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# Climate risk disclosures and global sustainability initiatives: A conceptual analysis and agenda for future research

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## Abstract

Climate change impacts, risks and sustainability disclosures have attracted increasing attention from scholars in various streams of the economics and finance literature towards achieving the UN's Sustainable Development Goals (SDGs). Within the stream of climate finance, the global initiatives for corporate social responsibility (CSR) and environment, social and governance (ESG) practices have had important roles in leveraging firms to become more actively involved in environment-related disclosure, in which climate risk reporting is central to evaluating whether and to what extent a firm and its operations are friendly to the environment. Along with the growth of the UN Principles for Responsible Investing in 2005, one of the most recent global initiatives that has been formed is the Taskforce on Climate-Related Financial Disclosures (TCFD), which has considered the climate-related financial disclosure recommendations of G20 finance ministers. Given that TCFD recommendations have recently been released for a broad domain of players (such as banks, investors, insurers and governments) in various countries (e.g., New Zealand, the United States and Japan), we surveyed the most recent studies on the TCFD by using a conceptual framework for climate-related disclosures focusing on studies published worldwide. On the basis of a thorough review, we highlight the essential functions of financial markets and also provide the critical implications for different market players ranging from providers to supporters of the TCFD. Our study offers a timely conceptual review of the TCFD which is critical for stimulating sustainable investments, climate finance and enhanced corporate reporting.

**KEYWORDS**

climate disclosure, climate risk, conceptual analysis, reporting, sustainability initiatives

**Abbreviations:** CSR, corporate social responsibility; ESG, environment, social and governance; FSB, Financial Stability Board; GRI, Global Reporting Initiative; IFAC, International Federation of Accountants; IFC, International Finance Corporation; IPCC, Intergovernmental Panel on Climate Change; SASB, Sustainability Accounting Standards Board; SDGs, Sustainable Development Goals; TCFD, Taskforce on Climate-Related Financial Disclosures; UN, United Nations; UNEPFI, United Nations Environment Programme Finance Initiative; UNFCCC, United Nations Framework Convention on Climate Change; WEF, World Economic Forum.

> Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. But since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil, and gas.
>
> United Nations (2021)

## 1 | INTRODUCTION

Climate change has become an increasingly important topic in recent years. Its consequences have been documented and several scholars, experts and policymakers have suggested solutions and action plans for mitigating its impacts on the global economy, global warming and inverse changes in temperatures and the weather.

Scholars have conducted research in area of Climate Change Adaptation that has clarified the characteristics of climate change in multiple ways, to provide suggestions to adapt to its consequences (Berrang-Ford et al., 2011; Intergovernmental Panel on Climate Change [IPCC], 2001; Smith et al., 2009; Stern, 2006; Weinhofer & Hoffmann, 2010). One of the clear consequences of climate change is the economic effects (i.e. the total damage costs) caused by climate change's externalities that have become larger, more uncertain and more complex (Tol, 2009). More importantly, the industrial sectors such as transportation account for the largest 26% the world's carbon emissions (Chapman, 2007). The complexity and inverse impacts of climate change risks are also linked to a wide range of macro-economic factors such as national security (Barnett, 2003), agriculture (Aragón et al., 2021; Cui & Xie, 2021; Lal, 2021; Smit & Cai, 1996), human health (Kotcher et al., 2021; Meierrieks, 2021), poverty (Tonn et al., 2021), migration (Milán-García et al., 2021; Parsons & Nielsen, 2021) and tourism (Arabadzhyan et al., 2021; Knowles & Scott, 2021).

Since the consequences of climate change have been identified and determined to be an urgent problem, climate change reporting is necessary for entities to make sure they disclose and report useful and sufficient information about climate-related risks that could affect the entity and how they are responding to these climate-related risks (Deloitte, 2021). In this sense, the climate change reporting framework provided by the United Nations Framework Convention on Climate Change (UNFCCC, 2012) has facilitated companies to report climate-related risk information in their main financial reports. This, in turn, has helped investors and capital markets around the globe to take increased action to support the mitigation of and adaptations to climate change risk through providing climate-related information disclosed in financial statements, thereby improving market resilience and achieving sustainable development with a minimized amount of carbon emissions.

Towards such efforts, recent studies have documented climate reporting activities and issues in specific countries such as the United States (Bohr, 2020), the United Kingdom (Ruiu, 2021; Tang & Demeritt, 2018; Taylor & Nathan, 2002), Papua New Guinea (Pascoe et al., 2019), Australia (Debrett, 2011; Foxwell-Norton, 2017; Shea et al., 2020), Sweden (Berglez & Lidskog, 2019; Kleinschmit & Sjöstedt, 2014), Germany (Kaiser & Rhomberg, 2016), Greece (Tsalis & Nikolaou, 2017), China (Yang & Farley, 2016) and other emerging countries (Jeswani et al., 2008; Solomon et al., 2011). These studies indicate the importance and necessity of enhanced climate change risk reporting in mainstream financial statements and these studies ask for greater involvement of international accounting standard setting bodies (Deloitte, 2021; International Federation of Accountants [IFAC], 2021; PricewaterhouseCoopers [PWC], 2021).

To promote the implementation of climate-related reporting by entities, regulatory frameworks play a crucial role. For instance, the European Commission published the *European Climate Law* on 9 July, and this law became effective on 29 July 2021. The main goals are (1) drafting the long-term administration of travel to achieve the 2050 climate neutrality goal via national level policies and reforms; (2) achieving the higher goals of the 2030 EU target and making the EU become more responsible for being climate-neutral by 2050; (3) generating a scheme for monitoring progress and taking further action, if necessary; (4) determining the predictability of climate change's impacts on investors, stakeholders and related entities in the markets; and (5) ensuring that the EU's transition to climate neutrality is thorough and inclusive (European Commission, 2021). In the United States, the Center for Climate and Energy Solutions has presented the '*Federal Action on Climate*', also known as the 'Effective Federal Policy', to achieve an intensive decrease in greenhouse gas emissions and to support climate resilience.[1] Other research and development programmes such as the Advanced Research Project Agency–Energy also aim to promote technological developments regarding the use of clean energy resources and commercialization of those clean technologies.[2] Alongside leading countries such as the US and European economies, regulatory frameworks have also been established by other countries such as New Zealand, with the world's first climate reporting legislation.[3] According to Carbon Brief (2017), the number of climate change laws around the world has increased 20 times since 1997, based on the database of over 1200 climate-related policies from 164 countries that account approximately for 95% of the world's greenhouse gas emissions.[4]

The existence, consequences and severe impacts of climate change are undeniable, with increasing efforts being made by governments, private sector, enviromental activists, NGOs, and policymakers. This highlights the substantial need for and the importance of climate change reporting activities and regulations. Along with the growth of the *UN Principles for Responsible Investing* in 2005 for responsible investments, one of the most recent global initiatives has been formed namely the *Taskforce on Climate-Related Financial Disclosures (TCFD)*, which has considered the climate-related financial disclosure

[1]For more details about the Federal Action on Climate, please visit https://www.c2es.org/content/federal-action-on-climate/.
[2]For further information about the Advanced Research Project Agency–Energy, please visit https://arpa-e.energy.gov/.
[3]https://www.beehive.govt.nz/release/nz-passes-world-first-climate-reporting-legislation.
[4]For further details about the 'Climate Change Laws of the World' database, please visit https://climate-laws.org/.

recommendations made by G20 finance ministers and central bank governors since 2015. Given that TCFD recommendations have been released recently for a broad range of players, we surveyed the most recent studies on TCFD by using a conceptual framework for climate-related disclosures worldwide. On the basis of a thorough review, we discuss the implications for different market players ranging from providers of information to supporters of the TCFD. Our study offers a timely conceptual review of the TCFD which is critical for stimulating sustainable investments, climate finance and general purpose climate reporting. We suggest that future research and implementations of climate-related reporting, particularly the TCFD framework, need an integrated approach that can well articulate existing theory with practice, supported with empirical data, so that such regulations can benefit society and businesses in general (e.g., the regulatory capture theory; Dal Bó, 2006). In this sense, the TCFD framework should be used as the standard for any climate-related activities instead of just being recommendations.

