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Market Myopia's Climate Bubble

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MARKET MYOPIA'S CLIMATE BUBBLE

Madison Condon*

Abstract

A growing number of financial institutions, ranging from BlackRock to the Bank of England, have warned that markets may not be accurately incorporating climate change-related risks into asset prices. This Article seeks to explain how this mispricing occurs, drawing from scholarship on corporate governance and the mechanisms of market (in)efficiency. Market actors: (1) Lack the fine-grained asset-level data they need in order to assess risk exposure; (2) Continue to rely on outdated means of assessing risk; (3) Have misaligned incentives resulting in climate-specific agency costs; (4) Have myopic biases exacerbated by climate change misinformation; and (5) Are impeded by captured regulators distorting the market. Further, trends in institutional share ownership reinforce apathy toward assessment of firm-specific fundamentals, especially over long-term horizons.

This underpricing of corporate climate risk contributes to the negative effects of climate change itself, as the mispricing of risk in the present leads to a misallocation of investment capital, hindering adaptation and subsidizing future combustion of fossil fuels. These risks could accumulate to the macroeconomic scale, generating a systemic risk to the financial system. While a broad array of government interventions are necessary to mitigate climate-related financial risks, this Article focuses on proposals for corporate governance and securities regulation—and their limits. The Securities and Exchange Commission is currently drafting a rule on mandatory climate risk disclosure. This Article argues that the SEC should seek out climate expertise through interagency collaboration and staff hiring, work with auditors and the Public Company Accounting Oversight Board, and provide guidance on climate risk analytics. This Article argues that climate risk disclosure is

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necessary, though alone not sufficient, to address the widespread disregard of corporate climate exposure.

TABLE OF CONTENTS

I. INTRODUCTION	64
II. CLIMATE RISK AND EQUITY-MISVALUATION.....	70
A. Evidence of Misvaluation	73
B. Drivers of Mispricing.....	78
1. Lack of Asset-Level Data	79
2. Outdated Means of Risk Assessment: Model Risk, Latent Risk, and Duration Mismatch	80
3. Misaligned Managerial Incentives.....	84
4. Market Structure Limits Shareholders Demand for Risk Assessment.....	88
5. Misinformation and Biases	95
6. Corporate Opposition / Regulatory Capture	102
C. Market Failure	104
1. Inability of the Market to Self-Correct.....	105
2. Moral Hazard.....	107
3. Failures of Voluntary Disclosure Standards.....	107
III. SOCIETAL HARM OF CLIMATE RISK UNDERASSESSMENT	109
A. Climate Damage.....	109
B. Systemic Risk.....	111
IV. RECOMMENDATIONS.....	113
A. Update Disclosure Requirements.....	115
1. Dealing with Uncertainty.....	117
2. Engaging with Auditors and PCAOB.....	119
3. Provision of Climate-Risk Assessment Tools and Data.....	122
B. Limits of Disclosure	123
C. Shareholders	125
V. CONCLUSION	126

I. INTRODUCTION

In 2016, a duo of computer scientists undertook the laborious task of creating a map of U.S. Internet infrastructure, indicating where cable was laid and where colocation centers were based.¹ Because the whereabouts of this privately-owned infrastructure is kept secret by telecommunication companies, the researchers spent years scraping the web for scattered, publicly available information about infrastructure location.² When one of the researchers showed the results of his work to his wife, a climate scientist, she immediately remarked that much of the

¹ Alejandra Borunda, *The Internet Is Drowning*, NAT'L GEOGRAPHIC (July 16, 2018, 3:40 PM), <https://www.nationalgeographic.com/science/article/news-internet-underwater-sea-level-rise> [<https://perma.cc/6KZK-JT42>].

² *Id.*

infrastructure was located in coastal regions at risk of being inundated by sea level rise as soon as the coming decade.³ All three scientists then worked together, publishing a study showing that thousands of miles of fiber optic cable, and more than a thousand nodes of key Internet infrastructure, could be underwater in the next fifteen years.⁴ The researchers also identified which providers had the most infrastructure at risk, concluding that AT&T and CenturyLink were the most exposed to the risks of sea level rise.⁵

Any investors in these two companies paying attention to the 2018 study were likely surprised by its findings: neither of these companies' recent 10K filings, meant to disclose potential risks to investors, included any mention of sea level rise.⁶ Their voluntary reporting of climate risks to the nonprofit CDP similarly omitted any mention of flood risk.⁷

* * *

A growing number of financial experts at institutions ranging from BlackRock, to McKinsey, to the U.S. Commodities Futures Trading Commission, have reached the conclusion that markets are not accurately assessing and pricing climate change-related risks.⁸ In April 2019, a coalition of thirty-nine central banks recognized that “there is a strong risk that climate-related financial risks are not fully reflected in asset valuations.”⁹ Christine Lagarde recently warned that central bankers “will have to ask themselves” if they are “taking excessive risk by simply trusting mechanisms

³ *Id.*

⁴ Ramakrishnan Durairajan, Carol Barford & Paul Barford, *Lights Out: Climate Change Risk to Internet Infrastructure*, 2018 ANRW 9.

⁵ *Id.*

⁶ CenturyLink, Inc., Annual Report (Form 10-K) (Mar. 11, 2019), <https://www.sec.gov/Archives/edgar/data/18926/000001892619000006/ctl2018123110k.htm> [<https://perma.cc/62JP-3SGU>]; AT&T, Inc., Annual Report (Form 10-K) (Feb. 20, 2019), <https://www.sec.gov/Archives/edgar/data/0000732717/000119312519045608/d705958d10k.htm> [<https://perma.cc/SJC4-FF9W>].

⁷ In CenturyLink's 2017 voluntary disclosure of climate risks to the nonprofit Carbon Disclosure Project (“CDP”), the company made no mention of sea level rise. However, in 2018 it updated its disclosure to acknowledge rising sea levels as a long-term risk with an impact valued at \$2 million. See *Lumen Technologies - Climate Change 2018*, CARBON DISCLOSURE PROJECT (2018), https://www.cdp.net/en/formatted_responses/responses?campaign_id=62255737&discloser_id=738433&locale=en&organization_name=CenturyLink&organization_number=31497&program=Investor&project_year=2018&redirect=https%3A%2F%2Fcdp.credit360.com%2Fsurveys%2Fft9rgfbw%2F15343&survey_id=58150509 [<https://perma.cc/KFX6-2LF7>] (to access the disclosure information, click “Register” and create an account, then search “CenturyLink”).

⁸ See *infra* Part II.

⁹ NETWORK FOR GREENING THE FIN. SYS., A CALL FOR ACTION: CLIMATE CHANGE AS A SOURCE OF FINANCIAL RISK 2 (2019) [hereinafter NGFS, CALL FOR ACTION].

that have not priced in the massive risk that is out there.”¹⁰ According to one survey, 93% of institutional investors agree with her that climate risk “has yet to be priced in by all the key financial markets globally.”¹¹

Yet while the consensus (and evidence)¹² grows that assets are mispriced, there has been less attention paid to diagnosing why that might be; what are these faulty “mechanisms” that Lagarde says are not to be trusted?¹³ This Article seeks to explain how this mispricing can exist at the level of individual assets, disputing academic claims that climate risks are “already reflected in market price[s].”¹⁴ Contrary to recent arguments in the corporate law literature, there is, in fact, ample reason to believe that equity analysts “are systematically less able to assess the valuation implications” of climate risks.¹⁵

First, shareholders and analysts currently lack the fine-grained asset-level data they need in order to make climate-risk assessments.¹⁶ A corporation’s location, the

¹⁰ Carolynn Look, *Lagarde Says ECB Needs to Question Market Neutrality on Climate*, BLOOMBERG (Oct. 14, 2020, 3:29 AM), <https://www.bloomberg.com/news/articles/2020-10-14/lagarde-says-ecb-needs-to-question-market-neutrality-on-climate> [<https://perma.cc/PS98-85UJ>].

¹¹ *Climate Change and Artificial Intelligence Seen as Risks to Investment Asset Allocation, Finds New Report by BNY Mellon Investment*, BLOOMBERG (Sept. 16, 2019, 6:00 AM), <https://www.bloomberg.com/press-releases/2019-09-16/climate-change-and-artificial-intelligence-seen-as-risks-to-investment-asset-allocation-finds-new-report-by-bny-mellon-investm> [<https://perma.cc/L7WT-R2RZ>].

¹² See *infra* Section II.A.

¹³ But see Jakob Thomä & Hugues Chenet, *Transition Risks and Market Failure: A Theoretical Discourse on Why Financial Models and Economic Agents may Misprice Risk Related to the Transition to a Low-Carbon Economy*, 7 J. SUSTAINABLE FIN. & INV. 82 (2017).

¹⁴ Paul Brest, Ronald J. Gilson & Mark A. Wolfson, *How Investors Can (and Can’t) Create Social Value* 24 (Eur. Corp. Governance Inst., Working Paper No. 394, 2018), https://ecgi.global/sites/default/files/working_papers/documents/finalbrestgilsonwolfson.pdf [<https://perma.cc/3VCP-VD7N>].

¹⁵ *Id.* at 23.

¹⁶ See *infra* Section II.B.1. A note on terminology: When “value-relevant” information about a company is withheld from the market, that information cannot be reflected in share price, and so prices diverge from “fundamental efficiency,” or the “correct” price, meaning the discounted present value of expected cash flows from holding the stock. The assertion that stock prices reflect all publicly available information is the “semi-strong” version of the Efficient Capital Markets Hypothesis (ECMH) (the strong version of the ECMH, that prices reflect *all* information, even information kept internal to the firm, has been widely accepted as untrue). As the following reasons show, this Article argues that with respect to climate risks, markets are *both* fundamentally inefficient (not reflecting true underlying value) and informationally inefficient (not reflecting information that is already publicly known, or knowable with presently available data and analytical tools). See, e.g., Ronald J. Gilson & Reinier Kraakman, *Market Efficiency After the Financial Crisis: It’s Still a Matter of Information Costs*, 100 VA. L. REV. 313, 317 (2014) [hereinafter Gilson & Kraakman, *Market Efficiency After the Financial Crisis*] (discussing relationship between fundamental and informational efficiency).

origins and routes of their supply chains, the sources and quantities of inputs like water and energy—this is the type of information needed to assess climate risk exposure but is not the type of information currently disclosed in financial reports.¹⁷ Often, the information that corporations voluntarily disclose aggregates data at too high a level, gives widely varying timescales that make comparison difficult, and fails to clearly differentiate between exposure and liability.¹⁸

Second, market actors continue to rely on risk-assessment methodologies that are outdated in a climate-changed world.¹⁹ They may employ strategies that expose them to *model risk*, such as relying on unrepresentative historical records to project future exposure. And traditional means of risk assessment may ignore *latent risks*: The entire capital stock of corporate America was built using engineering specifications designed to endure certain temperature and weather extremes that may be regularly exceeded under a climate-changed world. A facility that was built to withstand a “100-year flood” may now have a much higher likelihood of failure. Additionally, corporate managers may continue to rely on outdated methods of risk assessment that suffer from a *duration mismatch*. Insurance premiums, for example, can no longer be relied upon to serve as a proxy for the cost of physical risk on a contemplated project; returns are calculated over many years, but premiums can change annually to reflect previously unpriced risk.

