Knowledge Asymmetries and Climate Finance: An Inquiry into Environmental Market Failures and Political Legitimacy

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ABSTRACT

This paper examines how asymmetric information distorts climate-related financial markets and undermines democratic legitimacy in political institutions, contributing to epistemic climate injustice. Building upon canonical theories of information economics, I refine the classical concepts of adverse selection and moral hazard to accommodate the distinctive features of climate risk: deep uncertainty, cascading fluctuations over time in trend and cyclicality, systemic feedback loops, and intergenerational trade-offs. I show how informational gaps generate market failures in the pricing and allocation of green assets and climate-linked securities, demonstrating that, for some agents, climate modelling and verification mechanisms produce systematic mispricing of green assets, leading to inefficient capital misallocation that cannot be remediated without recourse to new forms of global governance. I propose a multi-pronged normative framework for democratising climate knowledge production through democratic changes that amplify deliberative processes using intergenerational mechanisms based on the institutionalisation of access to information. This article offers a roadmap for mitigating informational asymmetries while advancing a substantive global response to climate change.

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I. Introduction

Climate change represents what Gardiner characterises as a "perfect moral storm"—a convergence of global, intergenerational, and theoretical challenges that strain conventional frameworks of ethics, politics, and economics.[1] The gradual but inexorable transformation of Earth's climate system creates profound risks for current and future societies, demanding not merely technological innovation and political will, but fundamentally new approaches to organising markets and institutions under conditions of deep uncertainty.[2] Yet as this article argues, the informational foundations necessary for effective climate governance are

[1] Gardiner, S. *A Perfect Moral Storm: The Ethical Tragedy of Climate Change*. Oxford University Press, 2013.

[2] Knight, F. *Risk, Uncertainty, And Profit*. Houghton Mifflin, 1921; Keynes, J. "The General Theory of Employment." *The Quarterly Journal of Economics*, vol. 51, no. 2, 1937, pp. 209-223.

systematically corrupted by asymmetries in knowledge, access to information, and illiberal epistemic authority that generate both market failures and threats to democracy. The theory of asymmetric information, pioneered in the seminal contributions of Akerlof,[3] Mirrlees,[4] and subsequently formalised by Rothschild and Stiglitz,[5] illuminates how disparities in knowledge among economic agents give rise to adverse selection, moral hazard, and market structures that are adversarial and opaque. Throughout this article, I draw on both Rawlsian traditions of justice as well as those from Amartya Sen, but with distinct emphases. From Rawls, I take the concern for fairness in institutional design and the intergenerational obligations that follow from it. From Sen, I adopt the view that justice must be judged by the expansion of people's real freedoms and capabilities to act within and upon climate-affected environments.

In archetypal credit and capital markets, informational gaps can lead to the withdrawal of high-impact participants and incentivise excessive risk-taking by parties unaware of the risks they face. Within climate-related markets there is a similar trend: investors systematically underestimate tail risks associated with carbon-intensive assets—including risks from climate-caused natural events, which threaten those assets—while firms strategically under-disclose their exposure to these physical and transition risks.[6] However, unlike conventional markets operating under risk (where probability distributions are known), climate change is one of the phenomena of our modern era that involves a deeper level of uncertainty—situations where the probability distributions themselves are unknown or contested.[7] This distinction proves philosophically crucial. Standard models of asymmetric information presuppose well-defined probability spaces and short temporal horizons over which rational agents optimise. Climate risk, by contrast, involves black swan events: low-probability, high-impact occurrences that resist probabilistic quantification.[8] More fundamentally, climate change involves fat-tailed distributions where extreme outcomes become disproportionately likely, rendering expected utility maximisation inadequate or meaningless.[9] The temporal scales over which climate impacts unfold—spanning decades to centuries—further complicate standard decision-theoretic approaches by introducing the non-identity problem, whereby the actions we take today will determine not merely the welfare of future persons, but their very identities.[10]

These epistemic challenges generate informational climate injustice—social structures within which systematic patterns of knowledge asymmetry concentrate climate-relevant information among powerful actors while marginalising the epistemic contributions of those most vulnerable when searching for solutions to global climate impacts. Drawing on Fricker's groundbreaking analysis,[11] I argue that modern, present day climate governance exhibits both discriminatory injustice (whereby marginalised groups are deemed less credible sources of climate knowledge) and hermeneutical injustice (whereby dominant

[3] Akerlof G. "The Market For "Lemons": Quality Uncertainty and The Market Mechanism." *The Quarterly Journal of Economics*, vol. 84, no. 3, 1970, pp. 488-500.
[4] Mirrlees, J. "An Exploration in the Theory of Optimum Income Taxation." *Proceedings of the Royal Society of London: Series A, Mathematical and Physical Sciences*, vol. 330, no. 1584, 1971, pp. 3-98.
[5] Rothschild, M, and J Stiglitz. "Equilibrium in Competitive Insurance Markets: An Essay on The Economics of Imperfect Information." *The Quarterly Journal of Economics*, vol. 90, no. 4, 1976, pp. 629-649.
[6] Bolton, P, et al. "The Green Swan: Central Banking and Financial Stability in The Age of Climate Change." BIS Working Paper, 2021.
[7] Knight (n 2) *supra.*
[8] Taleb, N. *The Black Swan: The Impact of the Highly Improbable.* Random House, 2007.
[9] Weitzman, M. "On Modeling and Interpreting the Economics of Catastrophic Climate Change: The Limits of Integrated Assessment Models." *The Review of Economics and Statistics*, vol. 91, no. 1, 2009, pp. 1-19. Liesen, A. "Climate Change and Financial Market Efficiency." *Business & Society*, vol. 54, no. 4, 2015, pp. 511-539.
[10] Parfit, D. *Reasons and Persons.* Oxford University Press, 1984.
[11] Fricker, M. *Epistemic Injustice: Power and the Ethics of Knowing*. Oxford University Press, 2007.

interpretive frameworks obscure or delegitimise alternative ways of understanding climate risk). In financial markets, asymmetric information regarding climate risk manifests across multiple dimensions that compound these epistemic injustices. First, the valuation of green financial instruments—including green bonds, sustainability-linked loans, and ESG-rated securities—depends critically on credible disclosures by issuers. Yet corporate reporting standards for greenhouse gas emissions and climate-related risks remain voluntary in many jurisdictions and exhibit wide variation in scope, methodology, and verification.[12] Climate policy, worldwide, still suffers from weak enforcement mechanisms and allows substantial discretion in the risk modelling approaches used by a variety of stakeholder parties including states, NGOs, multinational corporations, and firms.[13]

Second, conventional asset pricing models systematically understate transition risks—the financial risks arising from the shift toward a low-carbon economy. As Carney warns,[14] current carbon-intensive investments may become stranded assets if future regulation or technological shifts abruptly re-price fossil fuel holdings, potentially triggering a Minsky moment in carbon markets.[15] Third, tail risks associated with extreme climate scenarios are often omitted from risk management systems or assigned negligible probabilities, leading to inadequate capital buffers and systemic financial fragility.[16] These market failures cannot be understood merely as technical inefficiencies; they constitute forms of structural injustice that systematically disadvantage market participants without necessarily involving intentional wrongdoing by any individual actor.[17] The concentration of climate-relevant information among financial elites and fossil fuel incumbents perpetuates the status-quo of sophisticated investors with access to proprietary climate models systematically outperforming retail investors in climate-sensitive markets, extracting rents from informational advantages while externalising climate risks onto less informed market participants.[18]

These challenges are compounded by the value-ladenness of climate science.[19] Despite efforts and theories that emphasise neutrality, scientific assessments of climate risk necessarily involve value judgments about acceptable levels of risk, appropriate discount rates for future benefits and costs, and the relative importance of different types (or magnitudes) of climate impacts. When these value judgments remain implicit or are delegated to a unique and isolated cadre of technical experts, they can systematically exclude certain critical players in international diplomacy who have financial power, generating forms of epistemic injustice, which can lead to malign incentive structures disincentivising participation in what should be a democratic market.[20] The politics of climate expertise thus become entangled with broader questions of epistemic authority and democratic inclusion within the

