Climate change reporting: a commentary on key issues

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Firms are more and more considered key actors for the attainment of sustainable development goals, including climate change (CC) action. Corporate reporting on carbon emissions and CC related issues is considered fundamental not only to evaluate companies' contributions to CC mitigation, but also to assess how CC affects organizations and how they are adapting to it. The importance of CC reporting has been acknowledged by the Financial Stability Board who has established, in 2015, the Task Force on Climate related Financial Disclosure (TCFD) to promote and set recommendations for an effective CC disclosure. Existing research documents conflicting results on the factors facilitating the implementation of CC reporting. In this commentary, I review prior literature on CC related disclosure with a particular focus on the most recent findings on the significant economic and ecological factors associated with it. I highlight that size bias, involvement of governance, relationship with emissions activity, integration in corporate reporting and assurance represent the key issues in such domain. I corroborate such findings in lights of early evidence on the TCFD implementation which points at the same factors representing challenges for an effective CC disclosure. This analysis could be of interest for academics, to develop future research on relevant although controversial areas, and for firms, policy makers and other stakeholders to unveil critical issues to be considered in the implementation of CC reporting.

Climate Change disclosure; Climate Change Reporting; Carbon disclosure; Carbon Reporting; TCFD

Climate Change Reporting: Eine Kommentierung von Kernthemen

Unternehmen werden mehr und mehr als Schlüsselakteure für die Erreichung von Nachhaltigkeitszielen, einschließlich Maßnahmen zum Klimawandel (KW), angesehen. Die Berichterstattung von Unternehmen über Kohlenstoffemissionen und andere den Klimawandel betreffende Themen wird als grundlegend angesehen; nicht nur um den Beitrag von Unternehmen zur Bekämpfung des Klimawandels zu bewerten, sondern auch um zu beurteilen, wie sich der KW auf Organisationen auswirkt und wie sich diese entsprechend anpassen. Auch das Financial Stability Board erkennt die Bedeutung der Berichterstattung zum Klimawandel an. Im Jahr 2015 rief es die Task Force on Climate Related Financial Discosure (TCFD) ins Leben, die Empfehlungen für eine wirksame Berichterstattung zu Themen des Klimawandels herausgibt und deren Umsetzung fördert. Die bisherige Forschung liefert widersprüchliche Ergebnisse bezüglich der Faktoren, die die Umsetzung der KW-Berichterstattung erleichtern. In diesem Kommentar begutachte ich die bisherige Literatur zur Berichterstattung zu klimarelevanten Themen mit einem besonderen Schwer-

punkt auf den neuesten Erkenntnisse zu den damit verbundenen wesentlichen wirtschaftlichen und ökologischen Faktoren. Als Schlüsselfaktoren identifiziere ich Unternehmensgröße, Einbeziehung von Kontrollorganen, Emissionsaktivitäten sowie die Integration in die Unternehmensberichterstattung und Prüfung. Diese Ergebnisse werden durch die ersten Erkenntnisse aus der Umsetzung der TCFD bestätigt, welche auf dieselben Faktoren als Herausforderungen für eine wirksame KW-Berichterstattung hinweisen. Diese Analyse könnte für Akademiker von Interesse sein, um zukünftige Forschung in relevanten wenn auch kontroversen Bereichen weiterzuentwickeln, und für Firmen, politische Entscheidungsträger und andere Interessengruppen, um kritische Themen aufzudecken, die bei der Umsetzung der KW-Berichterstattung zu berücksichtigen sind.