Third, corporate managers, with an eye toward maintaining a high share price, have little incentive to discover and disclose information that might reveal their company's stock price is overvalued.²⁰ Equity-based compensation and certain remuneration metrics may encourage managers to focus on the short-term and neglect to prepare their companies for longer-term climate resilience.²¹

Fourth, many physical climate risks will occur within the relevant horizon for valuing securities but outside of conventional risk assessment horizons for

¹⁷ See, e.g., NGFS, CALL FOR ACTION, *supra* note 9, at 30; CLIMATE-RELATED MKT. RISK SUBCOMM., MANAGING CLIMATE RISK IN THE U.S. FINANCIAL SYSTEM (Leonardo Martinez-Diaz, Jesse M. Keenan & Stephen Moch eds., 2020) [hereinafter CFTC REPORT]; FOUR TWENTY SEVEN, MEASURING PHYSICAL CLIMATE RISKS IN EQUITY PORTFOLIOS (2017); WORLD BANK & WORLD WILDLIFE FUND, SPATIAL FINANCE: CHALLENGES AND OPPORTUNITIES IN A CHANGING WORLD, EQUITABLE GROWTH, FINANCE & INSTITUTIONS INSIGHT (2020).

¹⁸ *Infra* Section II.B.1.

¹⁹ *Infra* Section II.B.2. Cf. Gilson & Kraakman, *Market Efficiency After the Financial Crisis*, *supra* note 16, at 343–44 (discussing how valuation models employed by banks and ratings agencies failed because they relied on historical housing price data to model future risk and ignored warnings of high unaccounted-for correlations between assets).

²⁰ *Infra* Section II.B.3. See, e.g., John Armour, Jeffrey Gordon & Geeyoung Min, *Taking Compliance Seriously*, 37 YALE J. REGUL. 1, 2631 (2020) (arguing that stock-based, including options-based, executive compensation models incentivize corporate managers to neglect risk management programs, to the detriment of the long-term value of the stock).

²¹ Cf. Michael C. Jensen, *Agency Costs of Overvalued Equity*, 34 FIN. MGMT. 5, 7 (2005).

investors.²² The investors with the longest investment horizons largely follow an indexing or quasi-indexing strategy—passively holding their funds instead of spending resources to research firm-specific fundamental values.²³ While investors continue to shift their money into funds with an “environmental, social, and governance” (ESG) focus, perhaps suggesting an awareness of climate risks, there is insufficient scrutiny of index providers and their climate-related methodologies.²⁴

Fifth, decades-long disinformation campaigns have intentionally confused public understanding of the cause and effects of climate change.²⁵ And lessons from behavioral finance tell us that investors and corporate managers can be slow to integrate new information, can be irrationally myopic, can overvalue short-term gains and undervalue longer-term losses—all of which, in the context of climate change, serves to maintain apathy regarding mitigation investment and long-term risk avoidance.²⁶

Sixth and finally, shareholders concerned about climate risk have begun to press for voluntary disclosure from companies, but their efforts face opposition from corporate management both directly and through industry influence on government regulators.²⁷ Under the Trump Administration, several agencies took actions to limit shareholder oversight of climate risks, including blocking requests for climate disclosure and preventing investors from integrating climate risks into their market decisions.²⁸

No amount of regulatory or corporate governance intervention can give shareholders and managers the ability to foresee the future. The outcomes of national elections, for example, are both largely uncertain and hugely influential in determining the strength of future climate policy. However, there are actions within

²² See, e.g., MONA NAQVI, BRENDAN BURKE, SVENJA HECTOR, TRICIA JAMISON & STAN DUPRÉ, *ALL SWANS ARE BLACK IN THE DARK: HOW THE SHORT-TERM FOCUS OF FINANCIAL ANALYSIS DOES NOT SHED LIGHT ON LONG TERM RISKS, TRAGEDY OF THE HORIZON* (2017); cf. Lynne L. Dallas, *Short-Termism, the Financial Crisis, and Corporate Governance*, 37 J. CORP. L. 265, 267 (2012).

²³ *Infra* Section II.B.4.

²⁴ See, e.g., Joe Rennison & Billy Nauman, *Vanguard ‘Green’ Fund Invests in Oil and Gas-Related Stocks*, FIN. TIMES (July 10, 2019), <https://www.ft.com/content/fbdb36d0-a293-11e9-974c-ad1c6ab5efd1> [<https://perma.cc/M4NP-EYMG>]; Adriana Z. Robertson, *Passive in Name Only: Delegated Management and “Index” Investing*, 36 YALE J. REG. 795, 848 (2019).

²⁵ See, e.g., JANE MEYER, *DARK MONEY* 251–60 (2017); see generally NAOMI ORESKES & ERIK M. CONWAY, *MERCHANTS OF DOUBT: HOW A HANDFUL OF SCIENTISTS OBSCURED THE TRUTH ON ISSUES FROM TOBACCO SMOKE TO GLOBAL WARMING* (2010).

²⁶ See *infra* Section II.B.5; see, e.g., Stephen J. Choi & A.C. Pritchard, *Behavioral Economics and the SEC*, 56 STAN. L. REV. 1, 7–8 n.25 (2003) (citing Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 SCI. 1124, 1127–28 (1974)).

²⁷ See *infra* Section II.B.6.

²⁸ Fair Access to Financial Services, 85 Fed. Reg. 75261 (proposed Nov. 25, 2020) (to be codified at 12 C.F.R. pt. 55); Brett McDonnell, Hari M. Osofsky, Jacqueline Peel & Anita Foerster, *Green Boardrooms?*, 53 CONN. L. REV. 335, 352 (2021).

the power of both market actors and government regulators that can help to counter the unfolding market failure that is the continued neglect of assessing companies' exposure to *foreseeable* climate risks. Net global sea level rise over the next fifteen years, for example, can be predicted with some certainty, and yet market actors nevertheless seem to disregard these projections when making asset-allocation decisions.²⁹

The widespread underassessment of climate risk may lead to two undesirable economy-wide harms: (1) systemic risk to the financial system and (2) the physical damages stemming from climate change itself, as mispriced equity leads to misallocation of investment resources.³⁰ If investors fail to demand risk assessment from companies, managers may be left unpunished by the market when they build homes and hotels in hurricane-prone regions too close to the shore or build bridges to withstand a "100-year-flood" based on a grossly unrepresentative historical record. This mis-investment imposes costs not just on the company and the investor, but also on the communities harmed by collapsing bridges and hotel evacuees.

Addressing climate-risk neglect will require an array of actions, from regulators and investors alike.³¹ The Securities and Exchange Commission, at the direction of President Biden, has begun to work on proposed rules for mandatory climate risk disclosure.³² This Article supports this agenda and provides some high-level guidance on how to design regulation to address the drivers of climate risk mispricing. Any mandatory climate risk disclosure regime has to meet climate science where it is. Regulators must pay particular attention to the spatial and temporal scales of requested disclosures and ensure they are both scientifically feasible and tailored to industry-specific needs.³³ In particular, an overemphasis on

²⁹ Cf. McDonnell et al., *supra* note 28, at 342–47.

³⁰ See *infra* Part III.

³¹ The work has already begun. See, e.g., Emily Glazer, *Companies Brace Themselves for New ESG Regulations Under Biden*, WALL ST. J. (Jan. 18, 2021, 9:15 AM), https://www.wsj.com/articles/companies-brace-themselves-for-new-esg-regulations-under-biden-11610719200?mod=searchresults_pos3&page=1 [<https://perma.cc/4EK9-AMVK>]; Kate Davidson, *Yellen Is Creating a New Senior Treasury Post for Climate Czar*, WALL ST. J. (Feb. 12, 2021, 9:01 AM), <https://www.wsj.com/articles/yellen-is-creating-a-new-senior-treasury-post-for-climate-czar-11613138479> [<https://perma.cc/25KY-ACEB>]; Larry Elliott, *UK to Make Climate Risk Reports Mandatory for Large Companies*, GUARDIAN (Nov. 9, 2020), <https://www.theguardian.com/environment/2020/nov/09/uk-to-make-climate-risk-reports-mandatory-for-large-companies> [<https://perma.cc/JCL4-N6J3>].

³² Public Statement, Sec. & Exch. Comm'n, Acting Chair Allison Herren Lee on Public Input Welcomed on Climate Change Discourse (Mar. 15, 2021), <https://www.sec.gov/news/public-statement/lee-climate-change-disclosures> [<https://perma.cc/GGP6-DDG9>] [hereinafter Public Statement, Lee]; Tim Quinson, *SEC Takes a Different Route than Europe on Climate Disclosures*, BLOOMBERG (Sept. 15, 2021, 4:00 AM), <https://www.bloomberg.com/news/articles/2021-09-15/the-sec-is-taking-a-different-route-than-europe-on-climate-disclosures> [<https://perma.cc/4SPT-ESHM>].

³³ See, e.g., Tanya Fielder, Andy J. Pitman, Kate Mackenzie, Nick Wood, Christian Jakob & Sarah E. Perkins-Kirkpatrick, *Business Risk and the Emergence of Climate Analytics*, 11 NATURE CLIMATE CHANGE 87 (2021).

false precision provided by complicated models might obscure the usefulness of other methods of risk assessment and communication.³⁴ This fact should inform how the Securities and Exchange Commission (SEC) decides to structure climate risk disclosure compliance, including balancing the pros and cons of principles-based versus line-item disclosures.³⁵ In crafting disclosure regulation, the SEC should seek out climate-related expertise through interagency working groups, advisory boards, and staff hiring.³⁶ Further, the SEC should: (1) Require methods for addressing uncertainty, including scenario analysis; (2) Work with auditors and the Public Company Accounting Oversight Board; and (3) Facilitate disclosure and market response through public provision of climate-risk analytical tools.³⁷

No amount of disclosure, however, can protect the market from climate change. The only path toward financial stability requires halting emissions. The CFTC Subcommittee's report on Managing Climate Risk in the U.S. Financial System acknowledges this and lists reducing emissions as its first recommendation.³⁸ However, direct regulation is also required to address physical risks and adaptation deficits, not just mitigation deficits. Climate adaptation requires planning at the national level. Beyond the "market failure" of emissions externalities, there is a limit to what increased disclosure can facilitate in the face of systemic risks; climate risks remain unhedgeable even with increased information.

