 6 summarises and concludes the study.

Institutional Background

Despite the significant enhancement concerning CGBP in Malaysia since the introduction of the first CG code in 2000, CG practices regarding disclosure quality and corporate social responsibility reporting remain questionable (Ahmad *et al.*, 2017). The former prime minister of Malaysia, Datuk Seri Abdullah Ahmad Badawi, stressed the importance of addressing these issues to minimise the gap between companies and their stakeholders. As a result, MCCG was revised in 2007, 2012, 2017, and 2021 to strengthen CG practices in line with the domestic and global capital market (Said *et al.*, 2009; Salleh *et al.*, 2012; Securities Commission Malaysia, 2021). Despite such significant efforts, the MCCG 2012 failed to improve CG's environmental practices significantly. The implementation of MCCG was mainly voluntary; the Securities Commission only demands listed public companies to either comply or explain any deviation from MCCG regarding company activities in their annual reports (Liew & Devi, 2020). The code revision on 26 April 2017 introduced substantial recommendations and changes encouraging non-listed entities such as Small and medium-sized enterprises (SMEs), licensed intermediaries, and state-owned enterprises to adopt MCCG to improve transparency, accountability, and sustainability (Zin *et al.*, 2020).

In other words, MCCG 2017 replaced MCCG 2012 to ensure and enhance CG culture, sustainability, transparency, and accountability for all Malaysian companies, continue strengthening external and internal control mechanisms, and promote good CG culture and company compliance (Chong, 2018). As a result, the responsibilities of the board and its sub-committees have been increased to ensure

CGBP and long-term sustainability practices. The board should incorporate and understand the new dimensions of reporting (environmental, social, and economic responsibilities) into their decisions to assist their companies in achieving sustainable growth and successfully operating (Hamad *et al.*, 2020). The board is expected to assess and seek information beyond the company's financial performance, including environmental performance information (Buniamin *et al.*, 2008). In summary, the MCCG has been revised over time to ensure the implementation of CGBP. However, due to the absence of direct instruction from the board of directors about what related information should be disclosed and the option for firms to comply or explain (Liew & Devi, 2020), there has been variation regarding the quality of carbon information disclosed within annual reports of Malaysian public listed firms. Thus, the current study attempts to assess the effect of CGBP on CDQ among Malaysian companies operating in the carbon-intensive industry.

Literature Review

Carbon Disclosures

Carbon disclosures are relatively new (Borghei, 2021). However, the demand for carbon information has increased. This demand results from emissions reporting schemes and mandatory emissions trading schemes. Therefore, there has been an increase in voluntary disclosures associated with reporting schemes starting with non-profit organisations (Green & Zhou, 2013). Carbon information has received significant attention from regulators and investors worldwide. Stakeholders such as institutional investors, analysts, governments, and customers have been calling for more information on climate change, global warming implications, and more regulation of disclosures related to carbon emissions (Ben-Amar & McIlkenny, 2015). Disclosing carbon information represents a firm's contribution to preventing environmental damage, especially global warming. This contribution is driven by the fact that the firm's existence is not separate

from the community environment (Choi *et al.*, 2013). Consequently, disclosing information related to carbon emissions has become commonplace (Andrew & Cortese, 2011).

Why does a firm disclose and report information related to its emissions in light of the absence of regulatory requirements? The current study addresses this question to assess and better understand factors or the determinants that encourage firms to provide more or less carbon information in their annual reports. Various academic researchers have begun linking the motivations and factors for such disclosure to its quality and extent. For instance, Kouloukoui *et al.* (2019) indicated that the number of firms beginning to disclose carbon information has grown over the years. This is due to the desire to meet various stakeholders' needs and legitimisation purposes. Andrew and Cortese (2011) pointed out that providing information about firms' carbon emissions could be a useful voluntary tool for external and internal decision-making. A study by Chithambo *et al.* (2020) showed that carbon emissions generated from firms' activities would expose these firms to intense public scrutiny. Hence, firms tend to provide more carbon information. Jaggi *et al.* (2018) stated that firms in highly polluting industries tend to provide this information. Tan *et al.* (2020) reported that firms participating in carbon emission trading systems provide greater carbon information disclosures.

On the other hand, according to Li *et al.* (2019), carbon disclosure means risk and opportunity. If the organisation's information is recognised and used by competitors, the corporation will face harmful effects. Consequently, organisations tend to reduce the amount of information disclosed. Giannarakis *et al.* (2017) reported that firms with higher carbon emissions deflect the dissemination of carbon information. Accordingly, it can be debated that firms' response to carbon information demand mainly depends on the return from providing such information or firms' expectations from such disclosures. Therefore, since carbon disclosure is voluntary and disparate in most

world states, the current study debates that the CDQ in Malaysia could depend on certain internal and external factors such as CGBP.

Corporate Governance Best Practices

Directors' accountability has been seen as one of the crucial issues on the company agenda, as the board is considered an agent for stakeholders (Al-Qahtani & Elgharbawy, 2020). The board is a firm's fundamental controlling body and acts as an entity accountable for maintaining stakeholders' interests in firms by performing its duties (Prado & Garcia, 2010). The board is critical in monitoring and ensuring shareholders' interests by preventing managers from acting for their benefit and maintaining transparency (Arena *et al.*, 2013). An effective board ensures that managers act in the stockholders' interests, which is now critical for businesses (Ogbechie, 2012). It is the heart of CG structures in healthy firms and vital to efficient capital markets. The board experience and oversight role assist management in operating efficiently, capitalising on opportunities, and providing reliable, timely financial information to stakeholders (Alfraih, 2016). Effective boards, audits, and EC appear key for determining how corporations respond to climate change issues. Corporations characterised by higher CG are more likely to integrate carbon emissions into their business strategy and potentially maintain long-term involvement to adopt climate change opportunities and risks across their whole operating system (Elsayih, 2018).

