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A MULTIDIMENSIONAL CONCEPTUAL FRAMEWORK FOR FINANCIAL RISK MANAGEMENT IN CLIMATE-SENSITIVE INDUSTRIES: INTEGRATING ESG, CLIMATE RISK, AND INVESTMENT DECISION-MAKING

[1]Devdatta Sant, [2]Dr. Snehal Sashte and [3]Amruta Kshirsagar
[1]HNIMR, Pune
[2,3]IMERT, Pune

ABSTRACT
Climate-related threats are escalating rapidly and require a fundamental re-evaluation of how financial institutions and corporations in climate-sensitive industry sectors manage risk. This paper proposes a multidimensional conceptual framework that integrates Environmental, Social, and Governance (ESG) and climate risk directly at the center of financial risk management (FRM) and investment decision-making. Traditional financial models often treat climate variables as externalities; our framework argues climate risk, both physical and transition, operates as an independent variable exerting direct influence over financial stability. Integrating Modern Portfolio Theory, Institutional Theory, Stakeholder Theory, and Behavioral Finance, we identify FRM as the mediating variable that connects climate risk to financial signals. We also incorporate the regulatory environment and information asymmetry as moderating variables that determine the success of integration. Our model puts forth five focal propositions that portray causal pathways between climate exposures, strategic ESG adoption, and informed investment outcomes. This conceptual synthesis articulates a path forward for researchers to conduct empirical studies to investigate the "Climate-FRM-Investment" nexus while providing practitioners a pathway to manage climate issues in the Anthropocene biosphere.

Keywords: *Climate Risk; ESG Integration; Financial Risk Management; Investment Decision-Making; Climate-Sensitive Industries; Sustainable Finance.*

1. INTRODUCTION
The global economy today is challenged to manage the "Anthropocene" reality, a time of increasing turbulence in systems in which humans have become the predominant force shaping planetary systems (Folke, 2021). For industries that are sensitive to environmental change, such as agriculture, infrastructure, and energy, this reality creates unprecedented financial turbulence. India's promise to reach net-zero by 2070 example of a move to a net-zero economy that can't be undone. Conversation moved to decarbonise how to handle the risks and opportunities (Chaturvedi, 2024). Even if need is clear, traditional ways of managing money and risk often have trouble to understand how climate change works overtime.

Climate risk is not just a risk for a single sector; it is now also a risk that affects whole system's financial performance. Integrating ESG factors is the main way for companies to show that they are somewhat stable and legitimate in a market that is watched more closely (Zahid, 2023). Link between ESG performance, climate risk exposure, and financial results is complicated. Some research suggests that higher ESG ratings correlate with higher long-term returns in highly sustainable nations however, this is not true in lower or developing economies with less advanced sustainability practices (Cantero-Sáiz, 2025).

This paper provides a conceptual model to support climate-sensitive industries in closing the gap between climate science and financial strategy to mitigate climate change. By positioning a framework for Financial Risk Management (FRM) as a mediating variable, the framework endeavours to explore the internal translation process that is required to convert qualitative climate assessments to quantitative risk-adjusted returns. In the sections below, we review the literature on climate risk and ESG, outline the theoretical framing for this model, and develop Proposition specific to the framework to guide future empirical investigations.

This study contributes to the literature by proposing a multidimensional conceptual framework that integrates climate risk, ESG factors, and financial risk management into a unified model of investment decision-making. By identifying financial risk management as a central mediating mechanism and incorporating regulatory and informational boundary conditions, the study extends existing sustainable finance research and offers a structured foundation for future empirical validation, particularly in climate-sensitive industries.

2. LITERATURE REVIEW

2.1 Climate Risk: Physical and Transition Risks
Climate risk is divided into two main parts: physical and transition risk, each has implications for financial modelling. Physical risk is the financial consequences associated with acute weather events (for example,

ISSN 2394 - 7780

floods and hurricanes), as well as chronic weather events (for example, rising sea levels and ongoing temperature increases) (Fliegel, 2025). A direct threat to physical assets and supply chains, particularly where they are sensitive to climate risk - for instance, real estate and agriculture.