Part II of this Article proceeds by collecting evidence of climate mispricing, including empirical studies examining how well the market has priced the 1.1°C of warming that has already occurred, and models of climate impacts on portfolios. It then enumerates six distinct drivers of asset mispricing in the climate context and explains why neither arbitrage nor private ordering through requests for voluntary disclosures can correct these market failures. Part III argues that there is a societal interest to correct this mispricing, beyond individual investor protection, as the inaccuracy may lead to: (1) systemic risk to the financial system and (2) the physical damages stemming from climate change itself, as mispriced equity leads to misallocation of investment resources. Part IV discusses recommendations for regulators and investors. Part V concludes.

II. CLIMATE RISK AND EQUITY-MISVALUATION

Climate risks facing the private sector are typically broken down into three categories: transition risk, physical risk, and liability risk.³⁹ Transition risk comes

³⁴ *Id.*

³⁵ *See infra* note 293.

³⁶ *See* Madison Condon, Sarah Ladin, Jack Lienke, Michael Panfil & Alexander Song, *Mandating Disclosure of Climate-Related Financial Risk*, N.Y.U. J. LEGIS. & PUB. POL'Y (forthcoming 2021).

³⁷ *See infra* Section IV.A.

³⁸ CFTC REPORT, *supra* note 17, at 123.

³⁹ These are the categories identified by Mark Carney, the Governor of the Bank of England. *See* Mark Carney, Governor, Bank of England, A Transition in Thinking and Action (Apr. 6, 2018).

from a failure to adapt in time to a changing, less carbon-intensive economy as governments begin to regulate emissions and alternative energy falls in price. “Stranded assets” in the fossil fuel industry are the classic example of transition risk.⁴⁰ Physical risks are the threats faced by all industries that come from the changing climate itself. They include the impact of sea level rise on the real estate industry, decreased labor productivity from hotter days, reductions in agricultural output due to droughts or floods, and many others.⁴¹ Liability risks are the potential that the parties that contribute to, or profit from, carbon emissions, will be required at some point in the future to compensate those harmed by climate impacts.⁴²

Many leaders in the financial sector have voiced their concern that the industry’s current assessment of these risks is woefully inadequate. Hank Paulson, former U.S. Secretary of the Treasury and CEO of Goldman Sachs, wrote in a McKinsey newsletter in 2015: “As someone who has spent a good deal of time

⁴⁰ See Christophe McGlade & Paul Ekins, *The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2°C*, 517 NATURE 187, 187 (2015) (suggesting that “to have at least a 50 per cent chance of keeping warming below 2°C throughout the twenty-first century . . . globally, a third of oil reserves, half of gas reserves and over 80 per cent of current coal reserves should remain unused from 2010 to 2050”); MARK C. LEWIS, STÉPHANE VOISIN, SUDIP HAZRA, SAMUEL MARY & ROBERT WALKER, ENERGY TRANSITION & CLIMATE CHANGE: STRANDED ASSETS, FOSSILISED REVENUES 3 (2014) (calculating that if “greenhouse-gas (GHG) concentrations in the atmosphere” are kept below “450ppm of CO₂-equivalent (CO₂e) . . . the fossil-fuel industry would stand to lose [\$28 trillion] of gross revenues over the next two decades . . .”); EUR. SYSTEMIC RISK BD. ADVISORY SCI. COMM., 6 TOO LATE, TOO SUDDEN: TRANSITION TO A LOW-CARBON ECONOMY AND SYSTEMIC RISK 2016 [hereinafter EUR. SYSTEMIC RISK BD.]; Thomas Lee, *Fossil Fuel Stranded Assets: Efficient Market or Carbon Bubble?*, PENN WHARTON PUB. POL’Y INITIATIVE (April 12, 2017).

⁴¹ See generally THE RISKY BUS. PROJECT, RISKY BUSINESS: THE ECONOMIC RISKS OF CLIMATE CHANGE IN THE UNITED STATES (2014) (attempting to quantify the specific costs businesses will face from climate change through the Risky Business Project, co-chaired by Michael Bloomberg, former mayor of New York, Henry Paulson, former U.S. Secretary of the Treasury, and Tom Steyer, hedge fund manager and philanthropist).

⁴² Lawsuits against emitters are increasing in frequency and gaining more traction in the courts. See, e.g., *Mayor & City Council of Balt. v. BP P.L.C. et al.*, 388 F. Supp 3d 538 (2019), *cert. granted*, 141 S. Ct. 222 (2020), and *vacated*, 14 S. Ct. 1532 (2021); Order at 1–2, *Conservation Law Found., Inc. v. ExxonMobil Corp.*, 448 F. Supp. 3d 7 (D. Mass. 2020) (No. 29) (ruling that an environmental group alleged facts sufficient to establish standing by claiming that ExxonMobil “is discharging pollutants” and “that there is a ‘substantial risk’ that severe weather events, such as . . . flooding, will cause the terminal to discharge pollutants”); Rebecca Hersher, *Supreme Court Considers Baltimore Suit Against Oil Companies over Climate Change*, NPR (Jan. 19, 2021, 11:12 AM), <https://www.npr.org/2021/01/19/956005206/supreme-court-considers-baltimore-suit-against-oil-companies> [<https://perma.cc/7NZB-NT47>] (reporting “more than 20 similar suits brought by cities, states and counties” against oil and gas companies “in recent years”); Michael Burger, Jessica Wentz & Radley Horton, *The Law and Science of Climate Change Attribution*, 45 COLUM. J. ENV’T L. 57 (2020) (discussing attribution science and the role it plays in climate change law and litigation).

assessing risk and dealing with crises, I'm struck by the similarities between the climate crisis and the financial crisis of 2008."⁴³ The world's largest asset management company, BlackRock, agreed:

Many equity investors ignore climate risk, and credit investors and ratings agencies do not routinely assess it. Real estate markets often ignore extreme weather risk, even in highly exposed coastal areas. Most asset owners do not measure their exposure to potentially stranded assets such as high-cost fossil fuel reserves that may have to be written off if their use is impaired by climate change regulation. Who can blame them? There is little evidence that assets more susceptible to climate change and related regulatory risks trade at a discount to the market.⁴⁴

In the six years since these statements were made, each of these actors—equity analysts, ratings agencies, asset owners, and corporate managers—have made slow progress toward integrating climate change into analyses of financial risks.⁴⁵ Evaluating climate risk involves forecasting macroeconomic energy demand, guessing on the success of carbon regulation and future technologies, modeling the relationship between atmospheric gas concentrations and global temperatures, predicting how temperature rise will change the earth's climate systems, and calculating how those changes impact physical economic assets. The task requires skills beyond that of a typical financial analyst, colossal amounts of data, and models that have only begun to be built. Each step of estimation adds layers of uncertainty to risk projections. In some cases, particularly those longer-term and macroeconomic, the estimation of the economic impact of climate change may be

⁴³ Henry M. Paulson Jr., *Short-Termism and the Threat from Climate Change*, MCKINSEY (Apr. 15, 2015), <https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/short-termism-and-the-threat-from-climate-change> [<https://perma.cc/QP2F-CUKE>].

⁴⁴ BLACKROCK INV. INST., *THE PRICE OF CLIMATE CHANGE: GLOBAL WARMING'S IMPACT ON PORTFOLIOS 6* (2015).

⁴⁵ See, e.g., Hana V. Vizcarra, *The Reasonable Investor and Climate-Related Information: Changing Expectations for Financial Disclosures*, 50 ENV'T L. REP. 10106, 10110 (2020) ("In 2019, Moody's acquired climate data and risk analysis company Four Twenty Seven, Inc., and MSCI acquired Carbon Delta. Further, S&P Global Ratings launched the ESG Evaluation program and ESG Risk Atlas designed to inform investors and companies of risks, including that of climate change. In 2017, Institutional Shareholder Services acquired the investment climate data division of the South Pole Group."); Letter from the American Society of Adaptation Professionals to U.S. Securities and Exchange Commission Chair Gary Gensler, <https://www.sec.gov/comments/climate-disclosure/c1112-8906783-244143.pdf> [<https://perma.cc/4XMX-U92G>] (reporting that as of 2021 only a few market participants such as insurance companies, asset managers, and ratings agencies, are using quantified climate risk metrics, but "[m]ost market participants are not using quantified information").

dwarfed by this uncertainty.⁴⁶ However, this Article focuses on climate risks at the scale of individual corporations and investors and their horizons. It argues that the market is neglecting to respond to foreseeable risks.

A. Evidence of Misvaluation

Evidence that the market is currently under-assessing climate risks comes in several forms. There are recent attempts by large institutional actors to model the impact of carbon regulation and climate damages onto a representative market portfolio. There are also a handful of empirical studies examining how well the market has priced the climate-related impacts we have already been experiencing. Added to these relatively scarce forward-looking and backward-looking studies are abundant anecdotal examples of market actors failing to prepare for climate impacts.

In April 2019, the world's largest asset manager, BlackRock, released its investigation into the pricing of physical climate risks in three different categories of investments: municipal bonds, commercial real estate, and equities of electric utilities.⁴⁷ The research was conducted alongside the climate-risk consultant Rhodium Group and concluded that for each investment type, the market was failing to price asset exposure to the predictable increase in severe weather events and rising seas.⁴⁸ In the case of municipal bonds, the report pointed out, for example, that declines in crop yields from increased temperatures could be expected to depress the GDP of many metropolitan areas by multiple percentage points.⁴⁹ Given cumulative damage impacts, BlackRock predicts that "within a decade, more than 15% of the current S&P National Municipal Bond Index (by market value) would be issued by [metropolitan areas] suffering likely average annualized economics losses of up to 0.5% to 1% of GDP."⁵⁰ Nevertheless, when these climate-sensitive bonds are compared to bonds issued by less climate-vulnerable areas, their valuations do not reflect this difference in risk.⁵¹ In the case of utility companies, it was found that the equities of more climate-resistant utilities are, in fact, already trading at a slight premium relative to more vulnerable assets, but that this price difference did not yet reflect the total risk exposure.⁵² Similarly, the International Monetary Fund found that present market-implied equity risk premiums are consistently lower than

⁴⁶ See PATRICK BOLTON, MORGAN DESPRES, LUIZ AWAZU, PEREIRA DA SILVA, FRÉDÉRIC SAMAMA & ROMAIN SVARTZMAN, *THE GREEN SWAN: CENTRAL BANKING AND FINANCIAL STABILITY IN THE AGE OF CLIMATE CHANGE* (2020); Martin L. Weitzman, *On Modeling and Interpreting the Economics of Catastrophic Climate Change*, 91 REV. ECON. & STAT. 1 (2009); Martin L. Weitzman, *Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change*, 5 REV. ENV'T ECON. & POL'Y 275 (2011).

⁴⁷ BLACKROCK, *GETTING PHYSICAL: SCENARIO ANALYSIS FOR ASSESSING CLIMATE-RELATED RISKS 1* (April 2019).

