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Climate change disclosure and the promise of response-ability and transparency: A synthesizing framework and future research agenda

Xiaolong Shui  | Minhao Zhang  | Palie Smart 

School of Management, University of Bristol,
Bristol, UK

Correspondence

Xiaolong Shui, Howard House, Queen's
Avenue, Bristol BS8 1SD, UK.
Email: xiaolong.shui@bristol.ac.uk

Abstract

This paper systematically reviews the burgeoning but fragmented body of literature on climate change disclosure in the first two decades of the 21st century. Although there is an increasing trend for organizations to engage in climate change disclosure, the level of transparency, which is the key to allowing organizations to be responsible and accountable, varies significantly. We have synthesized current research findings on disclosure practice, antecedents, and outcomes into an integrative framework. In light of this framework, a more theoretically informed construct of carbon transparency is introduced in this review paper. We further highlight some research gaps supplementing with promising theorizing opportunities to encourage future works that can go beyond the extant scope of inquiry. Given the urgency of the current carbon budget, more studies are encouraged to examine the mechanism under which carbon transparency can lead to enhanced carbon performance in addressing climate change at the micro-organization level.

KEYWORDS

carbon disclosure, carbon transparency, climate change, greenhouse gas emissions, systematic literature review

INTRODUCTION

Accompanied with the increasing significance of climate change at the beginning of the 21st century, firms' climate change disclosure has been attracting significant attention from researchers. The line of inquiry primarily comes from accounting and finance studies (Freedman & Jaggi, 2005; Kolk et al., 2008) and recently from Management and Organization Studies (MOS) (Hahn et al., 2015; Knox-Hayes & Levy, 2011; Reid & Toffel, 2009). Moreover, there is increasing coverage from ecological economics studies (Chen et al., 2017; Ziegler et al., 2011). Considering the multidisciplinary and applied nature of carbon disclosure,¹ it is imperative to achieve a systematic understanding of such an important initiative to tackle the global climate emergency.

Studies on carbon disclosure across a range of research communities make this subject field fragmented. Different emphases from distinct research communities prohibit a comprehensive understanding of carbon disclosure. For instance, a strong emphasis has been placed on the financial consequences of carbon disclosure in accounting and finance studies (Baboukardos, 2017; Matsumura et al., 2014), thereby overshadowing the environmental consequences of carbon disclosure documented in other disciplines (Bang et al., 2019). The incomprehensive understanding of the multifaceted performance consequences of carbon disclosure may demotivate firms to engage the relevant initiatives.

Carbon disclosure has been echoed in policies such as carbon emissions trading schemes, indicating the trend for disclosure to be mandatory. Furthermore, carbon disclosure is expected to help address climate change by implementing well-designed strategies to curb greenhouse gas (GHG) emissions. As Mark Wilson, ex-CEO of Aviva, claims, "what gets measured, gets managed and

¹"Carbon disclosure" is a more extensively adopted term, which not only includes details on carbon emissions but also broad information on organizational responses (e.g., goals or management strategies) to combat climate change. In this review, "carbon disclosure" and "climate change disclosure" are interchangeable.

what gets disclosed and published get managed better” (Lynch, 2016). Given organizational and policy implications, it is worthwhile to synthesize the proliferating but dispersed body of literature on carbon disclosure in the two first decades of the 21st century. Hence, this paper aims to provide a synthesizing lens for viewing various contributions to the carbon disclosure issue and discuss significant future research challenges.

Through an evidence-based investigation guided by a systematic literature review (SLR) (Tranfield et al., 2003), we identified and synthesized 135 peer-reviewed studies on carbon disclosure from fragmented research communities. We find that organizations increasingly commit to carbon disclosure, though the level of transparency varies significantly. Hence, we produce an integrative framework that examines antecedents and outcomes of carbon disclosure while considering transparency. Note there is an imbalanced focus on these two dimensions—antecedents outweigh outcomes. Therefore, we further highlight research gaps in all elements included in the integrative framework. To this end, we stress transparency in organizational carbon disclosure, allowing for them to be more responsible and accountable in responding to the climate change challenges.

The review methodology is articulated in Section 2. Section 3 explains three main elements of the integrative framework on climate change disclosure. Before drawing concluding remarks in Section 5, Section 4 calls for more studies with a summary of a future research agenda.

METHODOLOGY

To gain a comprehensive understanding concerning carbon disclosure, we adopted SLR, which is originated in medical science and further introduced into management scholarship (e.g., Tranfield et al., 2003). Compared with a “narrative” literature review, SLR includes all relevant research findings and evidence to provide “evidence-informed management knowledge.” SLR can be useful in bringing together evidence on the burgeoning phenomenon of carbon disclosure, leading to a more comprehensive picture.

To identify relevant research studies, we developed two sets of keywords capturing (1) the issue of climate change and (2) the issue of disclosure (see Table 1). The search has been conducted in key social sciences electronic databases, including EBSCO Business Source

Complete, Web of Science, Scopus, ProQuest, and ScienceDirect. The search time range has been determined to be from 2000, when the largest carbon disclosure repository, Carbon Disclosure Project (CDP) established, to 2020. Only peer-reviewed studies in English were included in the review.

Based on three criteria, we screened all papers based on reviewing titles, abstracts, and keywords. First, included papers should be directly related to carbon disclosure. Therefore, we removed some studies concerning carbon technology advancement. Second, we only considered organizational-level carbon disclosure. We recognize several types of organizations, including for-profit, nonprofit, and hybrid organizations. However, this study removed studies of city- or country-level carbon disclosure. Last, we use the Chartered Association of Business Schools’ *Academic Journal Quality Guide* rankings to determine the quality of the research outlet (Crowley-Henry et al., 2018; Cundill et al., 2018). More importantly, the Guide includes journals from fields that are either central or salient to MOS. The exclusion of studies not published in the journals listed in the Guide enables us to locate extant scholarship on carbon disclosure primarily within the MOS and with an extension to broad social sciences. After the scoping stage, we achieved a sample of 135 articles² from dispersed disciplines for the following analysis.