Klimawandelberichterstattung; Kohlenstoffberichterstattung; TCFD

1. Introduction

It is getting harder, even for the more skeptical, to deny the increasing impact of firms on the current climate change (CC) crisis and the urgency to take action to reduce global warming by cutting human made greenhouse gas emissions (GHG), which are considered almost uniquely responsible for temperature rise (*IPCC 2014*; *UNEP 2019*). Business organizations are more and more considered vital actors for CC mitigation as they are important sources of greenhouse gas emissions (GHG). According to the Carbon Majors Report (2017) just 100 companies have been the source of more than 70 % of the world's GHG since 1988 holding the key to systemic change on carbon emissions (*CDP 2017*). Furthermore, with the withdrawal of the US from the Paris Agreement – the global agreement to limit global temperature increase this century, to below 2°C above pre-industrial levels and in the long term, to 1.5°C – the commitment to emission reductions from non-state actors, especially companies, appears even more crucial (*CDP 2017*). At the same time, the risks of CC are having major impacts on global financial systems and companies are adapting to increasingly severe CC and the resulting socio-economic challenges (*Haman/ Borzel 2013*). Indeed, there is increased evidence that companies that are not taking into consideration carbon emissions management will be punished by investors and other key stakeholders: continued temperature increase will result in contending with the ever-greater physical impacts of CC, such as extreme weather events, ecosystem transformations and sea-level rise (i.e., physical risk); in addition, limiting warming to the 1.5°C Paris agreement target, means that companies will face transition risks from the required policy and regulation, such as the introduction of carbon taxes, as well as from technological developments and reputational impacts (*TCFD, 2020*). Many companies have incorrectly viewed the implications of CC to be relevant only in the long term and, therefore, not necessarily relevant to decisions made today. Those views, however, are changing as more information becomes available on the potential widespread financial impacts of climate change (*TCFD, 2020*). As stressed by Larry Page – Black Rock's CEO in January 2020, "climate risk is financial risk" and the "value at risk" from CC (to the total global stock of manageable assets) by 2100 is estimated to be 4.3 trillion US dollars (*EIU, 2015*)[1].

1 According to *Dietz et al. 2016* an expected US$2.5 trillion of the world's financial assets, equivalent to 1.8 per cent of their total value, are at risk from the impacts of climate change if global mean surface temperature is expected to rise by 2.5°C (4.5°F) above its pre-industrial level by 2100. However, uncer-

The Sustainable Development Goals (SDGs), set by the United Nations (UN) as the agenda of objectives to be achieved by 2030 by UN State Members, explicitly acknowledge the fundamental role of companies to address sustainability challenges including CC mitigation and adaptation. In particular, SDG 12 stresses the contribution of the business sector to ensure "responsible consumption and production" with target 12.6 encouraging companies not to adopt sustainable practices but also to inform externally on that through the integration of sustainability information in their reporting cycle (cf. UN SDG 12). Moreover, there is an increasing number of policy initiatives to foster firms' commitments towards CC including the Green Deal by the European Commission with the overarching aim of making Europe climate neutral by 2050. To measure progress against such a target, the Commission proposes the setting of a 2030–2050 EU-wide trajectory for greenhouse gas emission reductions, that will impact all countries and industry sectors (*EC 2020*). Another important initiative is the establishment of the Task Force on Climate Related Financial Disclosure by the Financial Stability Board (FSB) to develop recommendations for more effective climate-related disclosure that should ensure a better understanding of business implications of CC-related risks and opportunities creating an adequate information basis based on corporate voluntary CC reporting[2] (*TCFD, 2020*).

In this context, CC (related) disclosure (hereafter CC disclosure) on firms' efforts and performance regarding carbon emissions appears fundamental (*Hahn et al. 2015*). All these important initiatives are grounded on the idea that corporate transparency on CC issues and challenges could play a key role not only to ensure the transition toward more sustainable, carbon neutral business models but also to bolster economic growth (*TCFD, 2020*). Corporate disclosure on the impact of firms on CC and global warming can be seen as a key catalyst for driving change and realising the ambitions of the Paris Agreement. Moreover, external reporting of quantitative and qualitative CC related information by companies could favour the proper pricing of these risks and, subsequently ensure the effective allocation of capital (cf. *TCFD, 2020; Eccles and Serafeim, 2015*). Prior research stresses the fact that company CC disclosure is considered a way to increase transparency and improved emission management (*Matsumara et al. 2014; Saka et al. 2014; Kumar et al. 2018a and 2018b; Schiemann et al. 2019*). Nonetheless, several challenges have been identified in the literature and practices especially in light of the uncertainty on CC measurement estimation methods that renders assessing CC risks, as well accounting for carbon and other greenhouse gas emissions (GHG), extremely difficult (*Hahn et al. 2015 Milne and Grubinc 2011*).

In this paper, I offer a commentary on key issues (and challenges) related to CC disclosure. Many researchers have analysed the theme of CC disclosure with a particular focus on its determinants (*Hahn et al. 2015*). This study contributes to such existing debate by

tainties associated with climate sensitivity, the cost of damages, productivity growth and the cost of emissions abatement mean that the value of assets at risk could be higher. There is a 1 per cent chance that it could reach US$24 trillion, equivalent to 16.9 per cent of the value of global financial assets.

