

# REFORMULATING ESG THROUGH A QUINTUPLE HELIX GOVERNANCE FRAMEWORK FOR CLIMATE RISK INTEGRATION IN SUSTAINABLE FINANCE

**Vatimatus Zahroh, Muhammad Darul Ulum, Nikmatul Masruroh**

*Shariah Economy Master Program, Postgraduate of UIN Kiai Haji Achmad Siddiq, Jember, Indonesia*

*Email: nikmatul.masruroh82@gmail.com*

## ***Abstract***

This study reframes ESG as a systemic governance mechanism for integrating climate risk into financial stability. Fragmentation between ESG and macroprudential policy constrains risk internalization. A Quintuple Helix framework is proposed to bridge micro-, meso-, and macro-level dynamics. The study employs a theory-building systematic literature review of 22 empirical and conceptual studies across financial and industrial sectors. Insights from financial stability theory, ESG governance, and innovation systems are synthesized to develop an integrative conceptual framework. The findings ESG operates effectively as a firm-level risk signal but cannot internalize systemic climate risk rooted in interconnected financial and transition dynamics. Fragmentation across governance levels limits coordination. Positioning ESG within a Quintuple Helix framework enables its transformation into a systemic cross-actor governance mechanism. The study is conceptual and based on literature synthesis rather than empirical testing. Future research may operationalize the proposed governance model through quantitative or policy-oriented investigations. The study suggests that regulators and financial institutions should move beyond disclosure-oriented ESG practices toward systemic governance coordination. Integrating ESG within cross-actor frameworks can enhance climate risk supervision and improve financial system resilience under transition pressures. The originality from this paper by embedding climate risk within systemic governance, this study emphasizes the role of coordinated financial decision-making in supporting ecological sustainability and socially inclusive economic resilience. This study contributes to the literature by bridging ESG governance, macroprudential policy, and innovation system theory into a unified framework that positions climate risk as an endogenous driver of financial stability. It advances ESG from a transparency tool to a systemic governance mechanism within a Quintuple Helix architecture.

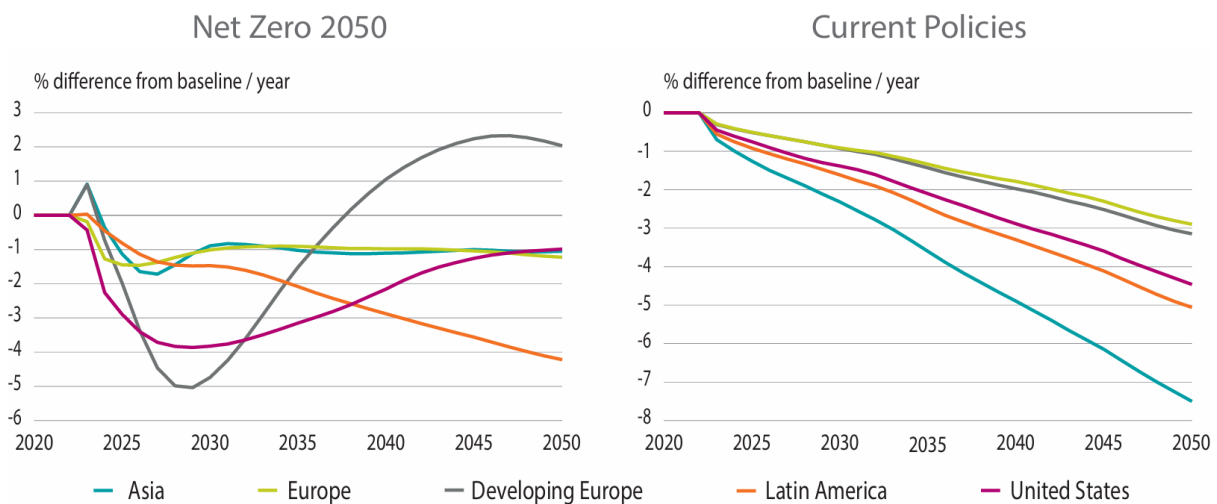
**Keywords:** *ESG governance, Climate risk, Financial stability, Macroprudential policy, Quintuple Helix Systemic*

## **1. INTRODUCTION**

Climate risks are increasingly recognized as a threat to the stability of the financial system, rather than just an environmental challenge (Battiston et al., 2021; D’Orazio, 2023). Nevertheless, the institutional response to these risks continues to operate within a fragmented framework. On one hand, macroprudential policies are beginning to integrate climate risks through instruments such as climate stress testing. On the other hand, Environmental, Social,

and Governance (ESG) is evolving as a reporting mechanism and investment preference at the corporate level (Hauch, 2025; Tian et al., 2025). Although both aim to enhance the resilience of the economic system, the interaction between them remains weak; consequently, climate risk has not been fully internalized as a structural determinant of financial stability (Varadi et al., 2026).

**Figure 1. Regional GDP Impact under Alternative Climate Policy Scenarios**



As shown in Figure 1, delayed climate policy responses under the Current Policies scenario generate persistent GDP deterioration across regions toward 2050. Although the Net Zero 2050 pathway initially produces transitional economic pressures, several regions demonstrate gradual long-term recovery. These projections indicate that unmanaged climate risks may create broader systemic instability than early transition costs.

These limitations become significant because the nature of climate risk is systemic. Its impact arises not only through physical damage caused by disasters but also through decarbonization policy changes, technological innovation, and shifts in market preferences toward a low-carbon economy (Peng et al., 2025). This transition process has the potential to trigger sudden asset price adjustments, particularly in carbon-dependent sectors. In this context, climate risk is no longer merely an external shock, but can accumulate within the structure of the financial system (Battiston et al., 2021).

This dynamic aligns with the concept of financial fragility proposed by Hyman Minsky, where long-term stability actually encourages an increase in exposure to risks that are not fully internalized (Fazzari, 2022). During a period of carbon-based economic growth, assets in carbon-intensive sectors may appear stable and profitable. However, when expectations shift

or transition policies accelerate, the value of these assets is prone to sharp corrections. Thus, climate risk functions as a source of endogenous instability that can amplify the fragility of the financial system (Huang et al., 2026).

