



DTCC

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CLIMATE-RELATED FINANCIAL RISK

An FMI's Perspective

A DTCC SYSTEMIC RISK WHITE PAPER

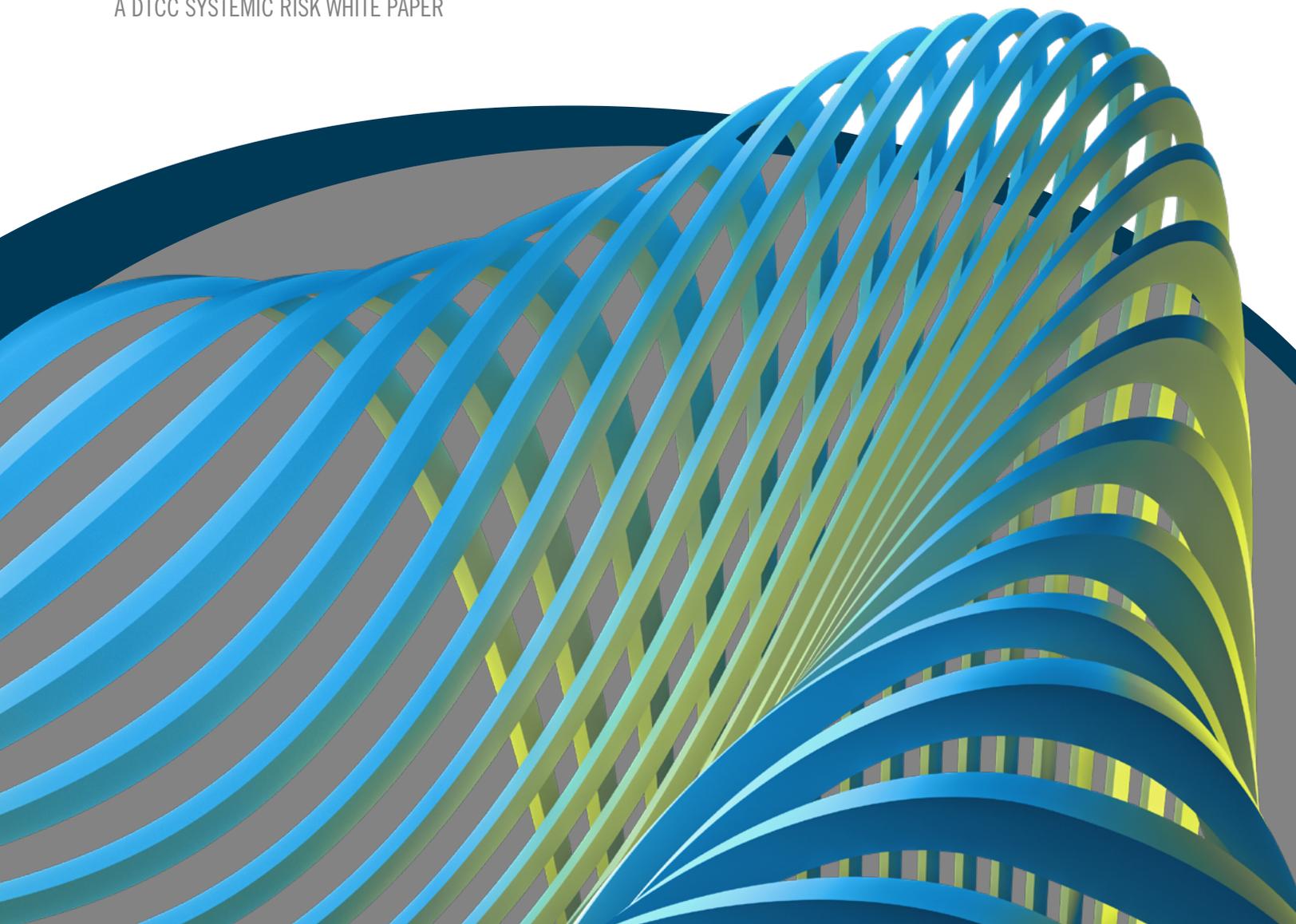


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FOREWORD

Climate change is expected to have a dramatic impact on our environment over the next few decades – and quite possibly beyond. Since the 1980s, each decade has been warmer than the previous one and this trend is expected to continue.¹

Some of the effects of climate change are already visible today. They include an unprecedented loss in biodiversity, as well as worsening agricultural and ecological droughts. Increasing temperatures and changing weather patterns are also cited as one of the reasons behind a global rise in hunger and poor nutrition in certain parts of the world where people cannot grow or find sufficient food.

In addition to these environmental and health-related effects, climate change has significant economic and financial implications. These are tangible in the case of extreme weather events, which can cause substantial loss of life, in addition to enormous property and environmental damage. Over the long term, rising sea levels will likely have considerable financial implications, affecting both the value and the insurability of real estate in coastal areas.

Aside from these physical risks, additional types of risks are associated with the expected transition to a greener economy. This transition, which is a key area of focus in plans to slow global warming, poses a myriad of economic, strategic, legal and other risks – not only to industrial companies in carbon-intensive sectors, but possibly also to the banks and other financial institutions that provide their funding.

In light of the above, climate change is no longer being considered primarily an environmental issue, but a multi-faceted source of economic and financial risks that might threaten the stability of the financial ecosystem. Several initiatives to better understand, address and mitigate these risks are starting to emerge. They include proposals to implement climate-related disclosure requirements, as well as efforts to explore the potential benefits of climate-specific scenario analysis to assess the effect of climate-related risks on the financial services industry – just to cite two well-known examples.

Given these developments, and in accordance with its mandate, DTCC's Systemic Risk Office (SRO) has included climate-related financial risk as one of the many potential systemic threats it actively analyzes and monitors. As part of these efforts, we have published this paper to share our thoughts on how climate-related financial risk applies to DTCC and, by extension, other Financial Market Infrastructures (FMIs) – and how the industry currently has the necessary resources to address these risks in a proactive manner.

More specifically, we will examine the exposure of FMIs to climate-related physical risk and transition risk, and we will identify unique aspects of these exposures as they pertain specifically to FMIs. Building on this analysis, we will explore the interplay of regulation and FMIs, in the hopes of showing how existing regulatory frameworks and standards could be applied to effectively mitigate climate-related challenges. We will also discuss the growing green bond market, as well as DTCC's approach to mitigating climate-related financial risk.

We hope that this paper will contribute to a better understanding of this important topic and that it will foster a lively dialogue with our members, the regulatory community and all other stakeholders.

¹ World Meteorological Organization. (2022, January 19). 2021 One of the Seven Warmest Years on Record, WMO Consolidated Data Shows.

EXECUTIVE SUMMARY

- Climate-related financial risk has become a prominent theme that is high on the agenda of U.S. and European policymakers and regulators. A number of these organizations have publicly declared climate-related risk a potential threat to global financial stability, and many have published formal consultations related to this topic.
- There are two broad categories of climate-related financial risk: *physical risk* and *transition risk*. Several studies have already been published that focus on the transmission of these risks from the economy to the financial ecosystem, but an analysis that focuses specifically on FMIs has not been performed yet. This paper fills that gap by focusing specifically on how FMIs may be exposed to physical and transition risk and by examining the implications of FMIs' exposure to these types of risks:
 - » FMIs' business continuity programs have proven to be sufficiently robust to mitigate their exposure to climate-related physical risk.
 - » While financial institutions face indirect exposure to transition risk through their financing activities of specific carbon-intensive companies, FMIs' exposure to transition risk through such financial institutions is even more indirect. This third-order exposure of FMIs to transition risk appears to be well within the range of credit, liquidity, market, operational and other risks that FMIs already must currently navigate.
- At the same time, we also believe that it would be beneficial for interested parties to consider ways in which existing and effective regulatory frameworks or standards could be applied to the new challenges of today. While such an approach may not be relevant for each and every variety of financial market participant, we believe, as a high-level principle, that policymakers would be well-served to ensure that they fully evaluate and exhaust the existing tools available to them in the interest of confronting new risks sooner, more dynamically, and in a manner that is consistent with past effective outcomes.
- Green bonds can play a significant role in contributing to the funding required to address the global challenges of climate change. That said, in order for FMIs to continue to safeguard financial stability – as per their mandate – it is key that these instruments should not be given preferential treatment if used for collateral purposes or in terms of how they are otherwise risk managed.
- The creation of a so-called “green bubble” is a potential unintended consequence of the success of green bonds that should be monitored as it might pose certain risks. The lack of standards around green bonds may be another problematic area. That said, green bonds still represent a very small percentage of the overall debt market – albeit one that is growing significantly.
- DTCC's approach to mitigating its exposure to climate-related financial risk focuses on enhancing its existing risk management practices:
 - » DTCC's Business Continuity department is adding climate-related trending metrics to its existing programs to reduce the company's operational risk exposure.
 - » DTCC's Counterparty Credit Risk department is looking to incorporate climate-related risk monitoring to assess counterparty exposure, compliance, controls, and governance.
- We also feel it is incumbent on us to do our part to contribute to a greener economy. As such, DTCC has embarked on a multi-year program to reduce its own carbon footprint operationally, through its suppliers, and as financiers of renewable energy.
- Additionally, DTCC's SRO will continue to actively analyze and monitor climate-related developments given their potential implications for global financial stability.

INTRODUCTION

Long-term observations show that the Earth's temperature has risen by about 2.0°F (1.1°C) on average since the 1880s.² This rate of global warming is at least an order of magnitude faster than any found in the past 65 million years of paleoclimate records.³

Natural phenomena, like volcanic eruptions, solar variations and the Earth's orbital changes, all have an impact on the Earth's climate. However, human activities have been the primary driver of a global rise in average temperatures over the last several decades, as illustrated by the graph below:

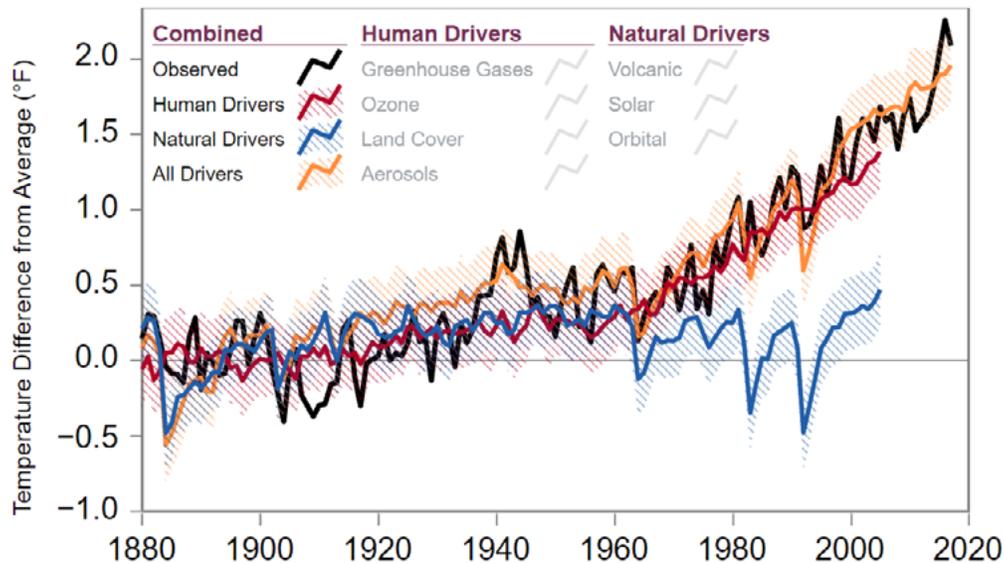


Illustration copied from: U.S. Global Change Research Program. (n.d.). *Fourth National Climate Assessment – Chapter 2: Our Changing Climate*. <https://nca2018.globalchange.gov/chapter/2>

Greenhouse gas (GHG) emissions from human (or “anthropogenic”) activities are the most significant driver of observed climate change since the mid-20th century. Fossil fuels – coal, oil and gas – are by far the largest contributor to global climate change, accounting for more than 75% of GHG emissions and nearly 90% of all carbon dioxide (CO₂) emissions. Other human activities that contribute to an increase in GHG emissions include clearing forests, fertilizing crops, storing waste in landfills, raising livestock and producing certain kinds of industrial products.

As GHG emissions from human activities increase, they build up in the atmosphere, trapping the sun’s heat and causing Earth’s temperature to rise. Because many of the major greenhouse gases stay in the atmosphere for tens to hundreds of years after being released, their warming effects on the climate persist over a long time and can therefore affect both present and future generations.

It is important to note that global warming is not the same as climate change, which refers to a broader series of long-term shifts in temperatures and weather patterns that are all part of an interconnected system. Climate feedbacks are natural processes that respond to global warming by offsetting or further increasing change in the climate system. Increasing amounts of water vapor and decreasing amounts of Arctic Sea ice are both examples of climate feedbacks that lead to further warming:

² The main sources used for this section include reports published and other information made publicly available by: the Intergovernmental Panel on Climate Change; McKinsey Global Institute; National Aeronautics and Space Administration; the U.S. Environmental Protection Agency; the U.S. Global Change Research Program; and the United Nations (see Bibliography at the end of this paper for additional information on these sources).

³ McKinsey Global Institute. (2020, January). *Climate Risk and Response: Physical Hazards and Socioeconomic Impacts*.

- As the Earth warms, the rate of evaporation rises and the amount of water vapor in the air increases as well. Because water vapor is a greenhouse gas, this leads to further warming.
- As temperatures rise, Arctic Sea ice melts. The loss of ice exposes the underlying sea surface, which is darker and absorbs more sunlight than ice, increasing the total amount of warming. Less snow cover during warm winters has a similar effect.

As a result of these feedback mechanisms and other types of interconnections, the consequences of climate change now include, among others:

- **More severe storms** – Destructive storms have become more intense and more frequent in many regions. As temperatures rise, more moisture evaporates, which exacerbates extreme rainfall and flooding, causing more destructive storms. The frequency and extent of tropical storms is also affected by the warming ocean. Cyclones, hurricanes and typhoons feed on warm waters at the ocean surface. Such storms often destroy homes and communities, causing deaths and huge economic losses.
- **Increased drought** – Climate change is making water scarcer in a growing number of regions. Global warming exacerbates water shortages in already water-stressed regions and is leading to an increased risk of agricultural droughts affecting crops, and ecological droughts increasing the vulnerability of ecosystems. Droughts can also stir destructive sand and dust storms that can move billions of tons of sand across continents, causing deserts to expand and reducing the amount of land that is suitable for growing food.
- **A warming, rising ocean** – Global sea levels are rising at a rate that is unprecedented over the past 2,500-plus years, threatening coastal and island communities. The rise in sea levels is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers, and the expansion of seawater as it warms. The ocean soaks up most of the heat from global warming. The rate at which the ocean is warming strongly increased over the past two decades, across all depths of the ocean. The ocean also absorbs CO₂, keeping it from the atmosphere – but more CO₂ makes the ocean more acidic, which endangers marine life and coral reefs.
- **Declining biodiversity** – The world is losing species at a rate 1,000 times greater than at any other time in recorded human history. One million species are at risk of becoming extinct within the next few decades. While this dramatic decline in biodiversity is due to a variety of circumstances, it is exacerbated by forest fires, extreme weather and other climate-related changes.

Looking forward, climate science tells us that further warming is unavoidable over the next decade at least, and in all likelihood beyond. With increases in global average temperatures, climate models indicate a rise in climate hazards globally. These models find that further warming will continue to increase the frequency and/or severity of acute climate hazards and further intensify chronic hazards.⁴

While we recognize that climate change may also create certain business opportunities and economic benefits,⁵ this paper focuses specifically on **climate-related financial risks**, which we define as risks that:

1. may have adverse financial or (macro)economic consequences (to consumers, corporations and other economic agents) or that may have a negative impact on the financial ecosystem (including the financial services sector, financial markets and market participants); and
2. may arise from or be related to (efforts to mitigate) climate change and/or extreme weather events, either directly or indirectly (i.e., through one or more transmission channels).⁶

⁴ McKinsey Global Institute. (2020, January). *Climate Risk and Response: Physical Hazards and Socioeconomic Impacts*.

⁵ For instance, certain regions may benefit from additional tourism opportunities and expanded growing seasons (see: Pomeroy, R. (2020, October 19). Three Places That Will Actually Benefit from Climate Change. *RealClearScience*). Another example of a potential business opportunity is the area of *transition finance*, which could be a promising segment for banks and other financial institutions.

⁶ Note that this definition excludes the impact of environmental incidents (such as major chemical leakages or oil spills).