Transition risk, on the other hand, relates to the societal or economic change that is needed to transition towards a low-carbon economy. This could involve policy, technological, or market forces (Fliegel, 2025). Measuring transition risk is difficult as various proxies e.g., carbon emissions, or ESG scores, can provide vastly different risk profiles (Fliegel, 2025). As recognized by scholars, CO2 data and E-scores are each commonly used as a proxy, but both demonstrate limitations such as backward-looking, or transition pathway specificity (Fliegel, 2025).

2.2 ESG Factors as Risk Proxy Indicators and Performance Drivers

ESG factors have moved away from an ethical lens towards strategic risk proxies. Research shows that incorporation of ESG criteria improves corporate sustainability performance across different nationalities (Barbosa, 2023). In relation to risk, ESG scores adopt a “forward looking” risk proxy associated with the firms' ability to adapt to environmental and social disruption. For example, firms with better ESG performance find they have lower probabilities of distressed financial outcomes, as firms with higher ESG scores are often associated with economic strategies such as successful cost leadership (Habib, 2023).

Furthermore, the impact of ESG upon financial performance has increasingly been identified as mediated by market attention and institutional quality. Notably, it is less clear how the relationship between ESG and returns is recognized by the market in efficient markets as the price of information is already accounted for. But firms with sound management practices yield substantive benefits in times of global crisis, as a result of the heightened level of global sustainability attention (Vu, 2024). This suggests that ESG is more than a reporting exercise, it can be interpreted as a tool for reputational risk management and cost of equity (Becchetti, 2023).

2.3 Current Paradigms in Investment Decision-Making for Sensitive Industries

Investment paradigms suggest that investors are moving away from simply developing short-term alpha, towards a focus on long-term risk adjusted sustainability. In sectors sensitive to climate risk, the "social license to operate" is as valuable as liquid financial capital.

Sustainable finance advances capital towards operations that aim to create a positive environmental impact and facilitate finance-on-demand through supportive tech-based innovations e.g., FinTech (Galeone, 2024). Alternatively though, investors remain burdened with the common obstacle of greenwashing (i.e., selective disclosure and decoupling of corporate communication from actual environmental performance) (Lublóy, 2024).

Investment decisions are also influenced by the nature of governance structures within the firm. The existence of CSR committees and Chief Sustainability Officers (CSOs) has been shown to contribute more than symbolism in terms of the firm’s CSR activities (Velte, 2020). Within climate-sensitive sectors, governance structures facilitate the incorporation of climate risk at the boardroom table and subsequently into a firm investment strategy.

3. THEORETICAL FRAMEWORK

3.1 Modern Portfolio Theory and the Integration of Non-Financial Risks

Modern Portfolio Theory (MPT) has historically aimed to maximize return for a given level of variance. However, the systemic nature of climate risk challenges the assumption that one can always diversify away all risk. In the Anthropocene, climate risk adds a "systemic beta" that affects the entire market (Folke, 2021). Therefore, a framework is needed that integrates a perspective that moves from the narrow corporate finance perspective to a broader ecosystemic perspective that explains the interrelationship and interdependence of firms, capital markets, and society (Billio, 2024).

3.2 Institutional Theory: Regulatory Pressure and Normative Isomorphism

Institutional Theory provides an explanation of why firms within an industry which is susceptible to climate risks adopt ESG practices. In most cases, the motivation is based on the legitimacy of the practice rather than efficiency. Institutional theory, based on the external pressures such as regulatory pressures, such as green credit policies to force companies to cut their carbon intensity by cutting their investments in carbon-intensive economic activity as well as bolster environmental surveillance that will punish them if they do not conform (Xu, 2023). As firms operate under these conditions they tend to adopt isomorphic practices that conform to normative practices within the industry to maintain access to capital markets, which have made ESG disclosure a major part of funding decisions (Zahid, 2023).