Recent macro-financial projections further reinforce the systemic nature of climate risk. According to the latest climate scenarios developed by the Network for Greening the Financial System (NGFS, 2023), delayed climate transition and unmanaged physical climate risks may generate substantial long-term macroeconomic losses. Under disorderly transition scenarios, abrupt policy adjustments and escalating physical damages are projected to significantly reduce global GDP while simultaneously increasing financial market volatility and asset repricing pressures. These findings indicate that climate risk possesses the capacity to propagate through interconnected financial and industrial systems, thereby amplifying systemic fragility within the broader macroeconomic architecture.

Figure 2. Chronic Global GDP

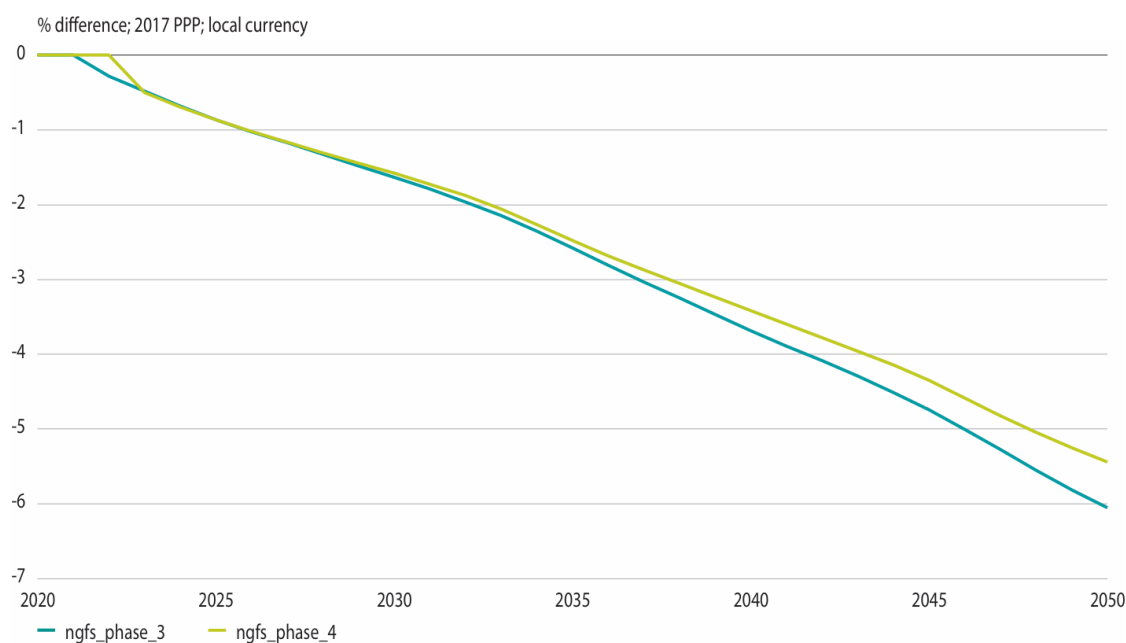


Figure 2 illustrates the long-term macroeconomic impacts of chronic climate risks under alternative climate scenarios developed by the Network for Greening the Financial System (NGFS). The projections indicate that climate-related damages may progressively reduce global economic output and increase systemic financial vulnerability over time. These findings reinforce the argument that climate risk should be understood not merely as an environmental issue, but as an endogenous source of fragility within the modern financial system.

Efforts to integrate climate risk into the macroprudential framework have evolved, yet they tend to focus on mitigating impacts through a technocratic approach (Q. Zhang et al., 2025). Meanwhile, ESG plays a role in enhancing the transparency of non-financial risks, but it still operates at a micro level and is frequently constrained by inconsistent standards and methodological variations. Consequently, ESG has not yet been able to function as a systemic coordination mechanism that bridges the gap between corporate governance and financial stability (Acharya et al., 2025; Al Hosani et al., 2025)

This gap indicates a decoupling between the micro level (firms and investors), the meso level (industrial and financial networks), and the macro level (policy authorities). Without a governance mechanism that connects these three levels, climate risk tends to be treated as a sectoral issue rather than a structural factor in long-term economic stability.

In this context, the Quintuple Helix model offers a more integrative approach by positioning the environment as an actor equal to government, industry, academia, and civil society (Shkarupeta & Babkin, 2024). This approach allows ESG to be repositioned from a mere reporting instrument into a cross-actor governance mechanism capable of simultaneously internalizing climate risks at various system levels.

Although the literature on ESG and climate risk is expanding rapidly, there is currently no conceptual framework that explicitly integrates the perspectives of financial fragility, macroprudential policy, and innovation governance approaches into a single coherent model (Q. Zhang et al., 2025). This separation creates an analytical void regarding how ESG can function as an instrument for systemic risk mitigation.

Building upon these gaps, this research aims to reformulate ESG within the Quintuple Helix framework to establish a governance perspective that connects climate risk with financial system stability. Unlike approaches that view ESG merely as a corporate-level reporting instrument, this study positions ESG as a governance mechanism with the potential to mediate the relationship between climate risk and systemic stability. By integrating the perspectives of financial fragility, macroprudential policy, and cross-actor governance approaches, this research seeks to bridge the fragmentation between the micro, meso, and macro levels of climate risk management. Conceptually, the primary contribution of this study lies in its effort to reposition ESG from a corporate transparency tool into a systemic coordination framework that enables the internalization of climate risks within the long-term financial stability architecture

Specifically, this research addresses the following questions:

- RQ1: How is climate risk conceptualized within the financial stability and ESG literature?*
- RQ2: How does the literature explain the role of ESG in mitigating systemic risks associated with climate change?*
- RQ3: What are the identified limitations in integrating ESG and macroprudential frameworks for managing climate risk?*
- RQ4: How are systemic governance approaches, including cross-actor perspectives such as the Quintuple Helix, discussed in the literature as a response to this fragmentation?*

The contribution of this research lies in the development of an integrative theoretical framework that connects financial stability theory, systemic risk, and innovation governance into a single conceptual model. Consequently, this article not only enriches the ESG and climate finance literature but also expands the macroprudential discourse by incorporating the ecological dimension as a source of endogenous risk within the system of modern capitalism.