It should be noted that some publications use the terms climate-related risks and environmental risks interchangeably. The definition above differentiates climate-related risks from the broader universe of environmental risks (e.g., for the purposes of this paper, the impact of environmental incidents, such as major chemical leakages or oil spills, would be considered an environmental risk, not a climate-related risk).⁷

Climate-related financial risks can be broadly categorized into physical and transition risk:⁸

1. Physical risk, in turn, can be divided in two sub-categories:

- » **Acute physical risk** is the risk that the increasing severity and frequency of extreme weather events (such as floods, tropical cyclones/typhoons, heatwaves, landslides, (hail)storms and wildfires) may cause economic costs or financial losses. These costs or losses may be the result of real estate, equipment, infrastructure and other assets being damaged or destroyed (or becoming more difficult or more costly to insure).
- » **Chronic physical risk** is the risk that longer-term gradual climate shifts (such as rising average temperatures, changes in precipitation, extreme weather variability, etc.) may cause economic costs or financial losses. Such costs or losses may be the result of rising sea levels, ocean acidification, lower crop yields due to soil degradation, desertification, deforestation and other environmental changes or impacts to the ecosystem.

Acute and chronic climate-related physical risks have fundamentally different time frames. Extreme weather events typically occur within a matter of days or weeks, while climatic changes manifest themselves over several years, if not decades. As such, it is reasonable to assume that sudden shocks may arise from acute physical risk only, not from chronic physical risk.

2. Transition risk is the risk that the process of adjusting (or transitioning) towards a low-carbon economy may be unpredictable, disorderly, or otherwise disruptive – and that, as a result, it may cause economic costs or financial losses. Transition risk is driven by several developments, all of which have the potential to accelerate, slow or disrupt the transition path towards an economy that reduces the global greenhouse effect. These drivers of transition risk include:

- » **Changes in public sector policies, legislation and regulation**, such as the introduction of carbon taxes, green certificates, subsidies for renewable energy or electric vehicles (EVs) and energy-saving projects.
- » **Changes in technology**, such as the growing use of solar plants, wind turbines and other clean energy technologies.
- » **Changes in market preference or public sentiment**, for instance, consumers who may prefer buying eco-friendly products or investors who may favor investing in “green” companies and assets.
- » **Other changes**, such as the growing importance of e-commerce and remote work, just to cite two examples.

Everything else being equal, carbon-intensive or “brown” companies (e.g., oil & gas, coal mining, and coal-fired power producers) will typically be more exposed to transition risk than “green” companies.

⁷ For a detailed discussion on the connection between environment-related risks and climate-related risks, refer to: Network for Greening the Financial System. (2020, May). *Guide for Supervisors. Integrating Climate-Related and Environmental Risks into Prudential Supervision*. See also:

- Basel Committee on Banking Supervision. (2021, April). *Climate-Related Risk Drivers and Their Transmission Channels*. Bank for International Settlements;
- Network for Greening the Financial System. (2019, April). *A Call for Action. Climate Change as a Source of Financial Risk*; and
- Network for Greening the Financial System. (2020, September). *Overview of Environmental Risk Analysis by Financial Institutions*.

⁸ We explicitly include climate-related legal or liability risk, which may arise when parties are held liable for the consequences of environmental damage that may have been caused by their actions or omissions, as a sub-category within physical or transition risk. By way of example, this type of risk could materialize due to an entity’s failure to protect people from impacts of climate change when a duty of care or other legal obligation exists. Some taxonomies consider climate-related legal or liability risk as a third category, separate from physical and transition risk (for instance, see: Financial Stability Board. (2020, November 23). *The Implications of Climate Change for Financial Stability*; and: Financial Stability Board. (2022, October 13). *Supervisory and Regulatory Approaches to Climate-Related Risks*. Final Report).

The Network for Greening the Financial System (NGFS), a group of central banks and supervisors that have made significant contributions to the development of climate-related financial risk management, has published several studies on the impact of environmental risks on the financial ecosystem.⁹ A report published by NGFS in April 2019 analyzes how the economic impact of climate-related physical and transition risk drivers can be transmitted to the financial system through a series of direct and indirect transmission channels,¹⁰ as illustrated below.

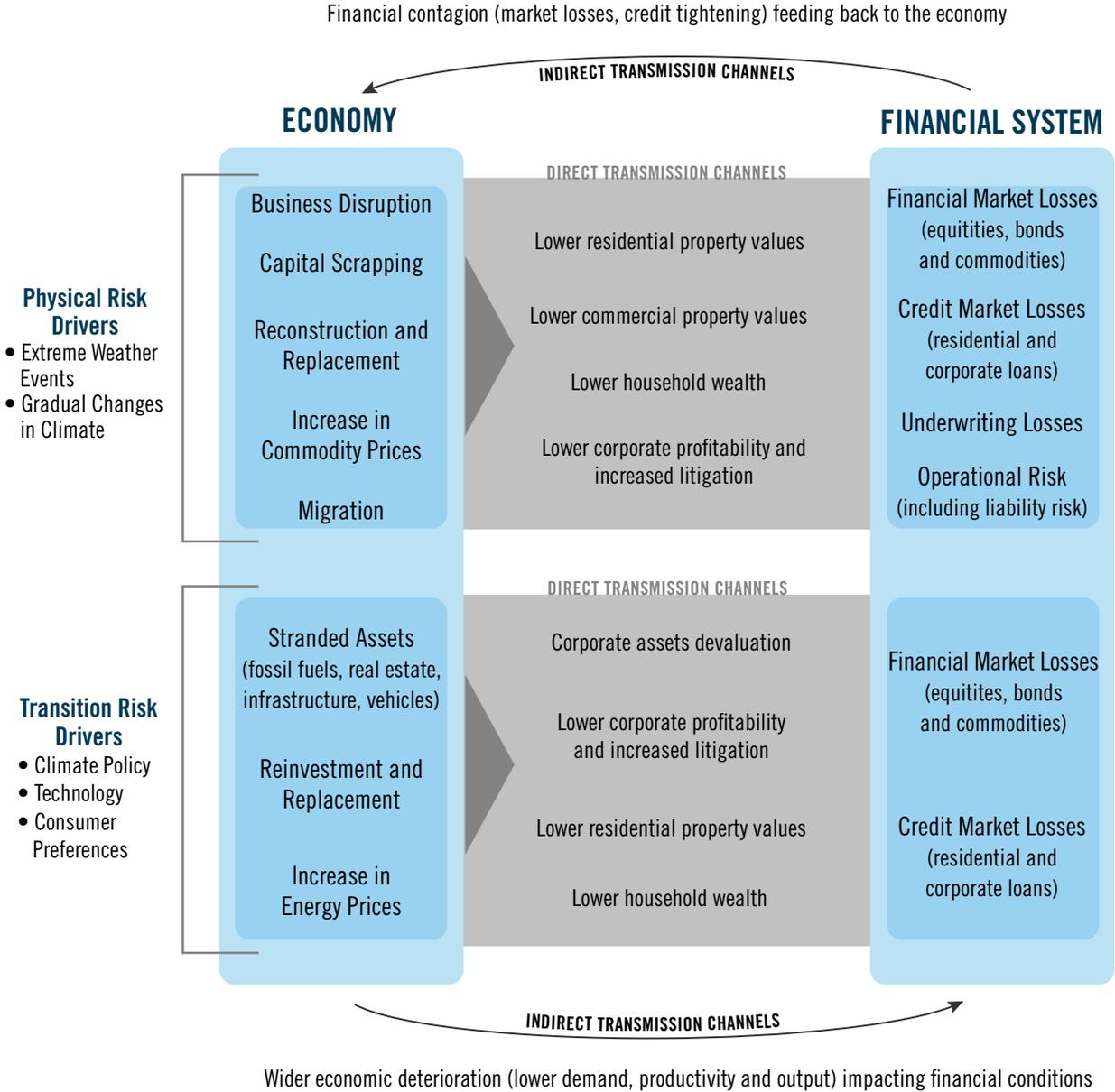


Illustration based on: Network for Greening the Financial System. (2019, April). *A Call for Action. Climate Change as a Source of Financial Risk*. https://www.ngfs.net/sites/default/files/medias/documents/ngfs_first_comprehensive_report_-_17042019_0.pdf

⁹ See, among other publications: Network for Greening the Financial System. (2020, September). *Overview of Environmental Risk Analysis by Financial Institutions*.

¹⁰ Network for Greening the Financial System. (2019, April). *A Call for Action. Climate Change as a Source of Financial Risk*.

The Financial Stability Board (FSB) published a report in November 2020 that further investigates transmission channels through which climate-related risks might impact the financial system.¹¹

A more recent report that was published by the Bank for International Settlements (BIS) in April 2021 focuses specifically on the impact of climate-related physical and transition risk on banks and the banking system.¹² This report examines micro- and macroeconomic transmission channels to assess the potential impact of climate-related physical and transition risk on financial institutions. Another NGFS report that was published in September 2020 also includes detailed analyses of micro- and macroeconomic transmission channels to assess the potential impact of climate-related physical and transition risk on financial institutions.¹³ Both of these reports conclude that traditional risk categories can be used to capture climate-related financial risks, as summarized below:

RISK CATEGORY	POTENTIAL EFFECTS OF CLIMATE-RELATED RISK DRIVERS (physical and transition risks)
Credit risk	<ul style="list-style-type: none"> • Credit risk increases if climate-related risk drivers reduce: <ul style="list-style-type: none"> - borrowers’ ability to repay and service debt (income effect); or - banks’ ability to fully recover the value of a loan in the event of default (wealth effect) * • Defaults by businesses and households ** • Collateral depreciation **
Market risk	<ul style="list-style-type: none"> • Reduction in financial asset values, including the potential to trigger large, sudden and negative price adjustments where climate-related risk is not yet incorporated into prices * • Climate-related risk could also lead to a breakdown in correlations between assets or a change in market liquidity for particular assets, undermining risk management assumptions * • Repricing of equities, fixed income, commodities, etc. **
Liquidity risk	<ul style="list-style-type: none"> • Banks’ access to stable sources of funding could be reduced as market conditions change * • Climate-related risk drivers may cause banks’ counterparties to draw down deposits and credit lines * • Increased demand for liquidity ** • Refinancing risk **
Operational risk	<ul style="list-style-type: none"> • Increasing legal and regulatory compliance risk associated with climate-sensitive investments and businesses * • Supply chain disruption ** • Forced facility closure **
Reputational risk	<ul style="list-style-type: none"> • Increasing reputational risk to banks based on changing market or consumer sentiment *
Underwriting risk	<ul style="list-style-type: none"> • Increased insured losses ** • Increased insurance gap **

* Sourced from: Basel Committee on Banking Supervision. (2021, April). *Climate-Related Risk Drivers and Their Transmission Channels*. Bank for International Settlements. <https://www.bis.org/bcbs/publ/d517.pdf>

** Sourced from: Network for Greening the Financial System. (2020, September). *Overview of Environmental Risk Analysis by Financial Institutions*. https://www.ngfs.net/sites/default/files/medias/documents/overview_of_environmental_risk_analysis_by_financial_institutions.pdf

The next two sections of this paper extend these analyses to explore the potential impact of climate-related physical and transition risk as it pertains specifically to FMIs. For the purposes of our FMI-centric analysis, we will include reputational risk as a sub-category of operational risk and we will exclude underwriting risk, given that this type of risk is specific to insurance companies. We will also show liability risk as a separate FMI risk category, in addition to operational, credit, liquidity and market risk.

¹¹ Financial Stability Board. (2020, November 23). *The Implications of Climate Change for Financial Stability*.

¹² Basel Committee on Banking Supervision. (2021, April). *Climate-Related Risk Drivers and Their Transmission Channels*. Bank for International Settlements.

¹³ Network for Greening the Financial System. (2020, September). *Overview of Environmental Risk Analysis by Financial Institutions*.

CLIMATE-RELATED PHYSICAL RISK

With respect to climate-related physical risk, it is important to point out the following:

- **Certain types of extreme weather events have steadily increased in recent decades, together with the economic losses associated with such events.** As noted in the Office of Financial Research 2022 Annual Report to Congress, climate-related damages in the U.S. alone have grown to about \$133 billion per year.¹⁴ Scientific studies suggest that extreme weather events such as heat waves and large storms are likely to become more frequent or more intense with human-induced climate change.¹⁵ This is illustrated in the graph below (even though not all natural catastrophes enumerated in the chart result from climate change, the overall trend is valid for extreme weather events).¹⁶

The impact of physical risks on the global economy has increased in recent decades

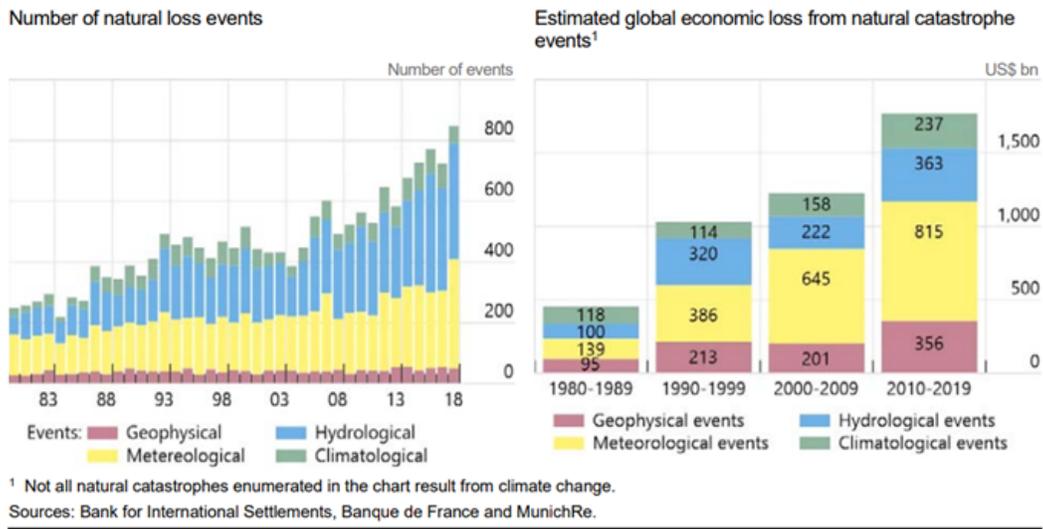


Illustration above sourced from: Financial Stability Board. (2020, November 23). *The Implications of Climate Change for Financial Stability*. <https://www.fsb.org/wp-content/uploads/P231120.pdf>

- **Absent action to reduce the effects of climate change, physical risks to the global economy are likely to continue to increase in the future.** Analysis suggests that the frequency and severity of extreme weather events might increase non-linearly and become increasingly correlated with each other over time.¹⁷
- **Estimates of the impact of physical risks on financial assets vary considerably.** All estimates are based on a number of assumptions and subject to numerous sources of uncertainty, including: (i) the assumed future path of global emissions; (ii) the impact of such physical risks on the global macroeconomy and financial assets (which is also highly uncertain and subject to numerous modelling assumptions); and (iii) the rate at which assets' future cash flows are discounted (estimated impacts are much larger if they are discounted at a lower rate).¹⁸

The remainder of this section describes how acute and chronic climate-related physical risk could have a direct impact on non-financial firms, financial institutions and real estate valuations, and how these could act as transmission channels that might affect specific risk categories for certain FMIs. This is illustrated on the next page:

¹⁴ Office of Financial Research. (2022). *Annual Report to Congress 2022*.