The remaining paper is structured as follows. The next section provides a literature review on climate change laws, policies and regulations around the world. Section 3 presents a comprehensive discussion of the important climate change regulation frameworks and initiatives based on the structured literature review presented in the second section. Section 4 presents the key points with policy and economic implications for further research.

## 2 | LITERATURE REVIEW

### 2.1 | Introduction of TCFD recommendations

Over the past decades, the global economy has witnessed rigorous development of non-financial information because of soft regulations (e.g., the non-financial reporting directive or Directive 2014/95/EU in Europe and the Carbon Disclosure Project,[5] Climate Disclosure Standards Board,[6] the Global Reporting Initiative [GRI],[7] the International Integrated Reporting Council[8] and the Sustainability Accounting Standards Board [SASB][9] at the international level). Such international reporting frameworks have attempted to assist firms, authorities and other organizations to understand and communicate their effects on issues related to the environment, social and governance and other sustainability matters.

Importantly, the climate risk also threatens global financial stability (Farbotko, 2019; Mackenzie, 2016). Two elements of the threat of climate change to the stability of the global financial system include physical risks (e.g., physical phenomena) and non-physical risks (e.g., societies' political, regulatory, legal and financial reactions to climate change).[10] Given these physical and non-physical risks related to climate change, the global financial system simultaneously faces two critical challenges: (1) mitigating economic dependence on fossil fuels and financing climate change adaptions and (2) stabilizing the global financial system that is altering because of climate change and the responses to it. To ensure that firms report information consistently to market stakeholders, the G20's Financial Stability Board, as the TCFD, developed a framework that can be used by companies worldwide across all industries (see Table 1). More specifically, the TCFD framework is designed to address the concern that financial investors seem to be behind the fact that global warming is affecting the investment risks of all industries of the global economy (e.g., the potential risks of assets in the fossil fuel sector and other related industries). The absence of correct information on climate risks could lead investors to inaccurately price and value assets, thus misallocating capital and creating financial instability. The TCFD recommends that data are essential for firms to know the vulnerability risks of their climate change activities and/or for investors to achieve greener portfolios. Hence, it is important to promote climate disclosures that enhance users' understanding of the financial consequences of climate risks (Demaria & Rigot, 2021).

Table 1 shows the four categories of the TCFD's recommendations, including governance, strategy, risk management and metrics and targets.

- Governance: reporting the firm's governance of climate-related risks and opportunities;
- Strategy: reporting the actual and potential impacts of climate-related risks and opportunities on a firm's businesses, strategy and financial planning;
- Risk management: reporting the processes that are used to identify, evaluate and control climate-related risks;
- Metrics and targets: reporting the metrics and targets that are used to evaluate and control the relevant climate-related risks and opportunities.

### 2.2 | Relevant studies on adoption of the TCFD's framework

Although the introduction of the TCFD's framework was unfamiliar and challenging for managers and investors (TCFD, 2017b, 2017c) in the early stage, however, over the recent years, information disclosure (aligned with the TCFD's framework) have significantly enhanced from four percentage points in 2019 to nine percentage points in 2020 (TCFD, 2020). This re-emphasizes the vital trend with the disclosure requirements of the TCFD's framework. Given the increasing importance of the TCFD's recommendations in practice, we observed that several studies have attempted to study the adoption of the TCFD framework and its impacts. The literature shows four strands of studies on the TCFD's recommendations.

[5] https://www.cdp.net/en/guidance/how-cdp-is-aligned-to-the-tcfd.
[6] https://www.cdsb.net/sites/default/files/cdsb_framework_2019_v2.2.pdf.
[7] https://www.globalreporting.org/about-gri/news-center/2019-09-24-driving-alignment-in-climate-related-reporting/.
[8] https://www.tcfdhub.org/resource/international-integrated-reporting-framework/.
[9] https://www.sasb.org/knowledge-hub/tcfd-implementation-guide/.

[10] For more discussion, please see Christophers (2017) and Farbotko (2019).

**TABLE 1** The TCFD's recommendations (adapted from Nisanci, 2021)

| Governance | Strategy | Risk management | Metrics and targets |
|---|---|---|---|
| Disclose the organization's governance around climate-related risks and opportunities | Disclose the actual and potential impacts of climate-related risks and opportunities on the organization's business, strategy and financial planning where such information is available | Disclose how the organization identifies, assesses and manages climate-related risks | Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is available |
| **Recommended disclosures** | | | |
| Describe the board's oversight of climate-related risks and opportunities | Describe the climate-related risks and opportunities the organization has identified over the short, medium and long term | Describe the organization's processes for identifying and assessing climate-related risks | Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process |
| Describe the management's role in assessing and managing climate-related risks and opportunities | Describe the impact of climate-related risks and opportunities on the organization's businesses, strategy and financing planning | Describe the organization's processes for managing climate-related risks | Disclose Scope 1, Scope 2 and (if appropriate) Scope 3 greenhouse gas emissions and the related risks |
| | Describe the resilience of the organization's strategy, considering different climate-related risks scenarios, including a 2°C or lower scenario | Describe how processes for identifying, assessing and managing climate-related risks are integrated into the organization's overall risk management | Describe the targets used by the organization to manage climate-related risks and opportunities and the performance compared with these targets |

### 2.2.1 | Conceptual studies on the TCFD's recommendations

In the first strand, several review studies have provided critical thoughts on the TCFD framework from different perspectives. Most studies in this strand recognized that the adoption of the TCFD's recommendations is challenging but provides opportunities for controlling climate related risks. These studies have demonstrated the significant need for the TCFD framework and the possible implications in practice. Nisanci (2021) provided a good explanation on the emergence of the TCFD framework, especially its implications for the financial sector, including insurance firms, banks, asset managers and asset owners. More importantly, their study outlined the alignment of existing frameworks into the TCFD's recommendations, implying the possible adoption of this framework worldwide across sectors. This was further emphasized by the report of the TCFD (2021a) that the framework had already aligned with other existing Climate reporting frameworks in order to reduce the administrative burden of disclosure specific projects, namely, the frameworks developed by the Carbon Disclosure Project, Climate Disclosure Standards Board, the GRI, the International Integrated Reporting Council and the work of Sustainability Accounting Standards Board (SASB).