2 The TCFD was established in December 2015 and published its recommendations for CC disclosure in June 2017. Interim reports on the implementation status of the recommendations followed in September 2018 and June 2019. It is composed of 11 recommended disclosures that met the criteria of consistency, comparability, reliability, clarity and efficiency on the four areas of the organization's governance around climate related risks and opportunities, their impact on the firm's strategy and financial planning, the way the organization identifies, assesses and manages climate related risks and the metrics and targets used for this last aim (TCFD, 2020).

offering an updated review of the literature in the area (cf. *Hahn et al. 2015*) and highlighting fundamental issues and challenges that represents future research opportunities and that firms and policy makers could consider when dealing with this more and more important practice. In particular, drawing upon prior reviews on carbon disclosure (cf. *Hahn et al. 2015*), I evaluate the current state of quantitative empirical research with regard to CC determinants distinguishing between economic, ecological and other factors that predict CC disclosure. To corroborate such evidence, I also look at challenges at implementation that have been highlighted by within the TCFD context (*TCFD, 2019*). As highlighted in the TFCD Status report, there is a very limited level of compliance with disclosure requirements on CC. For this reason, this commentary is primarily concerned with enabler factors that are likely to facilitate more disclosure on these aspects[3].

The remainder of the commentary is articulated as follows. In the next section, I expose the methodology used to perform the literature review and present key findings. I then analyse and discuss open issues and challenges on CC reporting that future studies can tackle and that firms and regulators could consider when embarking on CC disclosure.

2. Prior research on climate change related disclosure

2.1. Methodology

In order to identify the relevant research papers that treat the subject of CC disclosure I follow a systematic and structured approach (*Hahn et al. 2015*). I first conducted a systematic search in relevant databases including Google Scholar using two different keyword sets related to CC (e.g., climate change, carbon; greenhouse gas; GHG; CO2; emissions) and disclosure (e.g., disclosure, reporting, accounting, measurement, assurance), respectively. For each combination of keywords, I checked the first five pages of results and closely read the title and abstract to know if the articles were relevant to the aim of the research. For the aim of the literature review, CC disclosure is conceived as external reporting of CC related information which entails both qualitative (e.g., CDP adherence) and quantitative information (GHG emissions). Secondly, I checked the following top ranked accounting journals; Accounting Review, Accounting, Organizations and Society, Journal of Accounting and Economics, Journal of Accounting Research, Review of Accounting Studies and Contemporary Accounting Research. I used the same process of keyword combinations as before to find the relevant research papers. Thirdly, to be sure all the relevant working papers are included in the list, I also checked the SSRN website. Nonetheless, in this selection, I included only peer-reviewed scholarly articles written in English starting from 2014 to capture references published after the Hahn et al. 2015 review paper. I also checked if the references of 2014 were already included in Hahn et al.

3 In the 2019 TCFD status report, it is shown that CC related financial disclosure has increased since 2016, but is still insufficient for investors. An implementation gap is shown as the percentage of companies disclosing is still low: only around 25 % of companies disclosed information aligned with more than five of the 11 recommended disclosures and only 4 % of companies disclosed information aligned with at least 10 of the recommended disclosures. The Task Force notes that the survey responses are significantly lower in Latin America, Africa, and Asia (excluding Japan), which may potentially indicate greater challenges in adoption of the TCFD recommendations in these regions. Disclosure on resilience of strategy and scenario analysis remains very low, especially for smaller companies. Companies cite this as very challenging to implement and call for a discussion on measurement and details on how to provide it.

2015, and if so, I excluded them. Nonetheless, I analysed in detail prior relevant studies that were cited in the *Hahn et al. 2015* review. Fourthly, I excluded articles that do not represent empirical quantitative studies based on secondary data that represent the most common empirical approach in the area as highlighted by prior studies (*Hahn et al. 2015*). I closely read the introduction of the final list of papers resulting from this search to assess if the content was relevant to CC disclosure in the sphere of individual business related to management, finance or accounting[4].

In line with prior research (*Hahn et al. 2015*), I sorted the article depending on the nature of the determinants: economic determinants refer to the factors that economically push firms to disclose more carbon/CC content in their report (e.g., performance, size); ecological determinants relate to the environmental and emission related factors (e.g., emission level). I also included a residual category made other factors including: regulatory determinants, in the cases where firms make CC disclosures to comply with laws and regulations; disclosure determinants, that reflect the role played by previous disclosure, and other studies that cannot be classified into the previous categories.