ISSN 2394 - 7780

3.3 Stakeholder Theory: Aligning Corporate Value with Social Responsibility

Stakeholder Theory says that the long-term value of a firm is related to their relationship through any dimension that all stakeholders represent. Stakeholders include, but are not limited to, regulators, local communities, and the environment itself. In climate-sensitive industries, the cost of social irresponsibility, by measured ESG or fraudulent misconduct, increases the cost of equity (Becchetti, 2023). When firms proactively act to address the concerns of the various stakeholders through ESG, they can leverage a mode of synergy to increase financial performance and resilience given the complexities of climate related outcomes in the global system (Coelho, 2023).

3.4 Behavioral Finance: Cognitive Biases and Sustainability Preferences

Behavioral Finance explains the reasons for the phenomenon where investment decisions are lagging behind climatic realities. Cognitive biases, including "climate myopia," will cause investors to under price long-term physical risks. As it relates to sustainability, the prior preferences for ESG will begin to change as the attention to environmental sustainability grows globally (Vu, 2024). Lastly, uncertainty regarding the environmental impact of climate change has the potential to harm ESG performance by increasing the "real options" value associated with delaying the investment in sustainability as a firm balances long-term benefits with immediate direct costs (Bin-Feng, 2023).

4. CONCEPTUAL MODEL DEVELOPMENT

4.1 Construct Definitions: Climate Risk, ESG, and Risk Management

In creating a sensible model, it will be important to define the core construct in an agreed manner. **Climate Risk** is defined as the independent variable, which includes the dual threats of destruction from the physical environment as well as the economic transition (Fliegel, 2025). **ESG Performance**, is used strategically as a proxy or climate risk for a firm's internal resiliency and external legitimacy (Zahid, 2023). **Financial Risk Management (FRM)** is defined as the set of activities, such as scenario analysis, stress testing, and hedging, used to identify and limit financial loss. The ultimate dependent variable is **Investment Decision-Making**, which is defined as the willingness to deploy capital toward an asset that generates risk-adjusted and climate risk adjusted positive returns.

4.2 Financial Risk Management as a Mediation Mechanism

A fundamental assumption of this framework is that climate risk does not impact investment decisions, in a vacuum. Rather, FRM will serve as a “mediation space” by which decisions are made by agents (managers) influenced from within their socio-technical context (Lüdeke-Freund, 2019). FRM processes qualitative climate data to provide quantification of climate risk in financial terms, such as the probability of default or likelihood of financial distress (Habib, 2023). In the absence of a mediation mechanism, climate signals are too “noisy” for systematic shifts in investment behavior.

4.3 Moderating Variables: Regulatory Environment, Information Asymmetry

The value of the Climate - FRM - Investment nexus is moderated by two important factors. The first, **Regulatory Environment** (i.e., green credit policies), will act as a catalyst and improve the link between ESG performance and investment returns, through standardization of data and financial incentives (Xu, 2023). The second, **Information Asymmetry**, presented as greenwashing, acts as a barrier. If firms decouple ESG reporting from actual performance, investors can not correctly price climate risk and thus do not allocate capital optimally (Velte, 2023).

4.4 Text-based Conceptual Diagram: IV → Mediator → DV with Moderators

Based on the integration of climate risk, ESG factors, and financial risk management mechanisms, the proposed multidimensional conceptual framework is presented in Figure 1