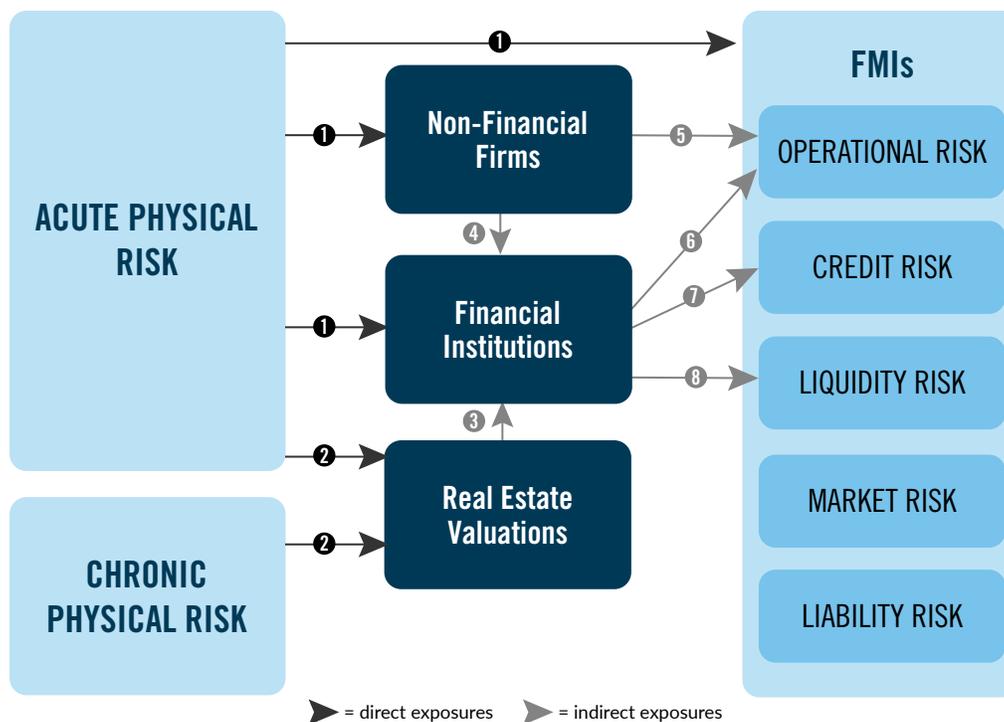
¹⁵ U.S. Environmental Protection Agency. (2022, August 1). *Climate Change Indicators: Weather and Climate*.

¹⁶ Financial Stability Board. (2020, November 23). *The Implications of Climate Change for Financial Stability*.

¹⁷ Ibid.

¹⁸ Ibid.

TRANSMISSION OF CLIMATE-RELATED PHYSICAL RISK



- **Financial institutions, non-financial firms and FIMs are all directly exposed to acute climate-related physical risk** (see arrows marked by ❶), given that extreme weather events may suddenly damage or destroy an entity's infrastructure and equipment, which can disrupt its operations and/or cause financial losses.
- **Climate-related physical risk can be transmitted to financial institutions through its impact on real estate valuations** (see arrows marked by ❷). This can happen due to a sudden drop in value (because of floods, wildfires and other types of acute climate-related physical risk) or it can happen more gradually (because of chronic climate-related physical risk). This initial impact can then be transmitted to financial institutions as follows (see arrow marked by ❸):
 - » **Lower property values** reduce collateral values of mortgage loans and increase Loss Given Default (LGD).
 - » **Disruption to economic activities** due to extreme weather events (e.g., income) increases mortgage default rates.
 - » **Higher default rates and LGD** increase expected losses of banks (credit risk).¹⁹
 - » **Larger-than-expected damage losses** for impacted real estate assets could result in unexpectedly high claims for insurers (underwriting risk).
- **The impact of acute climate-related physical risk on non-financial firms can be transmitted to financial institutions** (see arrow marked by ❹):
 - » **Business disruptions of non-financial firms** can reduce their revenue and increase their costs, thus reducing their profit.
 - » **Reduced revenue and profit of impacted non-financial firms** may weaken their ability to repay bank loans and increase loan default rates and LGD (credit risk).

¹⁹ Sun, T. Y., & Ma, J. (2020, September). Quantifying the Impact of Physical Risks on Default Probability of Bank Loans. *NGFS Occasional Paper – Case Studies of Environmental Risk Analysis Methodologies*.

- **The impact of acute climate-related physical risk on non-financial firms can be transmitted to FMIs** to the extent that FMIs rely on the services of impacted non-financial firms (as suppliers or third parties) or public infrastructure components (including the power grid and transportation facilities) for their operations (see arrow marked by ⑤).
- **The impact of acute climate-related physical risk on financial institutions can be transmitted to FMIs** to the extent that FMIs:
 - » **Rely on the services of impacted financial institutions for their operations** (see arrow marked by ⑥).
 - » **Have credit exposure to impacted financial institutions** (see arrow marked by ⑦).
 - » **Rely on the services of impacted financial institutions as liquidity providers** (see arrow marked by ⑧).

Despite the considerable number of extreme weather events in recent years, there is no indication that any of these events have affected the valuations of impacted entities in a significant way. Hypothetically, if there were a negative impact on the valuations of non-financial firms or financial institutions due to a future extreme weather event, it seems reasonable to assume that this will be an idiosyncratic impact that would be adequately covered by FMIs' market risk models. For these reasons, it does not seem plausible that climate-related physical risk can be transmitted in a way that would create any uncovered market risk for FMIs.

CLIMATE-RELATED TRANSITION RISK

With respect to climate-related transition risk, it is important to point out the following:

- **There is already evidence that the market values of equities of firms in some heavily polluting industries are being impacted by policy measures and market trends related to a transition to a low-carbon economy.** For example, the Dow Jones Coal Index fell by 85% in 2011-2018 in line with a significant increase in both the use of natural gas for power generation and climate-related policy measures.²⁰ The graph below illustrates the potential impact on equity valuations of capital relocation trends that may result from transition risks under specific circumstances and assumptions.

Estimated capital relocation resulting from transition risks and potential effects on equity valuations

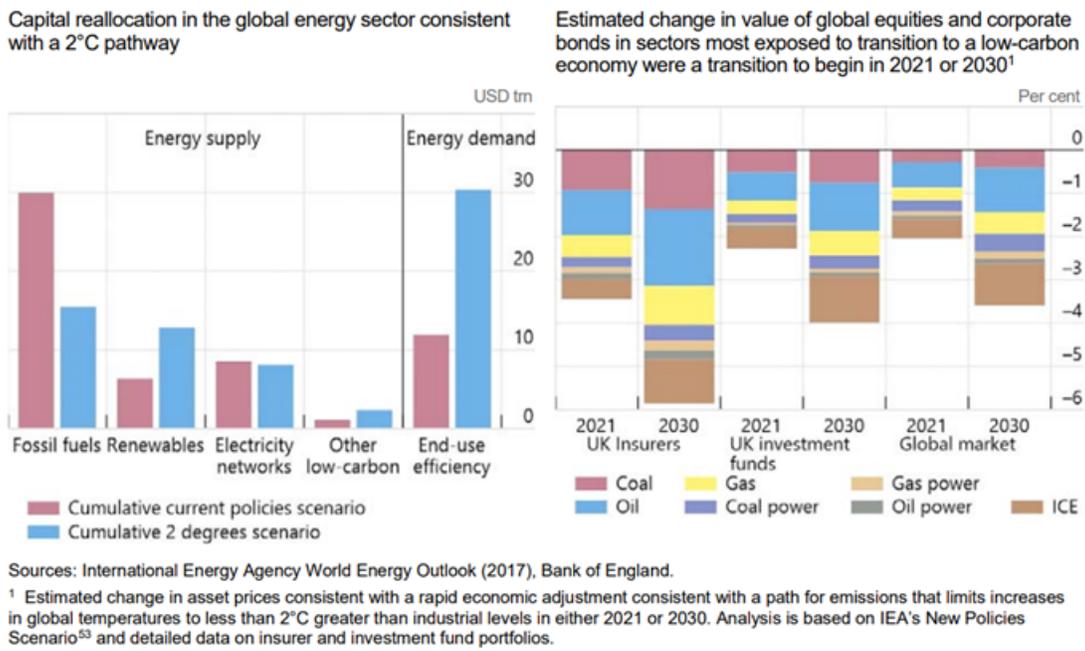


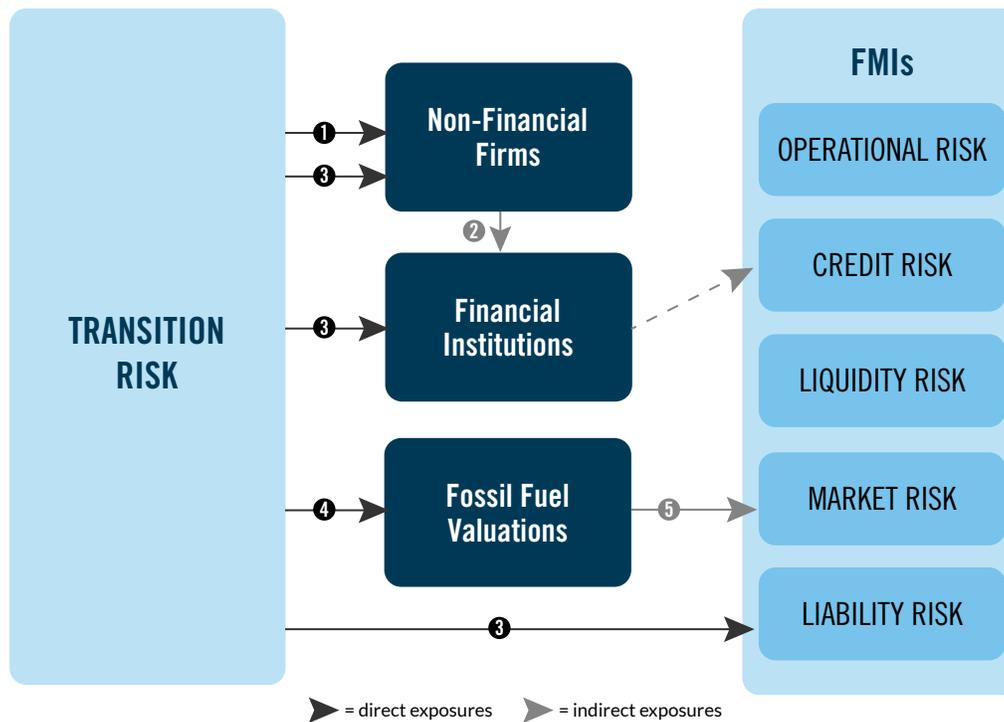
Illustration above sourced from: Financial Stability Board. (2020, November 23). *The Implications of Climate Change for Financial Stability*. <https://www.fsb.org/wp-content/uploads/P231120.pdf>

- **The impact of such changes in asset prices depends largely on the extent to which a transition to a low-carbon economy might be a disorderly process that is characterized by sudden events that are unanticipated by market participants.** Sudden changes in technology and/or unexpected changes in public policy are two potential examples of events that could cause such a disorderly transition. Consumer preferences may also shift more rapidly and abruptly than is modelled in many transition scenarios.
- **Estimates of the impact of transition risks vary significantly,** due to differences in: (i) the estimation of exposures to carbon-intensive production; (ii) the assumed path of transition to a low-carbon economy; and (iii) the scope of losses considered.

The remainder of this section describes how climate-related transition risk could have a direct impact on non-financial firms, financial institutions and fossil fuel valuations, and how these could act as transmission channels that might affect specific risk categories for certain FMI. This is illustrated on the following page:

²⁰ Bank of England Prudential Regulation Authority. (2018, September). *Transition in Thinking: The Impact of Climate Change on the UK Banking Sector*. Financial Stability Board. (2020, November 23). *The Implications of Climate Change for Financial Stability*.

TRANSMISSION OF CLIMATE-RELATED TRANSITION RISK



- The entities that are directly exposed to transition risk are primarily carbon-intensive or “brown” companies (e.g., oil & gas, coal mining, and coal-fired power producers – see arrow marked by ❶). They could be directly impacted by a wide variety of developments, including:
 - » **Energy transition policies or regulatory initiatives**, which may include measures to limit the utilization of fossil fuels (e.g., the introduction of carbon taxes or regulatory restrictions on fossil fuel financing), thus increasing costs for brown companies and/or reducing market demand for their products. This, in turn, may decrease their profits and reduce their future cash flows.
 - » **Technological innovations**, which may result in a decline in renewable energy costs, thus reducing the market share and pricing power of brown companies.
 - » **Shifts in market sentiment or consumer preferences** in favor of less carbon-intensive assets could also decrease market demand for brown companies.
- The direct impact of transition risk on brown companies could be transmitted to financial institutions, which may be affected by indirect, second-order impacts (see arrow marked by ❷).
 - » Financial institutions may be exposed to **credit risk** to the extent that loan default rates and LGD levels for brown companies would increase (or to the extent that they hold carbon-intensive assets as collateral for loans).
 - » They may also be exposed to **market risk** to the extent that the valuations of brown companies or other carbon-intensive assets held by financial institutions would decrease.
 - » Lastly, financial institutions may be exposed to **liquidity risk** to the extent that they would experience difficulties in selling brown assets.

Given that transition risk takes several years, if not decades, to materialize, it can reasonably be expected that financial institutions will have considerable time to manage their second-order exposure to these types of risks. As such, it seems unlikely that a (large) financial institution would fail due to the potential second-order impact of transition risk. It is therefore equally unlikely that FMIs would be impacted by any meaningful third-order effects of transition risk that would be transmitted due to the failure of a financial institution (see dashed arrow, which is not numbered).

- **Any entity that makes a claim about its green credentials is directly exposed to liability risk** (see arrows marked by ③):
 - » Any entity that makes a claim about its green credentials may be challenged to substantiate its assertions – regardless of whether it is a financial institution, a non-financial firm or an FMI. To the extent that an entity cannot prove that its green claims are accurate, it may be exposed to liability risk, possibly in addition to fines and/or reputational damage.²¹
- **The valuation of fossil fuels could also be directly impacted by transition risk** (see arrow marked by ④):
 - » This impact could be transmitted to those FMIs that trade oil contracts or energy-related derivatives (see arrow marked by ⑤).

²¹ Some taxonomies consider climate-related legal or liability risk as a third category, separate from physical and transition risk (for instance, see: Financial Stability Board. (2020, November 23). *The Implications of Climate Change for Financial Stability*; and: Financial Stability Board. (2022, October 13). *Supervisory and Regulatory Approaches to Climate-Related Risks*. Final Report).

INTERPLAY OF REGULATION AND FMIs

Concerns about the potential impact of climate-related risks on the financial ecosystem have prompted a growing number of regulatory and policymaking actions around the globe with respect to markets supervision, macroprudential policy, monetary policy and legislative initiatives. As such, Appendix 1 of this paper provides an overview of regulatory and policymaking actions that have been taken in the European Union, the United Kingdom, the Asia Pacific region and the U.S. to address climate-related financial risks.

It is not surprising that most regulatory and policymaking initiatives so far have focused on banks and other financial institutions that provide credit, given that they are more directly exposed to climate-related financial risks than FMIs, as illustrated in the previous two sections of this paper.²² Against that backdrop, the goal of this section is to explore the interplay of regulation and FMIs as it pertains to climate-related financial risks. In doing so, we feel it is important to identify both similarities and differences between FMIs and other types of financial services entities in terms of the potential risks they face as a result of climate change.

Financial institutions face unique risks that differ significantly from other sectors of the economy, primarily because of the unique roles that they play in the economy. And while financial institutions do have climate-related risks stemming from their own operations, because of their unique role in the economy many of the climate-related risks they face arise from interacting with their client base. These risks manifest themselves most directly from either the extension of credit or the providing of insurance. In either of these circumstances, if the climate-related risk was not properly identified and mitigated, a significant or sudden climate event could cause catastrophic financial losses to a financial institution. Like all financial risks, these risks multiply and are harder to identify as the duration of the risk exposure to the client increases. The fact that risk exposure duration plays such a significant role in the level of risk that is incurred by a financial institution means that not all financial institutions face equal climate-related financial risk, with banks and insurance companies that face long duration exposure to their clients much more at risk than FMIs. It is important to note, however, that these risks are simply one aspect of the financial risks that these institutions face and manage every day as part of their normal operations.

FMIs, even amongst their financial institution brethren, play an even more unique role in the markets. As special-purpose intermediaries facilitating the post-trade settlement of financial transactions amongst parties and managing the attendant risks that remain outstanding between execution and settlement, these entities face far shorter risk horizon exposures than other financial institutions, such as insurance companies or banks. For example, FMIs that clear and settle cash transactions in U.S. equities only have risk exposure outstanding during the settlement period, which is currently two days after the trade date (or T+2). This means that these FMIs have comparatively limited financial risk exposure related to settlement risk, and therefore the attendant climate-related financial risk that they incur through their participants is limited as well.