[12] Li, Q, et al. "Corporate Climate Risk: Measurements and Responses." *The Review of Financial Studies*, vol. 37, no. 6, 2024, pp. 1778-1830.
[13] *Recommendations Of the Task Force on Climate-related Financial Disclosures*. Financial Stability Board, 2017; *see* also Krueger, P, et al. "The Effects of Mandatory ESG Disclosure Around the World." ECGI Finance Working Paper No. 754/2021, 2023; thanks to a reviewer for pointing to this paper which discusses international ESG disclosure and compliance using a data-driven approach.
[14] Carney, M. "Breaking the Tragedy of The Horizon—Climate Change and Financial Stability." Bank of England. Speech at Lloyd's of London, 2015.
[15] A Minsky moment is a tipping point in a credit cycle when excessive speculation and leverage suddenly reverse into panic-selling and widespread deleveraging: *see* Minsky, H. *Stabilizing an Unstable Economy.* Yale University Press, 1986.
[16] Battiston, S, et al. "A Climate Stress-Test of the Financial System." *Nature Climate Change*, vol. 7, no. 4, 2017, pp. 283-288.
[17] Young, I. *Responsibility for Justice*. Oxford University Press, 2011.
[18] Eren, E, et al. "Pricing of Climate Risks in Financial Markets: A Summary of The Literature." *BIS Papers*, vol. 130, 2022, pp. 1-11.
[19] Douglas, H. *Science, Policy, And the Value-Free Ideal*. University of Pittsburgh Press, 2009.
[20] Anderson, E. "Epistemic Justice as A Virtue of Social Institutions." *Social Epistemology*, vol. 26, no. 2, 2012, pp. 163-173.

scientific project.[21] The sciences are, alas, distinct from financial markets and the international political forum where decisions are often made. Yet climate science operates under conditions of urgency and technical complexity that seem to preclude extensive democratic deliberation and careful prudence with respect to investment. This tension between epistemic and democratic values generates a climate knowledge dilemma such that the urgent need for authoritative climate knowledge conflicts with democratic requirements for inclusive deliberation about the values that should guide climate research and policy.

This article develops a systematic philosophical treatment of these issues by examining how informational asymmetries corrupt both market mechanisms and democratic institutions in the climate domain. I begin in Section II by describing a theoretical framework that extends canonical models of asymmetric information to accommodate the distinctive epistemic features of climate change. These include deep uncertainty about physical processes, overlapping awareness about knowledge pertaining to the interactions between the climate and the economy, systemic risks arising from tipping points and feedback loops, and the intergenerational transmission of both benefits and burdens from pollution and abatement. Section III analyses how these informational asymmetries generate specific forms of market failure in climate finance, including systematic under-pricing of tail risks, misallocation of capital toward high-carbon investments, and the emergence of green bubbles—greenwashing—even in supposedly sustainable subsets of financial markets. I also demonstrate how opacity in climate risk modelling creates opportunities for sophisticated actors to extract rents from information asymmetries while normalising (extreme) climate risks.

Section IV explores the political implications of the financial aspects of this theory, focusing on how informational asymmetries undermine the epistemic conditions necessary for legitimate democratic governance of international climate policy. Drawing on theories of deliberative democracy, global justice, and intergenerational ethics, I argue that current patterns of climate knowledge production and dissemination violate principles of epistemic justice and democratic inclusion. This section also proposes normative and institutional solutions designed to mitigate informational failures while advancing egalitarian epistemic climate justice. I do not advocate for any singular ideological position but instead suggest the need for the institutionalisation of structured information environments (both public and private) where climate-aware groups can exchange ideas, knowledge, goods, services, and solutions.

Finally, Section V offers concluding reflections on the broader implications of financial and informational climate injustice for theories of market failure, democratic legitimacy, and global justice. I identify promising avenues for future research at the intersection of philosophy, climate economics, and political theory, while acknowledging that there exist tensions between urgent climate action and the deliberative processes required for legitimate democratic governance. This article aims to contribute a novel framework for understanding how informational asymmetries both generate and perpetuate injustices in climate governance. My analysis reveals that addressing climate change effectively requires not merely better information, but more just distributions of epistemic power and more inclusive processes of knowledge production that honour both scientific rigor and democratic values.

II. **Concepts of Asymmetric Information**

At its core, asymmetric information arises when economic actors differ in either the data they hold or their ability to interpret it. Traditional treatments emphasise the distribution of explicit facts, but in climate

[21] Kitcher, P. *Science in a Democratic Society*. Prometheus Books, 2011.

settings we must also attend to Polanyi's notion of tacit knowledge—those embodied, context-sensitive understandings that defy complete formalisation.[22] In the standard formalism, two (or more) parties trade with different, basic, sets of available information, each comprising propositions and facts about the world with clearly defined truth values. In contrast, many climate-related insights fall into Rescher's category of aporetic knowledge: aporetic in the sense that there exist, within climate science, inherently indeterminate propositions—such as future weather patterns or the reactions of politics—for which stronger data alone cannot eliminate uncertainty.[23]

We can therefore refine asymmetric information into three interconnected forms. Distributional asymmetry denotes unequal access to the same information, reflecting not only market power but also the social processes that shape knowledge production—a dynamic Harding highlights when she describes how research always embodies the perspectives of its producers.[24] In climate finance, this plays out when sophisticated institutional investors commission proprietary, high-resolution financial models, while smaller actors depend on public reports that often lag behind current market movements or omit localised (systemic or tail) risks. Asymmetry we might term interpretative arises when agents share identical datasets but apply divergent hermeneutical or cognitive frameworks. As Gadamer observes, our readings always occur within particular "horizons of understanding" shaped by history, culture, and institutional norms.[25] Thus, a petroleum engineer and a climate scientist examining the same geological survey might reach sharply different conclusions about stranded-asset risk, not because the raw data differ but because their disciplinary paradigms guide which variables they consider salient. Finally, epistemic—or, more fundamentally, knowledge—asymmetry concerns disparities in the capacity to generate, validate, and deploy specialised knowledge. In climate governance, engaging with technical or political discourse creates asymmetries based on skill and individual awareness of technological frontiers that determine which voices are heard at decision-making tables and whose knowledge is deemed credible.[26]

In neoclassical economics, Akerlof's seminal analysis of markets treats quality disparities as hidden yet objectively determinable, leading informed sellers to drive uninformed buyers from the market due to losses founded on their lack of awareness of market conditions.[27] Climate risk challenges the assumption that we understand objective reality as pure, untarnished information; indeed, we may be corrupting or causal players in the information we seek to understand.[28] As Dupuy argues, our understanding of future environmental and regulatory outcomes is "projective", co-constituted by present beliefs and decisions.[29] Investors' current judgments about a green bond's quality, or the creditworthiness of a particular entrepreneurial endeavour feed back into policy debates and technological development pathways, thereby altering the very future states they seek to forecast. Akerlof's model assumes stable preferences and technologies, whereas climate dynamics often unfold as increasing-returns processes, in Arthur's sense, where small early advantages become self-reinforcing through feedback loops.[30] Early movers in emerging clean-tech markets have the ability to build

[22] Polanyi, M. *Personal Knowledge: Towards A Post-Critical Philosophy*. University of Chicago Press, 1958.
[23] Rescher, N. *Luck: The Brilliant Randomness of Everyday Life*. University of Pittsburgh Press, 2001.
[24] Harding, S. *Whose Science? Whose knowledge? Thinking From Women's Lives*. Cornell University Press, 1991.
[25] Gadamer, H. *Truth and Method.* Continuum International Publishing Group, 1960.
[26] Collins, H, and R Evans. "The Third Wave of Science Studies: Studies of Expertise and Experience." *Social Studies of Science*, vol. 32, no. 2, 2002, pp. 235-296.
[27] Akerlof (n 3) *supra*.
[28] Putnam, H. *Reason, Truth and History*. Cambridge University Press, 1981.
[29] Dupuy, J. *The Mark of The Sacred*. Stanford University Press, 2009.
[30] Arthur, W. *Increasing Returns and Path Dependence in The Economy*. University of Michigan Press, 1994.

critical expertise and network connections that allow them to capture information rents over extended periods, undercutting the equilibrium parity that standard neoclassical models often assume.