Finally, we adopt a method of qualitative cross-case analysis, each article being equivalent to a case, to extract and synthesize information from these 135 articles (Mays et al., 2005). We use a cognitively recognized framework of “antecedents-practice-outcomes” as a starting point, followed by an analytic induction approach to iteratively fulfill and modify the evolving framework until every new round of data is fitted. In so doing, the ultimate framework can not only review scholarly evidence but also organize them in a conceptually integrative manner (Dixon-Woods et al., 2007; Rousseau et al., 2008).

REVIEW OF PREVIOUS RESEARCH AND A SYNTHESIZING FRAMEWORK

There is an increasing trend in scholarly outputs on carbon disclosure in the sample year (see Figure 1). Specifically, carbon disclosure emerged into a scholarly discussion since the first request from CDP in 2003. After two key international climate change conferences (i.e., the Copenhagen Summit in 2009 and the Paris Agreement in 2016), scholarly outputs achieved a peak in 2011 and 2020, respectively.

We have synthesized the selected literature on carbon disclosure into the framework presented in Figure 2. The framework summarizes the detailed view on heterogeneous practices, multifaceted antecedents, and outcomes.

TABLE 1 Key terms used to identify studies on carbon disclosure

Climate change	CO2 OR emission OR carbon OR carbon dioxide OR carbon*equivalent OR CO2 equivalent OR greenhouse gas OR GHG OR climat* change OR global warming
Disclosure	disclos* OR report* OR disseminat* OR publication OR statement OR declar* OR release OR announce* OR transparen*

²Full lists available on request from the authors.

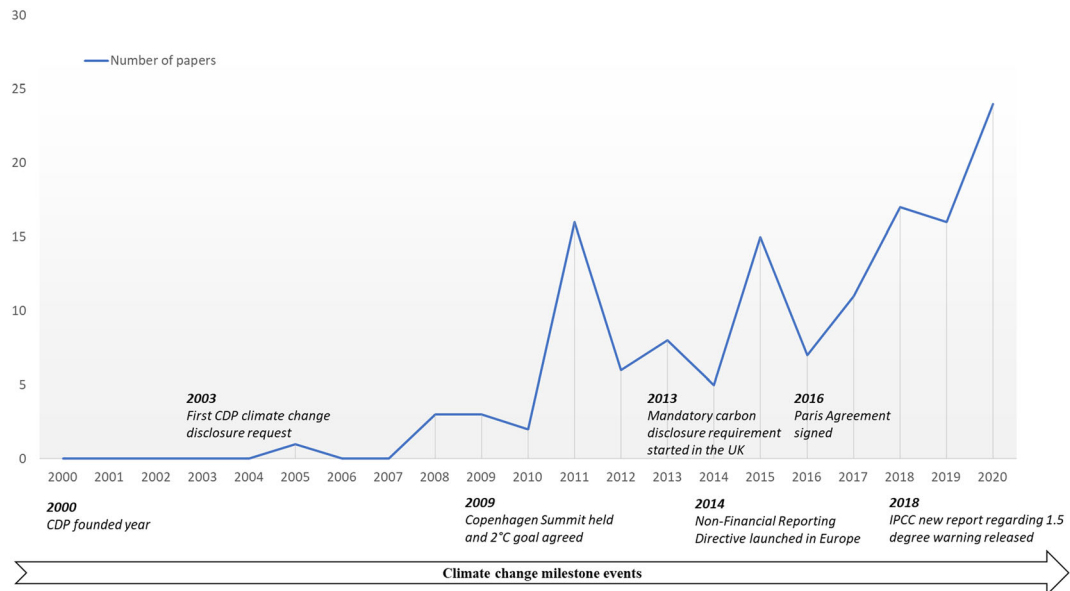


FIGURE 1 Yearly distribution of included papers and corresponding climate change milestone events

