



Building Sustainability Resiliency During Post Covid World Focusing ESG And Climate Risk Issue

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Abstract: This study evaluates the impact of climate-related risks on global financial stability, emphasizing both physical and transitional risks. It explores the influence of these risks on ESG (Environmental, Social, and Corporate Governance) goals, particularly within the context of the European Green Deal and post-COVID-19 recovery efforts. Utilizing a dynamic common factor model, the research analyzes time-series data from 2010 to 2019 to measure relative and absolute carbon risks across regions such as Europe, North America, Japan, and the Eurozone. The Kalman filter tool facilitates a detailed examination of regional carbon emissions and associated risks. Findings reveal that relative carbon risk is highest in North America, followed by Japan, Europe, and the Eurozone. In contrast, absolute carbon risk is most pronounced in the Eurozone, with Europe and North America trailing. The study highlights that absolute carbon risk surpasses relative carbon risk globally, underscoring the need for more aggressive and region-specific risk mitigation strategies. The study concludes that current climate risk management strategies require enhancement to effectively address rising carbon risks. Financial institutions play a critical role in supporting global sustainability goals, especially in the post-pandemic era. The implications suggest that policymakers and financial institutions must intensify their focus on climate risk management, particularly in high-risk regions. Strengthening data collection and analytical capabilities is essential for improving the accuracy of climate risk assessments, supporting global cooperation in achieving ESG goals, and ensuring financial stability amidst escalating climate risks.

Keywords: Sustainability, ESG, Climate Risk, COVID-19, Financial Distress, Sustainable Development Goal

1. Introduction

In recent decades, the global economy has experienced significant growth, marked by rising Gross Domestic Product (GDP) and remarkable advancements in business and technology. However, this economic prosperity has come at a considerable cost. The same factors that have driven economic development have also exacerbated environmental degradation and economic inequality, two of the most pressing issues of our time. The adverse effects of these crises have been further amplified by the COVID-19 pandemic, which has disproportionately impacted the most vulnerable populations, highlighting the deep-rooted inequities within our global systems (Afreen, 2021).

The relationship between economic growth and environmental sustainability is complex and often paradoxical. On one hand, industrialization and technological innovation have fueled economic progress; on the other hand, they have led to the overexploitation of natural resources and a dramatic increase in greenhouse gas emissions. According to the Intergovernmental Panel on Climate Change (IPCC, 2021), global temperatures have risen by approximately 1.1°C since the pre-industrial era due to human activities such as burning fossil fuels, deforestation, and industrial processes. This warming trend has triggered more frequent and severe weather events, rising sea levels, and shifts in biodiversity, all of which pose significant risks to global economies and human livelihoods (UNEP, 2020).

These environmental challenges are not merely ecological concerns; they also present substantial economic threats. Physical risks associated with climate change, such as hurricanes, floods, and droughts, disrupt supply chains, damage infrastructure, and reduce agricultural productivity, leading to significant economic losses. The World Economic Forum's Global Risks Report consistently ranks climate-related risks among the most likely and impactful threats to the global economy (WEF, 2021). As economies strive to transition to a low-carbon future, they face additional transition risks. These risks arise from the shift away from fossil fuels and other carbon-intensive activities toward more sustainable practices. While necessary for long-term sustainability, this transition can cause short-term economic disruptions, particularly in industries and regions heavily reliant on fossil fuels (IEA, 2020).

Parallel to the environmental crisis is the growing issue of economic inequality. Despite the overall increase in global wealth, its distribution has become increasingly uneven. The top 1% of the world's population now controls more wealth than the bottom 50%, a disparity that has widened significantly over the past few decades

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(Oxfam, 2020). Economic inequality is not only a social justice issue but also a critical barrier to sustainable development. Inequality undermines social cohesion, leads to political instability, and limits economic mobility and access to opportunities, perpetuating cycles of poverty (UNDP, 2020).