Mirrlees's mechanism design framework holds that a principal (an investor, politician, or economic agent), armed with knowledge of the incentive constraints faced by their interlocutors or trading partners, can engineer contracts to elicit truthful information from those partners.[31] Such an approach relies on a condition of internal consistency in choice—the idea that agents hold complete, transitive preferences that remain stable across contexts.[32] Yet climate decision-making often involves incommensurable values due to fundamental differences in moral standing among agents party to environmental decisions—one agent could be a major emitter of CO_2 and the other could be a denizen of a small island nation, for example.[33] For example, a pension fund must weigh fiduciary duties to current retirees against stewardship responsibilities to future beneficiaries who will face climate-driven dislocations—a dilemma that resists reduction to a single utility function. Furthermore, Mirrlees's model depends on the designer's near-omniscience to identify and enforce incentive-compatible allocations, running headlong into Hayek's critique of the knowledge problem. In Hayek's terms, no central planner can aggregate and process the dispersed, tacit, and context-specific information embedded in complex socio-ecological systems.[34] Instead, governance must incorporate Metis—practical, localised wisdom and Indigenous ecological knowledge that frequently, if not always, fall outside formal modelling frameworks.[35]

Stiglitz and Weiss's analysis of credit allocation and rationing assumes that lenders can observe loan performance over time and update their beliefs accordingly, such that the value of information is aligned through economic and financial mechanisms with outcomes that matter at the individual level.[36] Climate finance often operates similarly, on a kind of normative trust which can be defined as faith in counterparties' (or the planners') commitment to shared environmental and policy goals despite persistent technical uncertainties. Financing a large-scale solar or carbon capture project not only requires projections of future cash flows but also a belief in the durability and continued engagement of supportive, democratic, policy regimes. These complexities emphasise the necessity to study how evolving rules, norms, and collective strategies can govern common-pool resources—in this case, shared climate knowledge with the ability to move and motivate financial and political actors—under deep uncertainty.[37]

Prevailing information economics embeds certain philosophical commitments about the nature of knowledge, rationality, and agency that falter when applied to climate systems. Knight's foundational distinction between risk and uncertainty, later formalised by Savage, treats uncertainty as a temporary state of ignorance resolvable through additional data collection.[38] Climate science also exemplifies Funtowicz and Ravetz's notion of post-normal science, where facts are uncertain, values in dispute, stakes high, and decisions urgent.[39] In this context, Nowotny et al. argue for a

[31] Mirrlees (n 4) *supra*.
[32] Sen, A. "Rational Fools: A Critique of The Behavioural Foundations of Economic Theory." *Philosophy & Public Affairs*, vol. 6, no. 4, 1977, pp. 317-344.
[33] *see* Raz, J. *The Morality of Freedom*. Oxford University Press, 1986, on incommensurable values.
[34] Hayek, F. "The Use of Knowledge in Society." *The American Economic Review*, vol. 35, no. 4, 1945, pp. 519-530.
[35] Scott, J. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. Yale University Press, 1998.
[36] Stiglitz, J, and A Weiss. "Credit Rationing in Markets with Imperfect Information." *American Economic Review*, vol. 71, no. 3, 1981, pp. 393–410.
[37] Ostrom, E. *Understanding Institutional Diversity*. Princeton University Press, 2006.
[38] Knight (n 2) *supra*; Savage, L. *The Foundations of Statistics*. 1st edn, John Wiley & Sons, 1954.
[39] Funtowicz, S, and J Ravetz. "Science for the Post-Normal Age." *Futures*, vol. 25, no. 7, 1993, pp. 739-755.

socially robust knowledge that calls for a validation of social and political information by insisting that broader communities of practice have a role in certifying the credibility of scientific findings.[40] Thus, information asymmetries in climate governance become not merely technical issues but questions of democratic legitimacy, equity, and procedural justice. Individuals' lives depend on the findings of scientists and the actions that financiers and pundits take every day.

Decision theory under uncertainty further illuminates these tensions. Savage's expected utility framework presumes that rational agents can assign precise probabilities to all conceivable states of the world, a subjective requirement Jeffrey has developed some time ago.[41] Yet many climate phenomena involve ambiguity—situations in which meaningful probability assignments are impossible.[42] Gilboa and Schmeidler's maxmin expected utility model captures agents' aversion to ambiguity by privileging worst-case evaluations over uncertain prospects.[43] In the climate domain, choices made today will shape the well-being of future people whose identities and life circumstances cannot be fully anticipated. Parfit's non-identity problem expresses this and further complicates welfare analyses by demonstrating that policies determining which future individuals come into existence cannot be judged solely by whether those individuals fare better or worse than counterfactual selves.[44] Closely following this, O'Neill argues that intergenerational justice requires safeguarding substantial freedoms—including accepting variations in deciding, politically, what are the core requirements necessary for human flourishing irrespective of historical (or environmental) context.[45] When information asymmetries concentrate decision power among present-day elites, they risk undermining freedoms for those yet unborn, reflecting democratic failures as much as market failures.[46]

Integrating these perspectives, I reconceive the climate information environment as an epistemic commons: a shared knowledge resource demanding collective stewardship to remain vibrant, equitable, and adaptive. Building on Ostrom's analysis of common-pool resources,[47] I recognise that epistemic goods face central challenges familiar from material commons, particularly exclusion—when communities or stakeholders are barred from accessing or contributing to data when proprietary models or closed platforms create competitive advantages that discourage sharing. In addition to this, as Hess in collaboration with Ostrom emphasises, information is fundamentally non-rivalrous in consumption,[48] even though intellectual property regimes and technical barriers can impose artificial scarcity. Moreover, Fuller's account of knowledge through network effects can be used to show that the value of climate knowledge increases with the size and diversity of the community engaged in its production and use.[49] Addressing climate information asymmetries thus becomes a collective-action problem requiring institutional innovation and careful analysis by agents who enter the environmental and financial space.

Drawing on Ostrom's design principles for robust governance of common-pool resources,[50] I argue that six interlinked

[40] Nowotny, H, et al. *Re-Thinking Science: Knowledge and The Public in An Age of Uncertainty.* Polity Press, 2001.
[41] Jeffrey, R. *The Logic of Decision.* University of Chicago Press, 1965.
[42] Schmeidler, D. "Subjective Probability and Expected Utility Without Additivity." *Econometrica*, vol. 57, no. 3, 1989, pp. 571-587.
[43] Gilboa, I, and D Schmeidler. "Maxmin Expected Utility with Non-Unique Prior." *Journal of Mathematical Economics*, vol. 18, no. 2, 1989, pp. 141-153.
[44] Parfit (n 10) *supra*.
[45] O'Neill, O. *Justice Across Boundaries: Whose Obligations?* Cambridge University Press, 2001.
[46] Anderson, E. "What Is the Point of Equality?" *Ethics,* vol. 109, no. 2, 1999, pp. 287-337.
[47] Ostrom, E. *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge University Press, 1990.
[48] Hess, C, and E Ostrom. *Understanding Knowledge as a Commons: From Theory to Practice*. MIT Press, 2006.
[49] Fuller, S. *Social Epistemology.* 2nd edn, Indiana University Press, 2002.
[50] Ostrom (n 37) *supra*.

requirements emerge for an epistemic commons based on climate action and a just green transition. First, clearly defined boundaries that determine who may access, interpret, and enrich the shared knowledge base, must be balanced with the need for more, and more powerful, expertise and the universal imperative of inclusivity. Second, collective-choice mechanisms should empower all stakeholders in global climatological affairs to shape and revise the rules governing data collection, curation, and dissemination, particularly on closed platforms. Third, robust monitoring protocols are essential to detect and deter misuse of information—such as selective disclosure, false reporting, or greenwashing—and to ensure transparency in both model assumptions and data provenance. Fourth, graduated efforts to rectify norm violations can be proportional to the severity and frequency of breaches of trust, ensuring accountability without discouraging participation. Fifth, accessible conflict-resolution processes must adjudicate disputes over contested knowledge claims, methodological approaches, or policy interpretations in a manner perceived as fair by all parties. Finally, by recognising the rights to self-organise can acknowledge grassroots communities' ability to develop localised and decentralised climate knowledge systems. This may help foster epistemic diversity and resilience in an era shaped by big data and institutional agglomeration of knowledge and resources. By operationalising these principles, existing institutions, as well as activist groups, can both mitigate informational asymmetry and strengthen democratic legitimacy. Subsequent Sections will illustrate how these design elements can be deployed in specific arenas of climate finance and policy, bridging rigorous market analysis with broader concerns of justice, democracy, and collective action.