Edwards et al. (2020) reviewed the implementation of the TCFD framework and provided some recommendations to the public sector. Their work suggested that the TCFD's recommendations are not a 'sole solution' for mitigating climate risks and perhaps different prerequisites must be satisfied beyond the TCFD's recommendations. Nonetheless, their study emphasized that a better understanding of the TCFD's strengths, limitations and dependencies on the public sector's traits and challenges is important for the success of implementing the recommendations. Furthermore, the slow progress of the TCFD framework may be because its adoption is still voluntary. Myers (2020) discussed the critical issues surrounding the lack of success of climate-related financial disclosures aligned with the TCFD's recommendations. Their main argument is that a mandatory framework should be rules-based, rather than principles-based, as is in the present case. As argued, new legislation should be seriously considered, for example, requiring changes to the Climate Risk Disclosure Act of 2019. This is completely possible. Although many developed countries have taken a voluntary approach to climate-related financial risks. Partly aligned with the TCFD's recommendations, France and Japan are special cases, where mandatory disclosure has been implemented (International Finance Corporation [IFC], 2018a, 2018b). However, details guidelines are not yet available regarding the enforcement of such regulations.

Vizcarra (2020) offered several recommendations regarding how a court can treat climate-related information disclosure under the current regulatory framework. One of the most important aspect is the need to redefine what climate-related information disclosure is, and whether the information is relevant and reasonable; and under what cirmcusmstances the courts and other enforcement bodies may consider the materiality of information disclosures. Additionally, Farbotko (2019) identified climate justice as the missing part from the argument on climate risk disclosures, which must be seriously considered by market forces so that market particpants are not disadvantaged from the consequences of climate reporting.

The literature has shown that disclosures of climate-related financial information aligned with the TCFD's recommendation are more likely to be related to carbon risks and dependencies (O'Dwyer & Unerman, 2020). Other areas that future research may look into includes disclosure relating to air, water, biodiversity and soils. To make timely contributions to the development of the highly impactful and innovative TCFD framework, this requires additional evidence on the effects of many aspects of the TCFD framework across different sectors and also high-quality research insights into various angles of TCFD reporting.

Generally speaking, climate-related financial information disclosure has usually focused less on the banking sector. Park and Kim (2020) offered some discussion on the role of the central banks and financial regulators in terms of the implementation of the TCFD framework. Several authors demonstrated the possible adverse impacts of climate change on financial stability (Campiglio et al., 2018; Dietz et al., 2016). The banking sector is considered to be a key facilitator for low-carbon transaction activities (i.e. green financing) in the economy. The European Center Bank emphasized that it could and should support low-carbon projects within its mandate but it depends more on the European Center Bank members' opinions and viewpoints (Cœuré, 2018). Hence, the role of central banks and financial regulators should be promoted and extended to investors who are more interested in low-carbon transition investments (Park & Kim, 2020).

Along the same lines, Chenet et al. (2021) suggested that the finance sector has gained significant policy traction with the introduction of the TCFD framework, with an emphasis on the vital role of central banks. Their study also proposed a precautionary policy framework to overcome the financial stability risks associated with climate change. The precautionary policy framework approach is designed to enhance current frameworks such as climate-related financial information disclosure and benchmarks, making them standardized and compulsory rather than voluntary.

### 2.2.2 | Studies on the degree of TCFD reporting

Climate risk has received much attention from worldwide practitioners, policymakers and academics. Failure to reduce and adapt to climate change is the most critical risk for the coming years, as emphasized in the Global Risk Report 2020 (World Economic Forum [WEF], 2020).[11] This urges for strong firm-level climate risk disclosure for information of investors, shareholders, regulators and other market participants. Several studies have attempted to examine the degree of climate-related financial information disclosure in line with the TCFD's recommendations in different sectors. Most of them have used document/content analysis based on the annual reports of firms, and the qualitative approach (e.g., interviews and surveys), so a comparison between what has been reported and the TCFD's guidelines can be made. These studies have consistently shown the low level of disclosure. Therefore, significant progress is still needed in the area of corporate reporting. The TCFD (2021a) reported that only one in three firms, on average, disclosed climate-related information aligned with the TCFD's framework. However, De Bernardi et al. (2019), using 40 Italian listed firms with higher market capitalization, and liquidity observed that only half of the analysed firms was ready to disclose information, as recommended by the TCFD. Nonetheless, the disclosure of climate-related financial information may vary among different sectors and geographic regions and even among the four categories of the TCFD recommendations (Bingler et al., 2022).

#### *Variation across different sectors*

The energy and manufacturing sectors have received much attention from academics regarding the introduction of the TCFD's recommendations. Eccles and Krzus (2019) analysed the reports of the 15 largest oil and gas firms by their market capitalization and suggested variations in the disclosure of information among them. Most of them are making relatively modest disclosures but some are disclosing substantially. Similarly, Demaria and Rigot (2021), using French data, found that firms tend to reveal more climate-related risk information, especially in the case of polluting sectors. Another study by Achenbach (2021) observed that the TCFD framework is more relevant in some industries than it is in other industries. The importance of the TCFD framework is more prevalent for publicly listed firms in the global North. Using a sample of 22 firms in the energy sector, Maji and Kalita (2022) also found that the degree of information disclosure is moderate. Nonetheless, these studies have demonstrated that following the TCFD's recommendations is feasible for firms in energy-intensive areas if they are interested in doing so. Indeed, TCFD-supporting firms may simply restructure already existing information in line with the TCFD's recommendation, as much of the information was already being revealed before the arrival of the TCFD's recommendations (Bingler et al., 2022). On the other hand, the analysis by David and Giordano-Spring (2022) of 24 airlines showed that the compliance of firms in the air transport sector with the TCFD's recommendations is fairly poor.

Moreover, the TCFD (2021a) argued that firms in the materials and buildings sector disclosed the most, with an average disclosure level of 38% for the 11 recommended disclosure requirements. However, Bingler et al. (2022), using a climate BERT tool as a transformation-based language model on the TCFD reports of 818 companies, showed that energy and utilities disclosed the most, followed by transportation and financials, whereas materials, industrials and real estate exhibited lower than average disclosure levels between 2014 and 2019.

Since the TCFD's recommendations were introduced, only a few studies have been undertaken in the banking sector and have reported contradictory findings. Elliott and Löfgren (2022), studying the reports of the top 10 banks that are the most active in lending to the fossil fuel industry, showed that little has been said about how climate change may influence banks, and these banks have few narrative statements related to climate change in their annual reports. Their

[11] According to the predictions of the Swiss Re Institute, climate change may wipe out 18% of the GDP of the global economy by 2050 if the global temperature increases by 3.2°C. Please see https://www.weforum.org/agenda/2021/06/impact-climate-change-global-gdp/.

textual analysis indicated that banks seem to be keen on supporting the TCFD's recommendations. Their observations are in line with other analyses and early reports that there is a lack of sufficient detail on corporate climate-related financial risk disclosure in general (Hell et al., 2020; Paisley & Nelson, 2020). In contrast, a survey by Nelson et al. (2021) indicated that 77% of banks made disclosures in line with the TCFD's recommendations, of which 46% of disclosures were considered to be of fairly good quality. The mixed results on the information disclosure of banks may depend on the existence of a CSR committee in the banking structure. Cosma et al. (2022), using a sample of 101 European banks, argued that these banks somewhat achieved an intermediate level of information disclosure aligned with the TCFD framework.