Accordingly, numerous prior studies have investigated the expected effect of CG mechanisms (board and sub-committees) on firms' decisions regarding carbon disclosures. For example, Navarro and Urquiza (2015) confirmed that an effective board is aware of the need to increase information quality to improve the transparency of markets. Torchia and Calabro (2016) stated that growing evidence supports the argument that an effective board promotes better and higher transparency disclosure policies to stakeholders. Kouloukoui *et al.* (2018) revealed that the overall disclosure

related to climate risks is still relatively low. However, the board of directors' efficiency is linked to the climate risk disclosure level. Ben-Ama and McIlkenny (2015) showed that firms with an effective board are more willing to answer the CDP questionnaire. MCCG codified the CGBP in Malaysia and described optimal CG structures (Germain *et al.*, 2014). MCCG aims to set out practices and principles on processes and structures that firms may use in their operations to achieve an optimal governance framework. These processes and structures include the remuneration of directors, procedures for recruiting new directors, the composition of the board, and sub-committees and their activities and mandates (Securities Commission Malaysia, 2000). Thus, consistent with the premise that better compliance leads to stronger performance, the current study attempts to assess the adoption of CGBP in terms of an effective board, Audit Committee (AC), and the formulation of an EC on CDQ in Malaysia.

The board performs its duties through the full board or delegates its authority to other committees responsible to the board of directors (Klein, 2002). As a result, creating these sub-committees has been recommended as a suitable virtual mechanism for enhancing good CG (Spira & Bender, 2004). One central board committee is the AC, which is responsible for corporate financial reporting and disclosures (Song & Windram, 2004). Being the only CG mechanism with a particular competency requirement, the AC's environmental concerns, attention to carbon emissions, and rules relating to sustainable development will be fundamental (Marwa *et al.*, 2020). Overall, better supervision quality and impact management decisions can provide higher-quality reporting, including sustainability reports (Dizar *et al.*, 2019). Consequently, AC is a fundamental and necessary mechanism for the board to accomplish, monitor, and ensure transparency and financial and managerial efficiency (Kabara *et al.*, 2018).

The board's effectiveness relies not only on its composition but also on the effectiveness

of its sub-committees (Tingbani *et al.*, 2020). For that reason, several prior studies assessed the effect of such committees on the disclosure related to environmental activities (Samaha *et al.*, 2015; Chariri *et al.*, 2018; Elsayih *et al.*, 2018). For instance, Buallay and Al-Ajmi (2019) stated that the AC is vital in determining sustainability information. Samaha *et al.* (2015) reported a positive relationship between the proportion of independent AC members and the firm's voluntary disclosure. This suggests that independent committee members, free from management influence, can monitor managers' actions effectively. As a result, the credibility of CSR disclosure is protected. On the other hand, several previous studies (Haniffa & Hudaib, 2006; Giannarakis, 2014; Elsayih *et al.*, 2018) showed a negative or non-significant relationship between the board and AC regarding carbon disclosures.

Analogous to the significance of AC, corporations are now establishing specific committees, such as the EC, to manage and address the issues related to environmental activities. The management often hesitates to disclose information related to ecological activities. Hence, board oversight is particularly significant in monitoring the firm's environmental operations, legitimacy, and reputation (Peters & Romi, 2014). Currently, firms use the EC to deliver a message to the community and other stakeholders about the firm's concern for protecting the natural environment. In addition, formulating an EC is less costly than investing in projects that assist in reducing or eliminating toxic emissions (Berrone & Gomez-Mejia, 2009). Generally, these types of ECs are most frequently found in industries that are considered environmentally sensitive (Burke *et al.*, 2019). The committee is responsible for planning, implementing, and reviewing sustainability activities and policies. The committee members can weigh the pros and cons of the initiatives relating to carbon reduction and fossil fuel combustion, mitigating and attracting investors to invest in viable abatement projects and carbon-neutral products (Liao *et al.*, 2015).

The presence of an EC or any committee (Velayutham *et al.*, 2014; Biswas *et al.*, 2018) responsible for environmental matters at the level of the board refers to firms having a robust strategic posture relating to the stakeholders and the willingness of firms to balance conflicting interests between various stakeholders (Elsayih, 2018). The EC is like other board committees. The committee's role in monitoring environmental information is analogous to the AC's in monitoring and ensuring the proper financial accounting disclosures. Therefore, EC is similar to the AC in that, to carry out its responsibilities effectively, the committee must oversee the company activities by being involved in operational issues (DeZoort *et al.*, 2002). Generally, the board designs these committees to make their duties and responsibilities more efficient. Establishing particular committees enables the board to address specific matters better and allows those with expertise in a field to offer the most value to the board of directors (Smith, 2006). As a result, EC advocates believe this committee can play a significant role in risk management and integrating sustainability initiatives, reporting and goal setting, developing performance and protocols, and maintaining the firm's sustainable growth by implementing policies and practices of sustainability (Peters & Romi, 2015). Although establishing board AC has always been a tradition in the board's governance structure, formalising an EC is reasonably new (Tingbani *et al.*, 2020). According to Gennari and Salvioni (2019) and Velte *et al.* (2020), the topic of EC is rare in CG studies. Consequently, researchers are encouraged to pay more attention to this matter by providing more empirical evidence about the impact of EC on disclosures.

The number of studies investigating the role and the effect of ECs on firms' environmental disclosure appears to be scarce and limited (Peters & Romi, 2014; 2015). Walls *et al.* (2012) indicated that EC aims to support companies' environmental strengths by offering resources and expertise to board members. It can also assist companies in reducing litigation by drawing the board's attention to environmental

issues. Liao *et al.* (2015) found that firms that establish an EC tend to be more environmentally transparent. In addition, the EC may play an important role in balancing corporate financial and non-financial aims and reducing the conflict of interest among the firm's stakeholders. Yunus *et al.* (2016) confirmed that the formulation of an EC encourages firms to implement practices and strategies to report and measure carbon emissions. Based on such an argument, EC seems vital to legitimising the firm image in the community's eyes and among other stakeholders. The current study argues that analogous to the AC role, EC strengthens CGBP within firms and potentially significantly impacts improving CDQ provided by Malaysian firms. Hence, assessing the relationship between the formulation of EC and the CDQ is imperative.