III. **Asymmetric Information in Climate-Related Financial Markets**

As global financial markets increasingly seek to incorporate climate considerations into asset valuation and risk management, the pervasive influence of asymmetric information has become ever more salient. Financial instruments explicitly tied to environmental performance—green bonds, sustainability-linked loans, and carbon derivatives[51]—promise to mobilise capital toward emissions reduction and climate adaptation. Yet these markets suffer from profound information gaps that reflect deeper philosophical issues that plague the space including issues of knowledge, risk, and responsibility in the face of climate, economic, and political uncertainty.[52] The asymmetric distribution of information in climate finance is not a technical problem that can be solved through better disclosure regimes, but is, in fact, a manifestation of fundamental epistemological challenges that echo classical debates within economics and philosophy about the nature of practical knowledge and the limits of rational decision-making under uncertainty.[53] Insiders—leadership and elites within politics and firms—often possess private knowledge about the true macroeconomic exposure to both physical and transition risks, while investors and regulators—everyday market agents—must rely on imperfect disclosures and model-based projections. This misalignment of information can lead to mispricing, inadequate risk protection, and the misallocation of investment, undermining the very objectives that climate-oriented finance is meant to achieve—namely, protection of the environment and justice for different forms of life.[54]

The time-dependent dimension of climate risk—i.e., the necessity for immediate action—introduces additional philosophical

[51] Little, R, et al. "Funding Climate Adaptation Strategies with Climate Derivatives." *Climate Risk Management*, vol. 8, 2015, pp. 9-15.
[52] Boettke, P. "Economics in a World Amid Flux." *Behavioural Public Policy*, vol. 9, no. 3, 2025, pp. 630-645.
[53] Knight (n 2) *supra*; Polanyi (n 22) *supra*; Sunstein, C. "Knightian Uncertainty in The Regulatory Context." *Behavioural Public Policy*, vol. 9, no. 3, 2025, pp. 614-629.
[54] Grasso, M. "An Ethical Approach to Climate Adaptation Finance." *Global Environmental Change*, vol. 20, no. 1, 2010, pp. 74-81.

complexity that extends beyond conventional treatments of uncertainty in financial theory. Traditional economic models of asymmetric information assume that quality differences are ultimately discoverable through experience or reputation mechanisms.[55] They also suggest that some parties to praxeological coordination (i.e., market participants) benefit from access to private, closed information, through the process of exclusion and adverse selection.[56] Climate risks, I argue, operate on temporal scales that feed into these types of ethical quandaries. The long-term emergency of climate change, and the short horizon to implement a solution, means that the full consequences of today's market failures, exacerbated by incentive distorting information asymmetries, may not become apparent for decades, by which time the opportunity for corrective action may have passed.[57] This temporal mismatch between awareness of—or lack of awareness of—information and the policy response required creates the phenomenon of intergenerational moral hazard—a scenario where current actors can externalise the consequences of their private information advantages onto future generations who cannot participate in today's markets.[58]

The epistemic challenges of climate finance are further complicated by the problem of risks that cannot be quantified or even anticipated within existing analytical frameworks.[59] These are fundamentally the types of problems that will face future generations—their world will be very different from ours.[60] Drawing on Rescher's analysis of luck and contingency in human affairs, climate finance must grapple with the possibility that the most consequential risks are precisely those that lie outside the domain of calculable probability[61]—these future oriented risks might be termed "unknown unknowns".[62] This radical uncertainty differs qualitatively from the parametric uncertainty that can be addressed through improved data collection or more sophisticated modelling. It points instead to the limits of rational choice theory as a foundation for climate finance and suggests the need for more robust decision-making practices that allow for and anticipate irreducible uncertainty about future states of the world.[63]

It is worth noting that such irreducible uncertainties also exist within the physical climate models themselves. Even the most sophisticated models face inherent limits due to natural variability in the climate system and imperfect parameterisation. As Alizadeh observes, these uncertainties propagate into downstream financial and economic models, meaning that climate-related financial risks embed not only environmental uncertainty but also the epistemic uncertainty of climate science itself.[64]

Green bonds have emerged as a flagship instrument for channelling capital into environmentally beneficial projects. Unlike conventional bonds, green bonds commit issuers to allocate proceeds exclusively to projects that deliver climate or ecological benefits, such as installing and manufacturing renewable energy generation assets,

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[55] Akerlof (n 3) *supra*.
[56] Bebczuk, R. *Asymmetric Information in Financial Markets: Introduction and Applications.* Cambridge University Press, 2003.
[57] Kunstler, J. *The Long Emergency: Surviving The End of Oil, Climate Change, And Other Converging Catastrophes of The Twenty-First Century*. Atlantic Monthly Press, 2006.
[58] Tremmel, J. *A Theory of Intergenerational Justice*. Routledge, 2009.
[59] Ripple, W, et al. "World Scientists' Warning of a Climate Emergency." *BioScience*, vol. 70, no. 1, 2019, pp. 8-12.
[60] Jaakkola, H, et al. "Artificial Intelligence Yesterday, Today and Tomorrow." Proceedings of the 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), 2019, pp. 860-867.
[61] Rescher (n 23) *supra*.
[62] *see* Ilmola, L, and E Rovenskaya. "Three Experiments: The Exploration of Unknown Unknowns in Foresight." *Technological Forecasting and Social Change*, vol. 106, 2016, pp. 85-100; Seitz, R. "Knowing the Unknowns." *Earth's Future*, vol. 1, no. 1, 2013, pp. 45-52.
[63] Savage (n 38) *supra*; Schmeidler (n 42) *supra*.
[64] Alizadeh, O. "Advances and Challenges in Climate Modelling." *Climatic Change*, vol. 170, no. 18, 2022, pp. 1-26. Thanks to an anonymous reviewer for suggesting this point.

upgrading the energy efficiency of existing infrastructure, or investing in R&D for sustainable, future-oriented infrastructure. In principle, in the present state of climate finance investors must be willing to accept a modest yield concession to support the transition to a low-carbon economy.[65] In practice, however, the credibility—and therefore financial viability—of green financial instruments depends crucially on robust disclosure and verification regimes that must navigate difficult questions of environmental epistemology and measurement.[66] Drawing parallels across these divides between epistemological knowledge creation within a laboratory or study, and within an innovative entrepreneurial start-up, vying for venture funding for green innovation projects, could represent a major step toward standardising a climate-related ontology of knowledge creation, encouraging economic agents to disclose internal governance structures, strategy, risk management practices, and climate metrics such that information is democratised.[67] The voluntary nature of these regulatory frameworks, even within modern financial markets, reflects deeper philosophical challenges regarding the relationship between market-based governance and regulatory authority, echoing debates about the limits of self-regulation in complex systems.[68]