ISSN 2394 - 7780

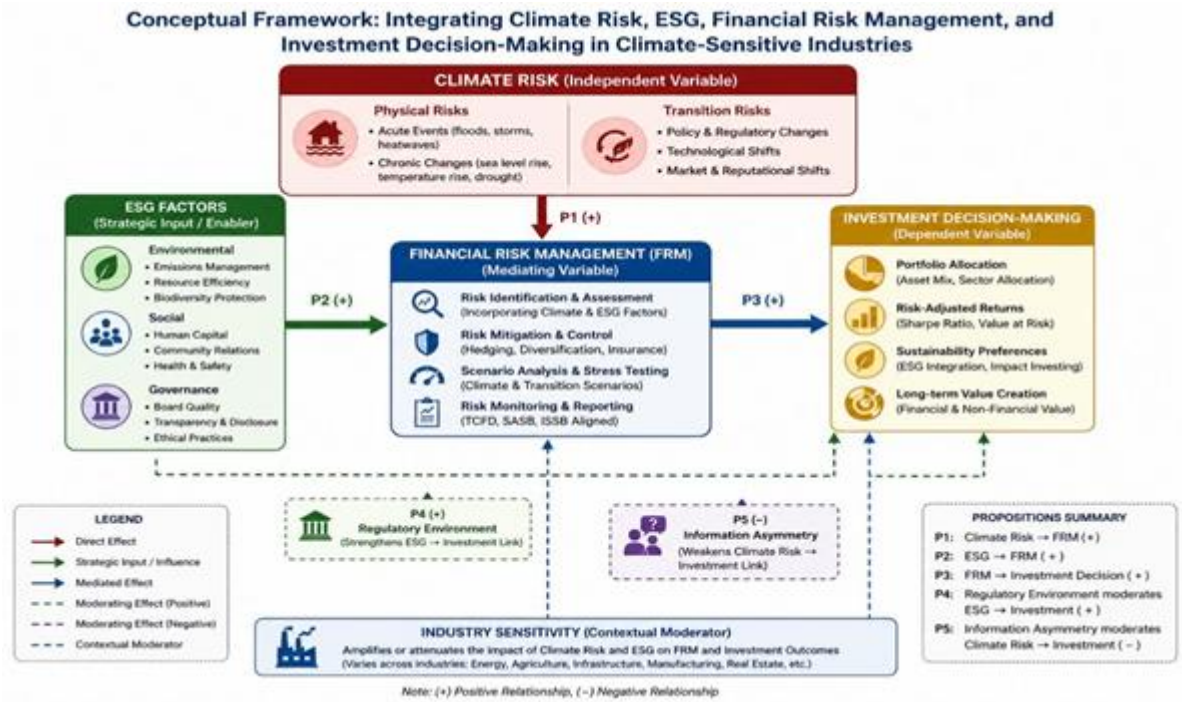

Figure 1: Multidimensional Conceptual Framework Integrating Climate Risk, ESG, Financial Risk Management, and Investment Decision-Making

The framework integrates macro-level climate risks, firm-level ESG practices, and financial system mechanisms into a unified decision-making structure

5. PROPOSITION DEVELOPMENT

Table 1: Summary of Propositions, Theoretical Basis, and Expected Relationships

Proposition	Relationship	Type	Theory	Direction
P1	Climate Risk → FRM	Direct	MPT	Positive
P2	ESG → FRM	Strategic Input	Stakeholder Theory	Positive
P3	FRM → Investment	Mediated	MPT	Positive
P4	Regulation moderates ESG → Investment	Moderation	Institutional	Positive
P5	Info Asymmetry moderates CR → Investment	Moderation	Behavioral	Negative

Table 1: summarizes the key theoretical relationships underlying the proposed framework. These propositions collectively describe the pathways through which climate risk and ESG factors influence investment decision-making via financial risk management, subject to moderating institutional and informational conditions.

5.1 Proposition 1: Climate Risk Impacts on Financial Risk Management

With increasing perceived severity of physical and transition risks, firms in climate-sensitive industries will increase their Financial Risk Management actions. In the Anthropocene,

shocks and extreme events are no longer “black swans” but are incorporated into a dynamic, interlinked system (Folke, 2021). Therefore, firms will need to move beyond traditional risk models and compromise climate specific scenario planning to avoid asset write offs and disruptions to operations.