Hypothesis Development

Usually, the board of directors is responsible for business control and the significant activities of the firm (Biondi & Rebérioux, 2012). The board of directors can hire, fire, compensate higher-level directors, and resolve conflicts of interest among residual risk bearers and decision-makers (Baysinger & Butler, 1985). Therefore, an effective board of directors is considered the heart of CG structures in healthy firms. The board experience and oversight role assist management in operating efficiently, capitalising on opportunities, providing reliable, timely information to stakeholders, and acting as an entity accountable for maintaining their interests (Prado & Garcia, 2010; Alfraih, 2016). Furthermore, to carry out its responsibilities effectively, the board of directors usually tends to delegate its authority to other committees responsible to the board of directors, such as AC (Klein, 2002).

Carbon disclosure means risk and opportunity (Li *et al.*, 2019). Climate change raises regulatory, physical, litigation, and reputational risks that may harm financial performance and threaten the competitive advantage of firms (Ben-Amar & McIlkenny, 2015). Consequently, the current study

assumes that adopting a higher level of CGBP will encourage firms to adopt a proactive and voluntary strategy to reduce carbon emissions risks in light of the Malaysian CG and disclosure-related guidelines and frameworks currently in place. In addition, CGBP is expected to motivate firms to respond to various stakeholders' concerns related to carbon reporting. Companies with strong CG potentially would be more environmentally and socially responsible than those with poor CG (Chan *et al.*, 2014).

Agency theory assumes that managers will not act to increase stakeholders' returns unless good CG structures are implemented in firms to protect stakeholders' interests (Donaldson & Davis, 1991). Consistent with this assumption, stakeholder theory claims organisational accountability is not bounded only by financial and economic performance. Firms disclose their social and environmental activities to dialogue with stakeholders (Murdifin *et al.*, 2019). Motivated by such assumptions, recent studies, such as Wang (2016), confirmed that good CG positively affects the valuation of environmental information total disclosure. Applying the agency theory, Kılıç and Kuzey (2018) stated that firms with an effective board of directors have a greater tendency to disclose carbon information in their reports. Kouloukoui *et al.* (2020) reported that one of the most effective strategies that can inhibit or pressure companies to become involved in climate management is the effectiveness of a board of directors.

Agency theory also refers to numerous mechanisms that reduce the conflict of interest between managers and shareholders. Firms can identify mechanisms to align managers' and shareholders' interests and monitor manager behaviour (Bukit & Iskandar, 2009). These mechanisms include the AC, which plays a significant role in the credibility and quality of financial reporting. It is part of the CG mechanism to enhance a firm's operations and economic profit (Nelson & Devi, 2013). The MCCG 2012 provides strict guidelines about AC composition. The code recommends that Malaysian firms establish AC with at least three

directors, most of whom should be independent. However, the latest code revisions of MCCG conducted in 2017 and 2021 represent a massive change in AC composition and responsibilities. As a result, AC is now free to inquire further about the firm's financial and non-financial reporting processes, risk management, governance, and internal controls. AC was given increased authority, and its responsibilities were expanded to include oversight of non-financial information (Securities Commission Malaysia, 2012, 2017, 2021). The role of the EC in disclosing environmental information is analogous to the AC's role in monitoring and ensuring the proper financial accounting disclosures (DeZoort *et al.*, 2002). Consequently, the EC can be considered a proxy of the board of directors' orientation toward environmental accountability, which comprises good and appropriate communication with various stakeholders (Liao *et al.*, 2015). The EC will be proactive and not reactive in addressing environmental activities and actions to assist firms in gaining environmental legitimacy by improving the environmental disclosure to benefit stakeholders (Ofoegbu *et al.*, 2018).

In contrast, several studies indicate that CG or board of directors' effectiveness does not seem to have any significant effect on firms' policy and practice concerning climate change risks and carbon disclosures (Giannarakis, 2014; Elsayih, 2018; Cucari *et al.*, 2018; Charumathi & Rahman, 2019). Thus, the current study inferred that CGBP (in terms of responding to stakeholders' demands for useful information and maintaining their interests) must be more accountable and involved in proactive measures to reduce risks related to climate change and improve higher-quality carbon disclosure in Malaysian firms' reports, as suggested in the following hypothesis:

Research Hypothesis 1: The level of Corporate Governance Best Practices (CGBP) is positively related to the quality of carbon disclosures.

Methodology

Sample Selection and Data Collection

The date range will be limited to 2015 to 2019 because it is the period in which Bursa Malaysia launched the sustainability framework (Bursa Malaysia, 2018). Accordingly, 2015 is a starting point for the current study because it was the year the sustainability framework was outlined, emphasising that Malaysian listed firms must practice good CG and provide more information about their environmental activities. The purposive sampling technique chooses a sample from publicly listed firms engaged in carbon-intensive industries. The reason for selecting this technique is that the sample chosen will fit the criteria pertinent to accessing carbon disclosures. Thus, the selection process is as follows. Firstly, carbon-intensive industries are identified as the main population of this study. The justification for such selection is that carbon-intensive industry firms face high climate-risk-related costs and liabilities. As a result, corporations operating in such intensive industries are subject to regulating these emissions (Stanny & Ely, 2008). These sectors are chemicals, oil and gas producers, construction, energy, infrastructure, equipment, service, and other energy resources. Those sectors were categorised as carbon-intensive industries by Zhao (2011), Choi *et al.* (2013), Cadez and Czerny (2016), Bakhtyar (2017), Rahman *et al.* (2019), Moussa *et al.* (2020), and Kouloukoui *et al.* (2021).

Secondly, firms with missing data are eliminated to identify the final sample. Carbon disclosure data will be collected manually from firms' annual reports published on Bursa Malaysia and their website. The annual report is considered a perfect place for conveying firms' disclosure, including non-financial information (Gunawan & Lina, 2015). In addition, the credibility of information disclosed within these reports is highly appreciated. As a result, various stakeholders use the annual report as the sole source of specific information, including carbon

information (Unerman, 2000). The current study will not consider sustainability reports because the proportion of Malaysian firms producing sustainability reports is low, and sustainability reporting in Malaysia remains relatively weak (Kasbun *et al.*, 2017). The primary sample comprised 505 firm-year observations, out of which 145 observations were rejected because of missing annual reports. Therefore, the final sample comprised 360 firm-year observations, as presented in Table 1.