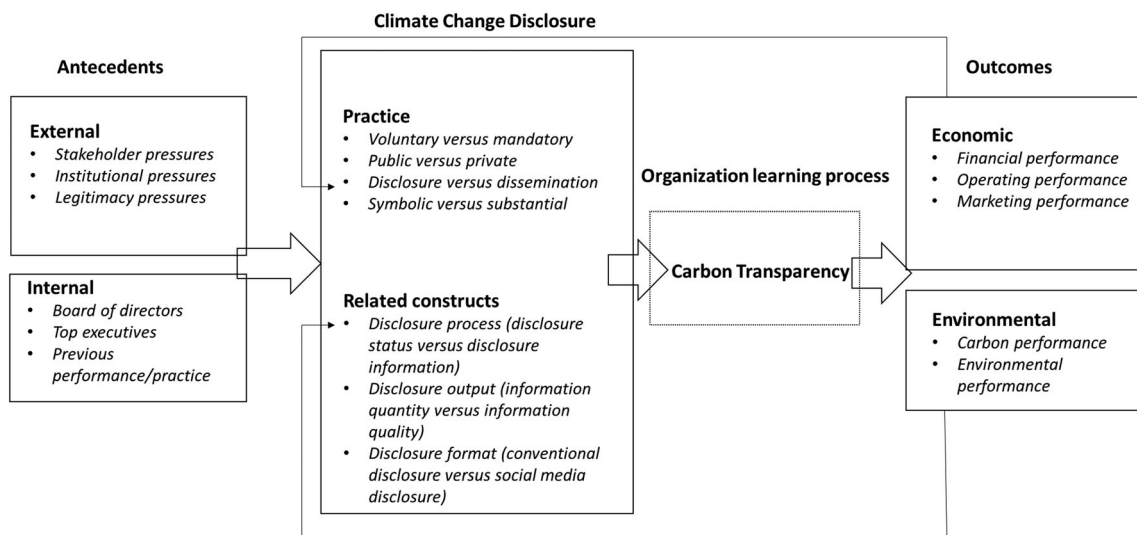


FIGURE 2 Integrated framework for carbon disclosure

Next, we begin with the discussion on the heterogeneous disclosure practices and relevant constructs employed in the prior studies by focusing on disclosure process, output, and format. This points out the necessity of a higher level construct of carbon transparency in capturing heterogeneity in carbon disclosure practice. What follows is an exhaustive review on antecedents (internal and external) and outcomes (economic and ecological) of carbon disclosure.

Carbon disclosure-related constructs

To get a better understanding of carbon disclosure, we first summarize the constructs deployed in the included

papers before analyzing the integrative framework (see Figure 2).

Disclosure status and disclosure information (disclosure process)

There is a significant shift of focus from carbon disclosure status to the disclosed information. Some earlier studies examine the antecedents or outcomes of firms' carbon disclosure status—whether firms disclose carbon-related information. For example, Reid and Toffel (2009) and Dawkins and Fraas (2011) use firms' responses to a CDP questionnaire to capture the carbon disclosure status. The public response includes two different disclosure

statuses, namely, response and publication. In a study by Ott et al. (2017), publication status is disentangled from response status, and this disentanglement provides novel insights into firms' decision-making on sequential disclosure. Nevertheless, although CDP has become one of the prominent channels for carbon disclosure, CDP response status cannot be the exclusive source to determine firms' carbon disclosure status, especially for small- and medium-sized enterprises (SMEs).

Information quantity and information quality (disclosure output)

Another stream of the studies created a construct that captures the quantity of disclosed items (e.g., Comyns, 2016). The quantity is often measured as words and lines that are carbon relevant in firms' public documents. The literature suggests that the quantity can be seen as one of the dimensions (i.e., comprehensiveness, extensiveness, or completeness) in information quality although it is not a perfect measure (Liao et al., 2015). For example, symbolic carbon disclosure may contain high-quantity but low-quality information, whereas substantial carbon disclosure may include both high-quantity and high-quality information. Hence, such a measure could be useful when integrated with the quality measure in examining the heterogeneity of a firm's carbon disclosure practice.

Conventional disclosure and alternative disclosure (disclosure format)

Firms have been using social media sites to disseminate their carbon-related information. Social media also provides a novel way of measuring firms' voluntary disclosure efforts. For example, Albarrak et al. (2019) examined firms' carbon disclosure through screening and matching relevant tweets. This approach is different from the conventional disclosure channels, such as CDP questionnaires or standalone carbon reports. Due to the large potential audience, social media sites can attract the attention of diverse stakeholder groups with potentially conflicting interests (She & Michelon, 2019). The associated consequences of using social media for carbon disclosure can be more complex than conventional disclosure. Hence, carbon disclosure via social media is worth further investigation.

Antecedents of carbon disclosure

Carbon disclosure is a crucial component for governmental emissions trading schemes (ETS), like UK ETS (de Aguiar & Bebbington, 2014) and EU ETS (Bebbington & Larrinaga-Gonzalez, 2008). In addition, the UK has been the first to mandate quoted firms to report their GHG emissions since 2013 according to the

Companies Act 2006 (Strategic Report and Director's Report) Regulations 2013. The enabling force for MCD is governments and their regulations for certainty, while the reasons why firms are voluntarily engaged in disclosure practice need further discussion. The extant literature has largely acknowledged the external pressures enabling firms to voluntarily disclose carbon-related information. In contrast, the internal mechanisms influencing firms to make strategic decisions on carbon disclosure remain underexplored.

External pressures

Stakeholder pressures

Although carbon disclosure can be considered as a voluntary organizational effort, such practice may not be as 'voluntary' as we imagine since it is mainly for mitigating the increasing level of climate change pressures, particularly those from various stakeholder groups (Comyns, 2016; Liesen et al., 2015). Similar to MCD, the influence of the state is prominent. Specifically, Reid & Toffel (2009) argue that government regulation threats, such as some potential rules regarding GHG emissions, can positively influence firms' engagement in voluntary carbon disclosure (VCD) practice. Moreover, Guenther et al. (2016), based on an international sample, find that all stakeholder groups, including the state, the public, the media, employees, and customers, play a constructive role in facilitating VCD. In addition, some multi-stakeholder initiatives, such as GRI and CDP, gather different stakeholder groups together and issues protocols and guidelines for carbon disclosure which pressures firms to engage in VCD practice (Andrew & Cortese, 2011; Halkos & Skouloudis, 2016).