It is acknowledged that the TCFD's recommendations concentrate on promoting a standard for disclosure of banks' risk management and strategies for climate-related finance. However, it seems to ignore whether these strategies can limit banks' carbon footprint. Furthermore, Elliott and Löfgren (2022) noticed that several international banks (e.g., Barclays, JP Morgan and MUFG) sometimes stated their commitment to improving due diligence and lending restrictions on controversial industries such as fossil fuels. This is comparable with the observation of Park and Kim (2020) that most financial institutions seem to be inactive in offering green banking products and services because they are often recognized as commercially inviable.

### *Variation across geographic regions*

The adoption of the TCFD framework may also vary across different geographic areas. David and Giordano-Spring (2022) revealed that the TCFD's recommendations somewhat align with the compulsory measures recognized by airline firms in some regions and encourage the formulation of global standards for climate reporting. Bingler et al. (2022) found that TCFD-supporting companies headquartered in North America and Europe disclosed more information than those in Asia. North American companies may disclose more information about strategy. According to the report of the TCFD (2021a), Europe was the leading area for disclosure, with the highest average level of disclosure for the 11 recommended criteria in 2020. This may be the reason why most relevant studies have primarily focused on this region, as mentioned earlier. Therefore, future research could look at whether or not TCFD reporting may vary between emerging and developed markets (Maji & Kalita, 2022).

### *Variation among the TCFD's categories*

In addition, the literature also indicates a certain degree of disparity across the four thematic areas of the TCFD's recommendations despite ongoing enhancement in each category. Bingler et al. (2022) stated that there have been improvements in disclosure on the four categories of the TCFD's recommendations. Given that information disclosure is unequal, governance and risk management disclosure have increased, whereas disclosures on strategy and metrics and targets have remained at a relatively low level with marginal increase over the recent years. Disclosures on strategy and metrics and targets are generally lower than those on government and risk management for all sectors, except for energy and utilities. Nonetheless, this is in line with the findings of the TCFD (2020). On the contrary, Eccles and Krzus (2019) indicated that the disclosures on three categories (governance, risk management and metrics and targets) were relatively the most deficient for the case of the biggest oil and gas companies. Demaria and Rigot (2021), however, noted that French firms tend to focus more on disclosures on the metrics and targets and risk management categories. De Bernardi et al. (2019) showed that that risk management and metrics and targets categories were, in general, comprehensively reported in Italian listed firms, adhering to the TCFD framework by more than 80% and 65%, respectively. Disclosures on the governance and strategy categories, however, were seen as relatively poor. This is comparable with the observation of David and Giordano-Spring (2022) that the core element of strategy in the TCFD's recommendations is poorly disclosed in the air transport sector. Their findings also demonstrated that the physical risk is most often reported by the highest number of firms, whereas reputation was the area of risk with the least disclosure. Nonetheless, the different types and categories of risk disclosures are far behind the TCFD's recommendations.

Given that the low level of disclosure in the strategy category, as found by several studies, a recent report of the TCFD (2021a) provided a closer look at the strategy related disclosures of firms across the globe. For example, the area with the highest level of TCFD disclosure was *Strategy A* in the recommendations, since over 50% of firms included such information in their 2020 reports. The lowest disclosure was found for *Strategy C* in the recommendations (so-called disclosure of the resilience of firms' strategies under various climate-related events), although it was increased from 5% of firms in 2018 to 13% in 2020. The second least disclosed area was governance, regardless of materiality. In addition, the insurance industry was the leading group in disclosing risk management processes (Risk Management B in the TCFD framework) with at least 15%.

In general, the studies using content/document analysis showed mixed findings because the adoption of the TCFD's recommendations is still voluntary. Therefore, firms are free to report in an inconsistent way. Sanderson et al. (2019) also stated that most disclosures rely frequently on qualitative rather than quantitative information. This has induced a limited number of studies to use different techniques to construct the overall disclosure score of TCFD adoption when investigating firms' disclosure levels. Notably, the study of Amar et al. (2022) proposed a novel composite index, namely the Climate Risks and Opportunities Reporting Index to initially assess the level of compliance of French firms to the TCFD framework. The most critical part in their proposed index is to determine the weights assigned to each question and sub-question in development of a weighted index. Using four rules to identify the weighted values and the principal component analysis method as alternative method, their findings indicated an overall enhancement in the Climate Risks and Opportunities Reporting Index over the examined period but significant sectoral disparities and large variation in four themes of the TCFD's recommendations. Similar to prior studies such as those of De Bernardi et al. (2019) and David and Giordano-Spring (2022), their results also

revealed that firms tend to be less compliant with the 'strategy domain' of the TCFD framework. They also concluded that the sectors most exposed to climate risks and opportunities (e.g., non-financial but controversial sectors and the financial sector) are more likely to be compliant.

The study of Siew (2020) introduced a simple TCFD index using a binary method where a value of 1 is assigned if one of the elements is present and 0 if the element is not indicated. The combined score of each of these elements makes up the overall TCFD index. In addition, their study also used a continuous approach by using rating scores on a Likert-type scale obtained from a group of experienced and professional experts. The results of both methods suggested a very poor level of adoption and disclosure quality aligned with the TCFD's recommendations in 100 Malaysian listed firms in the construction sector. A slightly different method (a binary method) was developed by Maji and Kalita (2022), who used an overall score based on a 3-point scale for the seven principles. A firm receives a value of 2 if the disclosure is relevant to each of the principles, and 1 otherwise. A value of 0 is assigned to a firm if the category is not disclosed in its report. The overall disclosure score does not exceed a value of 154. They suggested that the disclosure level of Indian firms in the energy sector is moderate.

### 2.2.3 | Empirical studies on the effect of adopting the TCFD framework

Since the TCFD provided the first disclosure framework that closely considers how climate-related risks and opportunities materially affect a firm (TCFD, 2021b), the effects of adopting the TCFD framework on a firm's operation and performance are investigated in the third strand. At the time of writing, one study by Maji and Kalita (2022) examined the impact of climate change-related disclosure following the TCFD framework on firms' performance in India. Their finding documented a positive relationship between these factors in the energy sector. A lack of empirical evidence on the positive effects of adopting the TCFD framework can be explained by several factors. These may include the current lack of data, the challenges of reporting scope across countries and methodological issues (Network for Greening the Financial System [NGFS], 2019).