Data Analysis Procedures

The data analysis process in the current study involves an examination of the data’s statistical description. Then, the correlations between all variables implemented in the model are reviewed in the correlation matrix. After a general overview of the data’s reliability, multiple regression analysis is applied to the model to discover the sign and strength of the relationships, followed by a series of robustness tests to ensure the reliability of the results.

Dependent Variable

Unlike the previous studies (Choi *et al.*, 2013; Depoers *et al.*, 2016; Herold & Lee, 2017; Faisal *et al.*, 2018; Luo, 2019) that used the CDP questionnaire extensively to collect, quantify, and measure carbon disclosures, the current study constructed a carbon reporting index to indicate CDQ in line with Jaggi *et al.* (2018) and Tan *et al.* (2020). Index items are a relatively small subset of the population of all the items

that could be disclosed. Commonly, the number of disclosure items is huge, if not infinite. Therefore, the effectiveness of the scoring index as a disclosure measure tool critically relies on the selection of items (Marston & Shrives, 1991). Thus, content analysis of annual reports was carried out. This was followed by selectively including items as stipulated in several Malaysian and international frameworks and guidelines (i.e., Bursa Malaysia sustainability guideline 2015, Malaysian Greenhouse Gas Reporting Program MYCarbon (2014), A Corporate Accounting And Reporting Standard GHG Protocol (2004), Sustainability Reporting Standards GRI 305 (2016), UK Environmental Reporting Guidelines: Including Streamlined Energy and Carbon Reporting Guidance ERG (2013), updated (2019), Environment and Climate Change Canada: Technical Guidance on Reporting Greenhouse Gas Emissions TGRGGE (2016) and Sustainability Accounting Standards Board Framework CDSB (2019).

As a result of this organised process, 64 disclosure items were divided into twelve categories and included in the new carbon reporting index. Validity and reliability are the two most fundamental and important features when evaluating measurement instruments for good research (Mohajan, 2017). Consequently, for the disclosure index to be a useful method for measuring and evaluating disclosure quality, it is necessary to ensure the validity and reliability of the measurement instrument (Haddad *et al.*, 2009). The measurement instrument is valid

Table 1: Sample composition

Sector	Firms	Eliminated Firms	Final Sample
Chemicals	17	4	13
Oil and gas producers	5	2	3
Construction	52	13	39
Energy, infrastructure, equipment, and service	25	10	15
Other energy resources	2	0	2
Total	101	29	72

Notes: The sample used in this table consists of 505 firm-year observations, out of which 145 observations were rejected because of the missing firms’ annual reports. Therefore, the final sample comprised 360 firm-year observations covering the period of 2015 to 2019.

when it effectively measures what it is supposed or delighted to measure; meanwhile, reliability refers to measurement consistency (Hanafi *et al.*, 2009). Therefore, to ensure the validity and reliability of our index, the preliminary list of carbon disclosure items was sent to one expert in pollution and carbon emissions. Additionally, the preliminary list was sent to two academicians with extensive experience in environmental and carbon accounting, sustainability disclosure, and climate change-related issues. Accordingly, a total of 64 preliminary carbon disclosure items were sent for validation purposes. Based on the expert and the two academicians' recommendations, only five carbon disclosure items were excluded from the preliminary carbon reporting index list, resulting in 59 carbon disclosure items. This aligns with Al-Janadi *et al.* (2012) and Liu and Zhang (2022), who sent the preliminary list of disclosure items to an expert seeking their opinions to validate the scores devolved to assess the level of voluntary disclosures.

Further, to ensure that judgment of relevance is not biased and the research instrument is consistent, reliable, and valid. The corporate annual reports are read before any decision is taken, followed by pilot testing to ensure that all disclosure items across firms are treated equally and considered (Haniffa & Cooke, 2002). Thus, the carbon reporting index (59 disclosure items) was tested using the pilot test. A total of 3 items not reported by any of the selected firms over the five years were removed from the index. As a result, the final carbon reporting index comprised 56 disclosure items distributed under eleven categories. To score the index items, the current study argues that an unweighted approach is suitable because no greater importance is given to specific user groups or items (Tauringana & Chithambo, 2015). Additionally, the unweighted method avoids the subjectivity issue of using the weighted approach and reduces any bias if an erroneous weighting is used (Hossain, 2002). Finally, scoring was calculated based on the presence of each item. Firms were awarded one if an item was reported and 0 if the item was not reported. The CDQ was determined by the

number of items disclosed by the firms. This aligns with Tauringana & Chithambo (2015) and Hossain *et al.* (2018).

Independent Variables

The effectiveness of CG is critical for individual firms, but it is also vital for sustainable development and the economy. Hence, CG effectiveness should be continuously promoted and improved. However, what is not measured cannot be improved. Thus, a new model to measure CG effectiveness is required (Argüden, 2010), given the many facets and facts covered by the CG system. It is pretty hard to have a deep understanding of the overall state of firms' corporate governance, and this may be due to the huge amount of information that needs to be processed for this understanding. Accordingly, the overall CG index can adequately summarise different governance aspects with a few numbers that may be highly useful (Sarkar *et al.*, 2012). Thus, the current study developed a composite index to calculate the composite measure of CGBP. The literature supports separate and composite measures of CGBP (Arora & Bodhanwala, 2018; Khan & Zahid, 2020). Thus, based on the suggestions from the literature, this study constructs a composite index, namely, the CGBP index. Each of the corporate variables in this index is a dichotomous variable, where a numeric value is assigned to reflect the status of each variable. The attributes representing CGBP are board independence, board gender diversity, frequent board meetings, board size, AC independence, AC meeting, audit financial-committee financial expertise, AC size, and presence of the EC. Previous studies (Epps & Ismail, 2009; Gulati *et al.*, 2020) utilised similar methods.