Appreciating that it is important for policymakers and regulatory bodies, both internationally and within the U.S., to ensure that financial markets remain resilient and responsive to all risks, including climate-related financial risk, we see a range of policy responses to consider. Some of these policy responses, such as proposing new requirements for disclosure and other transparency actions tailored to the specific aspects of climate-related financial risk, may be entirely appropriate. As such, we believe that it would be beneficial for interested parties to consider and innovate ways in which existing and effective regulatory frameworks or standards could be applied to the new challenges of today. While such an approach may not be relevant for each and every variety of financial market participant, we believe, as a high-level principle, that policymakers would be well-served to ensure that they fully evaluate and exhaust the existing tools available to them in the interest of confronting new risks sooner, more dynamically, and in a manner that is consistent with past effective outcomes. To demonstrate this approach, we can consider the

²² While less pertinent for the purposes of this paper, it should be noted that there is also a group of financial institutions that are being asked to provide additional climate-related disclosure information, not because of any associated credit risk, but because of their relationships with investors.

climate-related financial risks that FMIs face as described above. The current foundational policy tool FMIs have to address the risks they face, specifically tailored to the unique FMI role, is the “Principles for Financial Market Infrastructures” (PFMIs).²³ As we seek to demonstrate below, we find that these internationally developed standards (implemented in the U.S. by the CFTC, the Federal Reserve and the SEC, and applicable to the DTCC SIFMUs via the SEC’s covered clearing agency standards) already contain effective guidance on FMI risk management that FMIs can now use to address the emergence of climate-related financial risk in their functions and operations. While our discussion below highlights some but not all of the PFMI principles for this purpose, we appreciate, as highlighted in the original 2012 PFMI report, that the principles are designed to be applied holistically because of the significant interaction between principles.²⁴ Therefore, our intention is not to propose that only certain principles apply in the context of climate-related financial risk, nor that our discussion of how such principles apply is authoritative or universal for all FMIs and all markets. Instead, we seek to highlight for policymakers and market participants alike that the practice of “reduce, recycle, reuse” is one that applies equally as well in the area of financial risk management requirements, and that there is ample opportunity for all stakeholders to use the adaptive and heretofore effective suite of requirements and standards to address the problem of climate-related financial risk both now and in the future.

- **Principle 2** of the PFMIs states, “An FMI should have governance arrangements that are clear and transparent, promote the safety and efficiency of the FMI, and support the stability of the broader financial system, other relevant public interest considerations, and the objectives of relevant stakeholders” (emphasis added). In observing this principle for the purposes of addressing climate-related financial risk, we believe that an FMI’s governance can and should contemplate such risks for the purposes of supporting the stability of the broader financial system and the objectives of relevant FMI stakeholders, including but not limited to an FMI’s participants. For these purposes, FMI governance should look at physical and transition risks posed to participants, and how these risks may affect broad market stability and the objectives of participants who seek to avail themselves of the FMI’s services while also observing their own standards and requirements (such as the BCBS Climate Principles). Further, we believe an FMI observing this principle would seek to have the FMI’s governance take into consideration relevant public interest concerns about climate-related financial risks insofar as those concerns implicate the FMI’s own role and obligations to operate safely and efficiently. As we look further at the ways in which Principle 2 can help guide how an FMI might seek to address climate-related financial risk, we can also find useful guidance in the Key Considerations. For example, Key Consideration 6 provides that the board should establish a clear and documented risk management framework that includes the FMI’s risk tolerance policy, assigns responsibilities and accountability for risk decisions, and addresses decision making in crises and emergencies.²⁵

For the purposes of practical application, we think this could entail the board of an FMI reviewing its current risk management framework to ensure that climate-related financial risk, including concepts such as physical and transition risks posed by climate change, as well as the varying time horizons associated with these risks (short term, medium term, and long term) are adequately addressed. In addition, an FMI’s board could establish specific responsibilities and accountability for management in managing the climate-related financial risk decisions that are taken in the overall context of the FMI’s existing risk management framework.

- **Principle 3** of the PFMIs provides for the comprehensive management by an FMI of risk, saying that, “An FMI should have a sound risk-management framework for comprehensively managing legal, credit, liquidity, operational, and other risks” (emphasis added). This principle is a broad-based principle, and many of the

²³ Committee on Payment and Settlement Systems – Technical Committee of the International Organization of Securities Commissions. (2012, April). *Principles for Financial Market Infrastructures*. Bank for International Settlements. <https://www.bis.org/cpmi/publ/d101a.pdf>

²⁴ Ibid. (see paragraph 1.19 *Scope of the principles for FMIs* on page 12).

²⁵ Ibid. (see Key Consideration 6 of Principle 2 on page 26).

climate-related financial risks such as physical risks or the climate-related risks of participants that the FMI incurs during settlement are addressed in more depth in other principles.²⁶ That said, this principle does provide that an FMI should identify and establish policies and procedures to mitigate “other” identified risks; and as such, we believe that it is possible to include other climate-related financial risks, such as transition risks, in these “other” risks. In practice, this principle recommends that an FMI’s board and management ensure that the firm has the appropriate policies, procedures and controls to appropriately identify and mitigate the identified risks, including climate-related financial risks. However, it is also important to remember that climate-related financial risk is just one of the many risks that an FMI faces (as seen by the numerous risks enumerated in the principle) and should be treated as such when an FMI is analyzing, on a comprehensive basis, its overall risk profile. As Explanatory Note 3.3.2 to Principle 3 provides, in order to establish a sound risk-management framework, an FMI should first identify the range of risks that arise. As noted in Key Consideration 3, the FMI should also recognize the risks it directly bears from or poses to its participants, its participants’ customers and other entities. It should identify those risks that could materially affect its ability to perform or to provide services as expected.²⁷ But in addition to identifying these risks, as Explanatory Note 3.3.3 states, it is the ultimate responsibility of the board and senior management of the FMI to manage the FMI’s risks, setting the risk tolerance and determining the risk capacity of the firm.

The board and management, in addition to having policies and procedures to identify, measure and monitor risks, should also ensure that appropriate policies, procedures and controls to manage all relevant risks faced by the firm are in place.

In context, the various climate-related financial risks that the firm faces should include not just the climate-related financial risks to which it is directly exposed, but also those climate-related risks that it bears from other entities. As such, climate-related financial risks at FMIs should be imbedded in the policies, procedures, and controls of the firm across all relevant business functions and units, from counterparty credit risk management through operations. Climate-related financial risk should be an integral part of the risk assessment and mitigation policies, procedures and controls of the firm, similar to the other risks faced by an FMI.

- **Principle 17** is particularly relevant to any climate-related discussion because it concerns the operational risks facing an FMI, and states, “An FMI should identify the plausible sources of operational risk, both internal and external, and mitigate their impact through the use of appropriate systems, policies, procedures and controls (emphasis added). Systems should be designed to ensure a high degree of security and operational reliability and should have adequate, scalable capacity. Business continuity management should aim for timely recovery of operations and fulfillment of the FMI’s obligations, including in the event of a wide-scale or major disruption.” This principle goes into greater depth regarding operational risk than Principle 3. While this principle specifically addresses overall operations risk, Explanatory Note 3.17.2 calls on an FMI to actively identify, monitor, and manage the plausible sources of operational risks. One of many potential sources of operational risk is physical risk to the FMI’s operations posed by the effects of climate change. Additionally, Key Consideration 7 notes that key participants, including service and utility providers, may pose operational risk to an FMI. Finally, the principle itself mentions the “plausible” sources of operational risk, and Key Consideration 6 discusses “significant” risks of operations being disrupted. These phrases acknowledge that when identifying possible risks to operations, a robust risk management program should include the likelihood of an event occurring as well as the overall effect if the event were to occur. FMIs must have and do have plans

²⁶ As noted previously in this paper – and in: Network for Greening the Financial System. (2020, September). *Overview of Environmental Risk Analysis by Financial Institutions* – climate-related financial risk manifests itself in a variety of other identified risks that an FMI manages, including, but not limited to, credit risk, market risk, liquidity risk, operational risk, and reputational risk.

²⁷ Committee on Payment and Settlement Systems – Technical Committee of the International Organization of Securities Commissions. (2012, April). *Principles for Financial Market Infrastructures*. Bank for International Settlements. (see Explanatory Note 3.3.2 to Principle 3 on pages 32 – 33).

in place to address plausible and significant sudden interruptions in operations from multiple sources, including significant climate-related events. Robust management should include an acknowledgment that other risks may be triggered by an operational interruption, including, but not limited to, reputational, strategic, and regulatory risks.

As noted in Key Consideration 7, the board and management of an FMI should also recognize and manage physical and operational risk that does not directly impact the physical operations of the FMI, but rather affects a critical provider to the FMI.

- **Principle 18** addresses access to an FMI and participation requirements, suggesting that, “An FMI should have objective, risk-based (emphasis added) and publicly disclosed criteria for participation, which permit fair and open access.” Principle 18 addresses participant access to the FMI with a specific focus on the grounds for participation. Notably, the principle calls for there to be a risk-based criteria for participation. As noted in Key Consideration 3 to Principle 3, various third parties, including participants, pose multiple risks to an FMI. Explanatory Note 3.3.3 to Principle 3 makes clear that an FMI’s board and management are responsible for managing, through various policies, procedures, and controls, all of the risks faced by a firm. Part of the risk that a participant brings to an FMI, and that must be assessed, is climate-related financial risk. As noted in the preamble to Principle 18, fair and open access to an FMI is important given the critical role FMIs play in many markets. As Key Consideration 2 to the principle notes however, this desire for fair and open access must be tempered by the need to ensure that the FMI continues to operate safely and efficiently. The Key Consideration goes on to note, “Subject to maintaining acceptable risk standards, an FMI should endeavor to set requirements that have the least-restrictive impact on access that circumstances permit.”

This Key Consideration, along with Explanatory Notes 3.18.5, 3.18.6, and 3.18.7, acknowledges that the participation of participants poses risks to the FMI. In an appropriate operating environment, these risks, like other identified risks to the firm, should be identified and managed by the FMI’s board and management, as called on in Principle 3.

- **Principle 23** states, “An FMI should have clear and comprehensive rules and procedures and should provide sufficient information to enable participants to have an accurate understanding of the risks, fees, and other material costs they incur by participating in the FMI. All relevant rules and key procedures should be publicly disclosed” (emphasis added). As Key Consideration 1 notes, the FMI should fully disclose comprehensive rules and procedures to participants and relevant rules and procedures to the public. Key Consideration 2 goes on to note that disclosures should allow participants to assess the risks they incur by participating in the FMI. Principle 23 is a comprehensive principle that calls for necessary disclosures regarding the totality of the FMI’s business and risks, including climate-related financial risks. The disclosure of the climate-related financial risks to participants allows them to be able to fully assess the risks of the FMI as well as actions taken by the FMI to remediate these risks, as Key Consideration 2 calls for. Further, disclosure to the public of climate-related financial risks, through such medium as the updated disclosure framework, allows the public to fully understand the climate-related financial risks faced by an FMI, and the actions taken to address these.

As this paper lays out, climate-related financial risks manifest themselves in the myriad of risks that an FMI faces daily in its operation. Therefore, this discussion only includes the most significant of the PFMI recommendations that address these risks and concerns. DTCC, in conjunction with its regulators, members, and partners in the industry, looks forward to continuing to work to identify climate-related financial risks, how these affect the risk profile of the FMI as a whole, and what steps can be taken to manage these risks.

USE OF CLIMATE-RELATED SCENARIOS BY REGULATORS FOR THE ANALYSIS OF CLIMATE-RELATED FINANCIAL RISK

Scenario analysis has long been a helpful tool for financial institutions and regulators to understand potential impacts of certain events. The accuracy and usefulness of scenario testing is dependent on having accurate quantitative data to input into the scenario and having robust causal relationships between the inputs and the results of the scenario testing. Years of financial scenario modeling, such as the Federal Reserve's Dodd-Frank Act Stress Test or the Comprehensive Capital Analysis and Review, exemplify this by using inputs such as increases in unemployment, changes in equity markets, or corporate credit defaults to estimate capital or liquidity deterioration at depository institutions. These scenario tests can help institutions and regulators determine appropriate capital or liquidity responses to specific tested scenarios.

Various regulators around the world have proposed, to varying degrees, the utilization of scenario testing to attempt to quantify climate-related financial risk. The use of climate-related financial risk scenario testing has been more prevalent in the banking sector, where the ECB, the BCBS, the OCC, the FDIC, and the Federal Reserve have all broached the subject with regard to their regulated entities. Further, within the U.S., the FSOC has called on member agencies, including the SEC and the CFTC, to increase their analysis of climate-related financial risks to regulated entities through a variety of regulatory tools including, but not limited to, the use of scenarios.

At present, we observe that the usage of scenarios to analyze climate-related financial risk remains challenging both from a theoretical and practical perspective for the following fundamental reasons: the absence of two important aspects that serve as an established foundation for the forms of scenario testing referenced above, namely, robust quantitative data to input into the scenario, and well-established causal relationships. This is further exacerbated in the case of FMIs, where as previously noted, much of the climate-related financial risk that FMIs encounter is indirect risk through their participants. Thus, as a threshold matter, we believe that policymakers would be best-served by first working with market participants to address and resolve these fundamental limitations in the design and application of scenarios for assessing the potential impacts of climate-related financial risk before incorporating such scenarios as hard-coded regulatory requirements. That said, we believe that such efforts should be pursued collaboratively and responsibly by authorities and market participants together. As for the present, and with regard to the present use case for FMIs, we envision the usage of scenario analysis as an informational tool for both the FMIs and for regulators to show where the FMIs may have to further consider and probe upon potential climate-related financial risk exposure. We note that this form of informational approach is not unprecedented nor without important utility. For example, regulators such as the Federal Reserve have used climate-related financial risk scenario analysis of banks as an informational tool for regulators and banks. More pointedly, the Federal Reserve has announced that in launching a pilot climate scenario analysis exercise involving six of the largest U.S. banks, the results will not be used for capital or supervisory implications.²⁸ Likewise, we think it appropriate for regulators of FMIs to consider using climate scenario analysis to identify potential exposures of FMIs, but not use these results to prescribe specific regulatory responses beyond those otherwise required by applying the existing PFMI-based approaches to managing those risks relevant to the functioning and operations of an FMI.

²⁸ Federal Reserve. (2022, September 29). *Federal Reserve Board announces that six of the nation's largest banks will participate in a pilot climate scenario analysis exercise designed to enhance the ability of supervisors and firms to measure and manage climate-related financial risks.* Federal Reserve. (2023, January 17). *Federal Reserve Board provides additional details on how its pilot climate scenario analysis exercise will be conducted and the information on risk management practices that will be gathered over the course of the exercise.*

GREEN BONDS

In 2007, the European Investment Bank (EIB) issued a structured bond with proceeds dedicated to renewable energy and energy efficiency projects under the label *Climate Awareness Bond*.²⁹ This was the first green bond – a fixed-income security that raises capital to fund specific climate-related projects or other activities that promote environmental sustainability. Other than their specific purpose, green bonds are structured the same way as standard bonds, with the same characteristics in terms of seniority, rating, execution process, and pricing.

While there is no legal definition or uniform standard of what constitutes a green bond, a number of general principles and standards have been developed:³⁰

- The **Green Bond Principles (GBP)** are voluntary process guidelines that recommend transparency and disclosure to promote integrity in the development of the green bond market (see callout box on next page for additional details). The GBP were originally established in 2014 by a consortium of investment banks. Ongoing monitoring and development of these guidelines has since moved to an independent secretariat hosted by the International Capital Market Association.
- The **Climate Bonds Standard & Certification Scheme** (the “Certification Scheme”) is a key component of the Climate Bonds Initiative, an international not-for-profit organization that was founded in 2010 to promote investments in a low-carbon and climate-resilient global economy. The Certification Scheme builds on the GBP and aims to create a robust, flexible, and effective certification system. One of its purposes is to keep companies or issuers of financial products from making false or misleading claims about their green credentials – a practice known as *greenwashing*.
- The European Commission aims to provide a more extensive and uniform regulatory framework based on Regulation (EU) 2020/852 (the “EU Taxonomy”) with the introduction of a **European Green Bond Standard**.³¹

²⁹ Rosembuj, F., & Bottio, S. (2016, December). Mobilizing Private Climate Finance – Green Bonds and Beyond. *EM Compass Notes – Note 25, December 2016*. International Finance Corporation (IFC), World Bank Group; and Climate Bonds Initiative. (n.d.). *Explaining Green Bonds*. <https://www.climatebonds.net/market/explaining-green-bonds>

³⁰ Henry, P. (2021, October 26). *What Are Green Bonds and Why Is This Market Growing So Fast?* World Economic Forum.

³¹ For further information, see: European Parliament. (2022, May 17). *European Green Bond Standard: New Measures to Reduce Green Washing*; and Clifford Chance. (2022, June). *European Green Bond Regulation – A Look at the (Legislative) Train Schedule, the ECON Report and Next Stops*. *European Capital Markets Monthly Briefing Series*.