It has been argued that TCFD framework is strongly encouraged by regulatory bodies worldwide without any supporting empirical evidence. Therefore, we strongly encourage future studies to test the relationship between climate-related financial information disclosure and firms' value/performance using firms from different sectors using either the proposed disclosure scores mentioned above or by constructing their own indices. Additionally, cross-country analysis could be carried out in the future, especially for countries where the TCFD's guidelines for climate change-related financial disclosure are widely promoted. Furthermore, the analysis of Cosma et al. (2022) on the European banking sector demonstrated that disclosure vulnerability and board characteristics tend to play an essential role in promoting the adoption of the TCFD framework. The literature suggests that firms' value/performance is significantly affected by corporate governance (Bhat et al., 2018; Fatma & Chouaibi, 2021). Future research may consider the role of corporate governance in explaining the relationship between adoption of the TCFD framework and firms' performance in different sectors where the data are available. Further, future research may also consider relevant factors that might moderate the relationships among climate change risk disclosure and firm reputation, stock volatility and the cost of capital.

Given the main focus on the TCFD framework, we observed that the climate-related financial information aligned with the TCFD's recommendation has not been discussed and covered by credit rating agencies. To further support the adoption of the TCFD framework worldwide, the importance of international rating agencies needs to be emphasized. This may push firms to more disclose climate-related financial information following the TCFD framework (Courbage & Golnaraghi, 2022). Therefore, future studies should also consider the role of credit rating agencies in explaining the relationship between climate-related financial disclosure and firms' performance and value.

Last but not least, several studies have argued that the integration of risk management, as recommended by the TCFD framework, is crucial for revealing the daily practices of climate risk management (Bryant et al., 2020; Labelle & Rouleau, 2017; Palermo et al., 2017). In this regard, we suggest that future research could investigate how the TCFD's recommendations impact organizational risk cultures and what the implications are for strategic chief risk officers regarding climate risk management that is compliant with the TCFD's requirements.

### 2.2.4 | Studies on the determinants of adopting the TCFD framework

In the last strand, several studies have considered the factors that affect firms' adoption of the TCFD's recommendations. Sanderson et al. (2019) suggested that adoption of the TCFD framework will be driven by market demand such as investors, the supply and value chain of firms and insurers. In reality, the survey by HSBC of 2000 investors demonstrated that investors are seemingly uninterested in information about the companies' shift to a low-carbon economy. More specifically, only 10% of the surveyed participants recognized TCFD-style disclosures as a relevant source of information (Hook & Vincent, 2020). Investors' awareness of low-carbon projects might be a critical factor for determining firms' disclosure. Future research may take a closer look at this aspect.

A very limited number of empirical studies have investigated the factors that are likely to affect the disclosure of climate-related risk information following the TCFD's recommendations. To the best of our knowledge, Achenbach (2021) used a sample of global North countries to identify the intrinsic and extrinsic factors that influenced the level of climate risk reporting following the TCFD's recommendations. The corporate characteristics included the goal of strategic adaption, the desire to determine potential opportunities and the will to engage more with stakeholders. The extrinsic factors included

investor decisions, policy and legal reforms, the risk of litigation and alignment with other sustainability benchmarks.

Therefore, we invite future studies that provide a better understanding of factors that can affect the level of disclosure. Early studies showed that compliant disclosure was primarily explained by better environmental performance for firms listed by S&P 500 (Giannarakis et al., 2017), board effectiveness (Ben-Amar & McIlkenny, 2015) and Brazilian companies' size and financial performance (Kouloukoui et al., 2019). Thus, these factors could be considered in future work. Given the discussion on the possible impact of climate change-related financial disclosure on firms' performance and the operations of businesses, the reverse possibly occurs, disclosures may be affected by the firms' characteristics. It has been noted that climate change is also an opportunity for businesses to fulfill their CSR commitmmentsand contribute to the UN sustainable development goals (United Nations Environment Programme Finance Initiative [UNEPFI], 2021b). Therefore, future research may also consider the bidirectional relationship between firm performance and disclosure.

Given the worldwide impact of the COVID-19 pandemic, a proposed framework that considers COVID-19 pandemic implications is also necessary. When reviewing pandemic-related financial measures, D'Orazio (2021) demonstrated that macro-prudential reactions to the pandemic tended not to involve climate risks or green lending (Indonesia was one of the exceptional countries).[12] With the ongoing spread of new variants of the COVID-19 virus, governments worldwide may focus on macro-policies to recover the economy and help businesses back to normal operations, and therefore, green development may be ignored, at least in the coming years. Hence, the disclosure of climate change-related financial information is considered to be important for all market participants during the post-pandemic period. Future work may consider the COVID-19 pandemic (e.g., governments' responses to the COVID-19 crisis) when examining the determinants of climate risk information disclosures, examining the link between climate risk disclosure and firms' performance.

## 2.3 | The implementation of the TCFD

The previous sections have shown that there are both risks and opportunities that arise from climate change for the present as well as for the future. Although individual businesses or even nations have considered and adjusted their activities to reduce their negative environmental impacts such as emissions, there is a need for a systemic regulatory framework to guide the entities involved in these activities. The Financial Stability Board (FSB) established the TCFD in December 2015 in response to a request from the G20 to develop consistent recommendations for climate-related financial risk disclosures to businesses and investors that could provide more information to stakeholders. In June 2017, the TCFD released its Final Report on Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD, 2017a) to help businesses disclose their climate-related financial information. This report covers four core elements of businesses (including governance, strategy, risk management and metrics and targets) that relate to climate-related financial risks. Although the TCFD's recommendations are voluntary, they help businesses to identify and share both climate change risks and opportunities to their stakeholders. In fact, the adoption of those recommendations is expected to (i) ensure that the effects of climate change are routinely accounted for in business and investment decisions, (ii) help companies to demonstrate their responsibility and foresight included in their activities regarding climate change and (iii) lead to a more efficient allocation of capital and investment can help businesses and nations to transit to a more sustainable, low-carbon economy (TCFD, 2017a). By providing only high-level guidance, the TCFD allowed various industries to find the best way of disclosure that best suited to their specific needs and exposures. Such interpretation and implementation of the TCFD's recommendations therefore require effort and ingenuity by businesses and have left some businesses in a confusing situation of what and how to disclose.

Consequently, in October 2017, the UNEPFI began a series of TCFD Pilot Projects to provide a first but critical step for banks, investors and insurers to respond to the TCFD's recommendations (2018).[13] More than 70 financial institutions including 39 leading international banks such as ANZ, Barclays and Standard Chartered (UNEPFI, 2018, 2020); 20 institutional investors such as Aviva, KLP and Rockefeller Asset Management (UNEPFI, 2019); and 22 leading insurers and reinsurers across the globe such as Allianz, IAG, Lloyds Banking Group and TD Insurance (UNEPFI, 2021b) have participated in these pilot studies. To date, the pilot studies on investors and insurers have completed the first phase, whereas that on banks has completed its second phase (UNEPFI, 2021a).

With the help of the UNEPFI and other supporters such as the World Business Council for Sustainable Development, the UN Principles for Responsible Investing and the SASB, the number of firms and entities that support the TCFD's recommendations has quadrupled over the past few years, increasing from 513 in 2018 to 2616 in 2021 (TCFD, 2021a). Several nations have also proposed or finalized laws and regulations for disclosure mandates, some coming into effect as early as 2022 (see Figure 1 and Table 2).