Control Variables

CDQ is the dependent variable of the present study. Numerous control variables determined in previous studies influence the quality of carbon disclosure or are related to carbon disclosures. The control variables included in this study are firm size, profitability, age, liquidity, leverage,

Table 2: Definition of variables

Variables	Acronym	Measurement
Dependent Variable		
Carbon Disclosure Quality	CDQ	Disclosure score = The minimum is 0, the maximum is 56, and finally expressed as a percentage.
Independent Variable		
Corporate Governance Best Practice	CGBP	The sum of four board and AC attributes with scores ranging between 0.50 and 1. In addition to the presence of EC, there is a dummy variable with a value of 1 if a company has a board-level EC and 0 otherwise. The higher scores indicate the best CG practices.
Control Variable		
Firm Size	SIZE	The logarithm of total assets
Firm Profitability	PRO	Net income divided by total assets
Firm Age	AGE	The number of years the firm has operated to the end of 2019
Liquidity	LIQ	Current assets divided by current liabilities
Leverage	LEV	Total debt divided by total assets
Audit Quality	BIG4	Dummy 1 if the firm is audited by the big four audit firms, which are Deloitte, Ernst and Young (EY), PricewaterhouseCoopers (PwC), and Klynveld Peat Marwick Goerdeler (KPMG), and 0 otherwise.

and audit quality. This is in line with previous studies by Velayutham (2014), Giannarakis et al. (2017), and Yin et al. (2019). Thus, the model of this study is as follows:

$$CDQ_{i,t} = \beta_0 + \beta_1 CGOV_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 PRO_{i,t} + \beta_4 AGE_{i,t} + \beta_5 LIQ_{i,t} + \beta_5 LEV_{i,t} + \beta_6 BIG4_{i,t} + \epsilon_{i,t}$$

Results

The descriptive statistics of all variables used in this study are illustrated in Table 3. The findings show that the CDQ provided by publicly listed Malaysian firms ranged from 0.00% to 89.20%. Still, overall, the mean CDQ for the five years is 17.70%, indicating that the CDQ remains very low in Malaysia. This result is comparable with Ooi and Amran (2018), who reported an average climate change disclosure of 19.7%, confirming that the disclosures related to climate change are still relatively low in Malaysia. At the same time, the descriptive outcomes demonstrate that the CG score index ranges from 4.25 to a maximum of 8.3, with an average score of 6.18. These ratings indicate that for the investigated

sample, on average, firms have a satisfactory level of CGBP in Malaysia, in line with Bhatt and Rathish (2017), who indicated that CGBP had witnessed a marked improvement following the implementation of MCCG 2012 in Malaysia.

With regards to the control variables, firms' size (measured by the logarithm of total assets) ranged from 4.48 to 9.51 over the five years, with an average of 7.46 per tested firm. In general, the investigated firms are slightly profitable (with an average profitability of 0.009%). Meanwhile, the average firm age is 29.70, with a remarkable range from 3 to 83 years. Liquidity ranges from 0.055% to 1.41%, indicating firms' ability to meet their financial obligations, as shown through the leverage mean of 0.50%. As to audit quality, the descriptive statistics illustrate that the mean value is 0.48%, which indicates that 0.48% of the sample observations received external audit assurance from one of the BIG 4 audit firms.

Table 4 describes the correlation matrix among the independent, dependent, and control variables used in formulating the model. The

Table 3: Descriptive statistics-aggregate (2015-2019)

Variables	Mean	SD	Min	Max
CDQ	0.1767	0.1873	0	0.8928
CGBP	6.1830	0.8608	4.25	8.3
SIZE	7.4631	1.3298	4.4890	9.5186
PRO	0.0090	0.1029	-0.6966	0.1597
AGE	29.7083	13.3366	3	83
LIQ	2.3544	3.9547	0.0634	63.4875
LEV	0.5004	0.2049	0.0552	1.4111
BIG4	0.4805	0.5003	0	1

Notes: CDQ – Carbon Disclosure Quality; CGBP - *Corporate* Governance Best Practices; SIZE – Firm Size; PRO – Firm Profitability; AGE – Firm Age; LIQ - Liquidity; LEV – Leverage; BIG4 - Audit Quality.

Table 4: Correlation Matrix for the variables used in the model

	CDQ	CGBP	SIZE	PRO	AGE	LIQ	LEV	BIG4
CDQ	1.0000							
CGBP	0.5159*	1.0000						
SIZE	-0.2190	-0.0414	1.0000					
PRO	0.0480	-0.0437	0.0671	1.0000				
AGE	0.1442*	0.0263	-0.1943*	0.2098*	1.0000			
LIQ	-0.0584	-0.0213	0.1063	0.0752*	-0.0392*	1.0000		
LEV	0.0131	0.0527	-0.0597	-0.2332*	-0.0631	-0.2586*	1.0000	
BIG4	0.1704*	0.1344*	-0.2617*	-0.0921	-0.0820*	0.0030*	-0.0120	1.0000

Notes: CDQ - Carbon Disclosure Quality; CGBP - *Corporate* Governance Best Practices; SIZE - Firm Size; PRO - Firm Profitability; AGE - Firm Age; LIQ - Liquidity; LEV - Leverage; BIG4 - Audit Quality.

CDQ provided by Malaysian firms is positive and significantly correlated with CGBP. This result suggests that the CDQ is more likely to be higher among Malaysian-listed companies that adopt best practices as outlined in the MCCG. There are also positive associations between firms' profitability, age, audit quality, leverage, and CDQ. On the other hand, a negative correlation was reported between firms' size, liquidity, and CDQ. In general, the established correlation is consistent with the formulated hypothesis.

Table 5 shows the distribution and the frequency of carbon disclosure items disclosed by Malaysian firms from 2015 to 2019. Notably, the number of carbon items disclosed has

increased over time slightly. This can be linked to improving the level of CGBP in Malaysia, as mentioned earlier. To statistically assess the recorded carbon disclosure improvement, a Friedman Test and Wilcoxon signed ranks test were performed. In particular, the Friedman test is used to assess the statistical significance of improvement in carbon information from 2015 to 2019 (Cowan & Deegan, 2011; Omar, 2015); while the Wilcoxon signed ranks, the test is applied to test whether there are any significant changes for each adjoining two-year group (e.g., the carbon disclosure ratings for 2015 and 2016 as well as 2016 and 2017, etc.). Accordingly, Table 6 presents the Friedman test result, indicating that CDQ

statistically and significantly differed during the targeted period (Kendall = 0.9295 and $P < 0.05$). Meanwhile, in Table 7, the Wilcoxon signed ranks test result shows that variances in Pair 1 (Score 2015 - Score 2016), Pair 2 (Score 2016 - Score 2017), Pair 3 (Score 2017 - Score 2018), and Pair 4 (Score 2018 - Score 2019) are all statistically significant ($Z = -4.812, -5.862, -6.333$ and -5.987). The negative Z score implies a significant increase in CDQ over the years.

