Journal DOI: 10.36713/epra0412 ISSN: 2277–7741

International Journal of

Asian Economic Light (JAEL) – Peer Reviewed Journal

SJIF Impact Factor (2025): 8.579 Volume: 13 | Issue: 12 | December 2025

FUTURE OF CLIMATE FINANCE: TOWARDS A NET-ZERO GLOBAL FINANCIAL SYSTEM- AN EMPIRICAL EVIDENCE

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ABSTRACT

The future of climate finance involves massive scaling of blended finance, leveraging public funds for private investment, strong regulatory frameworks (like green taxonomies), innovative tech (FinTech, blockchain), and a focus on climate justice for developing nations, aiming to bridge the vast gap between current flows (around $2 trillion in 2024) and the estimated $9-$10 trillion needed annually by 2030-2050 for a 1.5°C path. Key shifts include integrating climate finance with development goals, pricing carbon, and prioritizing nature-based solutions, energy, and transport sectors. Climate finance – the flow of capital toward activities that mitigate or adapt to climate change – is entering a transformative new era. What began as a niche segment of environmental policy is now becoming a core pillar of global economic strategy. As climate risks intensify and the transition to a low-carbon economy accelerates, the financial system is being reshaped by new technologies, regulations, and investment priorities. In the coming decades, climate finance will no longer be limited to government grants or corporate sustainability initiatives. Instead, it will rely on sophisticated financial instruments, digital innovations, and global market mechanisms designed to mobilize trillions of dollars. From green bonds and carbon markets to AI-driven risk modeling and climate-aligned banking rules, the future of climate finance involves embedding climate considerations into every investment decision.

KEYWORDS

- *Climate finance*
- *Low-carbon transition*
- *Net-zero pathways*
- *Climate resilience*
- *Adaptation finance*

JEL Classification Codes

- ***Q50** – Environmental Economics: General*
- ***Q54** – Climate; Natural Disasters; Global Warming*
- ***Q56** – Environment and Development; Environment and Trade; Sustainability*
- ***Q58** – Environmental Economics: Government Policy*

INTRODUCTION

Nevertheless, the development of blue finance faces several challenges, including weak regulatory frameworks, limited project pipelines, measurement difficulties, and insufficient awareness among investors. Addressing these gaps is essential to scale up blue finance and ensure that capital flows genuinely contribute to sustainable outcomes rather than "blue-washing."In essence, blue finance represents a transformative approach to aligning economic development with environmental stewardship in ocean and freshwater systems. As global interest continues to grow, understanding its mechanisms, impacts, and potential is crucial for policymakers, researchers, and investors seeking to drive progress toward sustainable development. Oceans, seas, and freshwater bodies play a vital role in sustaining life on Earth, supporting global ecosystems, regulating the climate, and underpinning economies—particularly in coastal and island regions. However, accelerating environmental degradation, climate change,

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marine pollution, and unsustainable exploitation of aquatic resources have intensified the urgency to protect and manage water-based ecosystems more responsibly. In response, the global development agenda has increasingly recognized the need for targeted investments that support the sustainable use of marine and freshwater resources. Against this backdrop, blue finance has emerged as a strategic mechanism designed to mobilize public and private capital for activities that enhance ocean health and promote a resilient, inclusive blue economy.

Blue finance refers to financial instruments, policies, and investments directed toward the conservation and sustainable use of ocean and water resources. These instruments—including blue bonds, concessional loans, blended finance structures, and impact investment funds—have grown in prominence as countries and institutions seek innovative solutions to bridge the significant funding gap in ocean-related Sustainable Development Goals (SDGs). In particular, SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), and SDG 14 (Life Below Water) rely heavily on adequate financing for effective implementation. Despite this, ocean-focused SDGs remain among the least funded targets of the 2030 Agenda, highlighting the importance of blue finance as a tool for closing this investment deficit.