2.2. Findings

In line with prior research, I analysed studies on *economic*, *ecological* and *other* determinants of CC disclosure (or carbon disclosure, here used interchangeably). Among the *economic* determinants, the most important driver is the size of the firm. Hahn et al. 2015 identified 17 studies that affirm that big companies are more likely to disclose this type of information than smaller ones. Prior research analysed additional economic CC disclosure drivers such as performance measures, market-to book and leverage but with no significant effects is highlighted with few exceptions (i.e., *Jira/ Toeffle 2013*, on positive effect of performance measure; *Prado-Lorenzo et al. 2009* on positive effect of market-to book; *Cotter/ Najah 2012* and *Wegener et al. 2013* on positive and negative effects on leverage, respectively).The most recent research confirms the presence of a size effect on CC reporting: *Kumar et al. 2019* show that in the Indian voluntary environmental reporting framework, the firm's size together with cross border listing nature and the age of a company play a key role to explain a firm's Carbon Disclosure Project (CDP) disclosure across all industry sectors. Moreover, the same study found a significant effect of additional economic factors including book to market value and leverage in line with the above mentioned studies whereas there is no evidence as to the effect of the firm's profitability. Furthermore, it shows that ownership and other corporate governance variables impact on a firm's carbon disclosure. Similarly, another recent study on Indian firms by *Charuthamii et al. 2019* found that the percentage of women on boards impacts positively the CC disclosure. In this same study, CC disclosure is found to be negatively impacted by CEO duality pointing again at the importance to analyse specific corporate governance characteristics to predict CC disclosure behaviors. Finally, *Giannarakis et al. 2018* demonstrate the importance of economic factors linked to governmental ownership and independent verification of environmental data as they affect the likelihood of CC disclosure (for high liquidity European firms). It appears that among economic factors highlighted by most recent studies, the

4 I identified 12 empirical quantitative studies on CC disclosure determinants and effects but excluded studies on the effects because the primary interest of this research is on the factors favoring implementation which leads to analyse five studies.

most important ones are linked to size and corporate governance factors. Overall, size and corporate governance characteristics point, respectively, at two challenges: size bias and involvement of corporate governance to implement CC disclosure and call for future research on this area.

Among the various *ecological* determinants highlighted by the different research papers, the most important factor is carbon emissions. In particular, it supports the existence of a positive relationship between carbon emissions level and disclosure, meaning that the more a company is associated with GHG emissions, the more it discloses carbon information (e.g., *Apergis et al. 2013; Gallego-Álvarez et al. 2011; Luo et al. 2013; Dawkins et al. 2011*). Nevertheless, a contradictory result was reported in other studies which found a non-significant relationship between GHG emission level emissions and carbon disclosure (*Freedman/ Jaggi 2011, Luo et al., 2013 Reid/ Toffel 2009*). Such conflicting results are also similar to those found with reference to industry variables, and specifically to membership in carbon-intensive industry which tends to be positively associated with carbon disclosure (*Hahn et al. 2015*), but also with many studies finding no, or a negative, relationship (*Wegener et al. 2013 and Yu/Ting, 2012*). Surprisingly, there are relatively limited updates on the literature on ecological determinants of CC disclosure with the exception of *Ott et al. 2016* demonstrating that firms that are best environmental performers (i.e., with lower emission levels) publish their responses to the CDP questionnaire (i.e., disclose more CC related information) whereas weak environmental performers do not. Similarly, *Guenter et al. 2015*[5] find that lower emission intensity in relation to the industry average (i.e., better carbon performance) is associated with higher carbon disclosure. Finally, *Giannarakis et al. 2018* demonstrate that better environmental performance (measured with membership in a specific climate performance leadership index) affects the level of climate change disclosure for European firms. Therefore, a third challenge appears to assess the impact of emission activity on disclosure decisions, especially in light of the controversial findings of prior research.

Other determinants are linked to regulatory factors and specifically to the different laws and regulations that can force or push a business to disclose CC information. Prior research demonstrates that governments are seen to play a major role in motivating firms to address CC issues (*Hahn et al. 2015*). This fact is illustrated by prior research pointing at the positive effect of the Kyoto Protocol and the other GHG specific country regulations on CC disclosure among companies (e.g., *Brouhle/ Harrington, 2009*; *Kim/ Lyon, 2011*). More recent studies demonstrate that a stringent CC policy has a positive link with carbon disclosure (*Guenther et al. 2015*). The results also support a direct positive relationship between carbon disclosure and the relevance of other non-financial stakeholders (e.g., GHG politics, the general public, the media, employees, and customers). This positive relationship means that these stakeholder groups are regarded as relevant actors to whom the firms react by disclosing their CC related efforts. Besides, recent research also demonstrate that in countries in which corporate social responsibility (CSR) regulations are not yet implemented, other factors such as the publication of a CSR report, determine the CC reporting as highlighted by *Ott et al. 2016*. This last effect can be qualified as a disclosure determinant as found by the prior academic literature (*Hahn et al. 2015*). Indeed, past

5 See Guenter et al. 2015 for a detailed review of the studies investigating the environmental (carbon) performance–disclosure relationship.