⁴⁸ *Id.* at 3.

⁴⁹ *Id.* at 10.

⁵⁰ *Id.*

⁵¹ *Id.*

⁵² *Id.*

premiums calculated via an asset pricing model that takes temperature-induced disaster risk into account.⁵³ It concluded that the discrepancy suggests “that equity markets may not currently price [physical] climate change risk.”⁵⁴

In an assessment that considered transition risks in addition to physical risks, the institutional investment advisor, Mercer, modeled how various assets and industries within a typical portfolio will be impacted under three different warming scenarios: where the world acts to limit warming by 2100 to 2°C, 3°C, or 4°C.⁵⁵ For each scenario, Mercer estimated the portfolio impacts at three different points in the future, in the years 2030, 2050, and 2100. In a 2°C scenario, which models a world with aggressive regulation of emissions that reaches net-zero emissions by 2070, certain sectors suffer a severe decline in returns in the short term.⁵⁶ Assets in the oil and gas industry, for example, lose 42.1% of their value by 2030.⁵⁷ In the 3°C and 4°C scenarios, all sectors other than renewables have negative return impacts to both 2030 and 2050, with annual losses varying from 0.1% to 7.7%.⁵⁸

Substantial warming has already occurred—around 1.1°C as compared to preindustrial levels.⁵⁹ The earth’s planetary systems have reacted to this warming in manifest and measurable ways, making the economic impacts of climate change a matter of the present, not just the distant future. A growing number of empirical studies ask whether the market has efficiently anticipated and priced these changes. One recent study of publicly-traded food companies in thirty-one countries found that the market did not efficiently incorporate drought trend impacts on profits into stock prices and estimated the mispricing to be as much as 7%.⁶⁰ Another looked at

⁵³ INT. MONETARY FUND, GLOBAL FINANCIAL STABILITY REPORT: MARKETS IN THE TIME OF COVID-19, 95 (2020).

⁵⁴ INT. MONETARY FUND, GLOBAL FINANCIAL STABILITY REPORT: PHYSICAL RISK AND EQUITY PRICES—ONLINE BOXES 5.1-5.3 (2020), <https://www.imf.org/-/media/Files/Publications/GFSR/2020/April/English/onlinebox51.ashx> [<https://perma.cc/U9XN-N4LG>].

⁵⁵ See generally MERCER, INVESTING IN A TIME OF CLIMATE CHANGE (2019).

⁵⁶ *Id.* at 34–35.

⁵⁷ *Id.*

⁵⁸ *Id.* at 35.

⁵⁹ Compare Richard J. Millar, Jan S. Fuglestedt, Pierre Friedlingstein, Joeri Rogelj, Michael J. Grubb, H. Damon Matthews, Ragnhild B. Skeie, Piers M. Forster, David J. Frame & Myles R. Allen, *Emission Budgets and Pathways Consistent with Limiting Warming to 1.5°C*, 10 NATURE GEOSCIENCE 741, 741 (2017) (“Human-induced warming reached an estimated 0.93 °C . . . above mid-nineteenth-century conditions . . .”), with Laura Millan Lombrana, *Global Temperatures Already 1.2°C Above Pre-Industrial Levels*, BLOOMBERG GREEN: ENERGY & SCI. (Dec. 2, 2020, 6:00 AM), <https://www.bloomberg.com/news/articles/2020-12-02/global-temperatures-already-1-2-c-above-pre-industrial-levels> [<https://perma.cc/PPZ5-LKJL>] (“Global temperatures from January to October were around 1.2 degrees Celsius (2.2 degrees Fahrenheit) above pre-industrial levels . . .”).

⁶⁰ Harrison Hong, Frank Weikai Li & Jiangmin Xu, *Climate Risks and Market Efficiency*, 208 J. ECONOMETRICS 265, 268 (2019); see also Mathias S. Kruttl, Brigitte Roth Tran & Sumudu W. Watugala, *Pricing Poseidon: Extreme Weather Uncertainty and Firm Return Dynamics* (EBRD Working Paper No. 229, 2019), <https://papers.ssrn.com/sol3/paper>

the growing frequency of extreme temperature events from 1995 to 2017 and found that high temperatures reduce revenues and operating incomes of individual firms.⁶¹ Further, the greater the heat exposure, the greater equity analysts' estimates deviate from actual financial performance.⁶² The authors conclude from their findings that "investors do not fully anticipate the economic repercussions of heat as a first-order physical climate risk."⁶³ The climate data firm, 427, generates physical climate risk scores for individual firms based on their exposure to operational disruption risk.⁶⁴ A recent paper shows that a trading strategy employing 427's heat stress factor over the period from 2008–2018—by selling high-risk firms and buying low-risk firms—would have generated returns of 77%.⁶⁵

Evidence suggests that the housing market has begun to price in the risks of sea level rise but that the risk is still undervalued.⁶⁶ There are reasons to expect these

s.cfm?abstract_id=3451323 [https://perma.cc/VF93-RSDQ] (analyzing volatility risk premia changes due to hurricanes and finding that investors significantly underestimate the uncertainty associated with hurricanes, but that the underreaction became less pronounced after Hurricane Sandy).

⁶¹ See generally Nora Pankratz, Rob Bauer & Jeroen Derwall, *Climate Change, Firm Performance, and Investor Surprises* (Working Paper, 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3443146 [https://perma.cc/EQE7-KFSW].

⁶² *Id.*

⁶³ *Id.* (quoting the article's Abstract); see also Alok Kumar, Wei Xin & Chendi Zhang, *Climate Sensitivity and Predictably Returns* (Feb. 10, 2019) (unpublished manuscript), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3331872 [https://perma.cc/56MV-DB4Q] (similarly finding that extreme temperature anomalies negatively affect stock returns and concluding that markets underreact to firms' climate sensitivities); see also Jawad Addoum, David Ng & Ariel Ortiz-Bobea, *Temperature Shocks and Industry Earnings News*, (May 27, 2019) (unpublished manuscript), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3480695 [https://perma.cc/2K5G-SPBQ] (showing that quarterly earnings of firms in certain industries are negatively affected by extreme heat waves and that analysts' forecasts did not fully account for this impact in their earnings forecasts).

⁶⁴ See generally FOUR TWENTY SEVEN, <https://427mt.com/> [https://perma.cc/84TP-P9RJ] (last visited Jan. 30, 2021).

⁶⁵ Glen Gostlow, *Pricing Climate Risk* (Dec. 9, 2019) (unpublished manuscript) https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3501013 [https://perma.cc/YHP9-MKCY] (importantly, the paper notes that these returns may be attributed either to mispricing or to compensation for risk, and that further study is needed); see also Ruihong Jiang & Chengguo Weng, *Climate Change Risk and Agriculture Related Stocks* (Dec. 15, 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3506311 [https://perma.cc/U2-9A-JM27]; Mats Andersson, Patrick Bolton & Frédéric Samama, *Hedging Climate Risk*, 72 FIN. ANALYSTS J. 13 (2016) (employing the Actuaries Climate Index to test for the impact of physical climate risk on agriculture-related stock returns and similarly finding that a strategy of buying and selling based on climate risk scores would have generated positive returns).

⁶⁶ Markus Baldauf, Lorenzo Garlappi & Constantine Yannelis, *Does Climate Change Affect Real Estate Prices? Only If You Believe in It*, 33 REV. FIN. STUDIES 1256 (2020) (finding that homes vulnerable to sea level rise are priced at a discount only in those

risks to be ignored in this market in particular, despite the fact that more than 300,000 coastal homes are at risk of chronic inundation by the year 2045, which is within the lifespan of a 30-year mortgage issued today.⁶⁷ For one, flood maps made by the Federal Emergency Management Agency (FEMA) are out of date and fail to capture current flood risks, let alone projected flooding from sea level rise.⁶⁸ This means that highly-exposed homes are being covered by government insurance at heavily subsidized rates.⁶⁹ For another, in many states, there is no legal requirement to disclose flood history when selling a home.⁷⁰ And Fannie Mae and Freddie Mac's governing regulations prohibit them from factoring natural disaster risk into their pricing of mortgages bought from banks.⁷¹

Investors can only price the risks they are aware of, and increasing attention has been paid to the lack of climate-related risk disclosure, leaving investors in the dark. There is a large gap between the economy-wide estimates of the impact of

neighborhoods where residents largely believe in the existence of climate change); *cf.* Asaf Bernstein, Matthew Gustafson & Ryan Lewis, *Disaster on the Horizon: The Price Effect of Sea Level Rise*, 134 J. FIN. ECON. 253 (2019) (finding that coastal homes vulnerable to sea level rise are priced at a 6.6% discount relative to similar homes at higher elevations, and concluding that the market must either not fully believe in SLR projections or expect that cheap mitigation infrastructure will be available and installed to protect against property damage); Justin Murfin & Matthew Spiegel, *Is the Risk of Sea Level Capitalized in Residential Real Estate?*, 33 REV. FIN. STUD. 1217, 1219 (2020) (finding valuation impact that “would arise from an unmitigated 0.27 mm/year average relative sea level rise under 10% discount rates, an order of magnitude lower than the 2.8 mm/year experienced in recent history,” indicating significant underpricing of risk); Stefano Giglio, Matteo Maggiori, Krichna Rao, Johannes Stroebel & Andreas Weber, *Climate Change and Long-Run Discount Rates: Evidence from Real Estate* (Nat'l Bureau of Econ. Rsch., Working Paper No. 21767, 2015), <https://www.nber.org/papers/w21767> [<https://perma.cc/H8M9-TA7J>].

⁶⁷ *Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate*, UNION OF CONCERNED SCIENTISTS (2018), <https://www.ucsusa.org/sites/default/files/attach/2018/06/underwater-analysis-full-report.pdf> [<https://perma.cc/NRE4-7CNP>].

⁶⁸ Kate Duguid, *Citing climate risk, investors bet against mortgage market*, REUTERS (Sept. 29, 2019), <https://www.reuters.com/article/us-climatechange-mortgages/citing-climate-risk-investors-bet-against-mortgage-market-idUSKBN1WE0D3> [<https://perma.cc/MU9N-UUAC>]; Jen Schwartz, *National Flood Insurance Is Underwater Because of Outdated Science*, SCI. AM. (Mar. 23, 2018), <https://www.scientificamerican.com/article/national-flood-insurance-is-underwater-because-of-outdated-science/> [<https://perma.cc/Z9CZ-B5KK>].

⁶⁹ *Id.*

⁷⁰ *Climate Resilience: How States Stack up on Flood Disclosure*, NAT. RES. DEF. COUNCIL, <https://www.nrdc.org/flood-disclosure-map> [<https://perma.cc/23ED-5MQ9>].