In the context of the EU ETS,[69] regulators possess private information about future emissions cap trajectories, the number and dispersion of free allocations, and the pace of market interventions, while market participants must infer policy intentions from sparse public pronouncements. This fundamental information asymmetry between regulators and market participants creates a reverse process of regulatory capture where market actors must constantly anticipate and respond to policy signals that may themselves be responses to private information held by regulators about political feasibility and technological constraints.[70] Moreover, firms operating in the climate finance space often hold proprietary data on abatement costs or technological readiness that they do not fully disclose, creating opportunities for strategic behaviour and covert planning and decision-making that can distort price signals. These asymmetries can generate price volatility of financial instruments tied to specific firms, but which are unrelated to actual emissions performance or environmental fundamentals, as observed in the EU ETS's abrupt price collapses following policy uncertainty in 2007–2008.[71] The resulting volatility and uncertainty in both financial viability of returns to green investment and the friendliness of the political / regulatory agents to environmental initiatives raises the cost of engaging in climate finance for energy-intensive industries and may discourage long-term investments in low-carbon technologies.[72] I claim that this shows how information asymmetries can create path dependencies that lock in suboptimal technological trajectories.[73]

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[65] del Giudice, A, et al. "Climate Change Risk and Green Bond Pricing." *Journal of Empirical Finance*, vol. 82, 2025, 101616.

[66] Harding (n 24) *supra* argues that knowledge is embodied by practitioners who create and practice science. We might extend this philosophical definition to include financiers who are exposed to market mechanisms and pricing tools and are thus able to have a fuller view of the landscape of climate related asset valuations—science and (financial) economics rolled into one.

[67] FSB (n 13) *supra*.

[68] Ostrom (n 47) *supra*; Scott (n 35) *supra*.

[69] A cap-and-trade system—e.g., the European Union Emissions Trading System (EU ETS)—sets an aggregate emissions cap and allocate or auction allowances that firms can buy, sell, or bank for future compliance: *see Report on the Review of The European Union Emissions Trading System (EU ETS)*. European Commission, 2021.

[70] Stigler, G. "The Theory of Economic Regulation." *The Bell Journal of Economics and Management Science*, vol. 2, no. 1, 1971, pp. 3-21.

[71] Hepburn, C, et al. "The Economics of the EU ETS Market Stability Reserve." *Journal of Environmental Economics and Management*, vol. 80, 2016, pp. 1-5.

[72] Labatt, S, and R White. *Carbon Finance: The Financial Implications of Climate Change*. Wiley, 2007. Padvan, A, and X Vives. "Information, Coordination, And Market Frictions: An Introduction." *Journal of Economic Theory*, vol. 158, 2015, pp. 407-426, provide an excellent introduction to these issues with several citations to classical and contemporary texts.

[73] Arthur (n 30) *supra*.

Beyond details of specific instruments and assessments of various green financial vehicles, broader information gaps plague the modelling and quantification of climate risk itself,[74] raising basic questions about the nature of economic knowledge about the structure of environmental financial markets for products like derivatives and swaps and the application of these tools for the movement and growth of capital to policy problems. Standard financial risk models rely on historical data and established distributions of risk and payoffs, but climate change introduces future-oriented uncertainty that challenges the philosophical and mathematical foundations of quantitative risk assessment.[75] The assumption that statistical properties observed in the past will continue to hold in the future breaks down when dealing with climate risks that may trigger irreversible changes in Earth system dynamics.[76] This breakdown has profound implications for the philosophy of science underlying the study of climate change and climate finance,[77] suggesting the need for post-normal science, suggested by Funtowicz and Ravetz—modes of scientific practice appropriate for situations where "facts are uncertain, values in dispute, stakes high, and decisions urgent".[78]

Tail-risks associated with catastrophic outcomes—such as rapid ice-sheet collapse in Antarctica or Greenland, or cascading tipping points—are difficult to parameterise and often excluded from scenario analyses, reflecting deeper philosophical disagreements about how to reason about low-probability, high-impact events.[79] Modelling tail risks using financial models is not simply a technical challenge but a philosophical problem scientists and theorists face about the nature of different environmental and financial choices faced by rational decision-makers who must cope with an uncertain present and an even more uncertain future.[80] Traditional expected utility theory, as formalised by Savage and others, assumes that any outcome can be assigned a meaningful probability within a framework of possible states of the world.[81] Yet climate tipping points may represent situations where the likelihood of outcomes cannot be meaningfully quantified[82]—this includes high-risk low-probability events where bad luck (or poor decision making in the present) can prove catastrophic in the (near or distant) future. The lack of information and knowledge about future states of the world, given extrapolation of present variables, requires alternative decision-making frameworks that can accommodate irreducible ignorance about the incentives we currently face—i.e., subtle behavioural feedback loops that, for example, induce pollution, consumption, and extreme risk taking politically, economically, and financially. The maximin criterion proposed by Rawls or the precautionary principle developed in environmental law[83] may be solutions but their implementation is far from guaranteed.[84]

Advanced climate models, used by economists and financial institutions to assess

[74] Notably, this is an issue that has been taken up by statist institutions around the world, including but not limited to, international financial institutions like the BIS and national central banks: *see* Bolton (n 6) *supra*.
[75] *see* Knight (n 2) *supra*; Keynes (n 2) *supra*; *see also* Aldereai, O, et al. "Application of Mathematics in Finance, Natural and Social Sciences: A Perspective Study." *Applications of Mathematical Sciences*, vol. 1, no. 1, 2022, pp. 54-65.
[76] Peters, O. "The Ergodicity Problem in Economics." *Nature Physics*, vol. 15, no. 12, 2019, pp. 1216-1221.
[77] Winsberg, E. *Philosophy and Climate Science*. Cambridge University Press, 2018.
[78] Funtowicz & Ravetz (n 39) *supra*.
[79] Liesen (n 9) *supra*; Weitzman (n 9) *supra*.
[80] On tail risks, also known as black swan events due to their unexpected nature, extreme impacts, and our only post-hoc ability to explain their occurrence, *see* Taleb (n 8) *supra*.
[81] Savage (n 38) *supra*.
[82] Knight (n 2) *supra*.
[83] Rawls, J. *A Theory of Justice.* 1st edn, Harvard University Press, 1971; Sunstein, C. *Laws of Fear: Beyond the Precautionary Principle.* Cambridge University Press, 2009.
[84] It certainly has not been seen in the present, and it is doubtful if even the best publicly proposed and debated academic ideas regarding environmental protection and climate mitigation will be put into practice in the future; *see* Schutze, P, and P Haueis. "Philosophy and the Climate Crisis: An Agenda for Change." *Public Philosophy Journal*, vol. 5, no. 1, 2023, pp. 1-27.

environmental risk—whether from extreme weather events or the economic transition—and estimate consequent payoffs to sustainable investment, incorporate subjective judgments about climate sensitivity, damage functions, and socio-economic pathways that make accurate analysis of the future impacts of climate change more of an art than a science.[85] Within industry, models are frequently more sophisticated, powerful, and resource intensive than even the most complex systems created in academic social science due to researchers' inherent bias towards generalisability, comprehensiveness, and the necessity for valid and cross sectionally significant results. In this context, innovative private initiatives might be able to move faster in endeavours using artificial intelligence (AI) to model future emissions pathways and the corresponding economic costs and benefits. Indeed, the details of modern coupled environmental and economic models—driven by modern machine learning or more traditional techniques—are often confined to limited, expert audiences; the public needs to be informed about the nature and magnitude of damages we face now and will continue to face in the future through effective environmental communication. Without expert support and input, the interpretation of these models risks being obscured by the political and ethical interests embedded in the fossil fuel industry, and the models themselves risk becoming technical artifacts that mask nuanced social, political, and mathematical features that constitute robust claims of scientific validity.[86] Risks of scientific neglect, or a pushback against experts can arise when investors place undue confidence in a particular modelling framework, potentially underestimating the stochastic nature of possible environmental outcomes perhaps better explained by newer or more involved models.[87] Scientists themselves often rely on methodological assumptions and calibration methods that are taken as convention within the discipline but can neglect public interests. Key stakeholders must be aware of critical sensitivities and tipping points within interdependent variables used in models studied by researchers in both the economy and in the climate system.