Proposition 1: Higher levels of climate risk exposure (physical and transition) positively correlate with an increase in complexity and frequency of financial risk management processes in climate-sensitive industries.

5.2 Proposition 2: ESG Factors as a Facilitator of Strategic Risk Mitigation

ESG factors provide the informational foundation for identifying non-traditional threats to financial solvency. Firms that implement ESG criteria within their core strategy have a greater possibility of avoiding the probability of experiencing financial distress (Habib, 2023). More specifically, the ‘G’ (Governance) component ensures adequate oversight and monitoring of climate related factors within specialized committees, which corresponds with significant improvement in CSR performance and risk oversight (Velte, 2020).

ISSN 2394 - 7780

Proposition 2: Robust performance on ESG is a strategic force that improves financial risk management efficacy offering forward-looking measures of resilience.

5.3 Proposition 3: Risk Management as Mediator for Investment Decisions

Relationship between climate risk/ESG and investment decision-making is indirect and moderated by the organization's internal risk management process. Financial Risk Management is "translator" of environmental uncertainty into financial risk premiums (Bin-Feng, 2023). Absent formal processes to evaluate climate factor impacts on cash flows and discount rates, investment decisions will continue to rely on irrelevant financial metrics from bygone eras.

Proposition 3: Financial Risk Management is a mediator between climate risk exposure and investment decision-making ensures that climate data has meaning in capital allocation processes.

5.4 Proposition 4: Regulatory Environments as Moderator

The strength of the regulatory environment determines how effective the use of ESG and climate data is for financial markets. For example, China's green credit policies have been able to effectively reduce corporate carbon emission intensity by creating clear financial penalties for poor environmental performance (Xu, 2023). In a highly regulated environment, the "signaling" value of ESG is more favorable and increasing its effect on investment decisions.

Proposition 4: The regulatory environment positively moderates the relationship between ESG performance and investment decision-making and strong regulatory environments increases the financial materiality of ESG elements.

5.5 Proposition 5: Industry Sensitivity & Effects on Information Asymmetry

Information asymmetry, and the effects caused by greenwashing and CSR decoupling, successfully inhibits an accurate assessment of climate risk (Velte, 2023). In industries that are climate sensitive, where the stakes are higher, the "greenwashing trap" is particularly dangerous. However, an increase in digital transformation and interest by institutional investors can help diminish information asymmetry, making more reliable risk management to account for ESG disclosures (Sun, 2023).

Proposition 5: High information asymmetry (e.g., greenwashing) negatively moderates the impact of climate risk on investment decision-making and digital transformation, and scrutiny of institutional investors help reduce this impact.

6. DISCUSSION

6.1 Synthesis of Theoretical Contributions and Framework Logic

This framework contributes to the literature by grouping together disparate theories into a concise "Climate-FRM-Investment" nexus. It goes beyond just describing ESG literature. It focuses on one important part – Financial Risk Management – which links climate factors with investment decisions.

The model also supports stakeholder and institutional theory. It shows that financial decisions are not only economic, but also social and political. These decisions are influenced by the need for legitimacy and by pressures coming from changes in the environment (Folke, 2021; Zahid, 2023).

6.2 Addressing Complexity of Climate Sensitive Financial Modelling

The complexity of climate sensitive modelling occurs because the risks are non-linear and long-term. Traditional models largely fall apart especially as they consider a stable baseline that is no longer present in the Anthropocene (McPhearson, 2021). The new framework addresses this complexity because it conceptualizes climate risk as an independent variable rather than an externality. This framework also takes into consideration the limitations to implementing climate considerations, such as risk aversion, and smaller enterprises needing more knowledge (Takacs, 2022).

6.3 Strategic Convergence of ESG and Risk Management Objectives

A major finding of this research is that ESG and FRM are not mutually exclusive goals but are rather strategically consolidated. ESG represents the "what" (the risks and opportunities), and FRM represents the "how" (the integration process). Board committees of multinational enterprises play an important mediating role in this, although the mediating role differs based on whether the performance measure in question is accounting-based or market-based (Elmghaamez, 2023).