GREEN BOND PRINCIPLES

The GBP are voluntary process guidelines that recommend transparency and disclosure and promote integrity in the development of the green bond market. Originally established in 2014 by a consortium of investment banks, ongoing monitoring and development of these guidelines has since moved to an independent secretariat hosted by the International Capital Market Association.

The GBP emphasize the required transparency, accuracy and integrity of the information that will be disclosed and reported by issuers to stakeholders through core components and key recommendations.

The four core components for alignment with the GBP are:

- 1) **Use of Proceeds** – The proceeds should be used to finance projects that provide clear environmental benefits (e.g., climate-change mitigation), which will be assessed and, where feasible, quantified by the issuer.
- 2) **Process for Project Evaluation and Selection** – The issuer should clearly communicate to investors: the environmental sustainability objectives of the project; the process by which the issuer determines the green eligibility of the project; and complementary information on processes to identify and manage perceived social and environmental risks associated with the relevant project.
- 3) **Management of Proceeds** – Proceeds should be properly managed in a sub-account, a sub-portfolio or otherwise tracked appropriately by the issuer, and they should be linked to the issuer's lending and investment operations through a formal internal process.
- 4) **Reporting** – Issuers should make, and keep, readily available up-to-date information on the use of proceeds to be renewed annually until full allocation, and on a timely basis in case of material developments.

The two key recommendations for heightened transparency are:

- 1) **Green Bond Frameworks** – Issuers should have a Green Bond Framework or legal documentation that explains how they align with the four core components of the GBP.
- 2) **External Reviews** – It is recommended that issuers appoint (an) external review provider(s) to assess through a pre-issuance external review the alignment with the four core components of the GBP.

Sources:

<https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp>

<https://www.climatebonds.net/market/best-practice-guidelines>

<https://www.sustainalytics.com/esg-research/resource/corporate-esg-blog/about-green-bond-principles>

There are several types of Green Bonds:³²

1. **Standard Green Use of Proceeds Bonds:** unsecured debt obligations with full recourse-to-the-issuer only and aligned with the GBP.
2. **Green Revenue Bonds:** non-recourse-to-the-issuer debt obligations aligned with the GBP in which the credit exposure in the bond is to the pledged cash flows of the revenue streams, fees, taxes, etc., and whose use of proceeds go to related or unrelated Green Project(s).
3. **Green Project Bonds:** project bonds for a single or multiple Green Project(s) for which the investor has direct exposure to the risk of the project(s) with or without potential recourse to the issuer, and that are aligned with the GBP.
4. **Secured Green Bonds:** a secured bond where the net proceeds will be exclusively applied to finance or refinance either:

³² This classification is based on: International Capital Market Association. (2021, June). *Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds*. For an alternative classification of green bonds, see: Climate Bonds Initiative. (n.d.). *Explaining Green Bonds*. <https://www.climatebonds.net/market/explaining-green-bonds>

- » the Green Project(s) securing the specific bond only; or
- » the Green Project(s) of the issuer, originator or sponsor, where such Green Projects may or may not be securing the specific bond in whole or in part (a “Secured Green Standard Bond”). A Secured Green Standard Bond may be a specific class or tranche of a larger transaction.

As the market for green bonds has grown over the past several years, additional types of debt instruments have been introduced to fund projects that aim to have a positive impact on society, as well as other initiatives that promote sustainability. While there is no single label that denotes this broader range of debt instruments, the terms sustainable finance bonds, GSS bonds, GSS+ bonds or GSSS bonds are often used in this context.³³

While the lack of standardization makes it challenging to quantify the size of this market segment with precision, the growth of these financial instruments over recent years has been considerable and shows no sign of slowing. This is illustrated by the graph below, which was created by the Climate Bonds Initiative, and which shows annual debt issuance metrics across five themes, based on the types of projects, activities, and expenditures that are being financed:³⁴

- **Green bonds**, which are dedicated to funding projects or activities with environmental benefits (bond metrics captured since 2012).
- **Social bonds**, which are exclusively dedicated to funding projects with social benefits, such as housing, gender, women, health, education, etc. (bond metrics captured since 2020).
- **Sustainability bonds**, which combine green and social benefits into one instrument, such as socially responsible investment (SRI) or ESG-related investments (bond metrics captured since 2020).
- **Sustainability-linked bonds (SLBs)**, which raise general-purpose finance and involve penalties/rewards (e.g., coupon step-ups/step-downs, early repayment obligations, etc.) that are linked to (not) meeting pre-defined, time-bound Sustainability Performance Targets (bond metrics captured since 2021).
- **Transition bonds**, which predominantly originate from highly-polluting industrial sectors that are hard to abate (e.g., mining, steel, cement, aviation and shipping). These bonds are used to finance activities that are not low-emission or zero-emission, but that play a role in decarbonizing an activity or supporting an issuer in its climate transition efforts (bond metrics captured since 2021).

GSS+ debt volume surpassed USD1tn in 2021



Illustration above sourced from: Harrison, C. et al. (2022, April). *Sustainable Debt Global State of the Market 2021*. Climate Bonds Initiative. https://www.climatebonds.net/files/reports/cbi_global_sotm_2021_02h_0.pdf

³³ The term *GSS bonds* stands for green, social and sustainability bonds (this label is sometimes extended to *GSS+ bonds* to denote additional categories). Similarly, the term *GSSS bonds* stands for green, social, sustainability and sustainability-linked bonds.

³⁴ Graph copied from: Harrison, C. et al. (2022, April). *Sustainable Debt Global State of the Market 2021*. Climate Bonds Initiative.

The graph on the previous page shows that:

- Annual green bond issuance broke through the half-trillion-dollar mark for the first time, ending 2021 at \$522.7 bn, a 75% increase on prior year volumes.
- GSS+ annual debt issuance reached \$1.1 Tn in 2021, which is 46% more than the \$730.5 bn new issuance in 2020.

With respect to the cumulative volume (which is not shown in the graph on the previous page), a recent report that was published by the Climate Bonds Initiative noted that, at the end of 2021:³⁵

- The cumulative volume of green bonds had reached \$1.6 Tn.
- This represents well over half of the \$2.8 Tn cumulative volume of GSS+ debt instruments.

POTENTIAL RISKS TO FINANCIAL STABILITY

In its September 2021 Quarterly Review, the BIS published an analysis warning that a bubble might be developing in investment products classified as delivering ESG benefits unless market transparency can be ensured.³⁶ This analysis is supported by:

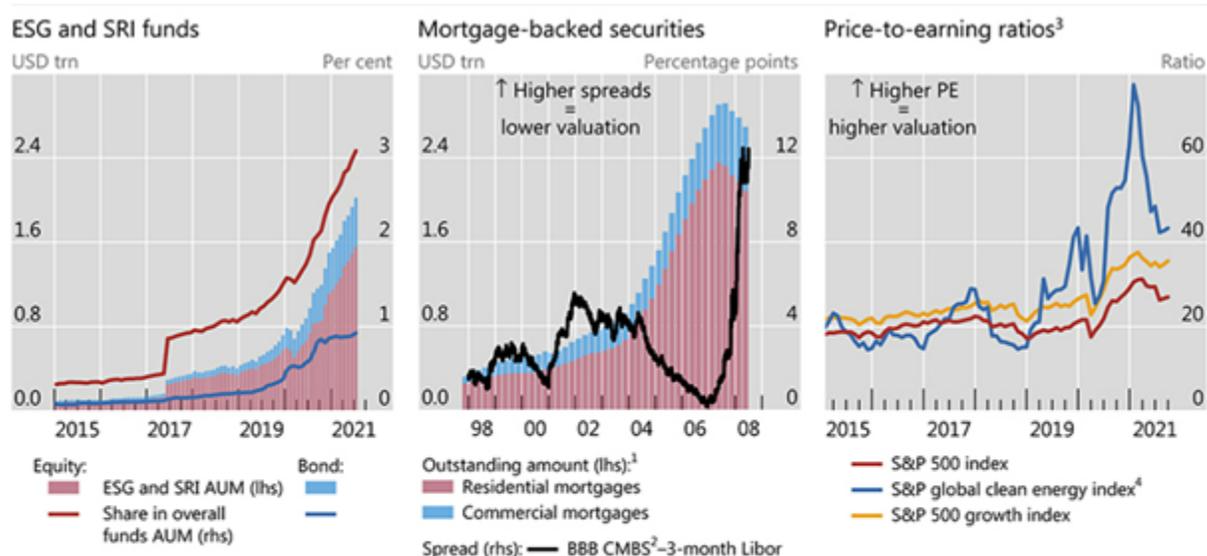
1. the rapid growth of ESG and socially responsible investing (SRI) funds since 2015 (as illustrated on the left-hand panel of the graph on the next page); and
2. the explosive increase in price-to-earnings ratios for clean energy companies over the same period, even after a decline from their peak in January 2021 (as illustrated on the right-hand panel of the graph on the next page).

Based on these two developments, the analysis draws parallels with the growth and size of the mortgage-backed securities markets in the years leading up to the Great Financial Crisis, as illustrated in the center panel of the graph on the next page.

³⁵ Harrison, C. et al. (2022, April). *Sustainable Debt Global State of the Market 2021*. Climate Bonds Initiative.

³⁶ Aramonte, S., & Zabai, A. (2021, September 20). Sustainable Finance: Trends, Valuations and Exposures. *BIS Quarterly Review, September 2021*.

Sustainable finance's growth prompts parallels with past market developments



ESG = environmental, social and governance; SRI = socially responsible investing.

¹ Private label. ² ICE Bank of America 0–10 year BBB US fixed rate commercial mortgage-backed securities index. ³ Monthly averages of daily values. ⁴ Includes firms that produce energy from solar, wind, hydro and other renewable sources, as well as those that supply clean technology. The top 10 constituents account for approximately 50% of total weight; no single stock's weight is higher than 8%.

Sources: Bloomberg; Datastream; EPFR; ICE BofA indices; authors' calculations.

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Illustration above sourced from: Aramonte, S., & Zabai, A. (2021, September 20). Sustainable Finance: Trends, Valuations and Exposures. *BIS Quarterly Review*, September 2021. https://www.bis.org/publ/qtrpdf/r_qt2109v.htm

Even though the potential for a so-called “green bubble” and other risks warrants further monitoring, it should also be noted that this market segment, while growing, still represents only a fraction of the overall fixed income market.³⁷

Requiring a central counterparty (CCP) to provide preferential treatment to asset types that are considered “green”, including through collateral haircuts or preferencing certain types of assets/issuers over others, would not be appropriate. While it may be appropriate for central banks to pursue this approach (subject to having a clear legal mandate to do so), CCPs should not be required, either directly or indirectly, to trade-off appropriately addressing market and liquidity risks, to address climate-related risks.

³⁷ The \$2.8 Tn cumulative volume of GSS+ debt instruments mentioned on the previous page is very small relative to the total value of outstanding fixed income debt securities across the world, which was recently estimated at \$128 Tn according to: Securities Industry and Financial Markets Association (2022, October). US Fixed Income Markets – Issuance & Trading. SIFMA Research Quarterly – 3Q22.

DTCC'S APPROACH TO MITIGATING CLIMATE-RELATED FINANCIAL RISK

In recognition of the fact that climate-related risk has the potential to affect financial stability, DTCC's SRO has included this type of risk as one of the many potential systemic threats it actively analyzes and monitors. The publication of this paper is part of the SRO's efforts to highlight the importance of this risk and help ensure that it is addressed timely and appropriately.

As we noted previously, DTCC (similarly to other FMIs) is directly exposed to the operational risk caused by extreme weather events, which are becoming more frequent and more costly, and which are categorized as acute climate-related risks. Additionally, DTCC has indirect climate-related credit exposure, given that the members of its clearing agencies (DTC, NSCC and FICC) are financial institutions that are directly impacted by climate-related financial risk. Finally, while the operational activities of DTCC and other FMIs are not particularly carbon-intensive by nature, we feel it is incumbent on us to do our part by being good environmental stewards.

As such, this section highlights what DTCC is doing to mitigate climate-related risk as it relates to:

1. DTCC's Business Continuity
2. DTCC's Counterparty Credit Risk (CCR)
3. The environmental aspects of DTCC's ESG program

DTCC'S BUSINESS CONTINUITY

DTCC's Business Continuity department specifically defines **location and area risk** as a form of operational risk that may be incurred due to significant business disruptions caused by inadequate or failed internal processes relating to the choice of DTCC sites, the unavailability of a site due to external events, or the failure of a site due to the loss of a key external service provider. As such, DTCC's exposure to climate-related physical risk is included in the broader definition above of location and area risk.

- **DTCC's Business Continuity department uses location and area risk profiles** to evaluate site-specific risks annually based on standardized threat and vulnerability criteria, which include: major infrastructure failures, man-made phenomena, natural phenomena, geopolitics, politics, crime, proximity to areas with a high-risk profile, proximity to major transportation areas, proximity to uncontrolled areas, building infrastructure, and security.
- **Location and area risk profiles are included in facility-level resilience plans**, which serve as the authoritative source of a DTCC facility's recovery and continuity arrangements. DTCC's site-specific and region-specific plans are reviewed on an annual basis by a series of internal departments and approved by the site/regional General Manager.
- **DTCC's Location and Area Risk Program within Business Continuity will be expanded to include trending metrics designed to show climate change risk for each significant DTCC location.** Additionally, simultaneous events across geographies will be tracked to assess the impact frequency.

To ensure the continuity of critical business functions, DTCC's Business Continuity department is responsible for identifying instances of key person risk, workforce balance risk, and geographic concentration risk. To mitigate these types of risk, DTCC's Business Continuity department utilizes **work area recovery strategies**³⁸ that may be employed in the event of a disruption.

- Work area recovery strategies are assigned by DTCC's Business Continuity department to employees as part of the bench strength analysis (BSA).

³⁸ Work area recovery strategies include workforce balance, work from anywhere, dedicated seating, transference, and on-demand seating.

- This BSA is completed semiannually in tandem with business line and support unit resilience plan reviews to identify gaps with respect to key person risk, geographic concentration risk, and workforce balance risk.
- To address gaps that have been identified, short-term or long-term remediation strategies are put into place (including, but not limited to, hiring personnel and cross-training existing personnel).
- This BSA is considered best practice in the business continuity space; DTCC's Business Continuity Program built a homegrown tool to complete this BSA, achieving a level of detail that is unique in the industry and that is informed by a series of inputs.
- DTCC also uses third-party tools to gather employee information and build out resilience plans, inclusive of business area call lists. Individuals in the call list are fed into the BSA tool, along with the region they work in, the facility they are assigned to, the hours they work, and the work area recovery strategy they are capable of. Subject matter experts then assign each individual bench strength capabilities per business function in their area.³⁹
- Once this data is collected, Business Continuity representatives run an automatic analysis to identify instances of key person risk, geographic concentration risk, and workforce balance risk, as defined per DTCC's Global Business Continuity Policy:
 - » **Key person risk** occurs when only one individual in a given business area is identified with a bench strength of "same day."
 - » **Geographic concentration risk** occurs for critical business functions when more than 60% of staff are located in one region.
 - » **Workforce balance risk** occurs when more than 60% of staff with "same day" capabilities for a given business function are concentrated in a single facility and work the same shift.

Business continuity exercises test an enterprise's response to physical risk-related scenarios. Operational exercises include workforce balance exercises and tabletops for site-based crisis response teams and senior management, while technology exercises test disaster recovery scenarios impacting DTCC's data centers:

- **Workforce balance exercises** simulate a loss of region scenario in which in-scope staff for critical business functions stand down from those functions for one business day and transfer those functions out of region. These exercises test the ability of distributed staff to support core services.
- **Tabletop exercises** test crisis response teams' ability to respond to an event/incident/crisis. Scenarios for tabletop exercises are drafted using hypothetical threats and impacts collected by DTCC's Business Continuity department on an annual basis from subject matter experts. The annual *Threat and Impact Survey* is a unique method employed by DTCC to ensure that exercise scenarios are relevant and based in reality.
- **Technology exercises** test disaster recovery scenarios impacting DTCC's data centers,⁴⁰ such as loss of region and/or out of region recovery. In each disaster recovery exercise, DTCC's Information Technology team tracks the completion of recovery and verification tasks required for each application that falls within the exercise scope. Dependencies for each application are required to complete within the Maximum Allowable Downtime⁴¹ and Recovery Time Objective⁴² assigned to such application.

³⁹ Individuals who are well-trained in a given business function and who are most likely to perform the associated duties on a daily basis are assigned a higher bench strength capability than individuals who require training to perform a given business function.