REVIEW OF LITERATURE

- Mr. Mark Carney June 15, 2017: One of the essential functions of financial markets is to price risk to support informed, efficient capital-allocation decisions. Accurate and timely disclosure of current and past operating and financial results is fundamental to this function, but it is increasingly important to understand the governance and risk management context in which financial results are achieved. The financial crisis of 2007-2008 was an important reminder of the repercussions that weak corporate governance and risk management practices can have on asset values. This has resulted in increased demand for transparency from organizations on their governance structures, strategies, and risk management practices. Without the right information, investors and others may incorrectly price or value assets, leading to a misallocation of capital.
- Romain SVARTZMAN January 2020 : Climate change poses new challenges to central banks, regulators and supervisors. This book reviews ways of addressing these new risks within central banks' financial stability mandate. However, integrating climate-related risk analysis into financial stability monitoring is particularly challenging because of the radical uncertainty associated with a physical, social and economic phenomenon that is constantly changing and involves complex dynamics and chain reactions. Traditional backward-looking risk assessments and existing climate-economic models cannot anticipate accurately enough the form that climate-related risks will take. These include what we call "green swan" risks: potentially extremely financially disruptive events that could be behind the next systemic financial crisis. Central banks have a role to play in avoiding such an outcome, including by seeking to improve their understanding of climate related risks through the development of forward-looking scenario-based analysis. But central banks alone cannot mitigate climate change
- Volkholz, J. (2024 : Established in 2017, the Network for Greening the Financial System (NGFS) today represents a major hub for the promotion of analytical work and best practices in the field of green finance. Currently (June 2024), the NGFS consists of 141 central banks and supervisors (and 21 observers) from across five continents committed to sharing best practices, contributing to the development of climate- and environment-related risk management in the financial sector and mobilising mainstream finance to support the transition toward a sustainable economy.1 One of the key initiatives of the NGFS is the development of climate-related scenarios that can be used by financial institutions to assess and manage climate-related risks. These scenarios are intended to be forward looking and consider various climate-related factors, as well as policy and technology developments. Hypothetical future pathways of climate change are used for analysing and assessing the potential impacts and risks associated with different climate outcomes. The scenarios are not intended to predict the exact future climate but rather provide a set of plausible pathways that can help policymakers, researchers, financial institutions, and private sector businesses explore impacts and evaluate adaptation and mitigation strategies in the face of climate change.
- Sarah Breeden October 2021 : This report sets out how 31 NGFS members are using climate scenarios to identify, assess and understand climate risks in their economies and financial systems. As a rapidly growing number of central banks and supervisors are conducting climate scenario analysis, this report takes stock of the current state of play, setting out methodological and design choices and challenges. For the purposes of this report, 31 NGFS members across six continents volunteered to share information by way of a survey of their completed, in progress, or planned climate scenario analysis. To date, four of these exercises have been completed and their findings published, and most exercises are expected to be completed by Q3 2022.