The COVID-19 pandemic has further exacerbated these inequalities. Vulnerable populations, particularly those in low-income and developing countries, have been disproportionately affected by the economic fallout. Lockdowns and economic shutdowns have led to widespread job losses, especially in sectors like hospitality, retail, and informal labour markets, where low-income workers are overrepresented. These workers often lack the financial safety nets and healthcare access needed to weather such crises, deepening the cycle of poverty and inequality (ILO, 2021).

The crises of climate change and inequality are deeply intertwined. Climate change disproportionately affects the poor and marginalized, who are often the least responsible for emissions but the most vulnerable to its impacts. For instance, low-income communities are more likely to live in areas prone to extreme weather events, such as floods or hurricanes, and have fewer resources to recover from such disasters (Islam & Winkel, 2017). Moreover, the economic transition required to combat climate change can exacerbate existing inequalities if not managed inclusively. Policies such as carbon taxes, while essential for reducing emissions, can disproportionately impact low-income households unless accompanied by measures to offset these costs (Stiglitz & Stern, 2017).

Addressing these intertwined challenges requires a systemic transformation of our economic systems. The concept of "building back better," which has gained prominence in the wake of the COVID-19 pandemic, encapsulates the idea of using the recovery as an opportunity to create more resilient, inclusive, and sustainable economies. This transformation, however, cannot be achieved through incremental changes alone; it requires a fundamental rethinking of how economies function (Hepburn et al., 2020).

Governments play a crucial role in driving this systemic change. They must create the regulatory frameworks and incentives needed to shift economies toward sustainability. This includes implementing carbon pricing mechanisms, investing in green infrastructure, and providing support for workers and communities affected by the transition to a low-carbon economy (Stern, 2015). The private sector must also embrace sustainability as a core component of its business strategy. Companies that fail to do so risk not only reputational damage but also financial losses, as consumers and investors increasingly demand greater corporate responsibility (Eccles, Ioannou, & Serafeim, 2014).

Moreover, the dual crises of climate change and economic inequality represent significant challenges that require urgent and coordinated action. This research paper seeks to explore these dynamics in greater depth, examining the strategies and policies needed to address climate change and inequality while promoting sustainable economic growth. By identifying the key actions required to "rewire" our economies, this paper aims to contribute to the broader discourse on sustainable development and provide actionable insights for policymakers and business leaders alike.

2. Literature Review

Recent years have seen an increased focus on climate risks and their impact on financial markets. Various studies have explored the intersection of climate change and financial systems, emphasizing the importance of transparent climate risk disclosure and the role of institutional investors.

Hong et al. (2019) examined the impact of climate risks on market efficiency, revealing that climate-related financial risks could significantly disrupt market stability. Similarly, Ilhan et al. (2019) investigated institutional investors' perspectives on climate risk disclosure, highlighting the growing demand for detailed and accurate reporting on climate risks.

Kolbel et al. (2021) explored the dual dimensions of climate risk—physical and transition risks. Physical risks are related to the direct effects of climate change, such as extreme weather events, while transition risks are associated with the economic shifts required to move toward a low-carbon economy. Their study emphasized the need for comprehensive strategies to manage both types of risks effectively.

Krueger (2020) underscored the importance of climate risk for institutional investors, arguing that understanding these risks is crucial for making informed investment decisions. Liu et al. (2019) contributed to this discussion by constructing a framework for climate risk-related research, offering insights into the methodologies used to assess climate-related financial risks.

The role of natural language processing (NLP) in climate risk analysis was demonstrated by Luccioni and Palacios (2019). They applied NLP techniques to analyze climate risk exposure, showcasing how advanced data processing tools can enhance our understanding of climate-related financial information.

Marquis et al. (2016) conducted a global study on greenwashing, examining how companies might misrepresent their environmental efforts to appear more sustainable than they are. This study raised concerns about the credibility of corporate climate disclosures, emphasizing the need for stricter regulations and standards.