⁷¹ Christopher Flavelle, *Climate Risk in the Housing Market Has Echoes of Subprime Crisis, Study Finds*, N.Y. TIMES (Sept. 27, 2019), *reporting on Amine Ouazad & Matthew Kahn, Mortgage Finance in the Face of Rising Climate Risk* (NBER Working Paper No. 26322, Sept. 30, 2019).

climate change in the financial sector (ranging broadly from \$4.2 to \$43 trillion),⁷² and the cumulative impacts disclosed by individual companies in their financial reporting. One recent study found that the total value of aggregated financial risk reported through both voluntary and mandatory corporate disclosures amounted to mere tens of billions of dollars of potential negative impact—at least two orders of magnitude smaller than top-down projections of costs to financial assets.⁷³ According to the UN Finance Initiative, public corporations can expect to face about \$3 trillion in climate-related losses in the next 15 years alone.⁷⁴

One recent example of this under-assessed and undisclosed climate risk comes from the California wildfires. In 2018, Pacific Gas and Electric (PG&E) voluntarily disclosed its climate-related risks to the nonprofit CDP (formerly the Carbon Disclosure Project).⁷⁵ The company highlighted climate change driven increases in wildfire risk as a potential liability and estimated its 2017 claim payouts at \$2.5 billion.⁷⁶ Any investor that relied on this information to be a fair predictor of future liability would be deeply disappointed in January 2019 when PG&E announced it was filing for bankruptcy and facing \$30 billion in wildfire liabilities.⁷⁷ PG&E's share price fell more than 80% in two months.⁷⁸

Expected damages from the changing climate extend far more broadly across the economy than mainstream financial news coverage might suggest to the average investor. With warmer days, labor productivity declines,⁷⁹ the rate of infectious

⁷² *The Cost of Inaction: Recognising the Value at Risk from Climate Change*, THE ECONOMIST INTELLIGENCE UNIT 41 (Jul. 24, 2015) (reporting \$43 trillion loss at high end of loss estimates, under 6°C of warming, which current consensus suggests we will not reach anytime in the next century).

⁷³ Allie Goldstein, Will Turner, Jillian Gladstone & David Hole, *The Private Sector's Climate Change Risk and Adaptation Blind Spots*, 9 NATURE CLIMATE CHANGE 18 (2019).

⁷⁴ U.N. ENV'T PROGRAMME FIN. INITIATIVE, CHANGING COURSE 51 (2019) (modeling a market portfolio of 30,000 companies and calculating value at risk, using a 15-year horizon under a scenario where warming is limited to 2°).

⁷⁵ *PG&E Corporation – Climate Change 2018*, CLIMATE DISCLOSURE PROJECT, https://www.pgecorp.com/corp_responsibility/reports/2018/assets/PGE_CDP_Climate_Change_Response_2018.pdf [<https://perma.cc/KE23-S5Q3>] (last visited Jan. 20, 2021).

⁷⁶ Brad Plumer, *Companies See Climate Change Hitting Their Bottom Lines in the Next 5 Years*, N.Y. TIMES (June 4, 2019), <https://www.nytimes.com/2019/06/04/climate/companies-climate-change-financial-impact.html> [<https://perma.cc/N9LM-GVDD>]; CLIMATE DISCLOSURE PROJECT, *supra* note 75.

⁷⁷ Russell Gold, *PG&E: The First Climate-Change Bankruptcy, Probably Not the Last*, WALL ST. J. (Jan. 18, 2019), <https://www.wsj.com/articles/pg-e-wildfires-and-the-first-climate-change-bankruptcy-11547820006> [<https://perma.cc/366P-QJHL>].

⁷⁸ *Id.*

⁷⁹ See Tord Kjellstrom, R Sari Kovats, Simon J Lloyd, Tom Holt & Richard S J Tol, *The Direct Impact of Climate Change on Regional Labor Productivity*, 64 ARCHIVE ENV'T OCCUPATIONAL HEALTH 217, 217 (2009) (concluding that “[w]orkers may need to work longer hours, or more workers may be required, to achieve the same output and there will be economic costs of lost production and/or occupational health interventions against heat exposures”).

diseases increases,⁸⁰ energy transmission becomes less efficient,⁸¹ wasps nests the size of cars become more common.⁸² And yet, when voluntarily disclosing their environmental risks to CDP, more than 1,000 U.S. manufacturing companies report they anticipate no climate-related risks.⁸³ The Brookings Institution recently found that communities exposed to heightened physical risk fail to report that risk in their municipal bond disclosures.⁸⁴

B. Drivers of Mispricing

An array of financial regulators share the conclusion that financial markets are failing to price climate risks, and this conclusion is supported by the growing number of empirical and model-based studies discussed in the preceding section. Yet, as critics of “sustainability” investing point out, this conclusion appears at odds with the Efficient Capital Markets Hypothesis (ECMH), which suggests that all known, or knowable, financial risks are already priced into the market.⁸⁵ This next section outlines the drivers of this mispricing, breaking them into six discrete categories: (1) Lack of asset-level data; (2) Model risk and latent risk; (3) Misaligned incentives of

⁸⁰ See Arthur Wyns, *Climate Change and Infectious Disease*, SCI. AM. OP. (Apr. 9, 2020), <https://blogs.scientificamerican.com/observations/climate-change-and-infectious-diseases/> [<https://perma.cc/S9GR-JDEW>] (citing research suggesting climate change is aggravating the negative health impacts of dengue, malaria, and cholera worldwide).

⁸¹ Matthew Bartos, Mikhail Chester, Nathan Johnson, Brandon Gorman, Daniel Eisenberg, Igor Linkov & Matthew Bates, *Impacts of Rising Air Temperatures on Electric Transmission Ampacity and Peak Electricity Load in the United States*, 11 ENV'T RSCH. LETTERS 114008, 1 (2016) (“As atmospheric carbon concentrations increase, higher ambient air temperatures may strain power infrastructure by simultaneously reducing transmission capacity and increasing peak electricity load.”).

⁸² Mariel Padilla, *Officials Warn of Wasp ‘Super Nests’ in Alabama*, N.Y. TIMES (June 30, 2019), <https://www.nytimes.com/2019/06/30/climate/yellow-jackets-wasp-nests.html> [<https://perma.cc/53HG-X7RS>].

⁸³ CDP, *Major Risk or Rosy Opportunity: Are Companies Ready for Climate Change?* (2019), <https://www.cdp.net/en/research/global-reports/global-climate-change-report-2018/climate-report-risks-and-opportunities> [<https://perma.cc/53HG-X7RS>] (showing that 1041 manufacturing companies report no climate related risk (as compared to 300 reporting physical risks, 326 reporting transition risks, and 472 reporting both)).

⁸⁴ Parker Bolstad, Sadie Frank, Erik Gesick & David Victor, *Flying Blind: What Do Investors Really Know About Climate Change Risks in the U.S. Equity and Municipal Debt Markets?*, HUTCHINS CTR. ON FISCAL & MONETARY POL’Y (2020), https://www.brookings.edu/wp-content/uploads/2020/09/WP67_Victor-et-al.pdf [<https://perma.cc/JBL8-JGSC>].

⁸⁵ See, e.g., Brest et al., *supra* note 14; Armour et al., *supra* note 20; Editorial Board, *Labor vs. The ESG Racket*, WALL ST. J. (Nov. 15, 2020, 6:23 PM), <https://www.wsj.com/articles/labor-vs-the-esg-racket-11605482618> [<https://perma.cc/QT3Y-3BC9>] (criticizing Larry Fink’s BlackRock for assuming markets don’t account for political risks like climate regulation and arguing that alleged “material” risks are “not clearly linked to financial performance”).

corporate leadership; (4) Myopic shareholders and market structure; (5) Misinformation and biases; and (6) Political opposition and regulatory capture.

This Article argues that in some cases, the market is mispricing risks that are already known, or could be known with present research methods and publicly available data.⁸⁶ In other cases, the data needed is unavailable to the market and kept internal to the corporation.

1. Lack of Asset-Level Data

Shareholders and analysts currently lack the fine-grained asset-level data they need in order to make climate-risk assessments.⁸⁷ The type of information needed to assess climate risk exposure—such as the location of a corporation's operations, the origins and routes of their supply chains, and the sources and quantities of inputs like water and energy—is not the type of information currently disclosed in financial reports.⁸⁸ Many climate risks are local in nature, so assets must be evaluated geospatially.⁸⁹ Often, however, the climate risk-related information that companies voluntarily disclose aggregates data at the parent or holding-company level and does not disclose information specific to subsidiaries or particular assets.⁹⁰ Corporate reporting of climate risks is far more likely to come in a qualitative, descriptive form

⁸⁶ In violation of the semi-strong version of the ECMH. See discussion of different forms of market efficiency under the Efficient Capital Markets Hypothesis, *infra* note 181.

⁸⁷ NGFS, CALL FOR ACTION, *supra* note 9, at 30 (“In the course of its work, the NGFS observed, like other institutions and academic papers before, that data scarcity and inconsistency are substantial obstacles to the development of analytical work on climate risk.”); *see generally* WORLD BANK & WORLD WILDLIFE FUND, SPATIAL FINANCE: CHALLENGES AND OPPORTUNITIES IN A CHANGING WORLD EFI INSIGHT-FINANCE (2020).

⁸⁸ CFTC REPORT, *supra* note 17, at 58 (“Some financial institutions may have asset-level data to overlay with physical risk data, for example, a bank providing project finance loans. However, most finance use cases will not have direct access to asset-level data for counterparty analysis, let alone analysis of multiple counterparties in a portfolio (such as a listed equities portfolio).”); FOUR TWENTY SEVEN, *supra* note 17, at 2 (“To do so, investors first need to identify the physical locations of the companies they invest in, a task made tricky by the generally poor corporate disclosure around these topics.”).

⁸⁹ JONATHAN WOETZEL, DICKON PINNER, HAMID SAMANDARI, HAUKE ENGEL, MEKALA KRISHNAN, BRODIE BOLAND & CARTER POWIS, MCKINSEY GLOB. INST., CLIMATE RISK AND RESPONSE: PHYSICAL HAZARDS AND SOCIOECONOMIC IMPACTS 39 (2020) [hereinafter MCKINSEY GLOB. INST.]; Letter from Jean M. Hynes, Managing Partner & Chief Exec. Officer, Wellington Asset Mgmt., to Allison Herren Lee, Comm’r, SEC (June 11, 2021) (“the lack of location data of their contractors obstructs us from understanding the climate risk of companies in the textile and clothing industries. Many of these companies disclose the locations of their direct properties but omit specific location information for the many other countries in which their production is located”).