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- Financial Stability Board (FSB) 23 November 2020T : his report discusses the potential implications of climate change for financial stability. It investigates channels through which climate-related risks might impact the financial system. It also examines potential mechanisms within the financial system that might amplify the effects of climate-related risk as well as the cross-border transmission of risks. The report draws on existing work by the official and private sector. Such work is, in places, nascent in its consideration of risks to financial stability. In places, therefore, the report raises issues that go beyond those discussed in the existing literature. Risks to financial stability from climate change can be divided into physical and transition risks. The value of financial assets/liabilities could be affected either by the actual or expected economic effects of a continuation in climate change (physical risks), or by an adjustment towards a low-carbon economy (transition risks).
- Lael Brainard 2021 : These are not easy problems, and they will not have easy solutions. Despite the challenges, it will be critical to make progress, even if initially imperfect, in order to ensure that the financial system is resilient to climate-related risks and well positioned for the transition to a sustainable economy. We are committed to building our capacity to understand and address the risks, complexities, and challenges related to climate change within the Federal Reserve's responsibilities. In working toward these goals, we will undoubtedly reach better outcomes if we tackle this challenge through open dialogue, information sharing, and transparency.
- Caldecott, 2017 : The NGFS scenarios have been developed to provide a common starting point for analysing climate risks to the economy and financial system. They have been created as a tool to shed light on potential future risks, and to prepare the financial system for the shocks that may arise. Importantly, the NGFS scenarios are not forecasts: instead, they aim at exploring the bookends of plausible futures (neither the most probable nor desirable) for financial risk assessment. • To reflect the uncertainty inherent to modelling climate related macroeconomic and financial risks, the NGFS scenarios use different models, and explore a wide range of scenarios across regions and sectors. • In this third iteration, the NGFS scenarios have been brought up to date, including by incorporating countries' commitments to reach net-zero emissions, and have been enriched with more sectoral granularity and a finer representation of physical risk, including acute.
- Löber, Parisi, 2022 : Climate-related financial risks (CRFR) are now recognised by central banks and supervisors as material to their financial stability mandates. But while CRFR are considered to have some unique characteristics, the emerging policy agenda for dealing with them has largely focused on conventional market-based solutions. Current policy emphasises information gaps that prevent the accurate assessment of market risk. The assumption is that these gaps can be remedied via disclosure, transparency, scenario analysis and stress testing, which will enable markets to self-correct. We argue this approach is misguided as CRFR are characterised by radical uncertainty and hence 'efficient' price discovery is not possible. Instead, a 'precautionary' policy approach is proposed. Since climate change poses a severe and potentially irreversible threat, lack of scientific certainty as to its exact nature or timing should not prevent regulatory action to mitigate its impact. Such an approach justifies fully integrating CRFR into financial policy, including both prudential and monetary policy frameworks. Central banks and financial supervisors can and should actively steer market actors in a clear direction — towards a managed transition — to ensure a scenario that minimises harm to the financial system and the wider economy in the future.
- Chnet 2019 : In recent years stranded assets caused by environment related factors, particularly climate change and societal responses to climate change, have become an increasingly prominent topic. Concern over the potential for stranded assets has been a key instigator of one of the fastest growing social movements in history - the fossil-free divestment campaign3 - and has prompted reaction from numerous key global leadersi. The economic processes that lead to asset stranding are not new to economic theory. Indeed, in the early 20th century, the prominent Austrian economist Joseph Schumpeter coined the phrase "creative destruction", where new and better products or novel production techniques replace older inferior ones4. Stranded assets are defined as assets that have suffered from unanticipated or premature write-downs, devaluation or conversion to liabilities5. There is a wide range of risk factors that can have an impact on asset values and drive incidences of liability in different sectors of the global economy. Increasingly, factors related to the environment are driving asset stranding, and many of these risks are poorly understood and are regularly mispriced, resulting in an over exposure to such risks in economies throughout the world6. Environ
- Tristan Jourde April 2023 : This paper proposes a market-based framework to study systemic climate risks in the financial sector. Our framework aims to identify the financial institutions most vulnerable to physical and transition climate risks and proposes a test to estimate whether climate risks can generate contagion effects in the financial sector. We apply our framework to large European financial institutions and show that,

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unlike physical risk, transition risk significantly influences systemic risk. We also show that the exposure to transition risk appears lower for institutions with cleaner investment and lending portfolios and long-term orientation.