## **2. THEORITICAL FRAMEWORK**

### ***2.1 Climate Risk and the Endogeneity of Financial Instability***

Conventional approaches to financial stability generally view risk as external disruptions that are cyclical or sectoral in nature. However, a perspective influenced by the thought of Hyman Minsky emphasizes that instability often arises from the internal dynamics of the system itself (Chamorro-Futinico, 2025). Prolonged stability tends to drive an expansion of expectations and the formation of financing structures that become increasingly vulnerable to fundamental shifts (Fazzari, 2022).

In the context of a global economy that remains heavily carbon-dependent, climate risk does not merely manifest as an environmental shock; rather, it exists as a structural condition that shapes the logic of capital accumulation and asset values, growth projections, and investment strategies are implicitly assumed to depend on the sustainability of a carbon-based economic model (Ding et al., 2025; Irshad, 2024b; J. Zhang et al., 2025).

Hyman Minsky's thought becomes particularly relevant in this context. Minsky argued that stability itself creates the conditions for the accumulation of latent risks through over-expectations and the expansion of leverage (Kulu & Osei, 2024; Smolo, 2024; Zachariadis, 2025). Climate risk amplifies this dynamic. A long-term dependency on carbon-intensive sectors creates an illusion of economic stability, while simultaneously building up exposure to potential future value corrections. Thus, climate risk must be understood as a source of

systemic fragility, rather than merely an external variable that can be managed on a sectoral basis (Battiston et al., 2021).

## *2.2 ESG and the Limits of Firm-Level Risk Internalization*

In response to the growing attention to sustainability, the ESG framework has evolved into a key tool for integrating non-financial factors into investment decision-making and corporate governance (Battiston et al., 2021). ESG functions to reduce information asymmetry, enhance transparency, and promote more responsible business practices (Wu et al., 2025).

However, although ESG plays an important role in internalizing risks at the firm level, its influence on systemic stability remains limited. ESG implementation tends to focus on reporting, ratings, and investor preferences. As a result, ESG more often operates as an evaluative mechanism rather than as an instrument of structural transformation (Jayawardhana et al., 2025; Qian et al., 2025).

This limitation creates a gap between risk management at the micro level and the need for stability at the level of the financial system as a whole. ESG can improve the behavior of individual companies, but it is not always capable of addressing the interdependencies across sectors that constitute the primary source of systemic risk (Abraham, 2025; Dziwok et al., 2025).

In other words, ESG is effective in shaping incentives, but it has not yet been fully able to coordinate the cross-actor transformations required to comprehensively internalize climate-related risks.

## *2.3. Macroprudential Governance and the Systemic Nature of Climate Risk*

The macroprudential approach emerged as a response to the limitations of microprudential regulation in anticipating financial crises stemming from the accumulation of cross-institutional risks (Rizwan et al., 2024). Unlike the micro approach, which focuses on the health of individual entities, the macroprudential framework establishes systemic stability as its primary objective through the monitoring of interconnections, collective exposures, and financial cycle dynamics (Quirici & Moro-Visconti, 2024). This perspective acknowledges that systemic vulnerabilities often arise not from a single failure, but from interdependencies that amplify the transmission of shocks across the entire financial sector.

In the context of climate change, the integration of climate risks into the macroprudential framework reflects a significant shift in the understanding of financial stability (Varadi et al., 2026). Stability is no longer viewed solely as a function of conventional

economic variables; it is also influenced by long-term structural transformations related to the transition toward a low-carbon economy (Challoumis, 2024; Friedman, 2024). Institutions such as the Bank for International Settlements (BIS) and the Network for Greening the Financial System (NGFS) have emphasized the necessity of developing climate stress testing, increasing the transparency of carbon exposures, and integrating transition scenarios into the financial stability oversight framework (Rizwan et al., 2024) .

Nevertheless, the macroprudential framework still relies on a regulatory approach that depends on formal instruments and institutional supervisory functions (Q. Zhang et al., 2025). At the same time, climate risks are evolving through broader dynamics, involving technological shifts, social preferences, market behavior, and ecological pressures that fall beyond the full reach of regulation-based policies. This situation indicates that efforts to maintain financial stability amidst the climate transition cannot rely solely on institutional controls; they require forms of coordination involving a wide array of actors outside the traditional regulatory framework.

#### *2.4 Quintuple Helix as a Systemic Governance Perspective*

To address the fragmentation in climate risk governance, a framework is required that not only connects actors but also integrates developmental logic with ecological boundaries. The Quintuple Helix Model, Carayannis et al., 2012; Carayannis & Rakhmatullin, 2014; Zakaria et al., 2025 offers an approach that views innovation and development as the result of multi-dimensional interactions between five subsystems: government, industry, academia, civil society, and the environment .

Conceptually, the Quintuple Helix proceeds from the assumption that economic transformation is not solely driven by technological or policy dynamics, but by a process of co-evolution between social systems and ecosystems. In this model, the environment is not positioned as an external backdrop, but rather as an active helix that shapes the direction of innovation, knowledge production, and social legitimacy (Zakaria et al., 2025). Consequently, development is no longer understood merely as the expansion of economic capacity, but as a process of systemic adaptation to ecological boundaries.

The primary difference from previous models, such as the Triple Helix or Quadruple Helix, lies in the absence of the ecological dimension as a structural determinant. In those models, the environment tends to be treated as a variable that can be adjusted through policy or technological innovation (Cai, 2022) .Consequently, development governance continues to operate within a growth paradigm that remains relatively detached from ecological pressures.

This approach becomes inadequate in the context of climate risk, which evolves through the interplay of economic dynamics, social behavior, and environmental changes that exert mutual influence on one another (Irshad, 2024).