⁹⁰ N.Y. Pub. Serv. Comm’n, Order Instituting Proceeding, In the Matter Regarding the Need for Reporting Risks Related to Climate Change, No. 20-M-0499, at 3 (Oct. 15, 2020), <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B0FFF1374-0511-41AC-8262-56BED5FAC8CC%7D> [https://perma.cc/6T8Q-J6RU].

than a quantitative one.⁹¹ And their assessment of risks occur at widely varying time scales.⁹² Further, many current models of climate risk fail to clearly differentiate between exposure and liability.⁹³ They may be able to describe that an asset is in a floodplain and exposed to hurricane risk, but they don't assess how resilient the asset will be to a hurricane. Have the operators of the asset made investments in climate adaption already? Is the asset relatively invulnerable?⁹⁴ More resilient than industry peers?

While companies have access to information regarding their own assets, they may be exposed to significant supply-chain risk. This risk may be impossible to evaluate without disclosure of the location and resilience of the facilities of suppliers and distributors.⁹⁵ Corporations may rely on key infrastructure, like roads and water utilities, that have unaddressed climate risk exposure, yet have operators who lack the resources or the mandate to even evaluate it.⁹⁶

2. *Outdated Means of Risk Assessment: Model Risk, Latent Risk, and Duration Mismatch*

The traditional methods by which market actors assess risk may be particularly prone to failure in a climate-changed world. Financial models, including those impacting capital-allocation decisions within corporations, often rely on historical data to make future risk projections.⁹⁷ In the climate context, the future will look

⁹¹ Goldstein et al., *supra* note 73; Bolstad et al., *supra* note 84, at 11 (reporting only 2% financial reports from the world's largest 250 firms quantified climate risks and only 3% "discuss if or how they use scenario analysis to model risk").

⁹² Bolstad et al., *supra* note 84, at 18.

⁹³ Asset-level data conference; CFTC REPORT, *supra* note 17, at 58 ("While an ecosystem of climate data is emerging, much of the advances in measuring and evaluating asset exposure have not been accompanied by corresponding advances in evaluating the sensitivity of exposed assets or the adaptive capacity of firms to manage sensitivity and exposure.").

⁹⁴ See generally WORLD BANK GRP., THE ROLE OF DESALINATION IN AN INCREASINGLY WATER-SCARCE WORLD (2019) (describing destination plants as an important asset to make communities resilient to climate change but not discussing the vulnerability of the plants themselves).

⁹⁵ MCKINSEY GLOB. INST., *supra* note 89, at 32.

⁹⁶ Sarah Whateley, Jeffrey D. Walker & Casey Brown, *A Web-Based Screening Model for Climate Risk to Water Supply Systems in the Northeastern United States*, 73 ENV. MODELLING SOFTWARE 64, 64 (2015) (describing that "small-scale [privately owned] water utilities in the northeastern United States that may lack the resources for detailed climate change risk investigations").

⁹⁷ Patrick Temple-West, *When Climate Change Threat to Weather Needs a Stilted Response*, FIN. TIMES (Dec. 1, 2019), <https://www.ft.com/content/80547020-bdbf-11e9-9381-78bab8a70848> [<https://perma.cc/X9CE-SY8C>]; MCKINSEY GLOB. INST., *supra* note 89, at 114 ("reliance on historical data or 'worst case' expectations based on experience to relying on climate modeling tools to prepare for the future, including building new analytics

very different from the past in myriad ways. Historical data representing a relatively stable climate past cannot be relied upon to predict future risks.⁹⁸ Future expected risk has to be creatively modeled—a challenge given uncertainties regarding emissions levels, future regulation, changes to the earth's ecosystems, and socioeconomic feedbacks.⁹⁹ The failure to adjust risk assessment methods for corporate decisions like crop selection, or the location and resilience of infrastructure, is one example of *model risk*.¹⁰⁰

Another type of model risk associated with climate change is failure to capture extreme unprecedented events. For example, one standard measure that portfolio managers use to estimate potential losses is value at risk (VaR). VaR provides a level of confidence, such as 95% or 99%, that an expected loss will fall within a certain range. But VaR says nothing about the potential magnitude of loss for the extreme event that has a 1% chance of occurring. Given that certain climate risks are highly

capabilities"); see also Colin Raymond, Radley M. Horton, Jakob Zscheischler, Olivia Martius, Amir AghaKouchak, Jennifer Balch, Steven G. Bowen, Suzana J. Camargo, Jeremy Hess, Kai Kornhuber, Michael Oppenheimer, Alex C. Ruane, Thomas Wahl & Kathleen White, *Understanding and Managing Connected Extreme Events*, 10 NATURE CLIMATE CHANGE 611 (2020).

⁹⁸ See generally BOLTON ET AL., *supra* note 46.

⁹⁹ While a challenge, insurance companies and other firms are increasingly turning to specialized private providers of climate forecasts, like Jupiter Intelligence. See Mary Franklin Harvin, *How Climate Prediction Tech Is Reshaping the Insurance Industry*, KQED (Nov. 29, 2019), <https://www.kqed.org/news/11788645/how-climate-prediction-tech-is-reshaping-the-insurance-industry> [<https://perma.cc/N9JX-J82Q>].

¹⁰⁰ MCKINSEY GLOB. INST., *supra* note 89, at 31–34. Firm managers make decisions about how to allocate their companies' capital to future investment projects by evaluating the expected future returns of these projects. To do this, they must account for how risky the project is, but current mainstream financial methods of evaluating this risk are not well-adapted to a future of climate extremes. The most common method used for assessing a potential investment is to calculate its net present value by summing all expected future returns over the lifetime of the project and discounting them by the risk-free rate (which represents the time-value of money) and a risk-premium, meant to account for riskiness of the project. This risk premium is rarely assessed by forward looking asset-specific analysis of risk, and instead is typically captured by backward-looking measures of past risk, often assessed at the company (rather than asset) level. See Mohsen Taheri, Mehdi Irannajad & Majid Ataee-pour, *Risk-Adjusted Discount Rate Estimation for Evaluating Mining Projects*, 4 FINSIA J. APPLIED FIN. 36, 40 (2009) (describing CAPM as the "main method" for estimating the risk-adjusted discount rate for mining projects). For example, one common method of approximating the appropriate risk premium is to calculate the cost of capital of similar firms in the same industry relative to the market. This calculation is often done using long term averages of the firms' stock prices. Marcel Kahan, *Securities Laws and the Social Costs of "Inaccurate" Stock Price*, 41 DUKE L.J. 977, 1040 (1992). In a world of climate change, however, past risk is no longer representative of future expected risk. Approximating a risk premium that accounts for expected climate risk is more challenging, as it requires more information than historical financial data. See, e.g., M. Onischka, *Environmental and Climate Risks in Financial Analysis*, 108 WIT TRANSACTIONS ON ECOLOGY & ENV'T 75 (2008).

uncertain, and potentially catastrophic, they may lie in this 1% zone that is likely to be discounted by market actors as “unlikely.”¹⁰¹ This “fat-tail risk” deviates from the normal distribution that market actors may be accustomed to relying on in their models.¹⁰²

A further potential for model risk comes from misjudging not only the increased frequency and severity of extreme climate events, but also their *correlation*.¹⁰³ Large multinationals, like PepsiCo, have operations located around the globe, and their size may factor into their traditional approach to risk management: it has been historically unlikely that a hurricane will hit operations in Brazil, Florida, and India in the same season.¹⁰⁴ Due to climate change, these physical risks may cluster in time and correlate across geographies in new and unanticipated ways.¹⁰⁵ Recent studies, for example, have highlighted the increasing, yet still largely unanticipated, chance for simultaneous temperature- and weather-induced crop failures in key breadbaskets around the world.¹⁰⁶ Lael Brainard, Board Member of the Governing

¹⁰¹ BOLTON ET AL., *supra* note 46, at 21 (“Moreover, climate-related risks typically fit fat-tailed distributions and concentrate precisely in the 1% not considered by VaR.”); *see also* Raymond et al., *supra* note 97.

¹⁰² VIVIAN DÉPOUES, VINCENT BOUCHET, MICHEL CARDONA & MORGANE NICOL, TOWARDS AN ALTERNATIVE APPROACH IN FINANCE TO CLIMATE RISKS: TAKING UNCERTAINTIES FULLY INTO ACCOUNT, INST. CLIMATE ECON. 6 (2019) (pointing out that “traditional approaches to risk management in the banking sector” rely on “historical data and on assumptions of normal distributions”); *see also* Yesha Yadav, *How Algorithmic Trading Undermines Efficiency in Capital Markets*, 68 VAND. L. REV. 1607, 1619, 1653 (2015) (noting that an estimated 70% of trading that occurs in the market is algorithmic or “quant” trading and these trades are based on models programmed to guess where the price will go in the relative short-term typically relying on backward-looking historical data. These models are “particularly prone to fail when confronted by new and abnormal events”) (“Catastrophes are difficult and costly to include in programming.”).

¹⁰³ *Cf.* Gilson & Kraakman, *Market Efficiency After the Financial Crisis*, *supra* note 16, at 343–44 (discussing how valuation models employed by banks and ratings agencies failed because they relied on historical housing price data to model future risk and ignored warnings of high unaccounted-for correlations between assets).

¹⁰⁴ *See, e.g.*, CFTC REPORT, *supra* note 17, at 33 (“Research suggests that bigger banks may be better able to offset temporary regional losses from natural disasters with earnings from other regions.” (citation omitted)).

¹⁰⁵ *See, e.g.*, L. Bonnafous, U. Lall & J. Siegel, *An Index for Drought Induced Financial Risk in the Mining Industry*, 53 WATER RES. RSCH. 1509, 1515 (2017) (showing that “spatial and temporal correlation in the frequency of climate extremes leads to tail portfolio risk that may . . . be substantially greater than expected from treating each asset as an independent exposure”); John Schwartz, *‘Like a Terror Movie’: How Climate Change Will Cause More Simultaneous Disasters*, N.Y. TIMES (Nov. 19, 2018), <https://www.nytimes.com/2018/11/19/climate/climate-disasters.html> [<https://perma.cc/EM8E-KXHY>].

¹⁰⁶ Andrew Freedman, *Extreme Weather Patterns Are Raising the Risk of a Global Food Crisis, and Climate Change Will Make This Worse*, WASH. POST (Dec. 9, 2019) <https://www.washingtonpost.com/weather/2019/12/09/extreme-weather-patterns-are-raising-risk-global-food-crisis-climate-change-will-make-this-worse> [<https://perma.cc/YAF3-LXYV>].