- Nick Robins 2020 : Assets in the fossil fuel industries are at risk of losing market value due to anticipated breakthroughs in renewable technology and governments stepping up climate policies in the light of the Paris commitments to limit global warming to 1.5 or 2 degrees Celsius. Stranded assets arise due to uncertainty about the future timing of these two types of events and substantial intertemporal and intersectoral investment adjustment costs. Stranding of assets mostly affects the 20 biggest oil, gas and coal companies who have been responsible for at least a third of global warming since 1965, but also carbon-intensive industries such as steel, aluminium, cement, plastics and greenhouse horticulture. A disorderly transition to the carbon free economy will lead to stranded assets and legal claims. Institutional investors should be aware of these financial risks. A broader definition of stranded assets also includes countries reliant on fossil fuel exports and workers with technology-specific skills.
- Pritha Mitra 2025 (August) : Financial stress among university students has been widely documented, impacting academic performance, mental health, and overall well being. This scoping review explores and synthesizes the existing evidence on the extent and impact of financial challenges experienced by university students in Australia and NewZealand and examines approaches implemented by universities in these countries to address these challenges. Methods: The Arksey and O'Malley framework was utilized for comprehensiveness, structure, and reproducibility. Four scientific databases (Scopus, ProQuest, Web of Science, and Informit) were searched until 30 June 2024, and 3542 articles were identified. Following extensive screening, 19 studies were included.
- Xiaoxiao Zhang2024 (July) : This study empirically investigates the impact of the climate transition on the French financial sector using a micro-macro approach to examine the long-term effects of climate mitigation and decarbonization policies on sectoral output and the effects on firm profitability and the likelihood of corporate defaults. We employ a recursive-dynamic, multi-regional, multi-sectoral computable general equilibrium (CGE) model to simulate the Fit-for-55 climate scenario and then integrate the sectoral output paths derived from the model into firm-level corporate balance sheets and risks. We then assess the extent of credit exposure of banks to energy-intensive sectors. Our findings indicate that, under the Fit-for-55 scenario, the mining, chemicals and manufacturing sectors might face notable increases in their probability of defaults, in turn creating pockets of vulnerabilities in some parts of the banking system depending on their exposure to these energy-intensive sectors. This highlights the importance for a timely and orderly transition, including integrating climate transition plans into the prudential framework.
- Joanna Russell 2025 (February) : Climate change poses significant and diverse impacts on countries' macroeconomic and financial stability, resulting in complex macro-critical policy challenges. Consequently, where significant, country-level macroeconomic analysis may need to integrate climate change-related impacts and policies. This paper reviews (i) climate change and related policies' channels of impact on the real, fiscal, external, monetary, and financial sectors over various time horizons and (ii) corresponding data sources, models, and climate scenarios that could be applied in assessing the impact of physical climate risks as well as adaptation, transition, and mitigation policies. The paper concludes with considerations for future work..

- Armon Rezai 2019 (December) : Net-zero is increasingly recognised as an important goal by leaders within the UK's financial community, but it is not yet embedded into routine decision-making and policy. Strikingly, COVID-19 has deepened rather than deflected financial sector commitment to climate action. The way the UK exits from COVID will profoundly shape its ability to meet its climate targets and achieve wider economic goals, not least in terms of levelling up prosperity across the country. An ambitious green recovery plan that accelerates investment in a net-zero, resilient and just transition is not just needed, but is also called for by business, finance and citizens. The net-zero economy of the future will be more capital-intensive, but mobilising the investment required is achievable with effective policies and responsive markets. Specifically
- Pedro de Aragão Fernandes 2023 ; Several major economies have already committed to achieving a carbon-neutral economy by 2050, in accordance with the Paris Agreement. The banking system in all countries has a key role to play in supporting the transition to a low-carbon economy, and academia has been researching the prudential regulation tools that will enable the incorporation of climate risk management into banking. However, no studies to date have attempted to systematize research on Climate-related Prudential Regulation Tools. This study conducts a systematic review of the English language peer-reviewed literature produced on

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this topic in the period since the 2007–2008 financial crisis, revealing the state of the art and the research gaps. The thematic synthesis carried out in this study shows the experience of some countries in the implementation of these tools and the advancement of academic knowledge in this field. These findings can serve as a reference for the further development of a harmonized international framework to address climate risk in banking