McFarland (2009) focused on climate change risk disclosure, discussing how companies report on their exposure to climate risks. Similarly, Michaels and Gruning (2017) investigated the relationship between corporate

social responsibility (CSR) disclosure and information asymmetry, finding that transparent reporting on climate risks can reduce the cost of capital for companies by lowering investor uncertainty.

The Network for Greening the Financial System (NGFS) has produced significant research on the financial implications of climate change. NGFS (2019a) identified climate change as a major source of financial risk, while NGFS (2019b) explored the broader macroeconomic and financial stability implications of climate-related risks. Their work has been instrumental in shaping the global dialogue on sustainable finance.

The energy sector, in particular, has been the focus of climate risk disclosure research. Nowiski (2018) examined the relevance of climate risk disclosure in the energy sector, discussing the potential long-term impacts on energy companies as they transition to more sustainable practices.

Sautner et al. (2020) extended this research by analyzing firm-level climate change exposure, providing empirical evidence of how companies are affected by climate risks. Their findings reinforced the need for robust climate risk management practices across all sectors.

The Task Force on Climate-related Financial Disclosures (TCFD) has been a key player in promoting transparency in climate-related financial reporting. In its 2017 and 2020 reports, the TCFD provided comprehensive recommendations for climate-related disclosures, aiming to enhance the quality of information available to investors, creditors, and insurers. These guidelines have become a cornerstone for companies seeking to align their reporting practices with global standards (TCFD, 2017; TCFD, 2020).

Varini et al. (2020) applied machine learning techniques to assess climate change, demonstrating how technology can be leveraged to improve climate risk assessment. Their study highlights the potential of artificial intelligence in enhancing our understanding of climate risks and developing more effective mitigation strategies.

In addition to academic research, significant progress has been made by international institutions in promoting green finance. The Bank for International Settlements (BIS) has launched euro-denominated and US dollar-denominated green bond funds to support investments in environmentally sustainable projects. These funds, which collectively manage approximately \$2 billion, are designed to stimulate demand for climate-friendly investments among central banks and official regulatory institutions (BIS, 2019).

The BIS green bond funds are structured to comply with the International Capital Market Association's Green Bond Principles and the Climate Bond Standard set by the Climate Bonds Initiative. These funds invest in projects focused on renewable energy, energy efficiency, and other environmentally beneficial activities. The BIS's annual impact reports provide transparency for investors by detailing the environmental outcomes of the bonds in which the funds are invested (Afreeen, 2020).

The BIS's commitment to green finance aligns with its broader participation in the global Central Banks and Supervisors Network for Greening the Financial System. By supporting environmentally responsible finance and investing practices, the BIS aims to contribute to the global transition toward a more sustainable economy. Peter Zöllner, Head of the BIS Banking Department, emphasized the importance of central banks' role in promoting the green bond market, stating that ongoing dialogue with issuers and adherence to best market practices are crucial for deepening the green bond market (Varini et al., 2020).

3. Methodology

Scenario methodologies have become widely available, differing in scale, time horizon, scope, and complexity. Some methodologies consider both physical and transition risks in an integrated manner. However, when they do, the complexity often makes them difficult to implement. Institutions face a trade-off between practicality and comprehensiveness. For instance, new adopters with limited capacity frequently start with simpler models, which are more feasible to operationalize. Over time, these institutions can build their practice and skill set. Companies could significantly benefit from guidance on effective methodologies and procedures for versatile purposes.

This research presents both relative and absolute carbon risks using a dynamic common factor model. The graphical representation of absolute versus relative carbon risk is measured. The model is estimated using the Kalman filter. Systematic carbon risk represents a common market risk measure, based on market beta β_{mkt} (general carbon risk exposure, such as market repricing risk). The following dynamic common factor model is used here:

$$R_i(t) = R(t)^T \beta_i(t) + \epsilon_i(t) \quad \dots\dots\dots (1)$$

where $R(t) = (1; R_{mkt}(t); R_{bmg}(t))$ is the vector of factor returns, $\beta_i(t) = (\alpha_i(t); \beta_{mkt, i}(t); \beta_{bmg, i}(t))$ is the vector of factor betas and $\epsilon_i(t)$ is a white noise. The BMG factor could be stated as a Fama-French risk concerning factor that is based on the scoring ranking system (BGS or brown green score).