ISSN 2394 - 7780

7. IMPLICATIONS

7.1 Theoretical Implications for Sustainable Finance Literature

This study advances theoretical frameworks within the multi-level context of sustainable finance, spanning from firm-level analysis to national market-level analysis (Billio, 2024). It recognises the significance of the "mediation space" in sustainable business models, where the viewpoints of agency and systems converge (Lüdeke-Freund, 2019). Finding specific moderators, like information asymmetry and regulation, gives us a deeper understanding of why ESG integration works in some situations but not in others.

7.2 Practical Implications for Portfolio Managers and Risk Officers

For practitioners, the framework emphasizes that ESG should be treated as a vehicle for "downside protection" instead of merely discovering alpha. Portfolio managers should assess and engage with the complexity of ESG and look beyond superficial ESG scoring to determine the soundness of a firm's internal financial risk management processes. Risk officers in climate-relevant industries need to look at implementing tools such as AI and digital transformation to mitigate information asymmetry and enhance climate risk analyses (Sun, 2023) (Mariani, 2022).

7.3 Policy Implications for Financial Regulators and Standard-Setters

Regulators should prioritize climate risk disclosure standards that enhance investor understanding of investment offerings and diminish the expected incidence of greenwashing

(Lublóy, 2024). Policies should mandate the integration of climate scenarios into stress testing and regulatory regimes that assess financial institutions. Regulatory regimes, when used with the green credits approach, have shown that they can help the economy switch to a low-carbon one by changing the risk-return profile of investments that use a lot of carbon (Xu, 2023).

8. LIMITATIONS AND FUTURE RESEARCH

8.1 Conceptual Boundary Conditions and Scope Limitations

The most significant limitation of this framework is its conceptual status and, thus, requires empirical validation. The relationships proposed within the framework are likely to vary considerably across jurisdictions and levels of development (Cantero-Sáiz, 2025). The model is also limited to climate-sensitive industries, and while the issues of the climate crisis and risk management are high-stakes, the applicability across sectors less exposed to the climate is limited.

8.2 Methodological Roadmap for Empirical Validation of Propositions

Future research should collect longitudinal data and use mixed-methods to test the five propositions put forth in this study. For example, the role of Financial Risk Management (FRM) as a mediator can be tested by using PLS-SEM method on data from energy companies (Habib, 2023).Also, CSR decoupling can be measured with the help of AI-based text analysis and then linked to cost of equity (Velte, 2023).Further, studies across different countries can be done to understand how different rules and regulations change or influence the relationship between climate factors, FRM, and investment decisions.

9. CONCLUSION

In the Anthropocene, considering climate risk and ESG in financial decision-making is no longer a matter of choice; it is critical to survival. This paper has put forward a multidimensional conceptual framework that identifies Financial Risk Management as the bridge between climate signals and investment returns, and recognizes the moderating roles of regulation and information asymmetry to provide a realistic picture of the challenges and opportunities of sustainable finance. As industries grapple with the transition to net-zero, ESG's strategic alignment with risk management will be the defining feature of resilient and successful organizations. To remain well within planetary boundaries, we need to take radical breaks with the status quo; this framework provides a starting point for that process (McPhearson, 2021).The operationalization of this framework necessitates a structural integration of digital governance and real-time oversight to effectively mitigate the information asymmetries that frequently obscure climate-related risk (Akhigbe, 2025).

Companies can improve the openness and honesty of their ESG reporting by using advanced monitoring tools and data-driven insights. This makes sure that sustainability disclosures are based on performance metrics that can be verified (Tumpa, 2025). For long-term strategic execution to be in line with the urgent need for planetary boundary stability, there needs to be a strong connection between governance architecture and financial risk management.

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