By incorporating the environment as the fifth helix, the Quintuple Helix shifts the focus from the coordination of actors toward system integration. Stability and sustainability are understood as the results of adaptive interactions between institutions, markets, knowledge, social values, and ecological conditions. In the context of sustainable finance, this perspective allows ESG (Environmental, Social, and Governance) to be repositioned as part of a broader governance architecture. In this framework, the internalization of climate risks does not solely depend on corporate compliance or formal regulation, but on the system's collective ability to adapt to ecological pressures.

## *2.5 Theoretical Propositions*

The preceding theoretical synthesis reveals a structural misalignment between the organizational logic of ESG and the systemic nature of climate risk. While ESG has evolved as a governance mechanism within firms and capital markets, climate risk unfolds through endogenous, cross-sectoral, and macro-financial dynamics that extend beyond organizational boundaries. This misalignment suggests that incremental refinement of ESG metrics alone is insufficient to ensure systemic financial resilience.

Building on the integration of financial fragility theory, ESG governance literature, and macroprudential perspectives, this study advances the following theoretical propositions:

### *Proposition 1*

Firm-level ESG mechanisms mitigate idiosyncratic risk exposure but do not internalize systemic climate spillovers.

ESG enhances transparency, improves governance practices, and may reduce firm-specific exposure to environmental and reputational risks. However, because ESG operates primarily within organizational boundaries, it lacks the structural capacity to coordinate cross-sectoral interdependencies. Climate risk, particularly transition risk, propagates through interconnected financial and industrial networks. Consequently, firm-level ESG improvements do not automatically aggregate into systemic stability.

### *Proposition 2*

Climate transition risk amplifies endogenous financial instability through collective expectation realignment dynamics.

Drawing on endogenous instability theory, financial fragility accumulates during periods of perceived stability. Carbon-dependent growth models embed long-term valuation assumptions into asset pricing and capital allocation. Climate transition through regulatory shifts, technological disruption, and changing societal preferences triggers simultaneous expectation adjustments. This collective realignment can generate abrupt repricing cascades across interconnected sectors, thereby amplifying systemic vulnerability.

### *Preposition 3*

Systemic climate risk requires cross-actor coordination mechanisms beyond regulator-centric macroprudential frameworks.

Although macroprudential policy recognizes systemic interdependencies, its instruments remain primarily regulatory and institution-centric. Climate risk, however, evolves through broader socio-technical and ecological dynamics involving innovation systems, market behavior, civil society pressures, and environmental constraints. Effective integration of climate risk into financial stability architecture therefore requires governance mechanisms that extend beyond supervisory control and enable cross-actor coordination.

### *Preposition 4*

Embedding ESG within a Quintuple Helix governance structure enhances the adaptive capacity of financial systems under ecological constraints.

The Quintuple Helix framework incorporates government, industry, academia, civil society, and the natural environment as co-evolving subsystems. By positioning the environment as a structural determinant rather than an external variable, this architecture enables ESG to function as a translational interface across actors and levels. Such embedding strengthens adaptive governance, facilitates coordinated capital reallocation, and improves the systemic internalization of climate risk within financial stability frameworks.

These propositions do not function as testable hypotheses in a positivist sense; rather, they serve as theory-building anchors derived from systematic literature synthesis. The following methodology section explains how the structured review and thematic integration of empirical and conceptual studies provide the analytical foundation supporting these theoretical claims.

### **3. RESEARCH METHOD (12pt, Bold)**

This study employs a Systematic Literature Review (SLR) approach grounded in theory-building to reformulate the role of ESG in integrating climate risk through a systemic governance perspective (Alcantud et al., 2024; Batool et al., 2025; Paul et al., 2024). Unlike conventional literature reviews that are descriptive in nature, this study is designed interpretatively to identify the conceptual limitations of ESG in internalizing systemic risks and to construct an alternative governance framework based on the Quintuple Helix model introduced by Elias G. Carayannis and David F. J. Campbell. Thus, the SLR in this research functions not only as a tool for knowledge synthesis but also as a mechanism for conceptual reconstruction that bridges the literature on financial stability, ESG, and innovation governance.