Board of the Federal Reserve, has noted this potential for unforeseen climate risk correlation and its resemblance to the 2008 mortgage crisis.¹⁰⁷

Additionally, traditional means of risk assessment may ignore *latent risks*: The entire capital stock of corporate America was built using engineering specifications designed to endure certain temperature and weather extremes that may be regularly exceeded in a climate-changed world.¹⁰⁸ A facility that was built to withstand a “100-year flood,” for example, may now have a much higher likelihood of failure.¹⁰⁹ Tens of thousands of steel bridges in the United States, for example, were built with design specifications for expansion and contraction based on estimated temperature extremes that are now expected to be surpassed.¹¹⁰ The businesses (and their shareholders) whose supply chains rely on these bridges are likely unaware of their heightened risk exposure. Climate change exacerbates the already fragile state of America’s aging infrastructure: more than 15 thousand dams (a majority of which are privately owned) have a “high-hazard” potential and 9–25% of bridges are structurally deficient without any consideration of climate impacts.¹¹¹

Finally, some corporate managers, especially those of mid-sized or smaller firms, are accustomed to relying on third-party insurance products to assess and price their company’s risk exposure, rather than internal statistical risk management.¹¹²

¹⁰⁷ Lael Brainard, Member, Bd. of Governors of the Fed. Res. Sys., Address at the Federal Reserve Bank of San Francisco’s “The Economics of Climate Change” Research Conference: Why Climate Change Matters for Monetary Policy and Financial Stability (Nov. 8, 2019) (transcript available in the Board of Governors of the Federal Reserve System).

¹⁰⁸ MCKINSEY GLOB. INST., *supra* note 89, at 49.

¹⁰⁹ See, e.g., Reza Marsooli, Ning Lin, Kerry Emanuel & Kairui Feng, *Climate Change Exacerbates Hurricane Flood Hazards along US Atlantic and Gulf Coasts in Spatially Varying Patterns*, 10 NATURE COMM’NS 1, 1 (2019) (finding that “100-year” flood events on the east coast will increase in frequency, to as much as annually or once every 30-years, depending on the region).

¹¹⁰ See Susan Palu & Hussam Mahmoud, *Impact of Climate Change on the Integrity of the Superstructure of Deteriorated U.S. Bridges*, 14 PLOS ONE 1, 7–8 (2019); see also U.S. DEP’T OF ENERGY, U.S. ENERGY SECTOR VULNERABILITIES TO CLIMATE CHANGE AND EXTREME WEATHER 8–16 (2013) (demonstrating that the United States’ average temperature is increasing, a trend which is expected to continue).

¹¹¹ AM. SOC’Y OF CIV. ENG’RS, 2017 INFRASTRUCTURE REPORT CARD: A COMPREHENSIVE ASSESSMENT OF AMERICA’S INFRASTRUCTURE 27 (2017) (listing 9.1% of bridges as structurally deficient); see also U.S. GOV’T ACCOUNTABILITY OFF., TRANSPORTATION INFRASTRUCTURE: INFORMATION ON BRIDGE CONDITIONS 2 (2015) (stating that nearly 25% of bridges are deficient, with 10% categorized as structurally deficient and 14% categorized as functionally obsolete).

¹¹² MCKINSEY GLOB. INST., *supra* note 89, at 114 (pointing out that “statistical risk management is often not part of ordinary processes in industrial companies”); cf. Zac J. Taylor, *The Real Estate Risk Fix: Residential Insurance-Linked Securitization in the Florida Metropolis*, 52 ENV’T PLAN. A: ECON. & SPACE 1131, 1133 (2020) (demonstrating “a strong tendency among . . . elected officials, planners, and real estate interests[] to assign re/insurers great responsibility for managing [Florida’s] climate risk”).

But insurance premiums are typically re-assessed and paid on an annual basis.¹¹³ In a world of non-linear climate responses, the price of insurance may dramatically skyrocket from one year to the next, and certain assets may become uninsurable altogether.¹¹⁴ Relying on insurance to price risks of investments that are expected to reap returns decades into the future leads to a “*duration mismatch*”¹¹⁵ that may leave these assets stranded without insurance, leading to unrecoverable losses in the event of a disaster.¹¹⁶

3. *Misaligned Managerial Incentives*

Corporate managers have access to their firms’ operational data and are likely better positioned, as compared to their shareholders, to assess their firms’ resilience to climate change. However, they may lack personal incentives for seeking out and assessing climate risk, let alone disclosing potential risk exposures to the market.¹¹⁷ The revelation that a firm is exposed to previously unaccounted-for climate risks may lead to a fall in share price that managers are trained, and incentivized, to avoid.¹¹⁸ In some cases, adapting to climate change requires up-front capital expenditures in order to stave off longer-term losses—like the raising or relocation

¹¹³ TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, 2019 STATUS REPORT 17 (“Since most of the re/insurance contracts with our clients have a duration of one year, we can thus adequately price natural catastrophe risks by updating our models to reflect the current climate.”).

¹¹⁴ See Jessica Shankleman, *Growing Climate Risks May Be ‘Impossible to Model’ – and Ultimately Uninsurable*, INS. J. (Nov. 13, 2017) <https://www.insurancejournal.com/news/national/2017/11/13/470949.htm>. [<https://perma.cc/7K7C-3EMG>].

¹¹⁵ See generally CONG. OVERSIGHT PANEL, JUNE OVERSIGHT REPORT: THE AIG RESCUE, ITS IMPACT ON MARKETS, AND THE GOVERNMENT’S EXIT STRATEGY 33–46 (2010) (stating the term duration mismatch typically refers to when a company’s liabilities are not closely linked in time with its assets in the United States).

¹¹⁶ MCKINSEY GLOB. INST., *supra* note 89, at 66; see also Bank of England Prudential Regulation Authority, *Transition in Thinking: The Impact of Climate Change on the UK Banking Sector* (Sept. 2018), <https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/report/transition-in-thinking-the-impact-of-climate-change-on-the-uk-banking-sector.pdf> [<https://perma.cc/W6XF-JXF2>] (arguing that while banks are aware that flood risk will increase, few have modelled effects on insurance premia of increased flood risk).

¹¹⁷ See, e.g., Armour et al., *supra* note 20, at 26–31 (arguing that stock-based, including options-based, executive compensation models incentivize corporate managers to neglect risk management programs, to the detriment of the long-term value of the stock); see also Anat R. Admati, *A Skeptical View of Financialized Corporate Governance*, 31 J. ECON. PERSPS. 131, 133–134 (2017).

¹¹⁸ William W. Bratton & Michael L. Watcher, *The Case Against Shareholder Empowerment*, 158 U. PA. L. REV. 653, 710–11 (2010).

of facilities. But managers whose performance is measured by stock price set by a myopic market are discouraged from making these investments in the short term.¹¹⁹

The reasons why managers may focus on keeping stock price high in the short term, even if that means sacrificing longer-term fundamental value, have been well explored in the literature. A drop in stock price may open up a manager to the risk of being fired,¹²⁰ so in the interest of self-preservation, the manager may focus on the demands of myopic shareholders while neglecting to spend resources assessing and mitigating longer-term risks to the company.¹²¹ Further, executive remuneration is regularly linked with short-term metrics of firm performance, including through compensation in stock or stock options.¹²² Evidence suggests that the shorter the time CEOs have to wait before their options vest, the more likely they are to cut investment budgets, personally profiting from the market's interpretation of short-term increases in earnings.¹²³ John Armour, Jeffrey Gordon, and Geeyoung Min show how options compensation, which becomes worthless if the stock falls below the strike price, mutes managers' personal exposure to downside risk.¹²⁴ Because managers are indifferent to the difference between a "bad" and a "worse" event, they are likely to ignore "insurance against low-probability high-impact events."¹²⁵

If cutting costs are not enough to meet earnings targets, managers may engage in "earnings management," a euphemism for accounting manipulations such as shifting expenditures to later quarters and revenues to earlier ones.¹²⁶ Earnings manipulation is just one example of managers undertaking "signal jamming," or the

¹¹⁹ Cf. Armour et al., *supra* note 20, at 24 (making analogous argument with respect to compliance programs, showing that up-front investment in compliance is shown on disclosed financial statements, while future benefits, both discounted and uncertain, are poorly reflected); LUCIAN BEBCHUK & JESSE FRIED, *PAY WITHOUT PERFORMANCE: THE UNFULFILLED PROMISE OF EXECUTIVE COMPENSATION* 183–85 (2004).

¹²⁰ See, e.g., Tim S. Campbell & Anthony M. Marino, *Myopic Investment Decisions and Competitive Labor Markets*, 35 INT'L ECON. REV. 855, 855–58 (1994); see also Bengt Holmstrom & Joan Ricart I Costa, *Managerial Incentives and Capital Management*, 101 Q. J. ECON. 835, 848–50 (1986).

¹²¹ Marcel Kahan & Edward B. Rock, *Hedge Funds in Corporate Governance and Corporate Control*, 155 U. PA. L. REV. 1021, 1088 (2007).

¹²² See, e.g., BEBCHUK & FRIED, *supra* note 119, at 137–38; Steven N. Kaplan, *CEO Pay and Corporate Governance in the U.S.: Perceptions, Facts, and Challenges*, 25 J. APPLIED CORP. FIN. 8, 9–11 (2013); Admati, *supra* note 117, at 133.

¹²³ Tomislav Ladika & Zacharias Sautner, *Managerial Short-Termism and Investment: Evidence from Accelerated Option Vesting*, 24 REV. FIN. 305, 305 (2020); see Alex Edmans, Vivian W. Fang & Katharina A. Lewellen, *Equity Vesting and Investment*, 30 REV. FIN. STUD. 2229, 2262–63 (2017); see also John R. Graham, Campbell R. Harvey & Shiva Rajgopal, *The Economic Implications of Corporate Financial Reporting*, 40 J. ACCT. & ECON. 3, 32–35 (2005) (stating that 80% of corporate executives admitted that they would decrease discretionary spending in areas such as research and development to meet quarterly earnings targets).

¹²⁴ Armour et al., *supra* note 20, at 20–21, 25.

¹²⁵ *Id.* at 25.

¹²⁶ See generally Dallas, *supra* note 22, at 296–97.

massaging of financial metrics used by investors to assess risk.¹²⁷ The coal company, Peabody Energy, may already provide an example of such agency costs in the climate context. In 2015 the New York attorney general announced it had reached a settlement with Peabody after an investigation revealed the company had withheld information from investors about the risks of future declining coal demand.¹²⁸ While Peabody's "disclosures denied its ability to reasonably predict the future impact of any climate change regulation on its business . . . the company and its consultants [internally] projected severe impacts from certain potential regulations that would materially affect Peabody."¹²⁹ In another example of potential managerial manipulation, the SEC is investigating the claim of an Exxon whistleblower that the company deceptively overvalued one of its largest oil assets and forced out employees who objected to the figure as unrealistic.¹³⁰

Equity-overvaluation can drive managers to preference short-term performance metrics over long term value-creation in an effort to meet market expectations.¹³¹ Michael Jensen has argued that in order to live up to the expectations of an overvalued stock price, managers spend money on schemes that destroy long-run value but "mask the inherent uncertainty in their businesses."¹³² In his model, executives sometimes spend money on investments that are not net-present-value justified, just to keep up the appearance of growth and the promise of future profits.¹³³ This

¹²⁷ *Id.*; Michael C. Jensen, *Paying People to Lie: The Truth About the Budgeting Process*, 9 EUR. FIN. MGMT. 379, 387 (2003).