CSR disclosure affects the implementation of current carbon disclosure suggesting that firms stick with their disclosing behaviors on sustainability issues (*Rankin et al. 2011, Wegener et al. 2013, Stanny, 2013*). The last set of results point to a fourth challenge that is the integration of CC disclosure in existing corporate disclosure (e.g., annual report, sustainability report, integrated report). More research is needed on this specific aspect as explained in the final section of this commentary. Finally, *Datt et al. 2018* expose their findings on carbon assurance and its role. They demonstrate that firms with higher carbon risks are more likely to voluntarily seek carbon assurance. They further show that internal carbon governance attributes play a vital role in maintaining organizational proactivity toward CC issues and that carbon assurance acts as a complementary rather than a substitutive tool for carbon governance. Moreover, findings are consistent with the institutional theory, which predicts that firms in a country with tough climate protection institutions perceive higher regulatory, mimetic, and normative pressures to adopt carbon mitigation measures, including assurance. This points at the final issue on CC disclosure that is the role of assurance, which I will discuss in the next section.

3. Key issues and challenges

Climate-related risk is increasingly the subject of new reporting requirements, such as the European Non-financial Reporting Directive 2014/95/EU, stress testing, and regulatory guidance based on the TCFD recommendations; furthermore, UN Principles for Responsible Investment have argued that the inevitable policy response to climate change will result in a "ratcheting up" of action between 2023–5 to achieve the ambitions of the Paris Agreement, emphasising the importance of climate risk assessment (and disclosure) to smooth repricing and steady potential disruption (*TCFD, 2020*). Regulators and companies in the EU, UK, Japan, New Zealand, Australia and Canada, to name a few, are acting to prioritise and price climate-related risks throughout their financial systems through transparency and disclosure. This issue has also been raised by Mark Carney, the former Governor of the Bank of England and now UN Special Envoy for Climate Action and Finance. He has stated in several occasions that to achieve a carbon-neutral economy, CC disclosure must become mandatory. In June 2017, the TCFD released its final recommendations (*TCFD 2017*), which provide a framework for companies and other organizations to develop more effective climate-related financial disclosures through their existing reporting processes. To better understand current CC disclosure practices and how they have evolved, the TCFD reviewed reports for over 1,000 large companies in multiple sectors and regions over a three-year period and found that the average number of TCFD disclosures made was 3.6 out of 11, with an increase of only 0.8 in two years (*TCFD 2019*). They also stress that given the speed and scale at which action is required to enact the economic and societal transition to meet the Paris Agreement, the rate of growth of CC disclosure is of concern, especially for the stability of the financial, social and environmental system. In this final section, I summarise key issues and challenges on CC disclosure that future research could address and that firms, policy makers and other actors should consider when approaching CC reporting. I further discuss and corroborate such findings in lights of early evidence on the TCFD implementation which points at the same aspects representing critical factors hampering the effectivness of CC disclosure.

3.1 Size bias

The percentage of companies disclosing information on CC tends to increase with company size. Although CC frameworks including the TCFD are voluntary and could be adopted by all organizations despite their size, country or listing status, they are especially adopted (and designed) for large firms. Specific to the TFCD, it has been highlighted that only a very limited percentage of companies comply with all recommended disclosure and, in particular, recommended disclosure on resilience of strategy and scenario analysis appeared particularly low for small companies (*TCFD, 2019*). Disclosing CC information could be difficult to execute also in light of the inclusion of confidential business information no matter firms' size. However, a first issue is the presence what could be defined as size bias: CC disclosure implementation is a challenge that is particularly severe for SMEs, possibly in light of limited resources (including human capacity constraints) to dedicate to CC reporting. Further work should endeavor to seek to understand why companies, especially small companies, lack information to implement CC reporting and assess the impact of a climate transition scenario (*Kumar et al. 2019*).