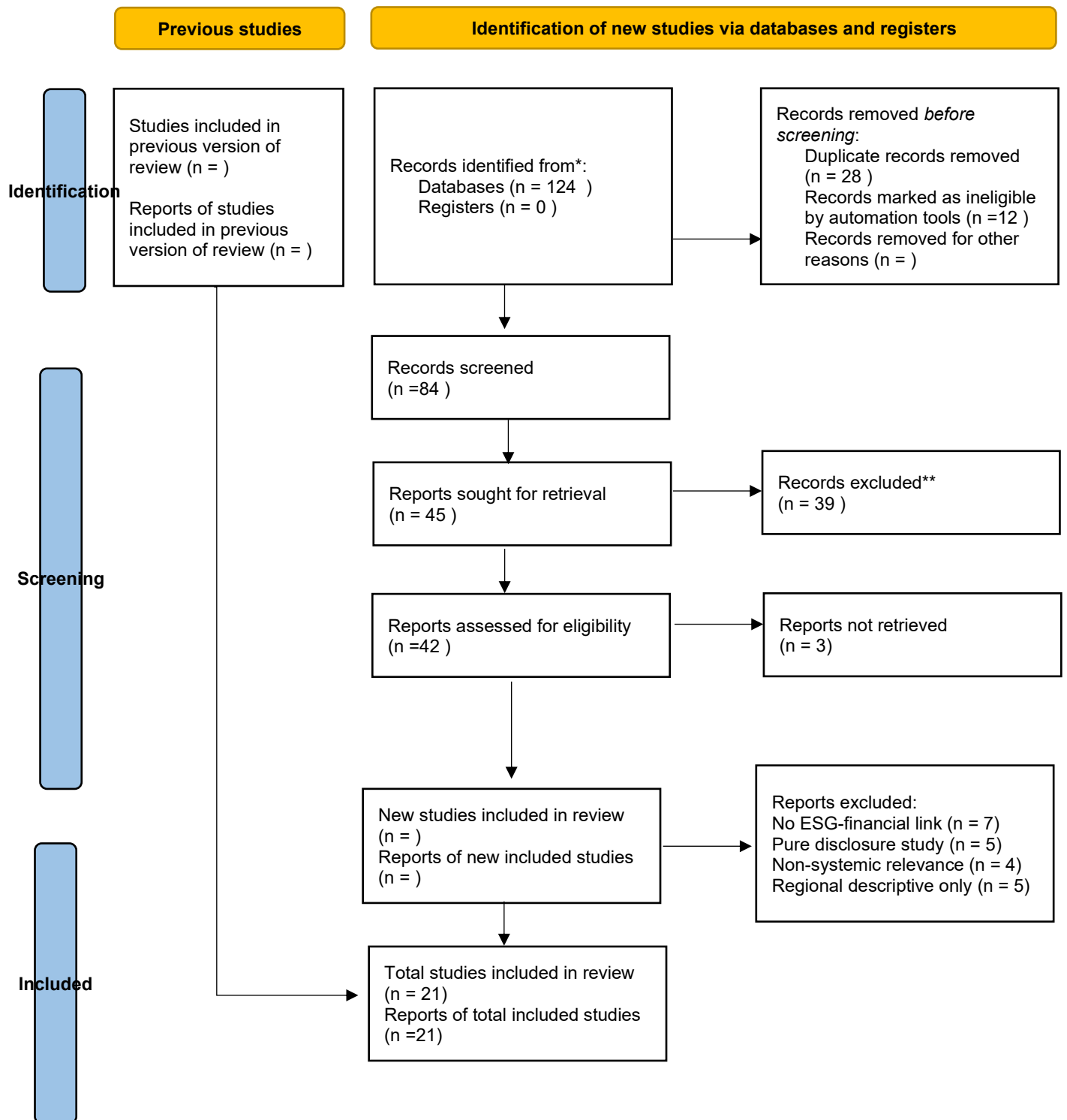
The literature search process was conducted systematically through reputable international academic databases namely Scopus, Web of Science, ScienceDirect, Emerald Insight, and SpringerLink to ensure multidisciplinary coverage and high publication quality. The search strategy employed a combination of keywords reflecting the interconnectedness of ESG, climate risk, financial stability, governance, and multi-actor approaches. The publication range was limited to the 2015–2026 period to capture the latest developments in the institutionalization of ESG, climate finance, and the integration of climate risk within macroprudential policy frameworks (Alcantud et al., 2024; Batool et al., 2025; Paul et al., 2024).

The article selection followed a three-stage screening process title, abstract, and full-text review based on predefined inclusion criteria. Studies were included if they examined ESG within financial or risk governance contexts, linked climate change to financial system stability, and demonstrated relevance to governance or cross-actor dynamics. Articles that were purely technical, lacked systemic implications, or focused on CSR without a risk dimension were excluded. This process resulted in 22 empirical and conceptual studies forming the analytical foundation of the research. Data were extracted using a structured framework covering the level of analysis (micro, meso, macro), the role of ESG in the research model, risk typologies, and governance perspectives (Alcantud et al., 2024; Batool et al., 2025; Paul et al., 2024).

The analysis employed thematic synthesis to identify recurring conceptual patterns in how ESG relates to financial performance, governance structures, risk measurement, and climate dynamics. Through relational integration, the review revealed a structural gap between the firm-level logic of ESG and the systemic nature of climate risk. To address this gap, the study integrates financial stability theory, ESG governance, and cross-actor innovation systems using the Quintuple Helix as an analytical lens. This triangulated approach enables the

development of a conceptual framework that repositions ESG from a disclosure instrument to a systemic governance mechanism for integrating climate risk into long-term financial stability

Figure 3 *Diagram Flow Prisma 2020*



## 4. RESULT AND DISCUSSION

This Systematic Literature Review identifies and analyzes 22 empirical and conceptual articles relevant to the themes of ESG, financial risk, governance, and their interconnections with climate dynamics and financial system stability. The analyzed articles originate from diverse geographical contexts, including ASEAN, Europe, Australia, China, the GCC (Gulf Cooperation Council), BRICS, and emerging markets, and encompass sectors such as banking, capital markets, manufacturing, construction, and global value chains.

Methodologically, these studies employ quantitative, mixed-method, and conceptual approaches to evaluate the role of ESG in: market performance, risk management, organizational governance, green innovation, and institutional transparency. The thematic analysis yielded four primary finding clusters that illustrate the position of ESG within the contemporary financial system.

### 4.1 ESG and Its Impact on Performance

The literature indicates that the relationship between ESG and financial performance is neither linear nor universal. The analyzed studies do not merely evaluate whether ESG impacts firm value, but also how ESG operates within that relationship model. In other words, the literature does not always position ESG as the primary driver of performance; instead, it frequently functions as a variable mediated by internal organizational processes. To understand the position of ESG in this relationship, the following table maps how ESG is constructed across different empirical models.

Table 1. ESG in Relation to Financial Performance

| Study                    | Level of Analysis | Role of ESG in the Model   | Nature of Impact                 | Theoretical Implications              |
|--------------------------|-------------------|----------------------------|----------------------------------|---------------------------------------|
| (Appolloni et al., 2026) | <i>Firm</i>       | <i>Value signal</i>        | <i>Contextual</i>                | <i>ESG is not a universal driver</i>  |
| (Ning et al., 2025)      | <i>Firm</i>       | <i>Market enhancer</i>     | <i>Positive</i>                  | <i>ESG as a reputational asset</i>    |
| (Le et al., 2026)        | <i>Firm</i>       | <i>Risk mediator</i>       | <i>Ambivalent / Inconclusive</i> | <i>ESG is unstable / inconsistent</i> |
| (Mohaghegh et al., 2026) | <i>Process</i>    | <i>Operational enabler</i> | <i>Conditional</i>               | <i>ESG is effective if embedded</i>   |

This mapping demonstrates that ESG does not operate as an inherent stabilization mechanism. Instead, ESG functions as an organizational attribute whose effectiveness depends

on the quality of internal implementation. Consequently, the literature does not support the view that ESG automatically generates financial stability.