One of the most frequently cited challenges in constructing climate criteria scenarios is the lack of high-quality climate-related risk data that is suitable for financial use. As scenario adopters seek access to verifiable, comparable, and decision-useful data to feed their models, they encounter three distinct gaps.

First, while reliable data on physical risks are available in the scientific field, they are not specifically tailored to financial institutions and cannot be easily applied as scenario inputs. Therefore, firms find it challenging to translate this data into relevant financial insights. Second, established market-related data sources are often

designed for policymakers rather than investors. These sources typically present optimistic transition plans for climate change pathways that governments aspire to achieve, rather than the more realistic paths that economies are likely to follow.

Finally, financial institutions aiming to conduct scenario analysis at the firm level must gather data from each of their portfolio companies. However, the number of organizations providing climate-related disclosures is currently insufficient to support analysis at the required level of detail. As a result, lenders and investors are increasingly urging companies to produce meaningful reports for stakeholders.

4. Results

Based on the dynamic common factor model, this research measures absolute versus relative carbon risk, with the model estimated using the Kalman filter. The graphical presentation indicates that relative carbon risk is trending higher in North America, likely due to the region's continued reliance on fossil fuels and slower transition to renewable energy sources compared to other regions. Chronologically, the countries with the lowest carbon risk in their portfolios are Japan, Europe, and the Eurozone, respectively, which may reflect these regions' more aggressive climate policies and higher energy efficiency standards.

When examining the average absolute carbon risk by region, the descending order is as follows: Eurozone, Europe, North America, and Japan. The higher absolute carbon risk in the Eurozone and Europe may be attributed to their extensive industrial activities and energy demands, despite their strong regulatory frameworks aimed at reducing carbon emissions.

From a global perspective, absolute carbon risk tends to be higher than relative carbon risk across these regions, suggesting that even regions with strong climate policies are still exposed to significant risks due to global market conditions and environmental changes.

The results indicate a statistically significant difference between the regions, with North America showing the highest relative carbon risk and Europe and Japan leading in terms of lower carbon risks. These findings align with previous studies but also highlight the ongoing challenges in achieving carbon neutrality, particularly in regions with diverse economic structures.

These results have important implications for policymakers and investors. Regions with higher absolute carbon risk, such as the Eurozone and North America, may need to accelerate their transition to low-carbon economies to mitigate these risks. Additionally, businesses operating in these regions should consider integrating more robust carbon risk management strategies into their operations.

However, it's important to note that the analysis is limited by the availability of consistent climate risk data across regions and the assumptions inherent in the dynamic common factor model. Future research should aim to address these limitations by incorporating more granular data and exploring alternative modeling approaches..