- Orestis Velentzas 2024 : Climate change has become a main concern of ministries of finance, cen tral banks, and financial regulators. In response, a suite of scenarios and tools have been developed to assess the financial risks from physical cli mate shocks (for example, hurricanes, droughts, wildfires, flooding). How ever, those scenarios do not fully capture such shocks, which could lead f inancial institutions to underestimate the potential scale of climate risks and underprice investments in resilience. This is particularly important for emerging markets and developing economies where exposure to physi cal climate risks is already high and is expected to further increase with climate change. The paper identifies five areas, or risk drivers, that make a material contribution to physical climate risks to the financial sector and that are not consistently included in current scenarios and tools
- Irene Monasterolo 2022 : Banks are facing increasing pressure to accelerate their climate mitigation efforts, driven by climate-related and transition risks related to their portfolios, international inter-governmental climate agreements (e.g. Paris Agreement), evolving regulatory developments, and elevated expectations from investors and customers. The imper ative for the banking sector to transition towards a net-zero economy is no longer optional but an essential undertaking. Currently, many banks have made climate commitments through UNEP FI's Principles for Responsible Banking framework and its climate accelerator the Net-Zero Banking Alliance and taken important steps in advancing climate mitigation, oftentimes though without a clear action plan of how to effectively operationalise their decarbonisation approaches. Other banks are hesitating to make climate commitments and still considering their approach towards net zero. In both cases, there are multiple challenges that banks face as they look to advance their path to net zero,
- J. David Cabedo 2023 : Climate Policy Initiative's Net Zero Finance Tracker (NZFT) is a collaborative and interactive data platform that aims to provide a comprehensive assessment of how private financial institutions (FIs) are progressing on their climate commitments and delivering impact on the ground. This marks the first effort to track comprehensive, material progress by major FIs globally: from their commitments, through action within the institution, to impacts on the wider economy. The 2023 edition of the NZFT covered 562 private finance institutions (FIs) that are members of the Glasgow Financial Alliance for Net Zero (GFANZ), whose collective assets under management exceed USD 80 trillion. Building on a beta tracker covering UK institutions released in 2021, the tracker monitors a wide range of actions signaling progress on financial alignment with the Paris Agreement and net zero emissions goals.
- World Economic Forum (WEF) January 2025 : The climate finance gap for both mitigation and adaptation is considerable. According to the Climate Policy Initiative (CPI), annual climate finance requirements are projected to rise to $9 trillion by 2030 and exceed $10 trillion annually from 2031 to 2050.3 Mitigation finance alone must surpass $8.4 trillion per year by 2030, yet only $1.2 trillion was invested in 2021/2022.4 On the adaptation front, financing reached a record annual value of $63 billion in 2021/2022, a 29% increase from $49 billion in 2019/2020. The great majority (98%) of this funding came from public sources.

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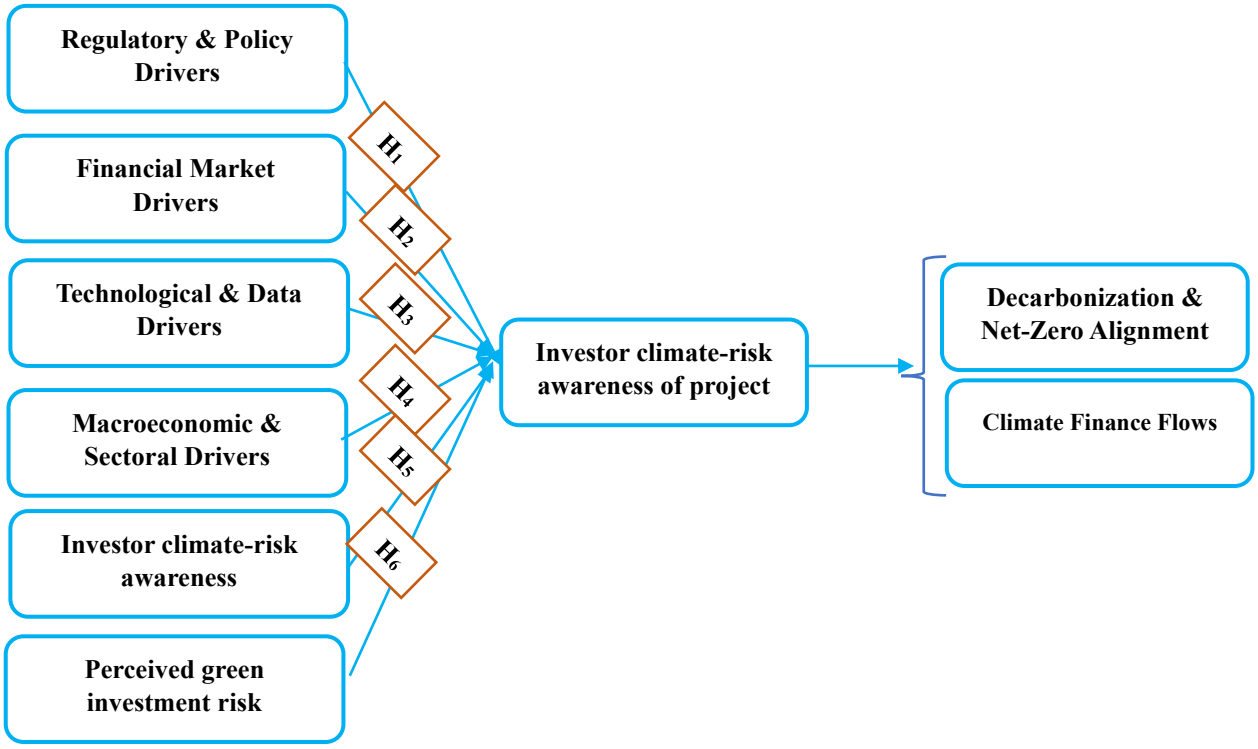
RESEARCH METHODOLOGY