Legitimacy pressures

Climate change has posed great threats to firms' existing legitimacy since they are largely accused of being the main driver of GHG emissions (Howard-Grenville et al., 2014). To repair, maintain and enhance their legitimacy, firms choose to voluntarily disclose carbon-related information (Kolk et al., 2008; Li et al., 2018). Stanny (2013) investigate American firms' VCD practices and find that they tend to answer the CDP questionnaire without disclosing detailed information (e.g., emissions amount and accounting methodology) to avoid scrutiny. However, according to legitimacy theory, if firms conduct an incomprehensive VCD, they will be regarded as serving "a symbolic legitimating function ... responding to stakeholder pressures" (Liesen et al., 2015, p. 1049). In addition, facing greater legitimacy pressures, firms even defraud audiences with inaccurate carbon information. The astonishing Volkswagen diesel emissions scandal is

one of the representative cases (Hotten, 2015). In sum, similar to general environmental disclosure practices, firms are motivated to engage in VCD by dealing with legitimacy pressures and impression management (Depoers et al., 2016; Fabrizio & Kim, 2019).

Institutional pressures

Institutional theory claims that firms can adopt similar practices when confronted with similar institutional pressures (Thornton et al., 2012). It has been extensively used to explain why firms are increasingly engaging in VCD practice to respond to institutional pressures (Knox-Hayes & Levy, 2011). Specifically, VCD is isomorphic behavior that can result from coercive pressures (e.g., governmental regulation stringency; see Liu et al., 2017), normative pressures (e.g., industry norms; see Rahman et al., 2019), and mimetic pressures (e.g., rivalries' 'successful' practices; see Villena & Dhanorkar, 2020). Matisoff et al. (2013) discovered a convergent trend in VCD practice across firms in a longitudinal examination of publicly disclosed firms. Nevertheless, the VCD heterogeneity across firms observed in recent studies challenges the explanations from institutional theory (Bui et al., 2020; Li et al., 2018). Although firms' VCD practices (i.e., disclosure status) are increasingly converging, the information quality is to a large extent diverging. The current literature remains nearly silent towards the antecedents of VCD in terms of information quality.

Key insights

The literature has focused on the antecedents of disclosure status (i.e., whether firms engage in VCD), but largely ignores the antecedents of disclosure channel choices and disclosed information quality. Future research directions to understand the antecedents of VCD are threefold. First, scholars can challenge the homogeneity of external climate change pressures the firms are facing. Although different stakeholder groups can exert influence on firms' VCD practice, their demands in carbon information and their power to exert influence are different. More research examining various pressures from different stakeholder groups associated with their legitimacy and power is needed to provide nuanced understanding towards heterogeneity of VCD practices regarding disclosure channel and information quality. Stakeholder salience theory, an extension of stakeholder theory, highlights the power, legitimacy, and urgency across different stakeholder groups, and could be an appropriate lens for future studies. Second, though isomorphism can be used to explain the dispersion of VCD across firms, it fails to recognize the conflicts among different isomorphic behaviors caused by

potentially competing institutional logics (Thornton et al., 2012). Firms have to face a complex institutional environment where multiple institutional logics impose conflicting demands. For example, firms, on the one hand, need to not make carbon performance public to avoid potential risks in response to market logic. On the other hand, firms also need to be more transparent, as required by sustainability logic. Hence, firms are more likely to engage in some decoupling responses, resulting in the heterogeneity of firms' VCD practice (Luo et al., 2017). This heterogeneity also paves a way for future research agendas.

Internal mechanisms

Board of directors

Some recent studies have begun to relate the heterogeneity of VCD practice to the board of directors (e.g., Ben-Amar et al., 2017; Bui et al., 2020). As suggested by agency theory, managers can opportunistically pursue firm growth at the cost of long-term benefits for firms' stakeholders, including minority shareholders and the environment (Jensen & Meckling, 1976). Hence, independent directors who undertake monitoring functions can ensure the best interests of all shareholders and broad stakeholder groups. For instance, Liao et al. (2015) confirm that there is a positive relationship between board independence (i.e., percentage of independent directors in the boardroom) and VCD (including both disclosure status and information quality). In addition, underpinned by resource dependency theory, directors can provide counseling and access to critical resources via their skills, expertise, and networks (Hillman et al., 2009). Ben-Amar et al. (2017) submit that female directors can offer more environmentally caring leadership to the firm, further confirming a positive relationship between board gender diversity and VCD. Moreover, the presence of an environmental committee is found to be positively associated with VCD, including disclosure status and information quality (Peters & Romi, 2014).

Nevertheless, the understanding of the relationship between board attributes and VCD remains inconclusive. For example, according to Bui et al. (2020), board diversity, size, and independence, are not significantly associated with VCD. In contrast to prior findings, this result critically challenges the examination of the role of directors in VCD practice. We argue that these structural attributes (e.g., size and independence) are insufficient in capturing the underlying mechanisms under which directors influence VCD practice. The literature assumes larger boards can have a stronger capacity in monitoring and resource provision (Prado-Lorenzo & Garcia-Sanchez, 2010). However, it is common to see some directors overlapping in their skills, networks, and expertise; thus, some structural attributes, such as board size,

are not appropriate for capturing the underlying effect. Therefore, future studies can address this inconclusive understanding with a better measurement of boardroom team-level constructs that captures their capacity in the two main functions of monitoring and the provision of resources.

Top executives

As key strategic decision-makers, top executives play a vital role in shaping VCD practice (Chithambo et al., 2020; Lewis et al., 2014; Peters & Romi, 2014). These top executives can “influence how institutional pressures are perceived and interpreted” and ultimately translated into organizational outcomes (Lewis et al., 2014, p. 713). Specifically, Lewis et al. (2014) conclude that firms led by CEOs with MBA degrees and new appointments are more likely to engage in VCD. Furthermore, more firms are setting up a position of Chief Sustainability Officer in the top management team (Fu et al., 2020). Peters & Romi (2014) conclude that the presence of chief sustainability officer can facilitate firms to engage in VCD both in disclosure status and information quality.