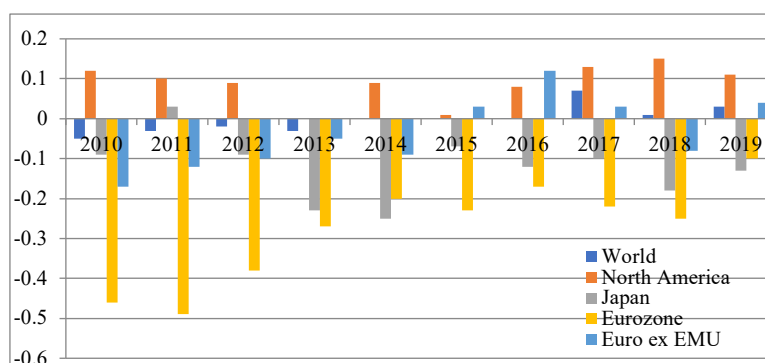


Figure 1: Region-wise dynamics of the average relative concerning carbon risk

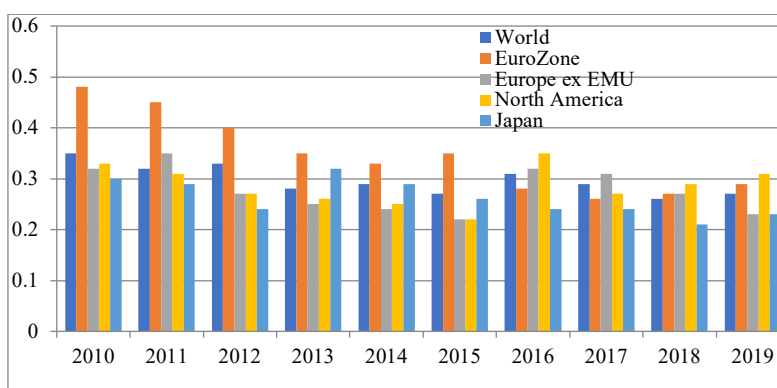


Figure 2: Region-wise dynamics of the average absolute concerning carbon risk

5. Discussion

Climate change has increasingly made the world a riskier place. Extreme weather events such as heatwaves, hurricanes, droughts, and coastal flooding not only threaten human lives and livelihoods but also pose significant long-term financial risks for nations. According to substantial research by the IMF (Pragyan et al., 2020), a country's resilience or vulnerability to climate change can directly impact its long-term creditworthiness, borrowing costs, and ultimately, the likelihood of sovereign debt default. In their working paper, Delis et al. (2019) explore how climate policy risks influence the pricing of bank loans, providing insights into the broader economic implications of climate change.

The economic consequences of climate change have been acknowledged for years, yet research connecting climate volatility to sovereign risk remains limited. The present study provides evidence of the cross-sectional relationship between climate change and sovereign credit ratings, building on prior analyses that, for the first time, link climate volatility to sovereign default risks. Our findings similarly establish a correlation between climate shocks and sovereign bond yields, underscoring the financial risks associated with climate change.

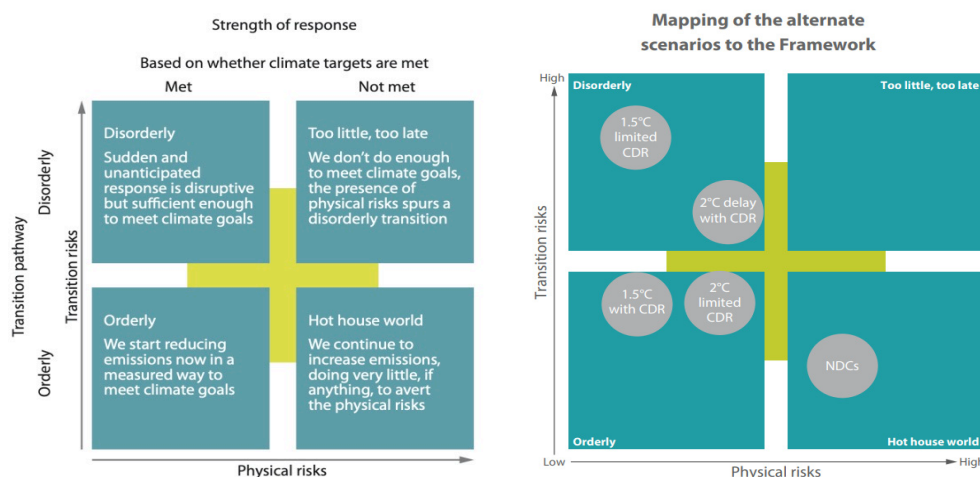


Figure 3: Integration of Physical and Transition Scenarios Based on NGFS Climate Scenarios Framework

A recurring theme in these findings is that the financial risks posed by climate change are acutely felt by developing economies, particularly those that lack the policy space and resources to address climate shocks effectively. The climate-specific credit score underscores the importance of understanding how climate change affects sovereign credit ratings, offering critical guidance on how much governments and firms can safely borrow and the associated costs.