- **Conceptual Model:**



- **Statement of the Problem:**
  Despite rapid growth in climate-related investments, global financial markets remain insufficiently aligned with net-zero pathways. The central research problem is understanding why climate finance flows are not scaling at the speed or magnitude required, and what financial, regulatory, and institutional barriers impede the transition toward a net-zero global financial system.
- **Research Gap:**
  A major gap also persists in the area of transition finance, especially for hard-to-abate sectors. Current studies lack a unified framework for distinguishing credible transition finance from greenwashing, making it difficult to assess the effectiveness of capital flows intended to support industrial decarbonization. Similarly, carbon markets—though expanding—are understudied in terms of cross-border linkages, integrity, liquidity, and their actual emissions-reduction performance. The research gap is even more pronounced in developing countries, where structural limitations, high capital costs, and poor data availability significantly constrain access to climate finance. Most existing literature disproportionately focuses on advanced economies, leaving questions unanswered regarding equitable climate finance distribution, blended finance mechanisms, and solutions for emerging markets. Finally, data and disclosure challenges remain a critical bottleneck, as climate-related information is inconsistent, non-standardized, and often unreliable, limiting evidence-based financial decision-making.

Objectives of the Study

1. To evaluate the extent to which global financial institutions are aligning their portfolios with net-zero pathways.
2. To analyze how climate-related risks—both physical and transition risks—are integrated into financial asset valuation and pricing.
3. To investigate the effectiveness and credibility of key climate finance instruments, such as green bonds, transition finance, and carbon markets.

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4. To examine the role of regulatory frameworks, taxonomies, and policy interventions in accelerating the scaling of climate finance.

Hypothesis of the Study

- H1a: Stronger net-zero governance structures within financial institutions are positively associated with lower portfolio carbon intensity.
- H1b: Institutions participating in global net-zero alliances (e.g., GFANZ) demonstrate greater reductions in financed emissions over time.
- H2a: Firms with higher exposure to climate risks have a significantly higher cost of capital than firms with lower exposure.
- H2b: Markets with advanced climate-risk modelling capabilities exhibit reduced mispricing between green and brown assets.

RESULT & DISCUSSION

INTERNAL CONSISTENCY AND CONVERGENT VALIDITY

Constructs	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Regulatory & Policy Drivers	0.94	0.95	0.96	0.82
Financial Market Drivers	0.93	0.93	0.95	0.79
Technological & Data Drivers	0.93	0.93	0.95	0.78
Technological & Data Drivers	0.95	0.95	0.96	0.84
Macroeconomic & Sectoral Drivers	0.90	0.90	0.93	0.72
ESG Investments in Total Portfolio	0.92	0.93	0.94	0.75
Investor climate-risk awareness	0.91	0.91	0.93	0.73
Economic Losses from Climate Disasters	0.93	0.93	0.94	0.77
Perceived green investment risk	0.91	0.92	0.94	0.74
GDP Stability in Climate Exposed Disaster Sectors	0.96	0.96	0.97	0.85

The results show that the measurement model demonstrates strong reliability and validity. All constructs exhibit high internal consistency, as indicated by Cronbach's alpha and composite reliability values well above the recommended threshold of 0.70. Similarly, the average variance extracted values are above 0.50, confirming convergent validity and indicating that the constructs capture a substantial proportion of variance from their indicators.