#### 4.2 ESG as a Governance Product

A number of studies indicate that ESG cannot be understood in isolation from an organization's governance structure. Variables such as ownership, board composition, and leadership characteristics have been proven to influence the quality of ESG implementation. To capture these dynamics, the following table maps how ESG is positioned in relation to governance structures.

Table 2. ESG within the Governance Structure

| Study                        | Governance Driver | ESG Positioning | Nature of Relationship | Theoretical Implications         |
|------------------------------|-------------------|-----------------|------------------------|----------------------------------|
| (Octavio et al., 2025)       | Ownership         | Outcome         | Struktural             | ESG governance-dependent         |
| (Menicucci & Paolucci, 2025) | Board structure   | Shaped variable | Institusional          | ESG is not a neutral mechanism   |
| (Soetanto et al., 2025)      | Leadership traits | Behavior-driven | Personalised           | ESG is influenced by power       |
| (Soetanto et al., 2025)      | Family control    | Value-embedded  | Normatif               | ESG rooted in social structures. |

Table 2 demonstrates that ESG does not emerge autonomously; rather, it is shaped through internal power configurations. Consequently, ESG is more accurately understood as a reflection of governance rather than an independent instrument of transformation.

#### 4.3 ESG and Measurement Limitations

The literature also highlights that ESG faces challenges regarding the consistency and validity of measurement. Inconsistent ratings and the potential for green signaling indicate that ESG does not always reflect substantive risks. The following table maps how these measurement issues affect the positioning of ESG within market information systems

Table 3. ESG as a Scoring System

| Study             | Isu Pengukuran       | Posisi ESG          | Impact          | Theoretical Implications  |
|-------------------|----------------------|---------------------|-----------------|---------------------------|
| (Hauch, 2025)     | Rating divergence    | Inconsistent signal | Risk Distortion | ESG epistemically fragile |
| (Li et al., 2025) | Rating inconsistency | Informational noise | Market bias     | ESG is not objective      |

| Study                | Isu Pengukuran    | Posisi ESG      | Impact           | Theoretical Implications                 |
|----------------------|-------------------|-----------------|------------------|------------------------------------------|
| (Tian et al., 2025)  | Imperfect ratings | Symbolic proxy  | Pseudo-practices | ESG can be performative                  |
| (David et al., 2025) | Green signaling   | Legitimacy tool | Misallocation    | ESG is not (inherently) transformational |

This finding indicates that ESG does not always function as an objective indicator of risk. Instead, ESG can also serve as a mechanism of symbolic legitimacy.

#### 4.4 ESG and Financial Risk

The relationship between ESG and financial risk has also become a central focus in recent literature. These studies evaluate whether ESG is capable of functioning as a risk mitigation tool. The following table maps the role of ESG within the context of financial risk.

Table 4. ESG in Risk Management

| Study                 | Risk Type       | Role of ESG         | Level of Operation | Theoretical Implications |
|-----------------------|-----------------|---------------------|--------------------|--------------------------|
| (Kazyte et al., 2026) | Credit risk     | Risk modifier       | Firm               | ESG mikro-level          |
| (Malhotra, 2025)      | Market risk     | Connectivity factor | Portfolio          | ESG parsial              |
| (Abraham, 2025)       | Managerial risk | Constraint          | Governance         | ESG behavioural          |

The mapping in Table 4 demonstrates that while ESG plays a role in risk mitigation at the organizational level, it has yet to demonstrate the capacity to internalize the interdependencies of systemic risk.

#### 4.5 ESG and Climate Risk

Recent literature increasingly links ESG to the progressively complex dynamics of climate risk. The following table illustrates how ESG is positioned in relation to climate-based systemic risks.

Table 5. ESG and Climate Risk Dynamics

| Study            | Focus             | ESG Positioning | Risk Scale | Theoretical Implications |
|------------------|-------------------|-----------------|------------|--------------------------|
| (Mellouli, 2026) | Climate spillover | Partial tool    | Sistemik   | ESG is not enough        |

| Study               | Focus             | ESG Positioning   | Risk Scale | Theoretical Implications |
|---------------------|-------------------|-------------------|------------|--------------------------|
| (Wang et al., 2026) | Policy transition | Indirect mediator | Makro      | ESG non-structural       |

The findings in Table 5 indicate that ESG has not yet been able to internalize climate risks that evolve across multiple sectors.

#### *4.6 Theoretical Synthesis*

The synthesis of existing literature demonstrates that ESG has evolved into a dominant mechanism for integrating non-financial dimensions into investment practices and corporate governance. However, empirical evidence consistently shows that the effectiveness of ESG in managing financial risk is neither universal nor stable. Its impact on firm performance, risk exposure, and market value is proven to be context-dependent, mediated by the quality of internal governance and the institutional configurations in which the organization operates. In this context, the literature findings directly address RQ1, showing that within financial stability studies, ESG is positioned primarily as a firm-level risk mitigation mechanism rather than as an instrument for stabilizing the financial system as a whole.

Furthermore, the relationship between ESG and various dimensions of financial risk including credit risk, market volatility, and managerial risk indicates that ESG possesses the capacity to reduce risk exposure at the micro level. However, this capacity is not accompanied by the ability to internalize cross-sectoral interdependencies, which are the primary sources of systemic vulnerability. As literature begins to link ESG with transition and physical risks associated with climate change, it becomes evident that the integration of climate risk within the financial system remains partial and fragmented. These findings substantially address RQ2, confirming that while ESG and macroprudential frameworks have evolved, the integration of climate risk into the financial architecture has not yet reached a systemic level, as ESG continues to operate within the logic of individual organizations.