Key insights

Scholarly discussions on internal mechanisms can contribute to a more holistic understanding of the antecedents of VCD, although this line of inquiry remains somewhat inconclusive and underexplored. It can be concluded that sustainable governance mechanisms and executive teams can contribute to VCD (Bui et al., 2020; Peters & Romi, 2014). For future research agenda, the examination of the boardroom and top management personnel should recognize the teamwork of these decision-makers. More studies could consider the team-level constructs to capture substantive functions influencing strategic decision-making on VCD (Ben-Amar & McIlkenny, 2015). Specifically, what is the role of monitoring and resource provision in influencing VCD practice? Second, due to the difference in cognitive styles, CEOs might not perceive climate change pressures the same, consequently making different decisions regarding VCD (Hambrick & Mason, 1984; Lewis et al., 2014). Hence, more studies should depart from some superficial attributes (e.g., demographic characteristics) and directly examine the role of CEOs’ cognitive capabilities and leadership styles (e.g., ethical leadership) in the interpretation and translation of external pressures into VCD practices. Furthermore, both boards of directors and top executives can influence organizational decision-making (Boyd et al., 2011). However, the extant scholarship has largely ignored the interactions between these two teams in influencing VCD practice, which could be a fruitful area for further work.

Outcomes of carbon disclosure

Financial outcomes

Economics-based disclosure theory (e.g., Verrecchia, 1983) has been extended to predict firms may gain financial benefits when they discretionarily disclose carbon-related information to outsiders because the decision is made after the cost–benefit evaluation. GHG emissions amount, included in VCD, has been mainly examined its role in affecting firm financial performance. For instance, Matsumura et al. (2014) argue that VCD enables external audiences, especially investors, to know the environmental liabilities reflecting some underlying risks, thereby being penalized by the capital market. This penalization effect is stronger if firms have not voluntarily provided such information. Hence, VCD is regarded as a way to avoid negative market reactions. Similarly, Lemma et al. (2019) argue that firms listed in South Africa with high carbon risk also engage in VCD to avoid potential negative consequences resulting from concealing information.

Regarding capital markets, scholars agree that GHG emissions are value-relevant—more specifically, negative to investment returns (Griffin et al., 2017; Liesen et al., 2017). However, researchers hold different views regarding the value-relevance of firms’ voluntary disclosure efforts. Liesen et al. (2017) argue that investors can gain risk-adjusted returns from firms who voluntarily disclose GHG emissions compared with those who do not disclose. The authors also suggest that investment returns can be achieved from those firms who disclose a complete level of GHG emissions (i.e., Scope 1, 2, and 3) compared with those who disclose incompletely. Such evidence does show the value-relevance of voluntary disclosure efforts; however, Griffin et al. (2017) demonstrate no significant difference in the negative value of GHG emissions between firms who engaged in VCD and those who has not such efforts.

Compared with financial outcomes resulting from voluntary efforts, MCD receives little attention in its role in affecting firms’ financial performance (Chen et al., 2017). One of the exceptions, Baboukardos (2017), finds that the magnitude of the negative relationship between GHG emissions (disclosed voluntarily) and market value experienced a significant decrease after the introduction of mandatory disclosure requirements for UK-listed firms. Moreover, Schiemann & Sakhel (2019) find that another mandatory scheme—EU ETS—moderates the relationship between climate change-related physical risk disclosures and information asymmetry.

Key insights

The financial benefits brought by VCD motivate firms to provide high-quality information. However, the question of whether capital markets punish (or reward) selective, inaccurate, and misleading carbon information disclosure

remains unanswered. Furthermore, the engagement of VCD can be initiated by practitioners in supply chains through institutional pressures (Villena & Dhanorkar, 2020). Future research can examine the roles of VCD in affecting interorganizational performances. Moreover, because more countries are launching emissions trading schemes, it will be promising for future research to explore the influence of MCD on financial outcomes as well as its interactions with VCD (Cousins et al., 2020; Kalkanci & Plambeck, 2020).

Environmental outcomes

Concentrated discussions on financial benefits may blur the focus of the ultimate end of carbon disclosure. The existing scholarship has not offered sufficient discussions on the relationship between carbon disclosure and carbon performance. An initial effort made by Qian & Schaltegger (2017) argues that VCD can serve as a management tool for firms to improve carbon performance (i.e., emission intensity). Specifically, they find that improvement of VCD quality is positively associated with the subsequent improvement in carbon performance. In this sense, VCD can contribute to environmental goods, confirming its effectiveness in addressing climate change. Nevertheless, Hassan & Romilly (2018) claim that there is no causation from VCD to carbon performance based on a cross-country sample. Even worse, Kim & Lyon (2011) find that firms use participation in VCD programs (US 1605(b) program) as a way of greenwashing—emitting more but reporting less. Disclosure program is found no significant effect on changes in carbon performance. Pizer et al. (2011) find similar findings with regards to 1,605(b) and Climate Wise in the United States. Indeed, there are increasing critiques that emerged from the literature challenging the effectiveness of carbon disclosure in addressing climate change (Knox-Hayes & Levy, 2011; Wright & Nyberg, 2017). In addition, the role of MCD in changing subsequent carbon performance is also to be explored further.

Key insights

Environmental benefits resulting from carbon disclosure are supposed to attract the most scholarly attention; however, this is not the case. We suggest that the debate needs to move forward from the negative/positive relationship to the underlying mechanism. For example, how does carbon disclosure lead to subsequent improvement of carbon performance? Future research should explore more regarding the substantial organizational change (e.g., innovation) caused by carbon disclosure in improving carbon performance (Passetti et al., 2018). Moreover, how can voluntary or mandatory disclosure programs prevent firms from greenwashing and facilitate real

change? For instance, Dahlmann et al. (2019) pinpoint “science-based targets” in carbon disclosure for more clarity. This line of inquiry could offer practical implications for the improvement of current programs and the introduction of future mandatory programs.