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DISCRIMINANT VALIDITY (FORNELL-LARCKER CRITERION)

Constructs	ACS	BFS	CFM	CFP	CRI	ESG	ED	EL	FDI	GDP	TR	GBI
ACS	0.90											
BFS	0.90	0.89										
CFM	0.89	0.94	0.88									
CFP	0.73	0.91	0.82	0.92								
CRI	0.82	0.88	0.89	0.86	0.85							
ESG	0.87	0.86	0.87	0.72	0.82	0.87						
ED	0.89	0.93	0.93	0.84	0.91	0.81	0.86					
EL	0.73	0.78	0.81	0.73	0.91	0.75	0.80	0.88				
FDI	0.87	0.92	0.92	0.86	0.88	0.81	0.95	0.77	0.86			
GDP	0.76	0.85	0.86	0.79	0.89	0.77	0.88	0.75	0.82	0.92		
TR	0.81	0.91	0.91	0.85	0.93	0.79	0.92	0.84	0.87	0.94	0.89	
GBI	0.89	0.93	0.96	0.82	0.87	0.89	0.89	0.77	0.88	0.85	0.88	0.89

The Fornell–Larcker results show that the square root of AVE for each construct is generally greater than its correlations with other constructs, providing evidence of discriminant validity. However, certain constructs display very high correlations, indicating conceptual closeness. While this does not undermine the model's validity, it suggests that some constructs may share overlapping conceptual domains, which should be considered during theoretical interpretation.

DISCRIMINANT VALIDITY (HTMT CRITERION)

Constructs	ACS	BFS	CFM	CFP	CRI	ESG	ED	EL	FDI	GDP	TR	GBI
ACS												
BFS	0.962											
CFM	0.943	1.004										
CFP	0.773	0.961	0.863									
CRI	0.881	0.952	0.874	0.921								
ESG	0.927	0.921	0.933	0.757	0.886							
ED	0.960	1.012	1.009	0.909	1.007	0.875						
EL	0.779	0.837	0.868	0.780	1.004	0.811	0.869					
FDI	0.942	1.006	1.007	0.918	0.976	0.890	1.047	0.841				
GDP	0.794	0.906	0.907	0.819	0.959	0.808	0.946	0.799	0.872			
TR	0.863	0.973	0.970	0.902	1.018	0.849	1.001	0.915	0.945	0.997		
GBI	0.948	0.998	1.029	0.870	0.945	0.953	0.966	0.830	0.957	0.899	0.935	

The HTMT results show most relationships are within acceptable limits, but several inter-construct ratios approach or exceed the critical threshold of 0.90. This suggests strong associations between some constructs, raising potential concerns about their distinctiveness. Such findings indicate that while the constructs are statistically