Despite the relatively high interest and support by both nations and businesses—as of October 2021, more than 2600 entities and institutions had signed up as supporters of the TCFD's recommendations (TCFD, 2021a)—there is still no detailed guideline on what to disclose and, more importantly, how to disclose the climate-related risks for these entities and institutions. In the next section, we will discuss some options to improve the climate change risk reforms and initiatives in the near future.

[12]For example, the minimum limit of down payments on green automotive lending was reduced from 5% to 10% to 0% for banks with a non-performing loans ratio below 5%.

[13]It took 6 months for the first report, UNEPFI (2018) on 16 international banks in the TCFD Banking Phase I pilot project to be released in April 2018.

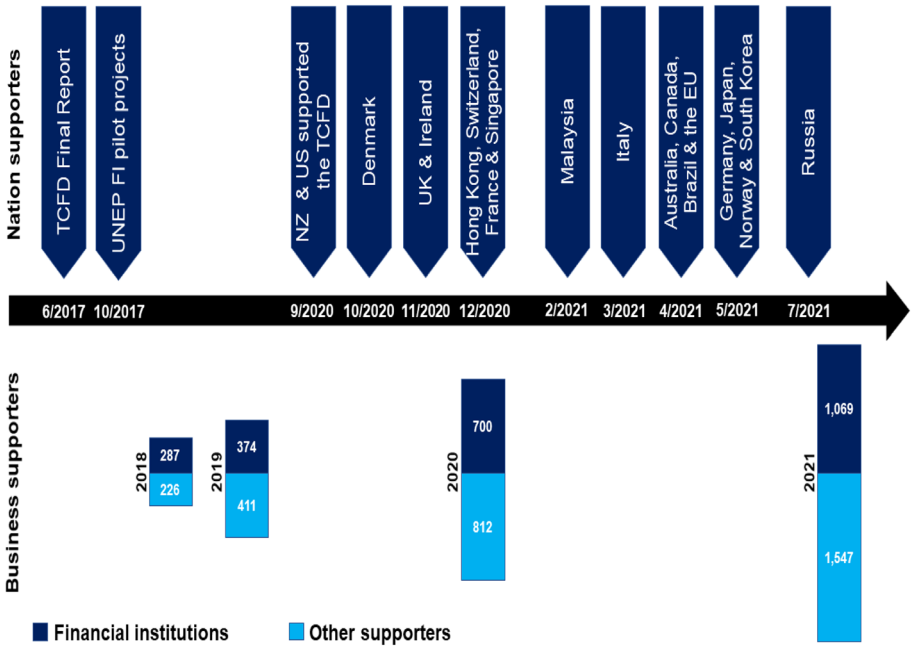


**FIGURE 1** Milestones of the TCFD's recommendations and regulation initiative. *Source*: Compiled from TCFD (2021a)

***Source**: Compiled from TCFD (2021).*

## 3 | DISCUSSIONS

This section discusses some directions for the future development of climate change disclosures and initiatives. Specifically, we suggest that future research and implementations of climate-related reporting, particularly the TCFD framework, needs to follow an integrated approach that can connect theory and practice, in which the TCFD framework is used as the standard for any climate-related activities instead of just as recommendations.

### 3.1 | An integrated framework

Most studies have focused on how climate change affects businesses and how businesses should disclose these risks, but not on how those disclosures affect the operations and performance of businesses (e.g., costs or sales, ROA, ROE, etc.). It has been noted that climate change is also an opportunity for businesses (TCFD, 2021). This bidirectional relationship between climate risks and firms' operation/performance are multidimensional and complex. For example, perceptions of risk are different among businesses and industries (UNEPFI, 2020). Climate risks also involve different aspects such as physical risks, transition risks and litigation risks and each of these also involves many other subcomponents (TCFD, 2017a). Climate change also involves many issues such as greenhouse gas emissions, water or waste pollution and even natural disasters. In this sense, studying climate change disclosures and initiatives needs to take a multi-criteria and integrated approach.

### 3.2 | The missing link between theory and practice

As shown in Section 2, the confounding findings in the literature can be explained by the following reasons. The issue of data quality and related data accessibility issues are likely to create barriers to accurate information disclosure (Mackenzie, 2016). Because the TCFD's recommendations are on a voluntary basis, firms can be flexible about which topics need to be disclosed. This may make it difficult for researchers to access comparable data across the globe. Therefore, there is a gap between theory and practice on the impact of the TCFD's voluntary framework on firms' performance and vice versa. Even though certain companies may report a large amount of climate change-related financial information, it may be considered irrelevant and perhaps inconsistent with their behaviour. Bingler et al. (2022) emphasized that supporting the TCFD's recommendations is seen as 'cheap talk' and is related to 'cherry picking' disclosures on TCFD criteria involving the least materially relevant information. This, in turn, may lead to the findings of empirical studies becoming biased and not reflecting the true situation. Future studies should consider the quality and the relevance by comparing environmental communications with companies' investment practices. Nonetheless, climate-related financial disclosure aligned with the TCFD's recommendations is considered to be only the beginning of the answers needed to understand the complicated climate-finance dynamics (Espagne, 2018).

Furthermore, Christophers (2017) outlined several concerns about the capacity for climate risk reporting that is also relevant to the TCFD framework, including (a) the issue of who has access to such information (e.g., whether investors have the right incentives to act