We now move from synthesizing the literature on carbon disclosure to delineating future research directions to understand some unresolved questions. Based on our integrative framework, theoretical barriers and methodological shortcomings in the extant scholarship are discussed in the following sections for the improvement of further work.

DISCUSSION: AN AGENDA FOR FUTURE RESEARCH

New foci for further understanding carbon disclosure

Carbon disclosure-related constructs

Without a theoretically informed construct, it is hard to achieve consistent and convincing understandings of carbon disclosure. Originally, the literature conceptualized carbon disclosure-related measures through the theory of “organizational transparency” (Schnackenberg & Tomlinson, 2016). Schnackenberg and Tomlinson (2016, p. 1788) offer a synthesized definition of transparency, “transparency is the perceived quality of intentionally shared information from a sender.” Carbon disclosure meets with the consensus that “transparency is about *information*,” and such information is intentionally created and shared by firms to targeted audiences. Moreover, information is perceived and examined by the information receivers. Hence, regarding carbon disclosure information quality, transparency would be an appropriate theoretical foundation point to establish related constructs.

Schnackenberg et al. (2021) further demonstrate the multidimensionality of transparency, confirming its nature as a higher order construct. The authors empirically find that disclosure, clarity, and accuracy are the three dimensions constituting transparency. This categorization sheds light on the theoretical development of carbon disclosure-related constructs. For instance, based on the transparency literature, Villena and Dhanorkar (2020, p. 3) first conceptualize and operationalize “supplier carbon transparency.” Although it is confined to the suppliers, the construct with a well-grounded theoretical foundation could be further adapted to resolve prior inconsistent carbon disclosure measures.

In light of transparency scholarship, we define corporate *carbon transparency* as the accessibility and availability of firm-level information in dealing with climate change (e.g., emission amounts or management strategies) to all relevant stakeholder groups. Based on the

disclosure-clarity-accuracy dimensionality, we further argue carbon transparency includes public disclosure, comprehensiveness, clarity, and accuracy. First, *public disclosure* refers to the publicity of carbon-relevant information via possible channels (see the variable of *publication* for an example in Ott et al., 2017). Second, *comprehensiveness* can be defined as the extent (or scope) of relevant carbon-related information presented in the disclosure statement. This is also termed as “extensiveness” (e.g., Freedman & Jaggi, 2011; Liao et al., 2015) or “completeness” (e.g., Comyns, 2016; de Aguiar & Bebbington, 2014) in prior carbon disclosure studies. Third, *clarity* refers to “the perceived level of lucidity and comprehensibility” of carbon information in the eyes of beholders such as investors and customers (Schnackenberg & Tomlinson, 2016, p. 1792). Carbon information should be illustrated and presented in a more user-friendly way for a higher level of carbon transparency. For instance, firms can relate financial risks associated with carbon emissions to stakeholder groups of investors and relate product or service offerings more explicitly to the stakeholder group of customers, who can then make informed decisions. Fourth, *accuracy* can be defined as the correctness and reliability of information presented in carbon disclosure documents. Figure 3 illustrates the conceptualization of corporate carbon transparency.

Complex external environment influencing carbon disclosure

A consensus agrees that pressures from external factors, such as the state, influence carbon disclosure practices. Nevertheless, pressures from one certain stakeholder

group are assumed to be consistent across times in prior literature. As mentioned above, climate change, as a super “wicked” problem, is sometimes polarized in political debate, further shaping policy regulations (McCright & Dunlap, 2011). Political threats to climate change are inconsistent and can even conflict over the years. The United States, as one of the largest concentrated institutional contexts, is a representative example of uncertain regulatory pressures. For instance, under the administration of then-President Donald Trump, the United States became the first nation to withdraw from the Paris Climate Accord, then rejoined the international agreement after President Joe Biden led the White House (McGrath, 2021). Hence, little is known about how an uncertain or competitive political or regulatory environment can influence firms’ carbon disclosure practices. Challenging consistent pressures from one certain stakeholder group could be a fruitful area for future studies. Additionally, with the diffusion of climate change disclosure into SMEs, our understanding remains highly limited, though SMEs’ emissions and efforts should also be held accountable. Considerably more work will need to be done in understanding climate change disclosure in SMEs.

Moreover, we understand relatively little about the influence of institutional complexity on carbon disclosure practices. Firms are expected to meet with diverse and dynamic institutional logics that contain different organizing rules in a complex institutional context (Thornton et al., 2012). Prior literature has extensively acknowledged the role of sustainability institutional logic in shaping carbon disclosure practice, while ignoring co-existing and potentially competing institutional logics, such as market logic (Ansari et al., 2013). For instance, sustainability institutional logic may expect firms to be more carbon transparent, whereas some critical operating