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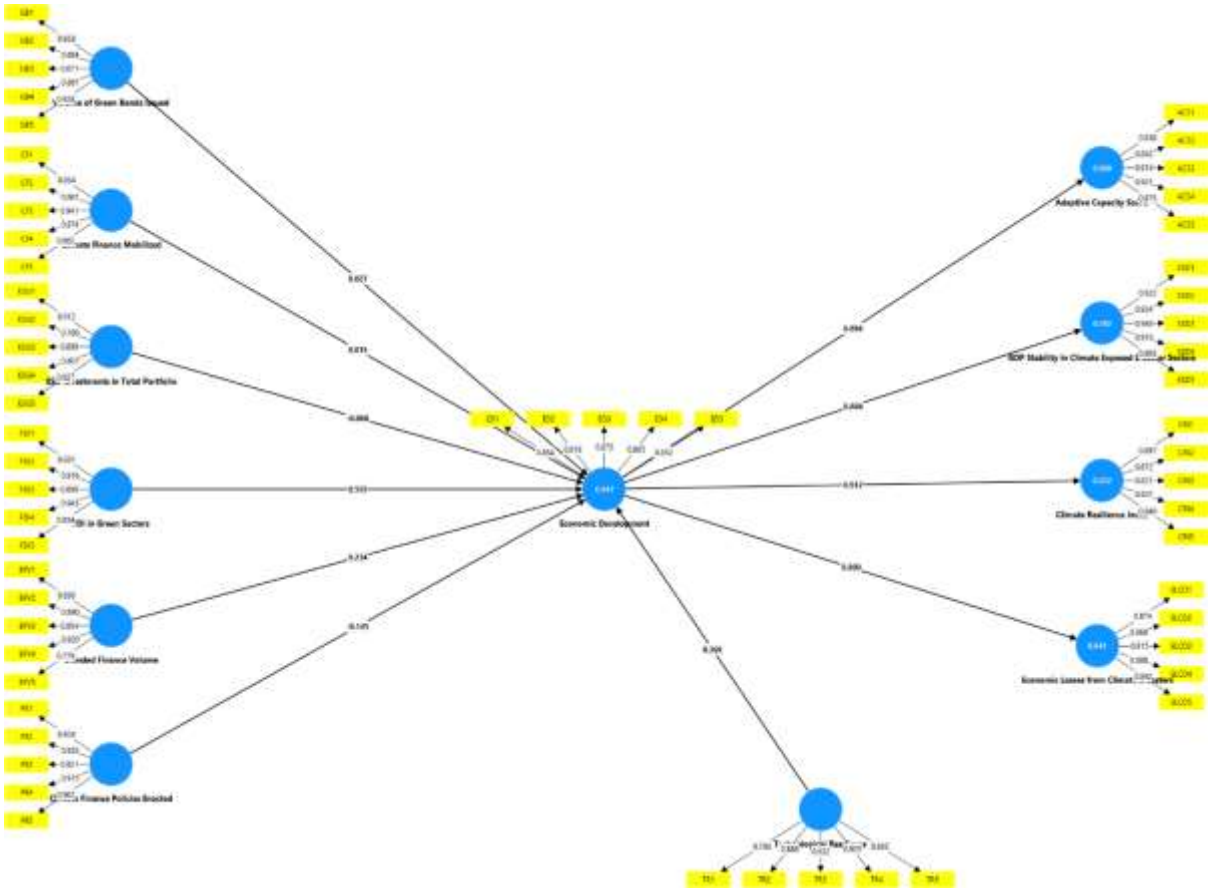
distinguishable, their conceptual overlap should be acknowledged, and future refinement of construct definitions may be necessary.



CONCLUSION

The transition toward a net-zero global financial system represents one of the most significant structural shifts in modern economic history, yet the evolution of climate finance remains uneven, complex, and constrained by multiple market, regulatory, and institutional barriers. This study, through its objectives and hypotheses, highlights that while financial institutions are increasingly committing to net-zero pathways, the degree of genuine portfolio alignment is still uncertain and depends heavily on the strength of disclosure requirements, governance mechanisms, and credible measurement frameworks. Similarly, although awareness of physical and transition climate risks is rising, their integration into asset valuation and pricing remains insufficient, leading to persistent mispricing of high-carbon assets and a distorted allocation of capital.

FURTHER RESEARCH

Future research can extend beyond developed economies to examine climate finance dynamics in emerging markets and developing countries. Comparative studies could reveal unique barriers, financial risks, and opportunities in regions with differing institutional capacities, regulatory environments, and climate vulnerabilities. New financial instruments, such as sustainability-linked loans, transition bonds, blended finance, and innovative carbon credit mechanisms, require further assessment. Research could explore their long-term effectiveness, credibility, market adoption

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