Table 5: Distribution of carbon disclosure items

No.	Carbon Disclosure Items	2015	2016	2017	2018	2019
1	The board monitors responsibility for issues related to climate change and GHG affairs	16	21	33	47	59
2	The board established a specific committee to review carbon performance periodically	13	15	38	53	57
3	The board is responsible for strategies to reduce carbon emissions	28	37	47	50	54
4	Operational control over the firm operation	2	5	6	8	9
5	A summary of the organisational boundaries chosen, comprising the chosen consolidation method	3	6	24	41	49
6	Climate change-related frameworks, standards, and guidelines used to prepare carbon reporting	3	6	29	41	52
7	The base year GHG emissions disclosure	0	2	1	3	3
8	The method used to collect GHG information	3	2	4	6	7
9	Carbon reporting is provided annually	3	5	9	11	12
10	A brief description of the emission sources	1	2	4	8	9
11	Total of carbon emissions scopes 1 and 2 in CO ₂ metric tons	4	5	6	9	12
12	Total GHG emissions were reduced in CO ₂ metric tons	3	3	3	5	5
13	Emissions data are presented independently for each scope in metric tons	2	4	4	8	8
14	Comparative GHG information from previous periods	3	4	4	7	9
15	The presented GHG emissions information has been verified independently	2	0	1	1	5
16	Climate change-related frameworks, standards, guidelines, and methodologies used to report energy consumption	1	3	5	8	9
17	The method used to calculate energy from renewable resources	1	1	3	4	6
18	Energy consumption information by type, facility, or segment (electricity use, coal, diesel, petrol, gas, etc)	2	4	9	16	24
19	Total energy consumed (e.g., tera-joules or peta-joules or MWh)	2	6	11	20	26
20	Comparative energy uses information from previous periods	2	6	7	12	23
21	Target to reduce GHG emissions	22	23	34	50	49

22	Target to reduce energy consumption	18	23	35	46	52
23	The target base year, length of the commitment period, and completion date are specified	0	1	0	1	2
24	Specific policy to purchase or develop renewable energy	1	2	4	7	9
25	Strategy to involve suppliers and other third parties to facilitate their management of environmental impacts	1	1	3	2	8
26	Carbon emissions and a firm's reputation or brand value are linked	2	2	2	11	13
27	Education and training in climate change awareness and related skills for management and employees	13	16	21	32	40
28	The creation of environmental protection, emission mitigation, and energy conservation institutions and an information system for the management platform	0	0	0	0	1
29	Action is taken to improve energy use efficiency	9	13	21	31	39
30	Action taken to reduce GHG emissions or to transition toward the use of renewable energy	10	13	22	30	38
31	Actions are taken or to be taken to manage the carbon-related risks	4	4	9	14	20
32	Regulatory risks	11	16	31	43	45
33	Physical risks	0	0	2	0	2
34	Reputational risks	3	2	3	9	15
35	Other risks	1	3	5	7	12
36	Evaluation of GHG emissions in the company's overall assessment of business risks	3	7	16	22	28
37	Information about the absolute emissions targets and progress made against those targets	0	1	1	1	1
38	Information about any significant changes to performance or unexpected results against targets	1	2	5	7	10
39	Information about any significant changes in environmental results over time	3	1	4	5	4
40	Information about whether the company met the GHG reduction requirements of government standards	1	2	6	7	7
41	Collaborations or work with government and other organisations in climate change-related projects	9	8	7	14	17
42	Product information (emissions reduction information) to customers through product labelling	0	0	2	6	10
43	Promote climate-friendly behaviour by raising awareness through environmental sustainability education/campaigns	7	11	10	15	15
44	Stakeholders' involvement in the carbon disclosure process	1	2	7	17	30
45	Stakeholders' involvement in setting corporate carbon policies	2	4	17	25	39

46	Suppliers' engagement related to carbon emissions	2	3	18	23	33
47	Community involvement and/or donations related to carbon emissions	3	6	12	24	39
48	Engagement in climate-related strategy with other partners in the value chain	2	3	11	19	30
49	Initiatives to reduce the carbon emissions to air	9	17	18	25	31
50	Initiatives to make the use of energy more efficient	9	13	21	34	39
51	Implementing a quality management system	19	27	26	36	36
52	Corporate intention to assist in reducing global emissions of the GHG that cause climate change through its ongoing operations and/or the use of its products and services	7	5	10	21	31
53	The company's low-carbon economy development-related technology and capital investment and research results, such as fixed assets	5	3	13	15	22
54	Investments made to prevent future accidents/spills	0	1	4	6	8
55	Project investment, energy saving and emission reduction subsidies, and incentive funds	2	1	1	8	7
56	Information about government subsidies and rewards for carbon reduction	6	10	11	18	17

Notes: Table 5 shows a slight improvement in carbon disclosure quality provided over the times (study period) in Malaysia, which can be observed from increasing disclosure items, especially during the last two years of the study period (2018-2019).

Table 6: Finding of the Wilcoxon signed ranks test

Wilcoxon Signed Ranks Test			
Pair		Z	P.Sig
Pair 1	Score 2015 - Score 2016	-4.812	< 0.05
Pair 2	Score 2016 - Score 2017	-5.862	< 0.05
Pair 3	Score 2017 - Score 2018	-6.333	< 0.05
Pair 4	Score 2018- Score 2019	-5.987	< 0.05

Notes: Table 6 indicates a significant difference in the quality of carbon disclosure for Malaysian firms for the five periods, 2015 to 2019, since the significance value is less than 5% and the negative Z value.