These nuanced and calibrated features of climate science, and the ease of misinterpretation, create incentives for sophisticated investors to trade on proprietary risk assessments, taking advantage of pockets of insight inaccessible to less privileged market actors, at their expense. The consequences of informational asymmetries for climate asset pricing and the valuation of risk premia within environmental finance are steep and reflect deeper philosophical questions about the value of the natural world and the desirability of justice within financial markets. Investors often incorporate climate premia into the required returns on carbon-intensive assets. This premium reflects the unknowns inherent in the expected costs of future regulation and physical damages, as well as an uncertainty premium that often takes the form of insurance against the possibility that current risk models fundamentally mischaracterise the nature of climate risk.[88] The philosophical challenge lies in determining whether such premiums represent rational responses to uncertainty or are simply manifestations of bounded rationality that may systematically bias capital allocation away from socially optimal outcomes.[89]

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[85] Stern, N. *The Economics of Climate Change: The Stern Review*. Cambridge University Press, 2007; Nordhaus, W. "Climate Change: The Ultimate Challenge for Economics." *American Economic Review*, vol. 109, no. 6, 2019, pp. 1991–2014.

[86] Latour, B. *Science in Action: How to Follow Scientists and Engineers Through Society*. Harvard University Press, 1988.

[87] What I mean to argue here is that the space of outcomes is much larger than many practitioners believe. With the advent of the fourth industrial revolution and its transformation of society, possibilities arguably range from brink of worldwide humanitarian disaster fuelled by a rapidly warming climate to a new renaissance guided by AI and cultural vitality.

[88] Weitzman (n 9) *supra*.

[89] Simon, H. "A Behavioral Model of Rational Choice." *The Quarterly Journal of Economics*, vol. 69, no. 1, 1955, pp. 99-118; Kahneman, D. *Thinking, Fast and Slow*. Penguin, 2011.

Empirical work suggests that firms in high-emitting sectors trade at lower valuations relative to fundamentals, consistent with a risk premium that creates the potential for, and aims to nudge markets towards, carbon repricing.[90] Carbon discounts can be understood as market-based mechanisms for internalising environmental externalities, but they also raise questions about distributive justice and the fair allocation of transition costs. The discount may disproportionately affect firms and communities that are least able to adapt to a low-carbon economy, potentially exacerbating existing inequalities[91] and funnelling already high-yield liquidity into cheap but potentially high-growth green financial instruments. Conversely, credible green financiers can enjoy a greenium, trading at tighter spreads than comparable conventional bonds[92]—more return for the same level of risk.

This misallocation is exacerbated by regulatory frameworks that treat climate risks as part of operational or market risk, rather than recognising them as distinct categories requiring scenario-based stress tests.[93] The regulatory treatment of climate risks reflects deeper philosophical disagreements about the nature of systemic risk and the appropriate role of financial regulation in addressing collective action problems. Traditional approaches to financial regulation assume that systemic risks can be managed through the aggregation of individual firm-level risk assessments, but climate risks may require more holistic approaches that recognise the interconnectedness of financial, social, and ecological systems.[94] The introduction of climate stress scenarios by central banks and supervisors aims to correct this, but the design of stress tests is itself subject to asymmetric information: regulators must set scenario parameters which firms then anticipate and may systematically exploit.[95] The exploitation of regulatory stress tests illustrates a broader problem in the governance of climate finance: the tendency for regulatory responses to information asymmetries to create new forms of strategic behaviour that may undermine the original policy objectives. Different sectors of society learn and adapt to the behaviour of other groups—driving innovation, evolution, and a steep increase in organisational dependency and complexity. The result is an ongoing arms race between legal regulators seeking to elicit truthful disclosure and firms seeking to maintain their informational advantages, with potentially counterproductive consequences for both financial stability and climate policy.[96]

The disconnect between local risk assessment and global capital markets illustrates a dichotomy—a substantial division—in climate finance between the spatial specificity of environmental risks—based in specific locations with identifiable properties—and the spatial abstraction of financial markets whose foundations are often algorithmic, intangible, and based on decentralised technology.[97] Financial instruments that are designed to be tradable across different contexts may systematically obscure the place-based knowledge that is essential for accurate risk assessment, creating spatially demarcated moral hazard, where global investors externalise environmental risks onto local communities that cannot participate in risk-sharing arrangements.[98] An example of this is found in the placement of chemical plants in New Orleans ('cancer alley') among poor, black communities for instance. Corporate carbon reporting presents another case of disclosure failure that surfaces deeper theoretical issues to do with the

[90] Bolton (n 6) supra; Carney (n 14) supra.
[91] Anderson (n 46) supra.
[92] Pietsch, A, and D Salakhova. "Pricing of Green Bonds: Drivers and Dynamics of The Greenium." European Central Bank Working Paper, 2022; Zerbib, O. "The Effect of Pro-Environmental Preferences on Bond Prices: Evidence from Green Bonds." *Journal of Banking & Finance*, vol. 98, 2019, pp. 39-60.
[93] Bolton (n 6) supra.
[94] Ostrom (n 37) supra.
[95] Acharya, V, et al. "Measuring Systemic Risk." *The Review of Financial Studies*, vol. 30, no. 1, 2017, pp. 2-47.
[96] Admati, A, and M Hellwig. *The Bankers' New Clothes: What's Wrong with Banking and What to Do About It*. Princeton University Press, 2014.
[97] Harvey, D. *The Limits to Capital*. 2nd edn, Verso, 2006.
[98] Beck, U. *Risk Society: Towards A New Modernity*. Sage Publications, 1992.

commodification of environmental information and the possibility of quantifying ecological assets.[99] Reporting has become widespread—many large firms now publish annual sustainability reports containing accounting statistics for emissions and climate-risk assessments within their supply chains—however there are still issues: these reports often vary widely in methodological rigor and scope[100] and the variation in reporting quality reflects not only different levels of organisational capacity but also deep disagreements within corporate and political leadership about what counts as relevant environmental information and how such information should be measured and disclosed.[101]

Some companies misuse financial accounting techniques by omitting scope 3 or other indirect emissions in their value chains—even when those emissions far exceed direct (scope 1) emissions.[102] This exemplifies a particular conception of corporate responsibility that privileges shareholder interests (profit, revenues, dividends, and stock buybacks, etc.) over broader stakeholder concerns (social impact, employee welfare, etc.), but it may be inadequate for addressing the systemic risks posed by climate change.[103] The boundaries of corporate environmental responsibility are not given by nature but are socially constructed through ethical accounting practices, just regulatory frameworks, and benevolent and trust-based stakeholder negotiations that reflect particular power relations and ideological commitments founded on equality among market and discourse participants. Investors seeking *comprehensive* risk assessments—not biased by insider knowledge or omissions due to knowledge asymmetries—must often rely on third-party data providers, such as the Carbon Disclosure Project (CDP), which aggregates voluntary disclosures but cannot enforce completeness or accuracy.[104] This reliance on intermediaries creates new forms of information heterogeneity, that can serve to deepen the divide between corporate data providers and institutional or independent users, creating potential conflicts of interest that can bias the selection and presentation of environmental information. The emergence in the digital era of a commercial market for environmental data reflects the broader commodification of environmental information, and also raises questions about the democratic governance of environmental knowledge and the potential for market-based solutions to address collective action problems.[105] The patchwork of data leaves analysts to fill in gaps using guesswork, thereby introducing significant uncertainty into climate risk assessments intended for use in portfolio construction.[106] This reflects a particular epistemological approach that assumes gaps in the foundation of knowledge an agent acts upon can be pieces together from sometimes sparse available information, but this approach may be inappropriate for environmental risks that exhibit complex, non-linear relationships[107] and in a more general sense where more (financial) information is always better. Firms with superior internal data can exploit firms having lower engagement with relevant and topical

[99] Such as forests, rivers, marshes, oceans, and deserts—not to mention the (non-human) living beings that inhabit them.