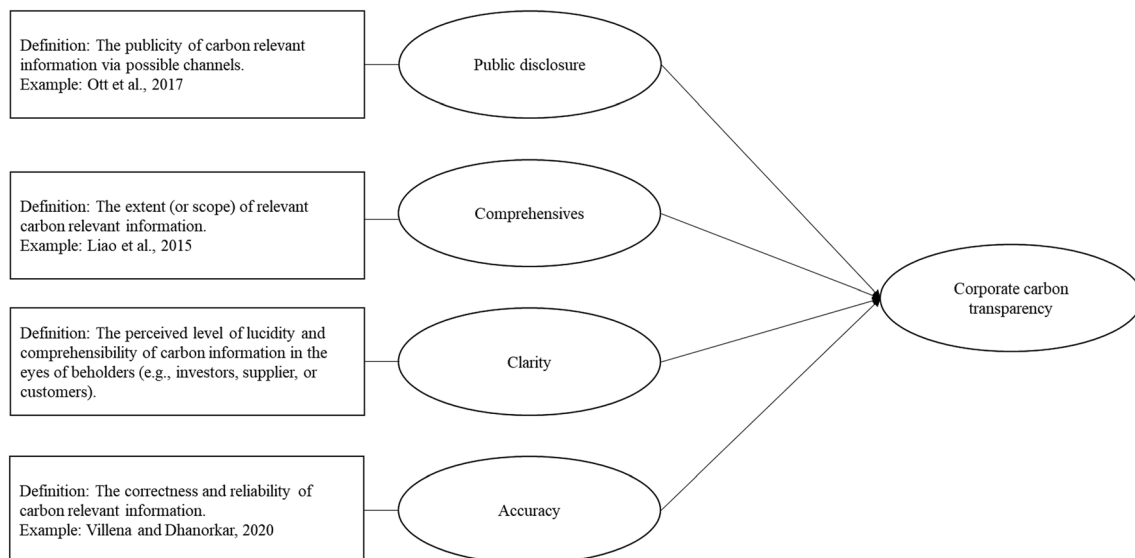


FIGURE 3 Conceptualization of higher order constructs of corporate carbon transparency

information (speculated from emissions) can be known by competitor firms that is not encouraged by market institutional logic. Therefore, future studies could benefit from exploring institutional complexity further and its role in VCD practice. By doing so, a more nuanced understanding of the antecedents of carbon disclosure can be achieved.

Interactions between external pressures and internal mechanisms

Compared with external pressures, internal mechanisms receive little attention in explaining firms' heterogeneity in carbon disclosure practices. For future works from the perspective of internal mechanisms, first, researchers should focus on how external pressures are noticed and translated into carbon disclosure practices. Some key strategic decision-making team members, such as the top management team and the board, are worth further investigation. For example, how do a board's two functions—resource provision and monitoring—influence corporate carbon transparency? Which leaders are inclined to bring attention to climate change to the firm? Which managerial attributes can help firms to translate external pressures on climate change into corporate carbon transparency? In addition, the board of directors and top executives might interact with each other in strategic decision-making. How do they jointly influence corporate carbon disclosure? This understanding may provide some explanations for boundary conditions governing the relationship between directors (or top executives) and corporate carbon disclosure.

Operating and marketing performance outcomes in the supply chain

As carbon disclosure is dispersed across the supplier chain, there is insufficient understanding of how carbon disclosure can lead to changes in operational performance. Villena & Dhanorkar (2020) point out that firms are pressured to be carbon transparent by customer firms in the supply chain. Firms without carbon disclosure or with lower levels of carbon transparency are forced to comprehensively collect carbon-relevant information, thereby providing a chance to ascertain weaknesses in operating performance and make further improvements. Moreover, the influence of carbon disclosure on customer-level marketing performance is, unfortunately, missing in the extant scholarship. Customers are currently willing to understand the carbon footprints of products and services they consume (Vanclay et al., 2011). It is worth explicitly investigating how carbon transparency results in customer-level marketing performance (e.g., purchase intention or word-of-mouth) changes. Hence, as little evidence is available to improve

operational and marketing performance and contextual conditions in achieving outcomes, these could be important foci for future research.

Substantial environmental performance improvement

Ironically, environmental performance outcomes resulting from carbon disclosure are the significantly weak area in carbon disclosure studies. First, future studies could focus more on whether MCD requirements can lead to a substantial carbon emissions reduction. If not, how can requirements be further revised to prevent firms from symbolic reporting? This knowledge would be beneficial for climate change policy development. Second, regarding voluntary disclosure efforts, a clear differentiation between symbolic and substantial disclosure should be made in future studies. If there is no environmental improvement resulting from symbolic reporting, how can mainstream reporting protocols or guidelines be revised to drive them to engage in substantial reporting? Last, carbon disclosure can provide an opportunity to examine the carbon footprints of business processes and associated management strategies in managing the carbon footprint. By doing so, firms are more likely to figure out where they can further improve carbon performance, but the substantial changes are dependent upon firms' other activities in curbing GHG emissions (Burritt & Schaltegger, 2010). Such activities (e.g., mitigation and adaptation activities) facilitated by carbon disclosure can be seen as mediators in achieving substantial environmental improvement. For the sake of a tight carbon budget, future studies should resolve the entire picture concerning how carbon disclosure leads to substantial carbon performance improvement.

Theorizing opportunities for future empirical studies

The extant literature has utilized a narrow range of theories perspectives, such as legitimacy theory, institutional theory, and stakeholder theory, to examine carbon disclosure. These theories are common in general environmental disclosure studies, shadowing the distinctiveness of climate change disclosure. In this section, two theoretical approaches that are not employed in prior studies are identified for antecedents and outcomes to formulate promising avenues for future research.

The behavioral theory of the firm (BTOF)

Originating from the Carnegie School, BTOF has been one of the influential theories in explaining firms' certain practices from the perspective of bounded rationality

(Cyert & March, 1963). The theory suggests that firms can engage in and adjust certain practices based on their prior performance and practices. BTOF offers many research opportunities for investigating the antecedents of carbon disclosure practice. First, VCD practice can be driven by the feedback on firms' prior environmental performance level. Disclosure can not only be regarded as a communication tool for external stakeholder groups but also for internal groups. That is, firms may recognize a shortfall or success in environmental performance (e.g., carbon performance), then decide to pursue disclosure practice. Different motives can finally shape firms' disclosure strategies (e.g., various levels of publicity, comprehensiveness, clarity, and accuracy). Future studies can also investigate how changes in firms' motives influence the transformation of their disclosure strategies. This insight could help highlight the differences in carbon disclosure practices, complementing the predominance of some sociopolitical theories in explaining the antecedents.