Table 7: Finding of Friedman Test for carbon disclosure quality

Friedman Test of Carbon Disclosure Quality (All Years)	
Friedman	204.4901
Kendall	0.9295
P	< 0.05

Notes: The Friedman test result indicates that there was a significant increase in carbon disclosure quality provided during the test periods ($P < 0.05$)

Regression Analysis

Due to the current study's data, several causality problems may appear between the dependent and independent variables. Accordingly, relying on ordinary least squares may not be appropriate for this study. Hence, to decide whether this study proceeds with a fixed or a random effect regression model, the Breusch and Pagan Lagrangian multiplier test for random effects and the Hausman test were carried out. These modelling techniques were used previously by Chijoke *et al.* (2020) and Wang *et al.* (2022). Consequently, the results of the Hausman and Breusch, as well as Pagan Lagrangian tests, support the use of a fixed effect regression, as shown in Table 8. Additionally, several diagnostic tests were conducted based on multiple regression assumptions to ensure that the collected data is fit and will not mislead the findings. Thus, linearity, normality, outliers, heteroscedasticity, multicollinearity, and autocorrelation were checked (Jaggi *et al.*, 2018; Pittrakkos & Maroun, 2019). Firstly, the outcomes of the correlation matrix represented in Table 4 indicated the absence of multicollinearity issues since the correlation among all variables is below the Variance Inflation Factor (VIF) value of 0.1 (Moroney *et al.*, 2012). Accordingly, the multicollinearity problem does not represent any concern for this study.

As for the linearity, various methods can be used to assess whether the model meets the assumption of a linear relationship, such as a scatter plot of the predicted against residual values, which refers to the visual inspection of the data and residuals (Casson & Farmer, 2014). The result of the scatter plot confirms the linear relationship between CDQ and CGBP in the model. Next, a histogram test was conducted to ensure that the residual values were normally distributed, revealing that not all data was normally distributed. Regarding heteroscedasticity and autocorrelation problems, the modified Wald test and the Wooldridge test were carried out. Findings indicated heteroscedasticity and autocorrelation problems, as reported in Table 9. Hence, as Rogers (1993) suggested, the robust standard errors clustered at the firm level are used to correct the estimated model represented in Table 10.

Table 10 provides the fixed effect regression results for the effect of the level of CGBP on CDQ. The model is considered appropriate and statistically significant at $P < 0.05$ with an F-value of 28.04. Accordingly, this value suggested that the CDQ was statistically valid, and the R square within the model was 0.0316. The low R square implies that almost 3% of the CDQ variance could be explained by the independent variables. However, the low

Table 8: Hausman and Breusch-Pagan test results

	Hausman Test	Breusch-Pagan Test
chi2 (7)	198.94	***
chibar2 (01)	***	211.79
Prob > chi2	< 0.05	< 0.05

Table 9: Modified Wald test and Wooldridge tests for heteroscedasticity and autocorrelation

	Modified Wald	Wooldridge Test
chi2 (72)	3126.43	***
F(1, 71)	***	71.278
P	< 0.05	< 0.05

Table 10: Fixed effect regression results for CGBP on CDQ with robust standard errors

Variables	Coef.	Std. Err.	t-stat	P > T	[95% Conf.	Interval]
CGBP	.0417	.0102	4.08	0.000	.0213	.0621
SIZE	-.0145	.0200	-0.72	0.472	-.0545	.02549
PRO	.0273	.0625	0.44	0.663	-.0974	.1521
AGE	.0550	.0052	10.48	0.000	.0445	.0654
LIQ	.0018	.0023	0.79	0.432	-.0028	.0065
LEV	-.0733	.0585	-1.25	0.215	-.1900	.0434
BIG4	.0390	.0230	1.69	0.095	-.0070	.0850
_cons	-1.5935	.2044	-7.79	0.000	-2.0012	-1.1859
N	360					
Prob > F	< 0.05					
R-S	0.0316					

Notes: CDQ - Carbon Disclosure Quality; CGBP - Corporate Governance Best Practices; SIZE - Firm Size; PRO - Firm Profitability; AGE - Firm Age; LIQ - Liquidity; LEV - Leverage; BIG4 - Audit Quality; N - Number of Observations; R-S - R-Squared.

R square value is generally common in social sciences, specifically studies investigating CG mechanisms (Rahmat *et al.*, 2009; Alodat *et al.*, 2021). Thus, the R square value in the current study is within the satisfactory range of CG studies. The results in Table 10 indicate a positive and significant relationship between the level of CGBP and CDQ ($t = 4.08, p < 0.05$). This finding suggests that formulating an effective board, AC, and EC can motivate firms to integrate carbon disclosures into their business strategies, providing higher-quality information about their carbon emissions. This finding is consistent with the findings of Ben-Amar and McIlkenny (2015) and Jaggi *et al.* (2018), who concluded that the board of directors' effectiveness positively affects a firm's decision to respond to the CDP questionnaire.

The model included six control variables to examine the CDQ: Firm size, profitability, firm age, liquidity, leverage, and audit quality. Hence, in the model, control variables were subjected to multivariate tests to explore whether they influenced the CDQ provided. The firm size was negatively and not significantly related to the CDQ ($t = -0.72, P > 0.05$), suggesting that large

firms expose them to more carbon risks. Hence, they tend to minimise such risk by limiting the carbon disclosure. However, these findings are inconsistent with the empirical evidence reported by Freedman *et al.* (2012), Matsumura *et al.* (2014), and Karim *et al.* (2021). They found that firm size is positively associated with the probability that corporations provide more information related to their carbon emissions. Concerning profitability, the result indicated a positive but not significant relationship with the CDQ ($t = 0.44, P > 0.05$). The result is consistent with the findings of Ben-Amar and McIlkenny (2017) and Kılıç and Kuzey (2018), who confirmed that profitable firms are more likely to voluntarily disclose information about their carbon activities. The firm age was found to be positive and significantly linked to CDQ ($t = 10.48, P < 0.05$), suggesting that old firms are highly motivated to practice good CG and value the experience of belonging to the surrounding environment. This finding is consistent with Leung and Philomena (2013), who reported a positive and significant relationship between AGE and voluntary disclosure of GHG in Australia.