In 2020, several major economies and leading financial firms set ambitious long-term emissions reduction goals. The year 2021 is expected to bring concrete plans to achieve these targets. Notably, major global economic players established new rules for the game in 2020, with a firm objective of achieving net-zero carbon emissions by 2050. The European Union, Japan, and the United Kingdom declared their net-zero targets in 2020, while China, the world's largest carbon emitter, pledged to reach net zero by 2060. With U.S. President-elect Joe Biden's commitment to putting the U.S. on an irreversible path to net-zero by 2050, the world's leading economies are now aligned on this goal. Canada also joined the effort with Bill C-12: The Canadian Net-Zero Emissions Accountability Act, expected to pass in 2021, legislating the net-zero target by 2050. These commitments align with the Paris Agreement, signed in 2015 by 197 countries, where parties agreed to limit global temperature rise to 2°C above pre-industrial levels.

Table 1: CO₂ Emissions by Country

Rank Country	CO ₂ emissions	Share total in GT	CO ₂ emissions per capita in MT
China	10:06	28%	7:2
USA	5:41	15%	15:5
India	2:65	7%	1:8
Russia	1:71	5%	12:0
Japan	1:16	3%	8:9
Germany	0:75	2%	8:8
Iran	0:72	2%	8:3
South Korea	0:72	2%	12:1
Saudi Arabia	0:72	2%	17:4
Indonesia	0:72	2%	2:2
Canada	0:56	2%	15:1
Turkey	0:42	1%	4:7
UK	0:37	1%	5:8
France	0:33	1%	4:6
Italy	0:33	1%	5:3

Source: World Bank Open Data, <https://data.worldbank.org/topic/climate-change>

Our analysis indicates that climate change volatility has a negligible impact on bond spreads and credit ratings in advanced economies but exerts a significant effect on emerging markets and developing economies. These regions are more vulnerable due to their weaker capacity to adapt to and mitigate the impacts of climate change. A 10 percentage point increase in climate vulnerability is associated with a rise of over 150 basis points in long-term government bond spreads in emerging and developing economies, while a 10 percentage point improvement in climate resilience is linked to a 37.5 basis point reduction in bond spreads. This impact is five times greater in emerging and developing economies compared to advanced economies (Giuzio et al., 2019).

Without sufficient action, climate change remains an unavoidable reality globally. Rising temperatures, changing weather patterns, melting glaciers, intensifying storms, and rising sea levels create significant vulnerabilities, particularly in low-income countries. As nations seek a sustainable recovery from the COVID-19 pandemic, the benefits of enhancing climate resilience become increasingly clear. Developing economies with limited financial capacity could benefit from alternative instruments such as catastrophe insurance and debt-for-nature swaps, designed to mobilize resources for investments in resilient infrastructure and environmental conservation while reducing credit-related debt burdens.



Figure 4: Climate-related Disclosure of Financial Sector in the Canadian Specific Financial Industry: Three-Year Based Progress Report

In the meantime, pursuing cost-effective climate mitigation and adaptation strategies, building resilient infrastructure, strengthening financial resilience through fiscal buffers and insurance, and improving economic diversification to reduce reliance on climate-sensitive sectors can ease the strain of climate change on public finances and lower the borrowing costs associated with lower credit ratings.

6. Limitations And Future Recommendations

To broaden the adoption of blended finance, numerous actors within the financial industry must play a significant role. Below are six considerations that can be implemented today:

1. **Involvement of Key Investment Personnel:** Chief investment officers, analysts, and portfolio managers must be actively involved. ESG issues, climate risks, and the SDGs typically fall under the purview of sustainability departments, which often do not allocate capital or have the financial expertise to structure blended finance deals. It's crucial to engage mainstream investment panels in these discussions.
2. **Encouraging Collaboration Between Investors and Project Developers:** Those who make capital allocation decisions for large institutional investors often remain inaccessible to development banks, governments, companies, and individuals seeking finance for their projects. There is a need to establish an international network of 'investment experts' willing to engage in blended finance initiatives.
3. **Allocating Sufficient Time for Blended Finance Opportunities:** The complexity and customization required in blended finance mean that the time spent on deals is often not proportionate to the size of the investment. In many cases, the involvement of investment professionals may not lead directly to investment but to sharing their expertise, which is still beneficial. Organizations must be aware that this contribution is valuable, even if it isn't directly linked to their primary job descriptions.
4. **Addressing Inherent Biases and Labels:** Investment literature often contains subliminal biases—such as images of wind farms and references to 'impact' or the SDGs—that may lead mainstream investors to prematurely judge the 'investability' of a project. Projects should clearly articulate the risk-reward potential and the justification for needing public and concessionary finance upfront to overcome these biases.
5. **Incorporating Expertise from Market Makers:** Designing blended finance arrangements is akin to structuring complex M&A deals and requires experts who understand both development goals and the SDGs. Bringing together the right parties and tailoring the investment to meet their risk-return profiles is crucial. Professionals like investment bankers and M&A lawyers could make significant contributions in this area.

6. **Engagement of Asset Owners:** Pension funds and insurance firms are eager to allocate large sums to investments but need to ensure that these investments align with their balance sheet obligations. They are interested in opportunities that meet both these criteria, but they must be assured that their capital will be deployed according to their fundamental needs.

Financial institutions have reported significant benefits from applying climate scenarios:

- **Enhanced Risk Resilience:** Understanding the implications of climate risk has greatly improved institutions' risk mitigation strategies and minimized potential losses associated with both physical and transitional concerns.
- **Preparedness for Regulatory Demands:** Scenario analysis aids businesses in preparing for upcoming regulatory requirements, such as climate-related stress testing and disclosure obligations.
- **Increased Stakeholder Engagement:** Transparency in scenario development and results helps demonstrate to investors and stakeholders that the company takes their concerns about climate risk seriously, which can improve public perception and reputation.

However, financial markets and institutions have also faced challenges in integrating climate scenarios into decision-making. Since climate risk is a relatively new practice, there is a pressing need for guidance to help institutions understand the various aspects of the financial materiality of climate risk.

7. Conclusion

The pandemic and resulting economic downturn have exacerbated the risk of debt distress, particularly in low-income regions. Measures such as the G20 debt relief initiative have been introduced to prevent countries from exacerbating their debt burdens in response to the crisis.

As countries' debt portfolios and long-term sustainability come under increased scrutiny, it is essential to assess the need for incurring new debts and improve transparency in sovereign borrowing. Recent debt scandals have highlighted the importance of ensuring that debts are incurred for legitimate purposes.

Addressing debt distress after the fact is crucial, as demonstrated in various restructuring contexts. However, it is equally important to address debt issues proactively, determining whether countries should take on financial commitments and under what conditions. A focus solely on debt relief addresses problems as they arise but fails to tackle the underlying causes.

8. Implications of the study

The implications of this study underscore the critical need for financial institutions, policymakers, and investors to integrate climate risk management into their decision-making processes. Financial institutions must enhance their risk management frameworks to incorporate climate scenarios, which will not only improve their resilience to potential losses but also ensure compliance with upcoming regulatory demands. For policymakers, the development of comprehensive guidelines and standardized approaches to climate-related disclosures and stress testing is essential. This will create a consistent framework across institutions, enhancing transparency and investor trust. Additionally, institutional investors must prioritize investments that align with long-term obligations and address climate risks, engaging more deeply with project developers and governments to structure investments that balance risk and reward, particularly in emerging markets.

Moreover, the study highlights significant opportunities for the broader financial market in developing new sustainable financial products, such as green bonds and climate-linked loans, which will drive growth in sustainable finance offerings. For developing economies, the focus must be on building capacity to access innovative financial instruments and developing resilient infrastructure to reduce vulnerability to climate risks. International collaboration will be vital, as developed nations can provide much-needed technical assistance and financial aid to help these economies manage their climate risks and debt burdens. This coordinated effort will contribute to a more resilient global financial system and support the achievement of sustainable development goals.

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