Second, as an extension of BTOF, the attention-based view can also be beneficial in theorizing carbon disclosure studies (Ocasio et al., 2018). This perspective claims that attention to certain issues can lead to firms' strategic agendas. Some prior studies have investigated the structural determinants of attention on carbon disclosure, including the board of directors and top executives (e.g., Bui et al., 2020). However, carbon disclosure, as a communication strategy, might further general strategic changes in operations, leading to improvements in carbon performance. To what extent can carbon disclosure lead to strategic change and further environmental performance improvement? This question is worth further investigation from the attention-based view—combining external pressures and internal key decision-makers. This perspective would strengthen current understandings of environmental outcomes resulting from carbon disclosure.

Eco-modernization theory (EMT)

EMT scholars normally hold optimistic opinions towards environmental degradations, believing in a harmony between economic and environmental goals (Christoff, 1996; Hajer, 1995; Gouldson & Murphy, 1996). Faced with the acclaimed “wicked” problem of climate change, EMT doubts the “controller” role of the state. EMT instead suggests a “facilitator or enabler” role in the process of decarbonization because the ideology of liberalization dominates Western economies (Gouldson & Bebbington, 2007; Bailey et al., 2011). Accordingly, EMT theorists advocate a combination of state intervention and liberal market effects in policy design after multiple reframing to tackling the wicked problem of climate change. The carbon trading market is an illustrative example in which the state allocates emission quotas for companies and problematizes environmental emissions into economic costs and benefits in the

free market. MCD requirements associated with emission trading schemes can be further examined with regards to environmental benefits. This would also contribute to the understanding of environmental outcomes of carbon disclosure.

CONCLUSION

In the context of the current climate emergency, understanding micro-organizational level climate change disclosure practices is far more critical. Taking a closer look at relevant studies, we argue there are significant fragmentations and dispersions across disciplines. The aim of this paper is, therefore, to synthesize the dispersed literature on climate change disclosure and offer a holistic understanding. We find that scholarly studies on carbon disclosure have been increasing alongside the milestone climate change events. Based on an integrative framework, we conclude that both external pressures and internal mechanisms can lead to diffusion of VCD practice; however, the focus on institutional complexity and managerial differences can provide more nuanced explanations of divergent carbon transparency across organizations. In addition, we summarize the financial and environmental consequences derived from VCD practice, though there is a strongly imbalanced focus in the extant scholarship.

This paper offers three contributions. First, this study moves from a stable perspective to examine climate change disclosure practice (e.g., disclosure status) to a more dynamic view to consider an organizational learning process (Baxter et al., 2017), thereby introducing a theoretically informed concept of carbon transparency. The newly introduced concept can be beneficial in highlighting the heterogeneity across different organizations when it comes to climate change disclosure and addressing some conflicting findings stemming from the extant scholarship. Second, we gather evidence from different streams of literature, including sustainability reporting (Boura et al., 2020; Cabeza-García et al., 2018), strategic leadership (Papagiannakis & Lioukas, 2018; Yamak et al., 2019), environmental management (Eiadat & Fernández Castro, 2018), and more, providing a holistic understanding of climate change disclosure. Third, although we find that the outcome dimension is less examined compared with the antecedent dimension, we highlight some critical gaps in both that suggest a future research agenda. In addition, we offer some promising theoretical and methodological opportunities in studying carbon disclosure to go beyond the current scope of inquiry.

On a practical note, this review paper is of relevance for sustainability practitioners and policy-makers to facilitate carbon transparency in response to the climate emergency. First, an important for firms of our synthesizing framework is that they should consider both

corporate governance mechanisms and top management team composition to promote carbon transparency in the process of organizational learning. Second, the integrative framework highlights the transition from VCD practice to the pursuit of carbon transparency. Corporate sustainability executives can consider four dimensions of carbon transparency as a checklist to comprehensively evaluate their current environmental responsiveness. Third, in the meanwhile, four dimensions of carbon transparency can assist policy makers to establish a solid framework in regulating firms' climate change disclosure practices. This framework can be beneficial in initiating mandatory disclosure requirements and establishing carbon trading markets. Additionally, the concept of carbon transparency can also be leveraged to the city or country level and further stipulated in international climate treaties.

Note that this review is not without limitations. On the one hand, although we try to minimize biased understanding through SLR, this study only considers the scholarly evidence and ignores "grey literature" which is a heterogeneous body of knowledge artifacts without peer-review processes. This grey literature can contain governmental reports and company publications, such as reports compiled by CDP and some management consultancy firms. Hence, future research can incorporate the grey literature in understanding firms' VCD practice (Adams et al., 2017). On the other hand, this review focus on one of the market-based solutions to climate change, and this may underestimate the firms' collective responsiveness to this grand environmental challenge. Yet, the SLR methodology might help replicate and extend empirical investigations to other climate-related management literature strands (e.g., climate change adaptation and mitigations).

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are 135 peer-reviewed academic papers. The list of papers is available on request from the authors.

ORCID

Xiaolong Shui  <https://orcid.org/0000-0002-8476-0773>

Minhao Zhang  <https://orcid.org/0000-0002-1334-4481>

Palie Smart  <https://orcid.org/0000-0002-8902-3369>

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