With regard to liquidity, the regression result shows a positive but not statically significant association between liquidity, leverage, and the CDQ ($t = 0.79, P > 0.05$). Meanwhile, the regression result shows a negative but not statically significant association between leverage and the CDQ ($t = -1.25, P > 0.05$). This result suggests that highly leveraged firms that minimise contracting costs may be encouraged to reduce carbon information. The reported finding is in line with the result of Salleh *et al.* (2022), who found that leverage is negatively linked to carbon disclosures. As regards audit quality, the findings document a positive relationship between audit quality and CDQ ($t = 1.69, P > 0.05$). This result is consistent with the results of Perera *et al.* (2019), Tingbani *et al.* (2020), and Khalid *et al.* (2022). Their findings revealed that firms with a sound liquidity position are more likely to disclose information, including carbon disclosure. In addition, companies audited by one of the Big4 audit firms are more likely to provide the highest level of carbon disclosure.

Sensitivity Analysis

According to Bokov and Vernikov (2008), the measurement of CGBP represents one of the main challenges facing research related to CG. There is no generally accepted methodology to measure CG mechanisms. Therefore, several previous studies measured CG effectiveness by measuring the board of directors and sub-committees individually (effects of individual characteristics) on the quality of disclosure related to sustainability (Liao *et al.*, 2015; Ofoegbu *et al.*, 2018; Tingbani *et al.*, 2020). Thus, to further examine the sensitivity in the current study, an alternative measure of CGBP is performed to see if the effect of individual characteristics on CDQ is different from the main result. The overall model is significant at $p < 0.05$, with an R square of .0352. Table 11 demonstrates the results of the sensitivity test. The results indicate that five out of nine characteristics, board size, board gender, AC independence, AC size, and the presence of EC are positively associated with CDQ. However,

only AC independence and the presence of EC were statistically significant. This suggests that the more independent directors on the AC and the presence of the EC, the higher the CDQ. The sensitivity results indicate that board independence, board meetings, AC meetings, and AC financial expertise are negatively associated with CDQ and are not statistically insignificant. These findings suggest that relying on individual characteristics of the board, audit, and the presence of EC to measure how good firms are at practising CG may not reflect the actual level of CG within that particular firm. Regarding this, female representation in the board room without diligent board independence and board size will not assist the board in performing its duties and responsibilities effectively. Accordingly, the group test (composite index) may be more appropriate in the case of investigating CGBP. Overall, the result is not different from the main result confirming that the adoption of CGBP positively impacts CDQ provided by Malaysian publicly listed firms.

Discussion and Conclusion

The purpose of this study was to assess if there is any change in CDQ over the five-year study period in addition to assessing the effect of the level of CGBP, defined as an effective board of directors, AC, and the presence of EC on CDQ provided by publicly listed firms on Bursa Malaysia using a sample of 72 carbon-intensive firms (360 firm observations) covering the period of 2015 to 2019. Unlike other studies, a comprehensive carbon reporting index was developed to measure CDQ. This index was developed in line with international frameworks and guidelines related to climate change disclosures as well as well-grounded literature. Thus, the findings can fill the literature gap regarding carbon measurement. As expected, the study found empirical evidence that listed firms that complied with CGBP as stipulated in MCCG provide a higher quality carbon disclosure than non-compliant firms. The finding of this study provides evidence that

Table 11: Fixed effect regression results of the alternative measurement of CGBP effect on CDQ

Variables	Coefficients	t-stat	P > T
BIND	-.0143	-0.16	0.874
BSIZE	.0043	0.51	0.615
BGEN	.2170	2.04	0.045
BMEET	-.0046	-1.22	0.226
ACIND	.1864	2.89	0.005
ACMEE	-.0086	-1.03	0.305
ACFEXP	-.0077	-0.33	0.740
ACSIZE	.0144	1.01	0.317
EC	.0634	3.24	0.002
SIZE	-.0093	-0.48	0.634
PRO	.0320	0.56	0.579
AGE	.0501	8.76	0.000
LIQ	.0010	0.39	0.697
LEV	-.0746	-1.28	0.203
BIG4	.0469	1.82	0.044
N	360		
R2	.0352		
Hausman test	139.94		
Breusch-Pagan test	167.32		

Notes: BIND - Board Independence; BSIZE - Board Size; BGEN - Board Gender; BMEET - Board Meeting; ACIND - Audit Committee Independence; ACMEE - Audit Committee Meeting; ACFEXP - Audit Committee Financial Expertise; ACSIZE - Audit Committee Size; EC - Environmental Committee Presence; SIZE - Firm Size; PRO - Firm Profitability; AGE - Firm Age; LIQ - Liquidity; LEV - Leverage; BIG4 - Audit Quality.

one of the reasons behind the low-level and low-quality carbon disclosure is firms' failure to adhere to CGBP. Additionally, utilising Wilcoxon signed ranks and Friedman tests, this study documented a remarkable improvement in CDQ in Malaysia over the period 2015 to 2019, suggesting that carbon disclosure awareness is increasing in Malaysia, which is in line with the improvements made in the MCCG from its first issuance. The improved disclosures imply that the capital market regulators' initiatives to address climate change challenges through good governance are effective. As is the case with prior relevant studies, this study is not without limitations. Firstly, the CGBP was defined as an effective board of directors, AC, and EC. However, growing evidence in the literature

referred to other CG mechanisms that strengthen CGBP within organisations, such as ownership structure and stakeholder pressure. Therefore, future research needs to consider other CG mechanisms when assessing CDQ. Secondly, CDQ was measured based on the disclosure index developed by the authors; there may be an element of subjectivity when the researchers select the international carbon guidelines and framework that fit the Malaysian business environment to develop the carbon index, with potential subjectivity when interpreting carbon information disclosed in firms' annual reports. Hence, future research could include and consider more carbon guidelines and frameworks when constructing academic indexes for carbon measurement.

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Conflict of Interest Statement

The authors declared that they have no conflict of interest.

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