Furthermore, literature examining ESG within the context of governance and global value chains indicates that ESG practices are shaped through multi-actor interactions involving regulators, capital owners, management, and global market pressures. However, these interactions remain implicit and lack coordination within a cross-level governance framework. This clarifies the answer to RQ3: ESG has not yet functioned as a coordination

mechanism capable of integrating the micro (firm), meso (sector), and macro (financial system) dimensions in climate risk management.

Furthermore, the literature concerning climate risk spillovers and energy transition dynamics emphasizes that financial risk is increasingly influenced by external factors that transcend the boundaries of individual organizations, including policy shifts, technological innovation, social dynamics, and ecological pressures. ESG, which operates primarily as a firm-based evaluative mechanism, is not designed to handle the complexity of these interdependencies. Consequently, these findings address RQ4, demonstrating that the limitations of ESG in strengthening financial system resilience against climate risk are not merely implementational; rather, they reflect its conceptual boundaries as an instrument oriented toward organizational behavior rather than systemic coordination.

Overall, the literature reveals that the impact of ESG is highly contextual, heavily dependent on governance structures, hindered by measurement limitations, and operating primarily at the micro level. In contrast, climate risk evolves as a systemic phenomenon determined by the interactions between public policy, technological innovation, market dynamics, and ecological boundaries. The gap between the character of ESG and the nature of climate risk is structural in nature.

Consequently, maintaining financial stability in the era of climate transition cannot be achieved solely through the refinement of ESG metrics or the strengthening of firm-based regulations. What is required is a governance framework capable of connecting the interactions between government, industry, academia, society, and the environment as the systemic determinants of stability. In this context, the necessity to transcend the logic of firm-level ESG becomes increasingly clear.

## **5. DISCUSSION**

### **5.1 The Structural Limits of Firm-Level ESG in Addressing Systemic Climate Risk**

The findings of this study demonstrate that ESG, while becoming the dominant mechanism for integrating non-financial factors into investment decisions and corporate governance, still operates within structural boundaries that limit its contribution to financial system stability. ESG functions primarily through mechanisms of transparency, reputation, and the formation of internal corporate incentives. Through disclosure, ESG provides inputs in the form of information regarding environmental and social exposure; this information is then processed into internal policy adjustments, risk management, and more sustainable investment

strategies. This process generates outputs in the form of improved governance and risk mitigation at the organizational level. In many cases, the resulting outcome is an increase in firm resilience against transition pressures or reputational risks.

However, this effectiveness is micro-centric and does not automatically accumulate into systemic stability. Climate risk evolves through cross-sectoral interdependencies, public policy shifts, and simultaneous technological dynamics. ESG is not designed to manage coordination between economic entities; therefore, it is incapable of internalizing the collective risks arising from shared exposure to carbon-based economic models. Consequently, ESG functions as a risk interpretation mechanism at the organizational level, but it does not serve as a systemic stabilizer in the face of the structural transformations triggered by the climate transition.

## **5.2 Climate Risk and the Endogenous Dynamics of Financial Fragility**

The limitations of ESG become increasingly apparent when climate risk is understood through the perspective of endogenous instability, as proposed by Hyman Minsky. Within this framework, financial instability is not merely the result of external shocks but evolves from the accumulation of expectations and financing structures formed during periods of stability.

Long-term dependence on carbon-intensive sectors creates an assumption of permanence in asset valuations and investment strategies. Climate risk particularly transition risk disrupts these assumptions through decarbonization policy shifts, technological innovation, and changes in market preferences.

Within systemic mechanisms, inputs such as climate policy pressures, technological shifts, and market dynamics trigger a process of collective expectation adjustment. This process generates outputs in the form of asset repricing and sectoral dislocations, ultimately resulting in outcomes characterized by systemic volatility and potential financial crises. ESG is not designed to manage these collective expectation dynamics because it operates through the logic of individual organizations. Consequently, climate risk cannot be treated as a mere operational variable; rather, it must be recognized as a source of structural fragility that requires a broader governance approach.

## **5.3 Governance Fragmentation and the Micro Meso Macro Disconnect**

The literature also indicates that the integration of climate risk within the financial system is hindered by governance fragmentation across the micro, meso, and macro levels.

ESG functions at the firm level, while macroprudential policies operate at the system level. Between these two lies a network of industries and markets that serve as the medium for risk transmission, yet lack a formal coordination mechanism.

Within this framework, inputs such as ESG adoption and regulatory policies are processed in isolation through internal risk management mechanisms and institutional oversight. This uncoordinated process results in partial sectoral adaptation without achieving cross-level integration. The resulting outcome is the persistence of systemic vulnerability, where risks continue to accumulate within the structures of financial interdependence. This fragmentation demonstrates that the primary issue lies not in a lack of regulation or ESG standards, but in the absence of a governance architecture capable of connecting cross-actor dynamics.