⁴⁰ Disaster recovery exercises are performed for DTCC-hosted/DTCC-managed public cloud, third-party managed cloud, hybrid public cloud and on-premises, and Regulation SCI systems.

⁴¹ Maximum Allowable Downtime: the total amount of time that a business process, product, or service can be disrupted without causing unacceptable consequences.

⁴² Recovery Time Objective: a measurement of time it takes to restore infrastructure and application components to an acceptable level following a disruption.

DTCC'S BUSINESS CONTINUITY PROGRAM EMBRACES CONTINUOUS IMPROVEMENT:

- Lessons learned reporting is completed for all business continuity exercises. This reporting allows for continuous improvement through the identification of issues and improvements. These lessons learned are documented as action plans and tracked through remediation.
- A robust issue management process documents lessons learned after an exercise or real-life event or incident. These lessons learned are broken down into actionable steps that are aimed at improving DTCC's Business Continuity Program (see box below for examples).

LEVERAGING LESSONS LEARNED TO IMPROVE DTCC'S BUSINESS CONTINUITY PROGRAM

DTCC's Business Continuity department utilizes a robust issues management process to document lessons learned after an exercise or real-life event or incident. These lessons learned are broken down into actionable steps that are aimed at improving DTCC's Business Continuity Program, as illustrated by the examples below:

- In 2012, after Hurricane Sandy, DTCC focused on geographically distributing staff and promoting work from home capabilities.
- In 2017, after Hurricane Irma, DTCC, along with the city of Tampa and several small firms, established the Tampa Business Emergency Council (TBEC – see <https://tampa-bec.org/>) to improve regional support across institutions in Tampa in the event of an emergency.
 - The TBEC was formed with two distinct focuses:
 - (1) Small and medium businesses need additional resources, such as training and funding, to prepare for and recover from emergencies.
 - (2) Large businesses, which typically have more resources, require slightly different resources.
 - In response to these areas of focus, the business-aligned emergency services function was streamlined and staffed to support both types of requests.
 - Small businesses were identified as being at the highest risk of not being properly prepared or able to recover from storms.
 - The observation that an individual was overwhelmed with requests from large, medium, and small businesses, each with different needs, led to the identification of a single point of failure in the regional information flow to and from the city.
 - A clearing house of information was created to enable city and county small business advocates to better provide businesses with consolidated preparedness information, training, and awareness.
 - Post-Irma, DTCC participated in a lessons learned initiative hosted by the City of Tampa Emergency Operations Center.
- In 2022, Business Continuity implemented a climate change component into its business continuity risk profiles. These risk profiles analyze business areas against 75 control qualifiers and are folded into overarching operational risk profiles for the entire DTCC enterprise.

DTCC'S COUNTERPARTY CREDIT RISK (CCR)

DTCC's Counterparty Credit Risk (CCR) department has begun to incorporate an assessment of each clearing member's exposure to climate-related financial risk into the overall assessment of credit risk. The department plans to review the climate-related financial risk disclosures from its publicly traded full-service members, and it has begun to ask due diligence questions of each clearing member related to physical and transition risk. However, the current disclosures and responses from clearing members are lacking in consistency and depth thus far, due to the lack of established industry best-practices for disclosures and benchmarks and lack of mandated disclosures by supervisory authorities. As a result, credit risk conclusions based on this information are tenuous at best at this point, although we expect the depth and standardization of disclosures to improve over time. To date, DTCC has observed that its clearing members based in Europe have provided more transparency as it relates to climate-related financial risk disclosures as compared to clearing members located elsewhere.

- The qualitative responses received by DTCC's CCR department from clearing members so far on their exposure to climate-related financial risk have focused mostly on physical risk, which is potentially more straightforward to assess (e.g., whether office locations are on a coastline and whether the firm has adequate remote working capabilities), while exposure to transition risk (e.g., changes in market values of financial assets impacted by climate change) remains less clear and more difficult to assess. Many firms have begun to incorporate climate-related financial risk into their broader risk management framework. However, without standardized disclosures across the industry, it remains difficult, if not impossible, to perform meaningful assessments of clearing members' climate-related financial exposures and internal risk controls.
- DTCC's CCR department has also assessed ESG-related materials from external rating agencies, but the information tends to be designed more for buy-side firms and banks. The weighting of the "E" in ESG by external rating agencies tends to be a low percentage of the overall score and based significantly on how transparent the firm is in providing information relative to other firms.
- While products designed to assess geographical physical risk are being offered by specialized organizations, their practical application may require additional information that is not always readily available. By way of example, DTCC found that one such product that assesses specific physical risks within a country or state could only be used effectively for counterparty credit purposes if it would be combined with additional data on a bank's loan exposure in a particular area and estimates of the potential loan losses that could occur due to an extreme weather event in that area. Given the multiple variables and assumptions that would need to be made to complete such an analysis, plus DTCC's short settlement risk exposure of only a few business days, we feel this type of analysis is not practicable for our purposes.
- The exposure of DTCC's clearing agencies' full-service members to transition risk is extremely difficult to assess at this time. Currently, DTCC would be reliant on the clearing member to disclose any material issues related to a wind-down or depreciation of a high-carbon asset. While there may be more risk in certain countries relative to others, and while it is possible that high-carbon assets may not always be efficiently priced, there currently isn't enough information being disclosed, or standardization of information being disclosed, to effectively assess this risk.
- The European Commission has put forward ideas requiring EU banks that hold brown assets to have an additional capital buffer based on risk-weighted assets. This proposal may make it easier for credit departments to assess transition risk if this proposal is adopted.

THE ENVIRONMENTAL ASPECTS OF DTCC'S ESG PROGRAM

At the core of DTCC's mission is our mandate to protect the capital markets. As such, we recognize that we can promote sustainable practices – and we fully agree with the following statement that was made at the 2021 World Economic Forum:⁴³

“As critical infrastructure, connectors, and platforms that transcend borders, capital markets have a responsibility to help influence companies and economies in their transition towards more sustainable practices and ensure that investors are prepared to finance that change.”

The SEC, as DTCC's main regulator, has been making efforts to provide investors with material information about environmental risks facing public companies since the 1970s, and in March 2022, proposed rules which would require public companies to disclose climate change-related information in their registration statements and annual reports.⁴⁴

DTCC's ESG PROGRAM

DTCC, like its peers, is spearheading initiatives to lower its energy usage as part of a larger, multi-year ESG program.

Examples of this program include the following:

- We started monitoring energy usage in 2016 with the goal to reduce our emissions, and as of 2021, we have achieved a 30% reduction in energy consumption.
- In 2021 we began developing a net-zero road map. The organization has made a commitment to move towards net zero carbon emissions by 2030; however, we are in the process of refining our science-based targets and determining the resources needed to achieve these targets.
- We received the ISO 50001:2018 Energy Management certification for our office locations and data centers in Jersey City, Tampa, Dallas Beltline/Crestside, Brooklyn, Wrexham, London, Chennai and Manila. Additionally, we operate within an ISO 14001:2015 Environmental Management framework. DTCC anticipates ISO 14001:2015 certification in the course of 2023.
- We know the largest area of emissions is through our supply chain, and we are in the process of understanding our scope 3 emissions in purchased goods and services, capital goods, waste generated in operations, business travel, employee commuting and leased assets.
- In addition, we are developing strategies to increase physical resilience while reducing emissions through microgrid development (e.g., solar panels, storage batteries, etc.) in order to:
 - » Further enhance our resilience when supply chain issues emerge.
 - » Source our own renewable energy and control emissions.

We expect that while DTCC will not be directly required to disclose climate change information if the SEC's rules are adopted as proposed, many of our clients will look to DTCC to provide climate-related information as a supplier. In July 2021, the FSB published a roadmap for addressing climate-related financial risk to ensure future stability of financial markets.⁴⁵ The FSB roadmap identifies four areas for action across companies, supervisors, regulators, and standard-setting bodies: (i) disclosure of environmental data; (ii) analysis of the data to identify climate-related financial risks; (iii) assess vulnerabilities for regulatory action; and (iv) develop regulatory tools and practices to

⁴³ Cha, L. (2021, January 20). *Capital Markets Can Help Us Reach Our Climate Change Goals*. World Economic Forum.

⁴⁴ U.S. Securities and Exchange Commission. (2022, May 12). Proposed Rule – The Enhancement and Standardization of Climate-Related Disclosures for Investors. *Federal Register* – Vol.87, No. 92..

⁴⁵ Financial Stability Board. (2021, July 7). *FSB Roadmap for Addressing Climate-Related Financial Risks*.

address climate-related risks.

With respect to firm-level disclosures, a milestone has been the publication by the newly established International Sustainability Standards Board of two Exposure Drafts, on climate and general sustainability-related disclosure standards.⁴⁶ The timely issuance of a final global baseline climate reporting standard ready for market adoption is critical given the global market demand for consistent, comparable and decision-useful disclosures on climate-related risks and opportunities. Alongside a global baseline reporting standard on climate, there is also a growing recognition of the importance of global assurance standards to drive reliability of disclosures.

DTCC voluntarily discloses climate-related data using the World Economic Forum's white paper *Measuring Stakeholder Capitalism: Towards Common Metrics and Consistent Reporting of Sustainable Value Creation*.⁴⁷ This white paper builds on long-standing reporting frameworks such as the Task Force on Climate-Related Financial Disclosures (TCFD), the Global Reporting Initiative, and the Sustainability Standards Accounting Board. Our annual progress in People, Environment, Governance, and Prosperity is published in our Annual Report. To see the latest ESG report, please visit <https://www.dtcc.com/annuals/2021/purpose>.

⁴⁶ See: International Sustainability Standards Board. (2022, March). *IFRS S1 – General Requirements for Disclosure of Sustainability-Related Financial Information*. IFRS® Sustainability Disclosure Standard Exposure Draft ED/2022/S1.
International Sustainability Standards Board. (2022, March). *IFRS S2 – Climate-Related Disclosures*. IFRS® Sustainability Disclosure Standard Exposure Draft ED/2022/S2.

⁴⁷ World Economic Forum. (2020, September). *Measuring Stakeholder Capitalism: Towards Common Metrics and Consistent Reporting of Sustainable Value Creation*.

KEY RECOMMENDATIONS

The key recommendations included in this paper are summarized below:

- We think that the PFMI should be leveraged to address climate-related financial risk as it pertains to FMIs around the globe, given that:
 - » they represent a standardized and internationally agreed-upon set of principles that were specifically tailored to help ensure that FMIs fulfill their unique mandate of preserving financial stability; and
 - » they already contain effective and adaptive guidance that can be applied holistically to mitigate both current and future climate-related risks.
- FMIs should consider adding climate-related trending metrics to their business continuity programs to ensure they effectively monitor and manage their exposure to physical risk.
- We think it appropriate for regulators of FMIs to consider using climate scenario analysis to identify potential exposures of FMIs, but not use these results to prescribe specific regulatory responses beyond those otherwise recommended by applying the existing PFMI-based approaches to managing those risks relevant to the functioning and operations of an FMI.
- Requiring a CCP to provide preferential treatment to asset types that are considered “green”, including through collateral haircuts or preferencing certain types of assets/issuers over others, would not be appropriate. While it may be appropriate for central banks to pursue this approach (subject to having a clear legal mandate to do so), CCPs should not be required, either directly or indirectly, to trade-off appropriately addressing market and liquidity risks, to address climate-related financial risks.
- Regulators and policymakers should continue working on standardizing robust disclosure requirements across the financial services industry to help FMIs perform meaningful assessments of their clearing members’ climate-related financial exposures and internal risk controls as part of the FMIs’ counterparty credit risk monitoring activities.

CONCLUSION

The climatic changes we have witnessed so far will likely be eclipsed by far more dramatic environmental shifts in the years and decades to come. As such, it is very encouraging to see growing levels of public awareness and debate around climate-related issues.

It is equally encouraging to see increasing interest on the part of financial regulators and policymakers, given that climate change will likely end up having a significant long-term impact on our economy and on the financial ecosystem.

At the same time, as much as this is a pressing issue, it is also an exceedingly complicated one. The myriad interdependencies within our planet's climatic system and the high level of uncertainty about assumptions pertaining to policies, behavioral patterns and many other factors present a daunting challenge, which is further compounded by the extremely long time horizons we must contend with.

Against this backdrop, it is imperative to clarify that the majority of financial institutions and FMIs are impacted by climate-related financial risk in very different ways. This is particularly important in at least two important respects. First, the multi-year (if not multi-decade) duration of banks' exposure to carbon-intensive industrial sectors (through long-term financing and other linkages) can hardly be compared to the duration of an FMI's exposure, which is typically measured in days. Second, given the nature of their activities, the exposure of FMIs to climate-related risks is far more indirect than banks' exposure to climate-related risks.

Banks and FMIs also have very different roles in the financial services ecosystem. While funding industrial and other economic sectors is a core part of a bank's credit transformation processes, the key mandate of an FMI is to help safeguard financial stability in stressful circumstances. As such, this mandate should always continue to come first in any regulatory framework that might be applied to ensure that FMIs adequately address climate-related risks.

DTCC addresses climate-related financial risk by enhancing its Business Continuity Program and by incorporating climate-related assessments into its Counterparty Credit Risk monitoring activities, in addition to developing a series of initiatives to reduce its own carbon footprint.

As much as our systemic risk white papers serve to articulate our views on important topics, their primary goal is to promote dialogue. As such, we encourage you to share your comments and feedback with us.

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APPENDIX 1 – REGULATORY AND POLICYMAKING ACTIONS

This section provides an overview of regulatory and policymaking actions that have been taken in the European Union, the United Kingdom, the Asia Pacific region and the U.S. to address climate-related financial risks.

EUROPEAN UNION

The European Green Deal aims to make the European Union (EU) climate-neutral by 2050. To obtain this goal, the EU has been working towards a sustainable finance framework to help increase the flow of money towards sustainable activities in alignment with the UN 2030 Agenda. Policymaking has therefore been adapted accordingly and includes sustainability targets, while a handful of supervisory authorities have incorporated climate-related targets into their mandates, such as the European Central Bank (ECB) and the European Securities and Markets Authority (ESMA).

Building on strategic documents produced by the European Commission (EC), such as the Strategy for Financing the Transition to a Sustainable Economy,⁴⁸ more work is expected on: a methodological framework assessing financial risks associated with biodiversity losses; an assessment of whether the current toolkit can address climate-related stability risks; efforts to broaden systemic risk considerations to include environment-related financial risks; and coordinating EU-level climate change stress tests by markets supervisors and central banks. During the remainder of 2023, the EU bodies will produce further reports on risks to financial stability and their likely evolution.

The integration of environmental, social and governance (ESG) considerations and risks in financial legislation/regulation is accelerating, as exhibited by debates on prudential frameworks and risk management for banks and insurers. Finally, climate-related financial risks are gradually being seen as part of macroprudential stability. However, European authorities have not yet offered dedicated supervisory guidance related to the governance, strategy and/or risk management of climate-related financial risks by FMI. Their focus has rather been on assessing the interaction between climate-related risks, monetary policy and macroprudential tools. Only recently, EU supervisors have begun inserting climate-related considerations into CCP supervision.

MARKETS SUPERVISION

ESMA is exploring ways to incorporate climate factors and other emerging risks into its annual stress testing exercises for CCPs. To this end, ESMA sought advice on how to cover physical, transition, business, and collateral risks, while discussing different options to ensure CCPs remain resilient and can meet new challenges stemming from climate-related financial risk. This workstream was recently laid out in the CCP Supervisory Committee's Strategic Objectives⁴⁹ and will include cooperation with the European Systemic Risk Board (ESRB).

ESMA is specifically working towards climate change scenario analysis by developing methods, parameters, and scenarios for bottom-up stress testing to be used by supervisors and supervised entities, as well as performing regular climate stress tests. ESMA's approach will likely result in integrating climate-related financial risk as a new, distinct category, alongside the traditional categories of risk.

MONETARY POLICY

The ECB has taken significant steps to incorporate climate change considerations into its monetary policy design, operations and implementation. Measures⁵⁰ are expected to be introduced gradually as of the end of 2023, including: (i) accounting for climate change in the ECB's corporate bond purchases, collateral framework, disclosure

⁴⁸ European Commission. (2021, July 6). *Strategy for Financing the Transition to a Sustainable Economy*.

⁴⁹ European Securities and Markets Authority. (2022, October 11). *CCP Strategic Objectives 2023-2025*.