**TABLE 2** Countries that have announced disclosure regulations

| Year started | Nation | Announcement |
|---|---|---|
| 2020 | New Zealand | September 2020: The Minister for Climate Change announced government plans to make climate-related financial disclosures mandatory for certain publicly listed companies and large insurers, banks and investment managers and that reporting would be against a standard developed in line with the TCFD's recommendations.<br>April 2021: The Financial Sector (Climate-related Disclosure and Other Matters) Amendment Bill was introduced to Parliament. If passed, the legislation would enter into force within 12 months after receiving royal assent. |
| 2020 | United States | September 2020: The Commodity Futures Trading Commission's Climate-Related Market Risk Subcommittee released a report titled *Managing Climate Risk in the U.S. Financial System*, urging regulators to consider the TCFD's recommendations in rulemaking.<br>March 2021: The Securities Exchange Commission launched a public consultation regarding the potential regulation of climate risk disclosure, highlighting the TCFD as an international reporting framework for regulatory consideration. The results of this consultation in July 2021 revealed a strong support for mandatory (TCFD) climate-related disclosure.<br>September 2020: *The New York State Department of Financial Services* announced several actions guiding its insurers to start developing their approach to climate-related financial disclosure and to consider engaging with TCFD and other initiatives when doing so. |
| 2020 | Denmark | October 2020: Denmark declared its support for the TCFD, urging companies to commit to TCFD-aligned climate disclosures in building a more resilient financial system. |
| 2020 | Ireland | November 2020: Finance Minister Paschal Donahue publicly announced that the government was actively encouraging greater uptake of the TCFD's recommendations among Irish firms. |
| 2020 | Hong Kong | December 2020: The Monetary Authority and the Securities and Futures Commission announced that TCFD-aligned disclosures would be mandatory across relevant sectors by 2025.<br>July 2021: The Monetary Authority issued draft guidance for organizations such as banks and deposit-taking companies to align their climate-related disclosures with the TCFD's recommendations. |
| 2020 | Switzerland | December 2020: The Federal Council officially advised Swiss companies to apply the TCFD's recommendations immediately.<br>January 2021: Switzerland became an official supporter of the TCFD.<br>June 2021: The Financial Market Supervisory Authority amended its 'Disclosure—Banks' and 'Disclosure—Insurers' circulars to include disclosures of climate-related financial risks; these disclosures are based on the recommendations of the TCFD. For large banks and insurance companies, these amended circulars would enter into force as early as on 1 July 2021. |
| 2020 | France | December 2020: Following the 5-year anniversary of the Paris Agreement, the 40 largest French companies listed on the CAC40 index declared their support for the TCFD. An official statement of support was signed by multiple government officials and demonstrated French commitment to building a more climate-resilient financial system through enhanced TCFD-aligned disclosures. |
| 2020 | Singapore | December 2020: The Monetary Authority of Singapore issued its 'Guidelines on Environmental Risk Management for Banks', 'Guidelines on Environmental Risk Management for Asset Managers' and 'Guidelines on Environmental Risk Management for Insurers'. These guidelines emphasized that disclosures should be in accordance with well-regarded international reporting frameworks such as those recommended by the TCFD.<br>June 2021: The Monetary Authority of Singapore announced that all banks, insurers and asset managers in Singapore were expected to make TCFD-aligned climate disclosures from June 2022. |
| 2021 | Malaysia | February 2021: The Joint Committee on Climate Change announced its intention to support the (voluntary) implementation of climate-related disclosures aligned with the TCFD's recommendations. |
| 2021 | Italy | March 2021: The Commissione Nazionale per la Societa' e la Borsa announced its formal support for the TCFD recommendations. |
| 2021 | Australia | April 2021: The Australian Prudential Regulatory Authority published draft guidance for banks, insurers and superannuation trustees on managing the financial risks of climate change. This draft was aligned with the TCFD's recommendations and was expected to be finalized before the end of 2021. |
| 2021 | Canada | April 2021: Canada published its *2021 Federal Budget* and included multiple stipulations related to alignment with the TCFD's recommendations, with the objective of making its businesses' climate disclosures consistent with the TCFD's recommendations. |
| 2021 | Brazil | April 2021: The Central Bank of Brazil issued a public consultation on TCFD-aligned rules for the disclosure of social, environmental and climate-related risk management.<br>September 2021: The Central Bank of Brazil issued the final disclosure rules. |
| 2021 | European Union | April 2021: The European Commission issued a proposed Corporate Sustainability Reporting Directive to amend the existing reporting requirements to be in line with the TCFD framework. |

**TABLE 2** (Continued)

| Year started | Nation | Announcement |
|---|---|---|
| 2021 | Germany | May 2021: The Finance Ministry published a sustainable finance strategy, stating that it would promote the TCFD's recommendations in Germany, as well as at the G7 and G20 levels. |
| 2021 | Japan | May 2021: The Financial Services Agency; the Ministry of Economy, Trade, and Industry; and the Ministry of the Environment released their final 'Basic Guidelines on Climate Transition Finance', which included several references to the TCFD framework. |
| 2021 | Norway | May 2021: The Finance Ministry announced Norway's official support for the TCFD. |
| 2021 | South Korea | May 2021: The Financial Services Commission, along with 13 other relevant institutions, declared the country's official support for the TCFD. |
| 2021 | Russia | July 2021: The Bank of Russia published recommendations for public joint-stock companies to disclose environment, social and governance-related information—these recommendations were based on both the TCFD framework and GRI standards. |

*Source*: Compiled from TCFD (2021a).

on what information is reported); (b) the extent to which climate risks to the global financial system can be correctly perceived, calculated and managed; (c) whether information disclosures can be processed by market actors and at what costs; and (d) whether the herd behaviours of investors might undermine rational risk calculations. These concerns are perhaps described as political issues (Thistlethwaite, 2015) or 'selected information disclosure' issues. Hence, it is argued that climate-related disclosures in line with the TCFD's recommendations are not enough to secure a stable world economy and a safe global climate. Ameli et al. (2020) stated that transparency, as promoted in response to the TCFD framework itself, will not be an adequate response. They suggested that transparency can overcome behaviour biases and increase pricing and market efficiency, but makes the strategic limitations of the efficient market hypothesis more serious. Farbotko (2019) suggested that social equity and the politics of a 'safe' climate–finance system are barely recognized and have seldom been discussed in the climate risk disclosure framework. Justice is therefore missing in climate risk disclosure arguments and must be considered by the market forces. The common agreements on the climate risk disclosure framework should be made mandatory rather than voluntary, as at present, in firms' mainstream financial reports to further support justice in climate-related matters. This would help researchers provide more empirical evidence on the topic of climate-related disclosure aligned with the TCFD's recommendations.

### 3.3 | From recommendations to standards

It is acknowledged that the TCFD framework was developed on a voluntary disclosure basis. However, several studies, as above, have highlighted that voluntary risk disclosure aligned with the TCFD's recommendations seems insufficient to make a remarkable change in investments and firms' behaviour or even banks' lending behaviour towards low-carbon projects (Ameli et al., 2020; Christophers, 2019). The consistent agreement by researchers is that a mandatory TCFD framework should be rules-based rather than a voluntary basis (Myers, 2020). This point was further demonstrated by Caldecott (2020), who stated that the targets and transition plans of alignment with climate outcomes via the TCFD's recommendations should be made obligatory for all financial institutions as soon as possible. O'Dwyer and Unerman (2020) also observed that there is a very limited number of accounting studies on potentially transformative TCFD reporting, whereas one of the main reasons is a lack of awareness among accounting researchers on how accounting could achieve the UN's Sustainable Development Goals because the adoption of the TCFD's recommendations is still voluntary.

Understandably, the transformation from the TCFD's recommendations to mandatory standards of climate risk disclosure is not an easy task. As mentioned, at least some firms (e.g., in France, Demaria & Rigot, 2021) have reported that most criteria of climate risk disclosures follow the TCFD's recommendations. For example, slightly higher disclosure in Europe can be observed because it is mandated for large listed firms in the EU according to the Non-financial Reporting Directive (Bingler et al., 2022). From the past lessons of the CBDC's framework (Paterson, 2001; Seabrooke, 2014), the adoption of the TCDF's framework can be a process of deliberation and 'learning by doing' that requires all market participants to interpret how climate change-related financial reporting affects their interests.