3.2 Involvement of governance

The role of corporate governance (including ownership and management) in assessing, monitoring and reporting climate-related risks (and opportunities) represent a key issue in CC disclosure. The TCFD sheds light on the fact that limited information is offered on the extent to which climate-related challenges can be overcome by management and governance systems and how such challenges are anchored in the organizational structure. In the same 2019 report, the TCFD further stresses that climate-related issues require the involvement of multiple functions. While sustainability functions are the primary drivers of TCFD implementation efforts, risk management, finance, and executive management are increasingly involved as well (*TCFD, 2019*). Prior research highlighted the importance of the involvement of management and governance to ensure CC reporting implementation. It would be particularly beneficial to study the specific corporate governance characteristics that explain CC disclosure adoption and quality (cf. *Giannarakis et al. 2018; Charumathi et al. 2019*).

3.3 Relationship with emission levels

Thirdly, the relationships between carbon disclosure and carbon emissions represents an open issue: current research on this area provides mixed evidence on this relationship (*Hahn et al. 2015*). Such findings could be ascribed to uncertainties in estimation methods as highlighted by prior research on accounting for carbon and GHG emissions (*Stechemesser/ Guenther, 2012*). The TCFD also emphasises that limited disclosure is offered on GHG emissions notwithstanding with the specific TCFD recommendations on climate related metrics and targets (*TCFD, 2019*). Such evidence could be explained in light of the proliferation of standards for metrics and the measurement options for carbon emissions (cf. *Bush et al. 2010; Murray et al. 2011*) that is indeed considered overwhelming for many companies (*TCFD, 2019*). An important milestone to understand and investigate the relationship between emissions and CC related disclosure, appears therefore to assess existing standards to measure carbon emissions that ensure comparability across different firms (and sectors). Furthermore, it is important to extend the scope of assess-

ment to other environmental performance measures (e.g., water usage, energy usage) used by the organization to manage climate-related risks and opportunities.

3.4 Integration in corporate disclosure

A fourth challenge in the implementation of CC disclosure that need deeper investigation is the integration of CC disclosure within existing corporate reports (e.g., annual report, sustainability reports, integrated report). Prior research tends to analyse CC disclosure focusing on the Carbon Disclosure Project (CDP) framework (*Charumathi et al. 2019; Hahn et al. 2015*). Nonetheless, CC-related information from other sources such as sustainability report, annual reports, integrated reports (and other reporting vehicles) should be analysed as firms tend to employ multiple reports (with different scope and users) to report CC information as also highlighted by TCFD (*TCFD, 2019*).

3.5 Assurance

A final issue to be considered is the assurance of CC related disclosure. Although assurance of CC related financial disclosure is not compulsory, companies could obtain significant benefits from it: the TCFD indeed suggests planning to "use the same quality assurance and compliance approaches for climate-related financial information as for finance, management, and governance disclosures and to prepare the information you report as if it is going to be assured, even if you decide not to do so right now" (*TCFD 2019*). Nonetheless, our review highlights that carbon disclosure assurance currently lacks a common theoretical basis and a question arises concerning whether assurance is only a tool to improve legitimacy (*Hahn et al. 2015; Datt et al. 2018*). More work is needed to understand the role and benefits of external assurance of CC disclosure.

To conclude, this commentary has a limited scope. In particular, it has a primary focus on determinants of CC related disclosure in the attempt to identify and discuss issues (and challenges) that can play in favor (against) of its implementation. Other issues to be considered, although they are not specifically discussed in this review, are the distinction between adoption of CC reporting and quality of disclosure offered and between quantitative and qualitative information. Similarly, the effects of CC reporting and in particular its financial implications should be analysed. As highlighted by *Hahn et al. 2015*, additional studies on the capital market effects of carbon disclosure are needed to develop a better understanding of the confounding results in the existing literature. This is also particularly important for the TCFD as it documented the difficulty in assessing "Financial Impacts of Climate-Related Risks and Opportunities" (*TCFD, 2019*). The relationship between financial performance and climate-related disclosure is not always clear or direct, and, for many organizations, identifying the issues, assessing potential impacts, and ensuring the material issues are reflected in financial filings may be challenging. Indeed, while CC affects nearly all economic sectors, the level of exposure and the impact of climate-related risks differ by sector, industry, geography, and organization. Additionally, the financial impact of CC related risks and opportunities is difficult to assess because of the limited knowledge within organizations on the subject, the focus on short term risks and the difficulty in quantifying climate related risks and opportunities on business operations and finance (*TCFD, 2020*).

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