⁵⁰ European Central Bank. (2022, July 4). *ECB Takes Further Steps to Incorporate Climate Change into its Monetary Policy Operations*.

requirements and risk management, in line with its Climate Action Plan; (ii) measures to reduce financial risk related to climate change on the ECB's balance sheet, encouraging transparency, and supporting the green transition of the economy; and (iii) assessing whether measures are fit for purpose and aligned with the EU's climate neutrality objectives.

Moreover, the ECB will limit the share of assets issued by entities with a high carbon footprint that can be pledged as collateral by individual counterparties when borrowing from the ECB. These limits will initially apply only to marketable debt instruments issued by non-financial corporations, with additional asset classes to follow as the quality of climate-related data improves.

The ECB will also consider climate change risks when reviewing haircuts applied to corporate bonds used as collateral. Finally, the ECB will further enhance its risk assessment tools and capabilities to better include climate-related risks. While it would still rely on rating agencies, the ECB has agreed with the Eurosystem on a set of common minimum standards for how in-house credit assessment systems should include climate-related risks in their ratings.

MACROPRUDENTIAL POLICY

The ECB and the ESRB recently launched a joint report⁵¹ analyzing how climate shocks can put financial stability at risk. The report provides a foundation for a macroprudential policy response to climate-related financial risks, including a theoretical case for macroprudential policies addressing climate transition risk. It argues in favor of adapting existing instruments, notably systemic risk buffers or concentration thresholds.

Such measures could complement efforts at the microprudential level, which include the ECB's climate-related stress test in 2022. Possible use of some flexible instruments, such as systemic risk buffers, could already be used to address climate-related risks of domestic bank exposures as a mitigant of macroprudential or systemic risk. It is a system-wide buffer that can be applied either for all banks or for targeted groups of banks across a subset of sectoral exposures (geographical or economic activity).

Using a scenario analysis-based approach, the report suggests that climate-related shocks could spread throughout the financial system, notably in the event of a disorderly green transition. Stresses that arise from market losses as a result of abruptly repricing climate-related financial risks could affect investment funds and insurers, as well as trigger corporate defaults and credit losses for banks. To mitigate systemic risk, macroprudential and microprudential policies should work hand in hand.

LEGISLATION

Most EU initiatives have primarily focused on a classification framework and a robust disclosure regime. Some notable examples of potential relevance to FMI are:

- The EU Taxonomy⁵² establishes a list of environmentally sustainable economic activities, to be used by institutional investors, publicly listed, and other large companies in their disclosure requirements. The Taxonomy Regulation was published in the Official Journal of the European Union on June 22, 2020 and entered into force on July 12, 2020.
- In June 2022 the European Parliament and Council reached a political agreement on a Corporate Sustainability Reporting Directive (CSRD),⁵³ which has since been published in the Official Journal of the European Union. The CSRD sets public disclosure requirements for the sustainability risk of economic

⁵¹ European Systemic Risk Board. (2022, July). The Macroprudential Challenge of Climate Change.

⁵² For further information, see: European Commission. (n.d.). *EU Taxonomy for Sustainable Activities*. https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en

⁵³ For further information, see: European Commission. (n.d.). *Corporate Sustainability Reporting*. https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en

activities of large, publicly listed and non-listed firms. An extra-territoriality provision has been included, covering all large companies operating in the EU market, irrespective of their headquarters. Large companies are currently defined as having: (i) a balance sheet total of at least EUR 20 million; (ii) a net turnover of at least EUR 40 million; or (iii) more than 250 employees on average during the financial year.

- On April 6, 2022, the European Commission adopted technical standards to be used by financial market participants when disclosing sustainability-related information under the Sustainable Finance Disclosures Regulation (SFDR).⁵⁴ SFDR requirements apply from January 1, 2023. On October 31, 2022, the European Commission adopted amendments to the SFDR to require financial market participants to disclose the extent to which their portfolios are exposed to gas and nuclear-related activities that comply with the EU Taxonomy. These amendments are currently being considered by the European Parliament and the Council.
- The objective of the Corporate and Supply Chain Due Diligence Principles is to introduce requirements for large firms across different sectors to publicly communicate due diligence on their sustainability and human rights standards throughout their value chains. Non-EU central securities depositories (CSDs) and CCPs providing services in the EU are in scope if they: (i) generate turnover of at least EUR 150 million within the EU; or (ii) generate turnover of more than EUR 40 million and no more than EUR 150 million, provided that at least 50% is in high-impact sectors.
- The European Commission adopted a legislative proposal on the European Single Access Point (ESAP) on November 25, 2021. The ESAP will offer a single access point for public financial and sustainability-related information about EU companies and EU investment products.

UNITED KINGDOM

In the UK, the Climate Financial Risk Forum, chaired by members from the Bank of England (BoE), the Prudential Regulation Authority (PRA) and the Financial Conduct Authority (FCA), builds capacity and shares best practices across financial regulators and industry, to advance the sector's responses to climate-related financial risks.

Separately, each supervisory authority has outlined its approach to resilience towards climate-related risks and adaptation to climate change.

MARKETS SUPERVISION

The FCA's focus revolves around ESG priorities and ways to support the financial sector in driving positive change, including the transition to net zero carbon emissions.

This is reflected in the FCA's *Strategy for Positive Change: ESG Priorities*,⁵⁵ which outlines its work on five key themes:

- promoting transparency on climate change and wider sustainability along the value chain;
- building trust and integrity in ESG-labelled instruments, products and the supporting ecosystem;
- working with others to enhance industry capabilities and support firms' management of climate-related and wider sustainability risks, opportunities and impacts;
- supporting the role of finance in delivering a market-led transition to a more sustainable economy; and
- developing strategies, organizational structures, resources and tools to support the integration of ESG into the FCA's activities.

⁵⁴ For further information, see: European Commission. (n.d.). *Sustainability-Related Disclosure in the Financial Services Sector*. https://finance.ec.europa.eu/sustainable-finance/disclosures/sustainability-related-disclosure-financial-services-sector_en

⁵⁵ Financial Conduct Authority. (2021, November 3). *A Strategy for Positive Change: Our ESG Priorities*.

MACROPRUDENTIAL POLICY

The BoE has designated climate change as one of seven strategic priorities that cover the four-year period to February 2024. The BoE outlined its response to climate change in a 10-part pledge⁵⁶ to advance the climate agenda across all their strategic priorities.

The BoE also publishes an annual report that explores the financial risks posed by climate change for the largest UK banks and insurers, known as the Climate Biennial Exploratory Scenario (CBES).⁵⁷ The CBES report includes the construction of scenarios to illustrate potential paths for climate policy and global warming, the identification of risks that are potentially impactful on the profitability of banks/insurers, and projections of climate losses which are still being refined.

The PRA works closely with the BoE to ensure the financial system's resilience to climate change. In 2019, it issued a Supervisory Statement,⁵⁸ outlining its climate-related supervisory expectations for regulated firms with regards to managing the financial risks from climate change in the form of:

- embedding climate-related financial risks into their governance framework;
- allocating responsibility for identifying and managing climate-related financial risks to the relevant existing Senior Management Function (SMF);
- incorporating climate-related financial risks into existing risk management frameworks;
- undertaking longer-term scenario analysis to inform strategy and risk assessments; and
- developing an appropriate approach to climate disclosure in line with the FSB's TCFD framework.

From 2022 onwards, the PRA has embedded climate change in its overall supervisory approach, and it actively supervises firms in line with these expectations.

Additionally, the PRA publishes an annual *Climate Change Adaptation Report*,⁵⁹ which sets out how the PRA is responding to the risks posed by climate change within its operations and policy functions.

ASIA PACIFIC REGION

Home to the world's most populous and fastest-growing countries, the Asia Pacific region has an impetus to take action to tackle climate-related financial risks, as it is the largest emitter of greenhouse gases, producing about half the world's carbon dioxide.⁶⁰ The region has also been hit by about 40% of all global climate disasters over the last three decades.⁶¹ Formal guidelines or policies on climate-related financial risk management are being rolled out by regulators across the region, including those in Australia,⁶² Hong Kong,⁶³ Japan,⁶⁴ and Singapore.⁶⁵

In tandem with the development of the green financing sector, regulators in the region, such as those in South Korea and Thailand, are pushing for the adoption of green finance frameworks. Most regulators in the Asia Pacific region

⁵⁶ Bank of England. (n.d.). *Climate Change*. <https://www.bankofengland.co.uk/climate-change>

⁵⁷ Bank of England. (2022, May 24). *Results of the 2021 Climate Biennial Exploratory Scenario (CBES)*.

⁵⁸ Bank of England Prudential Regulation Authority. (2019, April). *Enhancing Banks' and Insurers' Approaches to Managing the Financial Risks from Climate Change*. Supervisory Statement – SS3/19.

⁵⁹ Bank of England Prudential Regulation Authority. (2021, October 28). *Climate-Related Financial Risk Management and the Role of Capital Requirements*. Prudential Regulation Authority *Climate Change Adaptation Report 2021*.

⁶⁰ Gaspar, V., & Rhee, C. Y. (2021, March 25). Asia-Pacific, the Gigantic Domino of Climate Change. *International Monetary Fund Blog*.

⁶¹ Scatigna, M. et al. (2021, December 6). Public Support for ESG Markets: An Asian Perspective. *BIS Quarterly Review, December 2021*.

⁶² Australian Prudential Regulation Authority. (2021, November 26). *APRA Finalises Prudential Guidance on Managing the Financial Risks of Climate Change*.

⁶³ Hong Kong Monetary Authority. (2021, December 30). *Supervisory Policy Manual – Climate Risk Management*.

⁶⁴ Financial Services Agency. (2022, July). *Supervisory Guidance on Climate-Related Risk Management and Client Engagement*.

⁶⁵ Monetary Authority of Singapore. (2020, December 8). *Guidelines on Environmental Risk Management for Banks*.

have conducted or will be conducting climate stress tests in the next two years,⁶⁶ and supervisory reviews of their outcomes can help regulators determine the amount of resources required to better support an orderly and fair transition to net zero carbon emissions for their respective economies.

MARKETS SUPERVISION

Regulators in Australia, China, Hong Kong, Malaysia and Singapore are in the process of introducing requirements or guidelines for financial institutions to manage climate-related risks. While regulatory guidance varies across the Asia Pacific region, one of the key common focus areas centers on climate-related scenario analyses. Banks will likely consider risks beyond their typical strategic planning horizons on a more frequent basis as a result of this guidance.

Climate-related stress tests are underway or have been planned in several jurisdictions, including Australia, China, Hong Kong, Japan and Singapore, and it is expected that most supervisors in the region will conduct 30-year climate-related stress tests in the next two years.

MONETARY POLICY

Central banks in the Asia Pacific region have begun integrating ESG-related principles into their monetary policy as well as their reserve management. For example, the People's Bank of China (PBOC), the Hong Kong Monetary Authority, the Bank of Japan, the Central Bank of Malaysia and the Monetary Authority of Singapore have announced facilities or institutional arrangements to subsidize loans to commercial banks to support decarbonization efforts, to purchase green bonds or to extend green loans.

Efforts are underway to align with global standards, but the developing economies in Asia have the added challenge of balancing sustainability objectives with economic and social development goals. The increased focus on sustainability is not without benefits for developing economies, as there are lower barriers for them to build more resilient and sustainable economies and industries from the onset.

Access to green capital is expected to support Asia Pacific's transition towards a low-carbon future. Supported by the development of favorable policies and green financing frameworks, the green financing sector has made substantial progress in the region, especially in the more developed economies.

The presence of regional and multilateral development banks, such as the Asian Development Bank and the Asian Infrastructure Investment Bank, has facilitated a much-needed supply of funds for the sustainable development of the region, and has contributed to the growth of green bonds and other ESG-related investments. The BIS has also established an Asian Green Bond Fund to channel global central bank reserves to green projects in the Asia Pacific region.

MACROPRUDENTIAL POLICY

While the pace of policymaking initiatives differs across the Asia Pacific region, regulators have recognized the potential impact of climate-related risk to the financial sector. Most Asia Pacific regulators have already started communicating that they expect banks and other financial institutions to play an active role in managing climate-related financial risk. The PBOC has even included green bonds and loans in its macroprudential assessments.

LEGISLATION

The Asia Pacific region does not have standardized ESG-related industry guidelines and regulations. As part of its leading role in the region with respect to the development of green taxonomies, the PBOC has issued the Green

⁶⁶ Deloitte. (2022, February). *The Asia Securities Industry & Financial Markets Association (ASIFMA). Prudential Treatment of Climate-Related Risks and Stress Testing in Asia Pacific.*

Bonds Catalogue and it is working with the EU to standardize taxonomies across regions.

In line with the recommendations of the TCFD, climate-related disclosures are being made mandatory for listed companies and financial institutions in Hong Kong, New Zealand and Singapore. Proposals are already underway to mandate such disclosures in several other Asia Pacific economies as well, including China, India, Japan and Malaysia.⁶⁷

UNITED STATES

The rules and regulations that govern the operations of U.S.-based FMIs originate from various domestic and international sources. These can include international groups, such as the Board of the International Organization of Securities Commissions (IOSCO) who, in partnership with the Committee on Payment and Settlement Systems at the Bank for International Settlements, issued in 2012 the “Principles for Financial Market Infrastructures” (PFMI),⁶⁸ a set of principles for the effective operation and management of FMIs. Other international groups such as the FSB, whose mandate is to work with local regulatory agencies to promote financial stability, periodically issue recommendations that often have implications for FMIs, as those recommendations typically apply to institutions that are direct or indirect FMI members. These organizations have begun to review and make recommendations regarding climate-related financial risks, including the following actions:

- The FSB’s TCFD released a number of recommendations in 2017 that provided a framework for companies to develop more effective climate-related financial disclosures through the existing reporting system.⁶⁹ Since that time, the FSB has followed up by publishing annual status reports describing how companies’ reporting has aligned with the recommendations made.⁷⁰

Noting the breadth of climate-related concerns, and the multiple bodies that were looking at these concerns, the FSB published a roadmap for climate-related financial risks in July of 2021.⁷¹ This document had several areas of focus, set numerous goals, and looked at actions necessary to achieve these goals.

In October of 2022 the FSB published a final report entitled *Supervisory and Regulatory Approaches to Climate-related Risks*⁷² that contains:

- » five recommendations to improve data collection and information disclosures related to climate-related financial risks (which built on the FSB’s previous work); and
- » seven recommendations related to utilizing climate-related risks in stress testing and scenario analysis.⁷³
- In June of 2022, following a consultative and comment period, the Basel Committee on Banking Supervision (BCBS) published the *Principles for the Effective Management and Supervision of Climate-related Financial Risk*⁷⁴ (BCBS Climate Principles). This publication contains 18 high-level principles that provide guidance to banks regarding their management of climate-related financial risks, as well as guidance for prudential supervisors of banks.⁷⁵

⁶⁷ Schneider Electric. (2022, August 10). ESG Disclosure Regulations are Strengthening in Asia Pacific. *News Direct*.

⁶⁸ Committee on Payment and Settlement Systems – Technical Committee of the International Organization of Securities Commissions. (2012, April). *Principles for Financial Market Infrastructures*. Bank for International Settlements.

⁶⁹ Task Force on Climate-Related Financial Disclosures. (2017, June). *Recommendations of the Task Force on Climate-Related Financial Disclosures*.

⁷⁰ A list of recent TCFD publications can be found on: Task Force on Climate-Related Financial Disclosures. (n.d.). *Publications*. <https://www.fsb-tcfd.org/publications/>

⁷¹ Financial Stability Board. (2021, July 7). *FSB Roadmap for Addressing Climate-Related Financial Risks*.

⁷² Financial Stability Board. (2022, October 13). *Supervisory and Regulatory Approaches to Climate-Related Risks*. Final Report.

⁷³ See Appendix 2 to this paper.

⁷⁴ Basel Committee on Banking Supervision. (2022, June). *Principles for the Effective Management and Supervision of Climate-Related Financial Risks*. Bank for International Settlements.

⁷⁵ See Appendix 3 to this paper.

Within the U.S., oversight of FMI falls to a variety of governmental agencies depending on the operations of the FMI. These can include the U.S. Securities and Exchange Commission (SEC), the Commodity Futures Trading Commission (CFTC), the Federal Reserve Board, and the Financial Stability Oversight Council (FSOC). Other agencies relevant to financial institutions that are not FMIs include the Office of the Comptroller of the Currency (OCC) (as an authority over entities that are often FMI participants), the Federal Deposit Insurance Corporation (FDIC) (as a resolution authority for both certain FMI participants and certain FMIs in the U.S.), and various state agencies.