[100] Christensen, H, et al. "Mandatory CSR And Sustainability Reporting: Economic Analysis and Literature Review." *Review of Accounting Studies*, vol. 26, no. 3, 2021, pp. 1176-1248.

[101] Power, M. *The Audit Society: Rituals Of Verification*. Oxford University Press, 1999.

[102] Some firms have strong institutional commitments to environmental protection—I do not intend to rule these out; indeed, they are crucial players in the climate finance landscape.

[103] Blowfield, M. *Business and Sustainability.* Oxford University Press, 2013; Freeman, R. *Strategic Management: A Stakeholder Approach*. Pitman, 1984.

[104] Gibson, R, et al. "ESG Rating Disagreement and Stock Returns." *Financial Analysts Journal*, vol. 77, no. 3, 2021, pp. 104-127; "CDP Global Climate Change Report 2020." *Carbon Disclosure Project*, 2020.

[105] I will address this issue of democratic governance of what may be called the "knowledge commons" below; *see* Castree, N. "Commodifying What Nature?" *Progress in Human Geography,* vol. 27, no. 3, 2003, pp. 273-297.

[106] Benedetti, D, et al. "Climate Change Investment Risk: Optimal Portfolio Construction Ahead of the Transition to a Lower-Carbon Economy." *Annals of Operations Research*, vol. 299, 2019, pp. 847-871.

[107] Bachelard, G. *The New Scientific Spirit*. Beacon Press, 1984.

information by engaging in strategic disclosure to signal lower risk while withholding adverse information[108]—a clear instance of moral hazard that undermines the integrity of individual judgment within and alongside environmental reporting systems.[109] The strategic manipulation of environmental information reflects broader questions about the relationship between knowledge and power in the governance of climate finance. Following Foucault's analysis of disciplinary power, environmental disclosure requirements can be understood as technologies of governance that shape corporate behaviour not only through direct regulation but also through the creation of new forms of visibility and accountability with respect to sustainability and an awareness of the impact of the cycle of production and consumption on the natural world.[110] However, the effectiveness of environmental governance depends on its ability to generate reliable frameworks for environmental action in a world shaped by profit motives and self-interest. The credibility of initiatives blending the duties of a financial institution with those of a regulator may be undermined by the strategic behaviour of the organisations such initiatives seek to moderate or control.[111]

In sum, climate-related financial markets show the systemic structural presence of asymmetric information, but they also reveal how informational problems are intertwined with deeper philosophical questions about knowledge, uncertainty, and responsibility in the face of environmental crisis. From green bonds and carbon markets to mortgage portfolios and corporate disclosures, information gaps distort prices, elevate risk premiums, and misdirect capital, but these distortions cannot be addressed through purely technical solutions. The challenge of governing climate finance requires attention not only to improved disclosure regimes and regulatory frameworks, but also to the normative, epistemic, and moral foundations of environmental decision-making. The philosophical dimensions of asymmetric information in climate finance point toward the need for more reflexive and participatory approaches to environmental governance that can accommodate irreducible uncertainty while maintaining democratic legitimacy and social justice. In the next section, we turn to the implications of these informational failures, examining how issues of agency, legitimacy, and justice shape the governance of climate finance within the disciplinary context of contemporary political theory.

IV. **Environmental Political Theory and Finance**

The intersection of asymmetric information and climate finance raises deep questions about agency and accountability within political institutions that extend far beyond conventional treatments of market failure. In addition to serving as aggregators and temperature gauges of private preferences and economic risk assessment, financial markets are also embedded within networks of diverse regulatory regimes, democratic (and non-democratic) governments and institutions, and are affected by power relations that, in turn, shape the incentives and constraints facing firms, investors, and citizens.[112] As we have seen, information about climate risks is unevenly distributed, and certain actors—typically large firms and incumbent energy producers—can leverage their private, acquired knowledge about specific economic metrics to skew policy outcomes in their favour, creating a form of hegemonic control that is exercised through technical expertise rather than overt coercion derived from the use of force (hard or soft).[113] This subversion of traditional accountability mechanisms through the acquisition of proprietary power undermines normative

[108] This is the classical definition of asymmetric information—*see* Bebczuk (n 56) *supra*.
[109] Tversky, A, and D Kahneman. "Judgment Under Uncertainty: Heuristics and Biases." *Science*, vol. 185, no. 4157, 1974, pp. 1124-1131.
[110] Foucault, M. *Discipline and Punish: The Birth of The Prison*. Vintage Books, 1977.
[111] Scott (n 35) *supra*.
[112] Block, F, and M Somers. *The Power of Market Fundamentalism: Karl Polanyi's Critique*. Harvard University Press, 2016.
[113] Gramsci, A. *Selections from the Prison Notebooks*. International Publishers, 1971.

ideals of corporate and political norms: regulators, elected or otherwise, may find their deliberations siphoned-off by well-resourced organisations that possess privileged access to scientific data, model projections, and to exclusive lobbying channels.[114] The result is a deficit of democratic integrity within climate governance, in which the institutions safeguarding the public interest become instruments for private gain as a result of hierarchies of access to information, showing that Schumpeter's concerns about the bureaucratisation of democratic life—demarcated by status and insider knowledge—remains prescient.[115]

When constitutive knowledge is excluded from decisions made on behalf of stakeholders, we run into the problem of lack of political legitimacy, which must be understood not merely as the absence of consent or compliance but a form of epistemic and illegitimate informational domination—the unwilling (or unwitting) surrender to authority because of a presumption of shared beliefs about the rightfulness of the trajectory in vogue.[116] Market-based instruments such as emissions trading schemes rest on the premise that price signals are accepted as fair and credible by all stakeholders, but this acceptance cannot be taken for granted when the informational foundations of climate asset pricing are opaque or contested. When asymmetric information breeds suspicion—whether through real incidents of greenwashing or more subtle forms of epistemic injustice—the moral authority of the political decision-making mechanisms erodes.[117] Citizens who perceive that policy on climate change is set behind closed doors, or that exceptions to the just exercise of environmental law—i.e., applying to everyone equally—are allocated to incumbent and culpable polluters, are less likely to view market instruments as legitimate expressions of collective will.

If information about potential harms from selective information exposure is fragmentary or contested, the epistemic conditions by which governments secure the consent of the public on issues of intergenerational justice and economic policy could be severely weakened, raising fundamental questions about the possibility of legitimate governance of these issues across time.[118] While we know that today's policies determine which future lives come into existence,[119] hypothetical consent is problematic as a foundation for intergenerational justice when considering investments in sustainable technologies because we fundamentally do not know the preferences of people living in the future. Instead, we might appeal to principles of just savings or stewardship of existing (natural) resources, having present generations act as custodians of the planet's habitability, but these principles require robust epistemic foundations of knowledge about the future state of the world that may be undermined by the very information asymmetries they seek to address.[120] Unless the epistemic foundations of stewardship are rooted in comprehensive, inclusive disclosure and consensus, trusteeship can decay into paternalism or hegemonic opportunism, perpetuating forms of domination that democratic theory seeks to overcome.