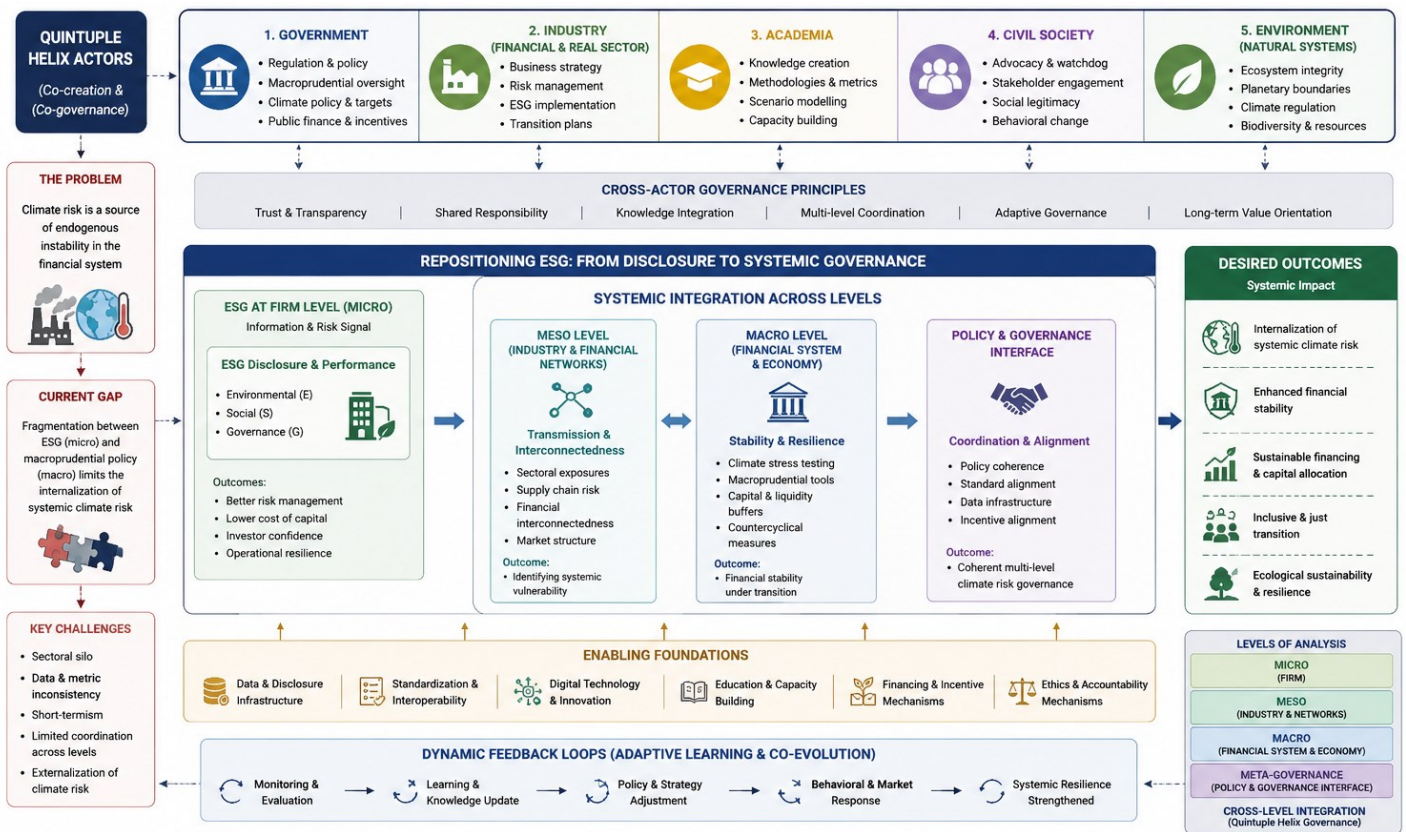
#### **5.4 Quintuple Helix as a Systemic Governance Mechanism**

To address these limitations, the Quintuple Helix model developed by Elias G. Carayannis and David F. J. Campbell provides a governance framework that integrates the interactions between government, industry, academia, civil society, and the environment. Within this perspective, the environment is no longer positioned as an external backdrop, but as a structural determinant that influences the direction of innovation and capital allocation.

Through this mechanism, inputs in the form of scientific knowledge, public policy, market signals, social legitimacy, and ecological boundaries are processed through multi-actor interactions. This coordination process generates an output of adaptive governance capable of integrating economic and ecological dynamics. The final outcome is the internalization of climate risk at the financial system level, rather than merely at the organizational level.

This approach allows ESG to be repositioned as a cross-actor coordination interface, rather than merely a reporting tool. Consequently, ESG can function as a mechanism that bridges organizational behavior with systemic dynamics in the face of climate risk.

Figure 2, *Diagram Flow Prisma 2020*



## 5.5 Proposed Governance Model

Building on the theoretical synthesis developed in this study, a systemic governance model is proposed that repositions ESG within a Quintuple Helix framework to enable the integration of climate risk into financial stability architecture. Conceptually, the model operates as a layered adaptive system that links structural drivers of transformation with institutional coordination mechanisms. At the foundational level, the system is shaped by key inputs, including public regulation and policy direction, technological innovation, scientific knowledge, evolving social preferences, and ecological constraints. These inputs do not function in isolation; rather, they form the structural conditions that influence how economic systems respond to climate-related pressures.

Within the second layer, these inputs are translated into systemic processes through the interaction of the five helices articulated in the Quintuple Helix model introduced by Elias G. Carayannis and David F. J. Campbell. In this interactional space, government provides policy direction and regulatory framing, industry determines capital allocation and investment behavior, academia generates knowledge and innovation pathways, civil society contributes

legitimacy and normative pressure, and the natural environment functions as a structural boundary condition that shapes the limits and direction of development. ESG, in this configuration, moves beyond its conventional role as a disclosure or reporting tool and operates instead as a translational interface that connects these helices. Through ESG, knowledge, regulation, market incentives, and societal expectations become aligned within the ecological limits that ultimately condition long-term economic sustainability.

This multi-actor interaction produces systemic outputs in the form of cross-sectoral coordination, institutional adaptation, and the integration of climate risk into financial decision-making processes. Rather than remaining confined to firm-level adjustments, ESG becomes embedded in governance dynamics that influence sectoral investment patterns and policy responses. Over time, these outputs contribute to broader systemic outcomes, namely the internalization of climate risk within financial structures, the emergence of adaptive financial governance, and the strengthening of long-term financial stability.

The theoretical contribution of this model lies in its reconceptualization of ESG from a firm-level evaluative instrument into a mechanism of systemic coordination. By embedding ESG within a Quintuple Helix governance structure, climate risk is integrated not as an externality to be managed but as a structural determinant of financial stability. This perspective expands macroprudential discourse by incorporating ecological interdependence into the foundations of financial governance. Consequently, financial stability is no longer understood solely as a function of economic variables, but as the outcome of adaptive interactions among institutions, markets, societies, and ecological systems operating within planetary limits.

Existing ESG scholarship implicitly assumes that firm-level transparency can aggregate into systemic resilience. However, this assumption overlooks the endogenous and cross-sectoral nature of climate-related fragility.

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