Issues related to climate change remain subject to intense debate within the U.S. political arena. For example, the Biden administration has made climate change an integral part of its agenda, creating a Climate Policy Office, and issuing Executive Order 14008, Tackling the Climate Crisis at Home and Abroad,⁷⁶ among other actions. Following the lead of the White House, several U.S. financial regulatory agencies have taken actions to address climate concerns. Similar to their European counterparts, a number of these actions revolve around the aggregation of relevant climate-related data and information as well as requiring entities to make certain climate-related disclosures to relevant parties. Actions taken by agencies include:

- The FSOC issued a Report on Climate-Related Financial Risk in 2021.⁷⁷ In the report, for the first time, the Council identified climate change as an emerging threat to U.S. financial stability and included more than 30 high-level recommendations for U.S. financial regulators. These recommendations included: (i) building capacity and expanding efforts to address climate-related risks; (ii) filling climate-related data and methodological gaps; (iii) enhancing public climate-related disclosures; and (iv) assessing and mitigating climate-related risks to financial stability. In October of 2022, following one of the recommendations in the 2021 report, the FSOC created a Climate-Related Financial Risk Committee.
- The SEC has been a lead U.S. regulatory agency in addressing climate concerns. In March of 2022, the SEC proposed a rule to enhance and standardize climate-related disclosures made by public companies.⁷⁸ A registrant, under the proposed rule, would be required to disclose information related to: (i) the registrant's governance of climate-related risks and relevant risk management processes; (ii) how many climate-related risks identified by the registrant have had, or are likely to have, a material impact on its business and consolidated financial statements, which may manifest over short, medium, and long term time horizons; (iii) how any identified climate-related risks have affected or are likely to affect the registrant's strategy, business model, and outlook; and (iv) the impact of climate-related events, such as severe weather events, and transition activities on the line items of a registrant's consolidated financial statements, as well as on the financial estimates and assumptions used in the financial statements. The proposed rule contains phase-in periods for implementation.

While initially the SEC intended to have a final rule in place by October of 2022, subsequent developments indicate that the timeline for final action has been prolonged and remains uncertain.⁷⁹ Adding to that uncertainty is the potential for judicial review, as both public commentators and the SEC Chair have noted that the Supreme Court decision of *West Virginia v. Environmental Protection Agency*⁸⁰ is "significant and meaningful."

Following on the public company disclosure rule proposal, in May of 2022 the SEC proposed two new rules

⁷⁶ The White House. (2021, January 27). *Executive Order on Tackling the Climate Crisis at Home and Abroad*.

⁷⁷ Financial Stability Oversight Council. (2021). *Report on Climate-Related Financial Risk*.

⁷⁸ U.S. Securities and Exchange Commission. (2022, May 12). Proposed Rule – The Enhancement and Standardization of Climate-Related Disclosures for Investors. *Federal Register – Vol.87, No. 92*.

⁷⁹ Ramonas, A., & Iacone, A. (2022, October 19). SEC Climate Rules Pushed Back Amid Bureaucratic, Legal Woes. *Bloomberg Law*.

⁸⁰ In the majority decision, the Supreme Court held that agencies need clear permission from Congress to create regulations that have major economic or political effects.

to enhance the framework for disclosures concerning investment funds and investment advisers' ESG-related investing strategies.⁸¹ As drafted, the proposed rules require SEC registered advisers to include ESG factors and strategies for investors in fund prospectuses, annual summaries and brochures. Registered funds that are categorized as an ESG fund, based on their advertising and whether they utilize ESG factors in their decision-making, will be required to make new disclosures in their prospectuses regarding their use of ESG factors in investment decisions; and annual fund summaries will be required that disclose ESG-related information, including disclosure of greenhouse gas information. Registered advisors will also have to disclose their ESG practices in brochures.

- The CFTC, in June of 2022, issued a Request for Information⁸² on climate-related financial risk to assist in the CFTC's understanding and oversight of relevant markets. The CFTC is seeking responses on questions specific to data, scenario analysis, stress testing, risk management, disclosure, product innovation, voluntary carbon markets, digital assets, greenwashing, financially vulnerable communities, and public-private partnerships and engagement. The CFTC notes that responses may be used for potential future actions, such as new or amended guidance, interpretations, policy statements, regulations or other actions. This request is important because it marked the first time that a U.S. regulator specifically included clearing organizations in its climate-related initiatives, as the CFTC sought information related to derivative clearing organizations.
- Other financial agencies have introduced climate-related initiatives for the banking sector in the U.S., often in response to international developments, such as the work that ultimately led to the recent finalization of the BCBS Climate Principles. These include:
 - » a series of climate-related risk management principles issued by the OCC for the large institutions it oversees;⁸³
 - » a climate-related financial risk management survey of the largest national banks;⁸⁴
 - » a series of climate-related principles released by the FDIC in March of 2022⁸⁵ that applies to institutions with over \$100 billion in assets;
 - » a climate scenario run by the Federal Reserve with the six largest banks in the country;⁸⁶
 - » proposed principles by the Federal Reserve for the management of exposures to climate-related financial risks for institutions with over \$100 billion in assets;⁸⁷ and
 - » numerous research papers on climate-related financial stability risks.

⁸¹ U.S. Securities and Exchange Commission. (2022, May 25). *SEC Proposes to Enhance Disclosures by Certain Investment Advisers and Investment Companies About ESG Investment Practices*.

⁸² Commodity Futures Trading Commission. (2022, June 2). *CFTC Releases Request for Information on Climate-Related Financial Risk*. Release Number 8541-22.

⁸³ Office of the Comptroller of the Currency. (2021, December 16). *OCC Seeks Feedback on Principles for Climate-Related Financial Risk Management for Large Banks*. News Release 2021-138.

⁸⁴ Office of the Comptroller of the Currency. (2022, January 18). *Agency Information Collection Requirements; Information Collection Renewal; Comment Request; Climate Risk Range of Practice Questionnaire*. *Federal Register* - Vol.87, No. 11.

⁸⁵ Federal Deposit Insurance Corporation. (2022, March 30). *Request for Comment on Statement of Principles for Climate-Related Financial Risk Management for Large Financial Institutions*. Financial Institution Letter FIL-13-2022. Federal Reserve. (2023, January 17). *Federal Reserve Board provides additional details on how its pilot climate scenario analysis exercise will be conducted and the information on risk management practices that will be gathered over the course of the exercise*. <https://www.federalreserve.gov/newsevents/pressreleases/other20230117a.htm>

⁸⁶ Federal Reserve. (2022, September 29). *Federal Reserve Board announces that six of the nation's largest banks will participate in a pilot climate scenario analysis exercise designed to enhance the ability of supervisors and firms to measure and manage climate-related financial risks*.

⁸⁷ Federal Reserve. (2022, December 2). *Federal Reserve Board invites public comment on proposed principles providing a high-level framework for the safe and sound management of exposures to climate-related financial risks for large banking organizations*.

APPENDIX 2 – SUPERVISORY AND REGULATORY APPROACHES TO CLIMATE-RELATED RISKS

In October of 2022 the FSB published a final report entitled *Supervisory and Regulatory Approaches to Climate-Related Risks*⁸⁸ that contains:

- **Five recommendations to improve data collection and information disclosures related to climate-related financial risks** (which built on the FSB’s previous work):
 - (1) Supervisory and regulatory authorities should accelerate the identification of their information needs for supervisory and regulatory purposes to address climate-related risks and work towards identifying, defining, and collecting climate-related data and key metrics for assessment and monitoring purposes.
 - (2) Supervisory oversight on financial institutions’ governance, processes and controls on climate-related data reported, along with reviews by financial institutions’ internal audit function, could strengthen the reliability of data. Establishing supervisory expectations addressing these areas would serve as an effective mechanism.

Where appropriate within jurisdictions’ legal and regulatory frameworks, supervisory and regulatory authorities should consider the need for third-party verification to strengthen the reliability of climate-related data, such as on emerging key metrics, that will be relied on by authorities and financial market participants more broadly. Third-party verifications could play an important role also in avoiding greenwashing risks.

- (3) To promote further consistency across jurisdictions and sectors, authorities should consider using common definitions (such as those proposed by standard-setting bodies and international bodies) for: (i) physical risk, including both acute and chronic risks; (ii) transition risk, including technological developments, behavior or social change, and policy changes; and (iii) liability risk, whether separate from or as a subset of physical and transition risk.
- (4) To the extent that more specific climate-related information is required for supervisory and regulatory objectives above and beyond public disclosures:
 - » authorities should begin with asking financial institutions to report to supervisors qualitative information supplemented with increasingly available quantitative information (including, where full information is not available, use of proxies or estimates); and
 - » as the availability and quality of data and measurement methodologies improve, authorities should move towards regular standardized regulatory reporting requirements, in a manner proportionate to the nature, size, and risk profile of a financial institution’s activities and that takes into account the balance of benefits and costs.

In this way, strengthening the quality of data and improving its availability can possibly move forward together.

- (5) Global coordination and cooperation towards common regulatory reporting frameworks could be a catalyst in the identification of exposures and understanding of impacts of climate-related risks on financial institutions, financial sectors and to the broader financial system. Where authorities and standard-setting bodies have needs for similar types of data, they are encouraged to work towards common regulatory reporting requirements and common data sets as part of future work.

⁸⁸ Financial Stability Board. (2022, October 13). *Supervisory and Regulatory Approaches to Climate-Related Risks*. Final Report.

- **Seven recommendations related to utilizing climate-related risks in stress testing and scenario analysis:**
 - (1) In addition to microprudential measures at the firm level, authorities' approaches should account for the potential widespread impact of climate-related risks across the financial system.
 - (2) Jurisdictions are encouraged to expand the use of climate scenario analysis and stress testing as a tool for macroprudential purposes. The design and scope of the analysis should ideally include the following features to inform a system-wide view: (i) both physical and transition risks; (ii) key financial sectors (e.g., banks, insurers, asset managers and pension funds); (iii) interdependencies between physical and transition risks, geographical and sectoral risks, as well as improved understanding of impacts on financial risks; and (iv) system-wide aspects of climate-related risks such as indirect exposures, risk transfers, spillovers and feedback loops.
 - (3) When designing their climate scenario analysis and stress tests, authorities should adopt features that can best inform a system-wide view. A top-down approach, or a combination of top-down and bottom-up approach (hybrid approach) could be used to capture cross-sectoral, system-wide aspects of climate-related risks. In addition, a dynamic balance sheet assumption could help capture second-round effects and potential feedback loops, while recognizing the inherent challenges on assumptions for financial institutions' future actions over a longer time horizon.
 - (4) Future exercises should consider the range of financial risks beyond credit and market risk, to the extent they pose material risks, such as liquidity and insurance (underwriting) risk, which could be important to assessing the resilience of sectors across the financial system and address their interconnectedness.
 - (5) As the FSB noted in its 2021 Report, the NGFS will continue its work to refine and develop climate scenarios, which authorities should make use of in their climate scenario analysis, as appropriate, in order to align the data and methodologies used in such analysis.
 - (6) Cooperation and coordination between authorities within a jurisdiction is encouraged. Authorities within each jurisdiction, aligned with their mandates, should cooperate and coordinate to better inform a system-wide view of climate-related risks. Such cooperation could, for example, include joint system-wide scenario analysis or stress test exercises on climate-related risks.
 - (7) With respect to cross-border coordination and cooperation, as authorities develop their approaches, authorities should engage in active dialogue on home-host coordination through means such as institution-specific supervisory colleges, given the global nature of climate-related risks. In addition, standard-setting and international bodies provide an important platform for cooperation and coordination on cross-jurisdictional risks stemming from climate-related financial risks.

APPENDIX 3 – PRINCIPLES FOR THE EFFECTIVE MANAGEMENT AND SUPERVISION OF CLIMATE-RELATED FINANCIAL RISK (BCBS CLIMATE PRINCIPLES)

In June of 2022, following a consultative and comment period, the Basel Committee on Banking Supervision (BCBS) published the *Principles for the Effective Management and Supervision of Climate-Related Financial Risk (BCBS Climate Principles)*.⁸⁹ This publication contains 18 high-level principles that provide guidance to banks regarding their management of climate-related financial risks, as well as guidance for prudential supervisors of banks:

- **Principle 1:** Banks should develop and implement a sound process for understanding and assessing the potential impacts of climate-related risk drivers on their businesses and on the environments in which they operate. Banks should consider material climate-related financial risks that could materialize over various time horizons and incorporate these risks into their overall business strategies and risk management frameworks.
- **Principle 2:** The board and senior management should clearly assign climate-related responsibilities to members and/or committees and exercise effective oversight of climate-related financial risks. Further, the board and senior management should identify responsibilities for climate-related risk management throughout the organizational structure.
- **Principle 3:** Banks should adopt appropriate policies, procedures and controls that are implemented across the entire organization to ensure effective management of climate-related financial risks.
- **Principle 4:** Banks should incorporate climate-related financial risks into their internal control frameworks across the three lines of defense to ensure sound, comprehensive and effective identification, measurement, and mitigation of material climate-related financial risks.
- **Principle 5:** Banks should identify and quantify climate-related financial risks and incorporate those assessed as material over relevant time horizons into their internal capital and liquidity adequacy assessment processes, including their stress testing programs where appropriate.
- **Principle 6:** Banks should identify, monitor and manage all climate-related financial risks that could materially impair their financial condition, including their capital resources and liquidity positions. Banks should ensure that their risk appetite and risk management frameworks consider all material climate-related financial risks to which they are exposed and establish a reliable approach to identifying, measuring, monitoring and managing those risks.
- **Principle 7:** Risk data aggregation capabilities and internal risk reporting practices should account for climate-related financial risks. Banks should seek to ensure that their internal reporting systems are capable of monitoring material climate-related financial risks and producing timely information to ensure effective board and senior management decision-making.
- **Principle 8:** Banks should understand the impact of climate-related risk drivers on their credit risk profiles and ensure that credit risk management systems and processes consider material climate-related financial risks.
- **Principle 9:** Banks should understand the impact of climate-related risk drivers on their market risk positions and ensure that market risk management systems and processes consider material climate-related financial risks.

⁸⁹ Basel Committee on Banking Supervision. (2022, June). *Principles for the Effective Management and Supervision of Climate-Related Financial Risks*. Bank for International Settlements.

- **Principle 10:** Banks should understand the impact of climate-related risk drivers on their liquidity risk profiles and ensure that liquidity risk management systems and processes consider material climate-related financial risks.
- **Principle 11:** Banks should understand the impact of climate-related risk drivers on their operational risk and ensure that risk management systems and processes consider material climate-related risks. Banks should also understand the impact of climate-related risk drivers on other risks and put in place adequate measures to account for these risks where material. This includes climate-related risk drivers that might lead to increasing strategic, reputational, and regulatory compliance risk, as well as liability costs associated with climate-sensitive investments and businesses.
- **Principle 12:** Where appropriate, banks should make use of scenario analysis to assess the resilience of their business models and strategies to a range of plausible climate-related pathways and determine the impact of climate-related risk drivers on their overall risk profile. These analyses should consider physical and transition risks as drivers of credit, market, operational and liquidity risks over a range of relevant time horizons.
- **Principle 13:** Supervisors should determine that banks' incorporation of material climate-related financial risks into their business strategies, corporate governance and internal control frameworks is sound and comprehensive.
- **Principle 14:** Supervisors should determine that banks can adequately identify, monitor and manage all material climate-related financial risks as part of their assessments of banks' risk appetite and risk management frameworks.
- **Principle 15:** Supervisors should determine the extent to which banks regularly identify and assess the impact of climate-related risk drivers on their risk profile and ensure that material climate-related financial risks are adequately considered in their management of credit, market, liquidity, operational, and other types of risk. Supervisors should determine that, where appropriate, banks apply climate scenario analysis.
- **Principle 16:** In conducting supervisory assessments of banks' management of climate-related financial risks, supervisors should utilize an appropriate range of techniques and tools and adopt adequate follow-up measures in case of material misalignment with supervisory expectations.
- **Principle 17:** Supervisors should ensure that they have adequate resources and capacity to effectively assess banks' management of climate-related financial risks.
- **Principle 18:** Supervisors should consider using climate-related risk scenario analysis to identify relevant risk factors, size portfolio exposures, identify data gaps and inform the adequacy of risk management approaches. Supervisors may also consider the use of climate-related stress testing to evaluate a firm's financial position under severe but plausible scenarios. Where appropriate, supervisors should consider disclosing the findings of these exercises.

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