Epistemic injustice arising from information asymmetries that in turn advantage or disadvantage particular market actors emerges as a crucial analytical framework for understanding how the topology of information in climate finance reproduces and amplifies existing patterns of social domination. We can extend this to define testimonial and hermeneutical injustice to show how losers in the competition for

[114] Stiglitz, J, and J Rosengard. *Economics of the Public Sector*. 4th edn, WW Norton & Company, 2015.
[115] Schumpeter, J. *Capitalism, Socialism and Democracy*. Harper & Brothers, 1942.
[116] Weber, M. *Economy and Society: An Outline of Interpretive Sociology*. University of California Press, 1978.
[117] Fricker (n 11) *supra*.
[118] Rawls (n 83) *supra*.
[119] Parfit (n 10) *supra*.
[120] Gardiner (n 1) *supra*.

predominance and access can be systematically discredited or silenced in public discourse—in addition to being put at a financial disadvantage—and the temporal and ecological dimensions of climate injustice give rise to high hurdles for those left behind.[121] In climate finance, some voices that are often absent from corporate, technocratic, and academic governance negotiations over carbon budgets and transition pathways, reflect systematic patterns of closed-mindedness and epistemic arrogance by elite managers that prevent dominant groups from recognising alternative instantiations of knowledge and information.[122] These groups may hold valuable micro knowledge about environmental thresholds and adaptation practices, but without institutional mechanisms for incorporating these data resources, epistemic contributions remain invisible and are systematically devalued.[123] This exclusion perpetuates social injustice and also impoverishes the informational ecosystem upon which robust policy depends, creating structural poverty traps where marginalised market actors avoid making claims or interventions because they predict that their audience will respond with epistemic bias and domination.[124] The politics of an inclusive information landscape, therefore, must attend to both hierarchical material and asset-based distribution and to the equitable diversification of sources of (financial) data, recognising that epistemic justice is a prerequisite for effective climate governance.

Dominated financial and political actors may need to develop oppositional strategies to recognise and vocally articulate their experiences of subordination.[125] In the context of climate finance, this suggests that practices of questioning dominant frameworks and developing alternative ways of understanding climate risks and responses[126] can be of value in creating a cognitive supply chain of knowledge. As noted in the introduction, Amartya Sen's capability approach complements rather than replaces the Rawlsian vision of justice. While Rawls emphasises fairness in institutional design, Sen insists that justice also depends on the substantive freedoms people possess to realise valued forms of life. In this framework, addressing information asymmetries in climate finance becomes both a procedural and an empowerment challenge: ensuring fair institutional rules while expanding the real capacities of individuals and communities to act within them.[127] Financial economics, by placing value on asset allocations and through the quantitative hedging of systemic pricing and valuation risk, often overlooks whether individuals and communities have the substantive capacity to respond emotionally, as well as physically, to climate impacts—these issues are central to human welfare including long-life, bodily health, social and economic equity, and control over one's environment.[128] Asymmetric information exacerbates the decay of human capacity; without knowledge of shifting economic and financial conditions, households cannot make informed investment decisions in housing, investment, saving, or education, undermining their capacity for self-determination.

Bridging this gap within potential human vitality requires concerted efforts to democratise climate information, through participatory mapping exercises, and educational outreach programs that build critical consciousness: the ability to perceive social, political, and economic contradictions and to take action to advantage and exploit

[121] Fricker (n 11) *supra*.
[122] Medina, J. *The Epistemology of Resistance: Gender and Racial Oppression, Epistemic Injustice, And Resistant Imaginations*. Oxford University Press, 2012.
[123] Scott (n 35) *supra*.
[124] Dotson, K. "Tracking Epistemic Violence, Tracking Practices of Silencing." *Hypatia*, vol. 26, no. 2, 2011, pp. 236-257.
[125] Pateman, C. *The Sexual Contract*. Polity, 1988; MacKinnon, C. *Toward A Feminist Theory of The State*. Harvard University Press, 1989.
[126] Stern (n 85) *supra*.
[127] Sen, A. *The Idea of Justice*. Harvard University Press, 2009.
[128] Nussbaum, M. *Women and Human Development: The Capabilities Approach*. Cambridge University Press, 2000.

one's own position through self-determination.[129] The goal is to empower citizens to convert environmental information into economic capabilities while transforming the social relations that structure access to and use of such information. The capability approach thus points toward a more fundamental reconstruction of climate finance that would prioritise human development over capital accumulation, following a vision of governance based on ecological principles and the rights of all life forms.[130] This might involve alternative economic models such as participatory economics, ecological economics, or post-growth (or de-growth) economics that challenge the assumption that climate problems can be solved within existing capitalist frameworks.[131] Such alternatives would require not only different institutions but different ways of understanding the relationship between human societies and natural systems, following the recognition that capitalism and fossil fuel dependence are structurally linked.[132]

In sum, the theoretical political implications of asymmetric information in climate finance cut across questions of accountability, legitimacy, justice, and freedom, but they also reveal the limitations of conventional democratic theory when applied to problems that span multiple temporal and spatial scales. Addressing these implications demands innovative institutional architectures that promote transparency, inclusion, and deliberation, while safeguarding the agency of both current and future generations. However, such reforms may ultimately require more fundamental transformations in the political and economic systems that structure climate governance and point toward post-capitalist governance alternatives that address the causes of climate change itself as well as democratic failures and institutional blind spots. The next section will conclude by examining normative solutions, evaluating how robust access to decision-making frameworks, and democratic access can mitigate the informational asymmetries identified above while remaining optimistic that these reforms may be able to mitigate deeper structural challenges.

V. **Conclusions**

The analysis in this article has shown that asymmetric information permeates climate-related financial markets as well as political institutions. It gives rise to adverse selection, moral hazard, and epistemic injustice that threaten both economic efficiency and democratic legitimacy. In financial markets, these issues lead to the mispricing of climate risk, misallocation of capital, and insufficient incentives for mitigation and adaptation. In political spheres, privileged access to specialised knowledge enables elite actors to navigate regulatory barriers, which undermines accountability and leaves rural, non-technocratic communities and future generations without effective representation. To find solutions to these challenges, normative and policy solutions must address the core of information asymmetries. They can do this by combining transparency, regulatory and mechanism design, with inclusive governance mechanisms and a commitment to intergenerational justice.[133]

Complementing disclosure obligations, regulatory governance frameworks must incorporate robust decision-making under deep uncertainty. Traditional economic and information theoretic models inadequately capture tail climate risks.[134] Regulators should therefore adopt adaptive rulemaking processes that embed scenario-based stress tests and robust control criteria within managed economies.[135] These initiatives could guide capital stock requirements and enact

[129] Freire, P. *Pedagogy of the Oppressed.* Continuum International Publishing Group, 1970.
[130] Shiva, V. *Earth Democracy: Justice, Sustainability and Peace.* South End Press, 2005.
[131] *see* Albert, M. *Parecon: Life After Capitalism*. Verso, 2004; *see also* Daly, H. *Beyond Growth: The Economics of Sustainable Development.* Beacon Press, 1997.
[132] Malm, A. *Fossil Capital: The Rise of Steam Power and The Roots of Global Warming*. Verso, 2016.
[133] Tremmel (n 58) *supra*.
[134] Liesen (n 9) *supra*.
[135] *see* Gilboa & Schmeidler (n 43) *supra* and the book by Hansen, L, and T Sargent. *Robustness*. Princeton University Press, 2007.

prudential investment and debt allocation buffers for financial institutions and market actors. For example, central banks could require supervised institutions to hold additional capital proportional to losses in worst-case climate change scenarios, thereby accounting for tail-risks and minimising over-exposure to carbon intensive assets. These stress tests should have parameters co-designed by regulators, civil society, and industry experts ensuring collaborative procedural democratic legitimacy.

Finally, continued research at the intersection of philosophy, economics, and political science is essential for refining information markets and knowledge economies. Open questions include the optimal design of environmental disclosure under epistemic ambiguity, the trade-offs between robust regulatory oversight and market liquidity, and the conditions within which deliberative forums produce robust policy consensus. Empirical studies could evaluate the effects of mandatory climate disclosures on cost of capital, while normative scholarship must clarify the moral premises of intergenerational respect and foresight as well as epistemic inclusion.

In conclusion, mitigating the effects of asymmetric information in climate finance using democratic political values demands a strategy that unites legal scholarship, just regulatory frameworks, market-based incentives, democratic novelty, and ethical commitments, respecting both present and future citizens. Only through this integrated approach can modern societies align private incentives with the public good and enhance the credibility and effectiveness of climate-related financial instruments, fostering a political order worthy of the challenges posed by the transformation of the planet known as the Anthropocene.