The UNEPFI provided some pilot studies on how these recommendations can be applied by banks, investors and insurance companies. However, there is a lack of step-by-step guidance for other types of businesses. It is also noted that beside the TCFD recommendations, there are other reporting standards such as the GRI, Climate Disclosure Standards Board and SASB, so the next step is to improve the TCFD's recommendations into standards to (i) better help businesses follow them and to (ii) increase the transparency and comparability of climate risk assessments (UNEPFI, 2021a). Bingler and Colesanti Senni (2022) used 16 climate transition risk tools to analyse firm level disclosure with climate-related financial information aligned with the TCFD's recommendations. They argue that once the TCFD's recommendations have become standardized, it is expected that tool setup and modelling assumptions should be almost equally reported. This

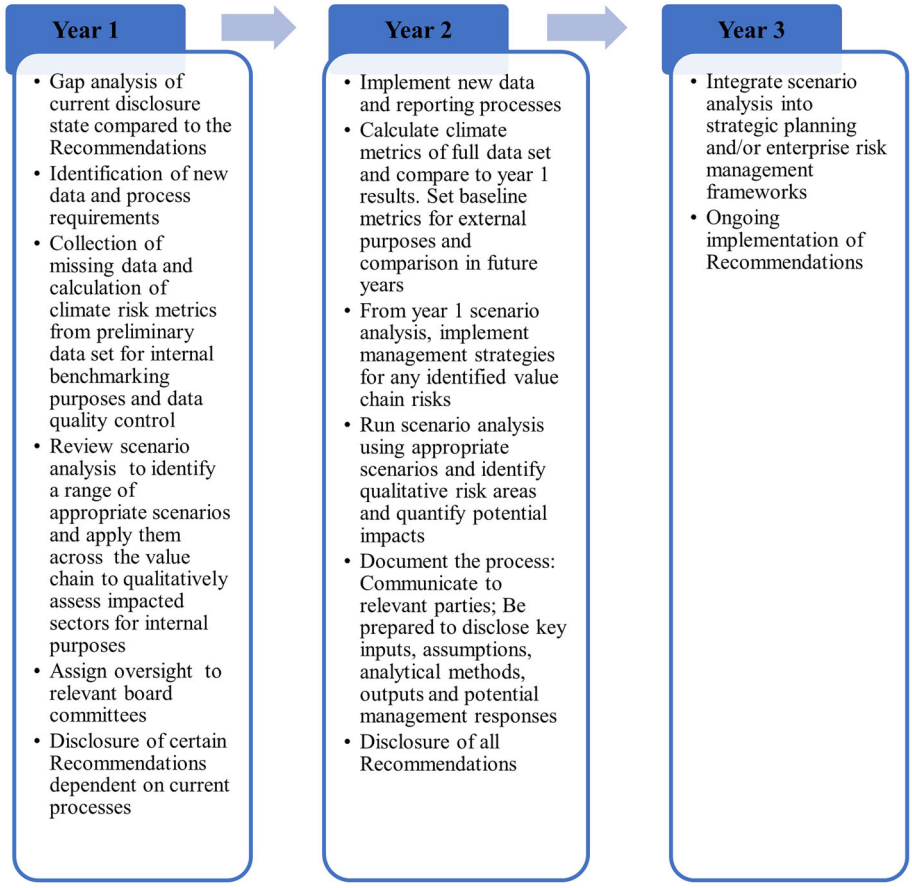


**FIGURE 2** The roadmap of implementing the TCFD's recommendations. *Source*: Adapted from EY (2017)

would make it easier for readers to interpret the disclosed climate risk metrics.

The proposed questions in the TCFD framework in operational terms were found to be too precise and sometimes redundant because of the repeated information in different sub-areas. This may require a proper review to reach a commonly agreed list of questions to avoid creating an administrative burden of disclosure for firms and practitioners. However, the TCFD's recommendations have made substantial progress in making climate risk disclosures better and more transparent. Nevertheless, EY (2017) proposed an optimistic timeline for implementing the TCFD framework, as shown in Figure 2. This progress may require firms to gather new types of information and data from their supply chains and integrate new processes and governance structures. Incorporating these changes into firms' existing operations is a time-consuming process and many organizations across different sectors will begin their journey to full implementation.

In summary, it may be difficult to follow the TCFD's recommendations at first, but firms should at least start complying it as soon as possible to reach a common standard. EY (2017) suggested that firms should show investors that they are making progress, and they can start this by adopting the TCFD's recommendations.

## 4 | CONCLUSIONS

Since climate-related risk has emerged as one of the undeniable 'chronic problems' facing the world, entities, investors and governments in many countries have proposed regulatory frameworks, governance models and climate-related risk reporting standards. However, no single governance system in different countries has received widespread acceptance worldwide, which is a great challenge to climate risk disclosure by firms (Griffin & Jaffe, 2022). Hence, G7 countries like the United States and other countries are putting in efforts to construct a common governance framework for making climate risk disclosure mandatory for firms, which is expected to be accepted globally in order to address the disparity among different countries' regulatory frameworks.

Through providing a structured review, synthesis and a proper discussion on climate change risk reporting and regulations around the world, this study has revealed the following important findings, having climate-related policy implications. Firstly, most earlier studies paid substantial attention to the one-way impacts of climate risk on businesses, climate risk disclosure and shareholders' activism, whereas the bidirectional effects of climate risk disclosure on firms' operation and performance have received little attention by scholars. Secondly, regardless of the different regulatory, reporting and climate risk disclosure frameworks used by many countries, the problems of data availability, quality and accessibility are the existing limitations

preventing entities, scholars and governments from comprehensively analysing firms' climate-related risk reporting activities, as these reporting requirements are still applied on a voluntary basis. These problems might lead to unexpected biases in previous scholarly papers and reports on climate risk issues in previous studies implying the potential problem of the missing link between theory and practice. Therefore, besides the recommendations of the TCFD, leading reports developed by auditing firms and governments have been analysed in this paper. With regards to the current climate change risk reporting standards and regulatory frameworks, climate researchers need a more standardized database that is able to provide real data on firm level climate proxies for listed companies from around the worldwide. This would be a good initiative for leading climate risk auditing firms, consulting organisations, enviromental protection bodies, supranational organizations, entities and governments across the globe to design a comprehensive framework of widely accepted standards on detailed climate change risk measures, reporting activities and government systems worldwide.

Within the stream of climate finance surveyed by Stroebel and Wurgler (2021), our conceptual analysis of the TCFD has contributed to the climate change research agenda highlighting the world's most recent sustainability initiatives with a strong focus on climate-related disclosures. From providers and recipients to supporters as the main players, the TCFD highlighted the essential functions of financial markets where we need more comprehensive and detailed climate-related information disclosed and sustainability reporting by firms. Since the trade-off between risk and return is under consideration by market participants, our study conceptualises the increasingly critical contributions of global initiatives like TCFD for promoting sustainable finance and investment with more insightful discussions on climate-related disclosure, supporting the recent studies by Cunha et al. (2021) and O'Dwyer and Unerman (2020).

From this conceptual analysis onward, future studies may provide more formal empirical evidence on the contributions of the TCFD in pricing climate-related risks in financial assets, by proposing theoretical links and developing new methodologies, as reviewed recently by Campiglio et al. (2022). Since climate-related disclosure and sustainability reporting are supported by the TCFD, as conceptualized in this study, we also recommend either theoretical or empirical future studies to provide more sound evidence on climate disclosure for countries that have or have not adopted the TCFD's recommendations and the implication of compliance on firm-specific outcomes. It is critical to note that data availability could be a challenge, given the recent establishment of the TCFD and the number of countries that have announced their TCFD disclosure regulations, as presented in Table 2. Consequently, theory-driven discussion papers at this stage should favour empirical-oriented papers based on our broad conceptualization of disclosures presented in this study.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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