¹²⁸ Press Release, N.Y. State Off. of the Att'y Gen., A.G. Schneiderman Secures Unprecedented Agreement with Peabody Energy to End Misleading Statements and Disclose Risks Arising from Climate Change (Nov. 9, 2015), <https://ag.ny.gov/press-release/2015/ag-schneiderman-secures-unprecedented-agreement-peabody-energy-end-misleading> [<https://perma.cc/QMP9-CFSL>].

¹²⁹ Clifford Krauss, *Peabody Energy Agrees to Greater Disclosures of Financial Risks*, N.Y. TIMES (Nov. 8, 2015) (quoting settlement documents between SEC and Peabody Energy), <https://www.nytimes.com/2015/11/09/business/energy-environment/peabody-energy-agrees-to-greater-disclosures-of-financial-risks.html> [<https://perma.cc/68J7-HZHA>].

¹³⁰ Christopher M. Matthews & Emily Glazer, *Exxon Draws SEC Probe over Permian Basin Asset Valuation*, WALL ST. J. (Jan. 15, 2021, 8:17 AM), <https://www.wsj.com/articles/exxon-draws-sec-probe-over-permian-basin-asset-valuation-11610716622> [<https://perma.cc/FT5Q-8GE2>].

¹³¹ See Henry T. C. Hu, *Risk, Time, and Fiduciary Principles in Corporate Investment*, 38 UCLA L. REV. 277, 335 (1990) ("There will be an especial tendency to overinvest with respect to those unusual investment projects which generate large negative cash flows in the long term. The manager might not care as much about the costs which arise after he retires or leaves the firm. He might not care [for example] about the restoration expenditures after strip mining . . .").

¹³² Jensen, *supra* note 21, at 7.

¹³³ *Id.* at 10; see also Kahan, *supra* note 100, at 1030–31 (describing a manager's attempt to "adapt" to a market misvaluation by pursuing strategies that result in overvaluation even though "pursuing business plans favored by the market even if they are not profitable . . . is obviously undesirable"). Under this view, stock buybacks, rather than

“overvaluation trap,” argued by Roger Martin and Alison Kemper, describes the decisions of oil executives to spend hundreds of billions of dollars, each year, on prospecting for new reserves, despite there being a fifty-three year supply of oil contained in the world’s existing two trillion barrels of reserves.¹³⁴ Oil companies derive most of their net present value from the future promised profitability of their reserves.¹³⁵ Any acknowledgment on the part of executives that these reserves may, in fact, not be worth bringing to the surface in a future world with stricter climate regulation and more competition from renewables will lead to a decline in stock price. For example, in 2004, under pressure from regulators, Shell downwardly adjusted its estimated proven reserves by 20%, and share prices fell 10%.¹³⁶ The practice of fossil fuel companies continuing to predict future cash flows from reserves that will likely be left undeveloped in an emissions-regulated world is consistent with these practices.¹³⁷

Some industries have adapted their compensation structures to counteract the general underinvestment pressure of short-termism, but these metrics may incentivize the wrong kind of long-term goals, reinforcing mispricing. In the fossil fuel industry, for example, many companies have policies that tie executive bonuses to the “reserves replacement ratio,” meaning the amount of reserves added relative to the amount extracted that year.¹³⁸ This metric, along with the common practice of

inflating shares, makes them fall, as investors interpret buybacks as a signal that the company does not have anything better to spend the money on.

¹³⁴ Roger L. Martin & Alison Kemper, *The Overvaluation Trap*, HARV. BUS. REV. (Dec. 2015), <https://hbr.org/2015/12/the-overvaluation-trap> [<https://perma.cc/H2M8-WDVS>].

¹³⁵ Analysis from McKinsey & Co. and Oxera and the Carbon Trust has shown that more than half of oil and gas companies’ valuation is based on anticipated cash flows more than ten years in the future. CARBON TRUST, CLIMATE CHANGE – A BUSINESS REVOLUTION? 13 (2008).

¹³⁶ John Carey, Christopher Palmeri & Stanley Reed, *Shell: The Case of the Missing Oil*, BLOOMBERG BUSINESSWEEK (Jan. 26, 2004), <https://www.bloomberg.com/news/article/s/2004-01-25/shell-the-case-of-the-missing-oil> [<https://perma.cc/W2CU-ZFJB>].

¹³⁷ See CARBON TRACKER INITIATIVE, MEASURING COMMITMENT TO CLIMATE GOALS (2019) (identifying \$50 billion of investment since 2018 in major fossil projects that undermine climate targets and warning that oil and gas companies risk wasting \$2.2 trillion by 2030 if they base investment decisions on current emissions policies announced by governments).

¹³⁸ Compare Sarah Anderson, Chuck Collins & Sam Pizzigati, *Money to Burn: How CEO Pay Is Accelerating Climate Change*, INSTITUTE FOR POLICY STUDIES 1, 13 (2015), <https://ips-dc.org/wp-content/uploads/2015/09/EE2015-Money-To-Burn-Upd.pdf> [<https://perma.cc/B8AG-9TZW>], and ExxonMobil, Notice of 2015 Annual Meeting and Proxy Statement (Form DEF 14A), 26 (April 14, 2015), <http://www.sec.gov/Archives/edgar/data/34088/000119312515128602/d855824ddef14a.htm> [<https://perma.cc/4Z7B-TE3M>] (citing the successful drilling of the first exploration well in the Russian Arctic as a basis for executive compensation decisions), with ConocoPhillips, 2017 Proxy Statement 86 (citing the removal of the reserves replacement ratio metric from the compensation incentive program as part of the company’s long term strategy for adapting to climate change), and

linking incentives to exploration and production rather than revenue, is meant to encourage investment in capital projects that may not generate revenues for many years.¹³⁹ At ExxonMobil, for example, 23% of executive pay is tied to metrics that directly incentivize growth in reserves and production, and another 23% is tied to “indirect growth” metrics like earnings and cash flow.¹⁴⁰ But these metrics are now out of synch in a world where long-term capital would best be served by *not* adding to likely unprofitable reserves.

4. *Market Structure Limits Shareholders Demand for Risk Assessment*

The ECMH rests on the assumption that the buyers and sellers in a market are actively seeking out relevant information on a firm’s fundamental value in order to profit off of any misvaluation.¹⁴¹ But the past few decades have seen innovation in the capital markets that suggest investors are following a different methodology than what we traditionally think an investor does (i.e., learning about a company to predict future profits and trading on that information). The corporate governance literature contains a voluminous debate about whether short-term focused hedge funds pressure corporations to be myopic, and if so, whether their longer-term counterparts—institutional investors like asset managers and pension funds—serve as a counteracting force to this short-termism.¹⁴² But this debate has largely failed to grapple with another difference (besides horizon) between long-term institutional

Simon Bowers & Harry Davies, *Oil Company Bosses’ Bonuses Linked to \$1tn Spending on Extracting Fossil Fuels*, GUARDIAN (May 25, 2015, 5:00 PM), <https://www.theguardian.com/environment/2015/may/25/oil-company-bosses-bonuses-1tr-spending-fossil-fuels> [<https://perma.cc/99BS-74X7>].

¹³⁹ See CARBON TRACKER INITIATIVE, PAYING WITH FIRE: HOW OIL AND GAS EXECUTIVES ARE REWARDED FOR CHASING GROWTH AND WHY SHAREHOLDERS COULD GET BURNED 20 (2019) (finding that out of 40 of the largest listed oil and gas companies in the S&P Global Oil Index, 32 had growth incentives based on production levels, 27 linked compensation with reserves, resources, drilling inventor, and acreage metrics, and 24 included both).

¹⁴⁰ CARBON TRACKER INITIATIVE, GROUNDHOG PAY: HOW EXECUTIVE INCENTIVES TRAP COMPANIES IN A LOOP OF FOSSIL GROWTH 18 (2020) (finding that 90% of oil and gas companies directly reward executives for production or reserves increases in some shape or form and recommending that “growth neutral” metrics be used instead, such as “return on average capital employed”).

¹⁴¹ Sanford J. Grossman & Joseph E. Stiglitz, *On the Impossibility of Informationally Efficient Markets*, 70 AM. ECON. R. 393, 403–04 (1980).

¹⁴² Compare Lucian A. Bebchuk, Alon Brav & Wei Jiang, *The Long-Term Effects of Hedge Fund Activism*, 115 COLUM. L. REV. 1085, 1090 (2015) (“Most importantly, there is no evidence that activist interventions produce short-term improvements in performance at the expense of long-term performance.”), with Leo E. Strine Jr., *Who Bleeds When the Wolves Bite?: A Flesh-and-Blood Perspective on Hedge Fund Activism and Our Strange Corporate Governance System*, 126 YALE L.J. 1870, 1915 (2017) (“[T]hose who manage active funds are likely to have compensation arrangements more based on the fund family’s profit’s or short-term returns than the long-term returns of the funds they manage.”).

investors and short-term focused hedge funds and quant traders: the former are increasingly quasi-indexers who “passively” buy and hold baskets of assets, while the latter make frequent firm-specific trades. Even if institutional investors are able to promote long-termism through governance measures and oversight of management, it is still active investors trading on the margins that determine share price.

One piece of evidence for short-termism in the equities market is decreased demand for longer-term risk analysis. While roughly 80% of the net present value of a long-term investor's portfolio is based on cash flows expected beyond the five-year horizon, most equity analysts buy or sell recommendations using risk analyses that fall within the three to five year mark.¹⁴³ Some of the sectors that are likely to be the most exposed to long-term climate risks, like utilities and real estate, have the largest percentage of their net present values derived from expected cash flows that extend more than 20 years into the future.¹⁴⁴ One recent survey asked equity analysts why there was such a focus on the short term, despite the fact that most equity is now held by “long term” investors.¹⁴⁵ The analysts reported that disconnect was due, in part, to lack of demand from investors.¹⁴⁶

Weak investor demand for long term risk analysis may be explained, in part, by the rise in short-term trading.¹⁴⁷ In 1960, the average share of stock was held for eight years and four months.¹⁴⁸ Current estimates of average length of share hold-time range between four and eight months,¹⁴⁹ with hedge fund holdings averaging

¹⁴³ NAQVI ET AL., *supra* note 22, at 5–6.

¹⁴⁴ 2 DEGREE INVESTING INITIATIVE, HIT AND MISS: ABOUT TCFD DISCLOSURE GUIDANCE FOR FINANCIAL INSTITUTIONS 8 (2017).

¹⁴⁵ NAQVI ET AL., *supra* note 22, at 5 (explaining that retirement funds and insurers have long term liabilities and are “supposed to optimize their return on a 15- to 30-year horizon”).

¹⁴⁶ *Id.* at 39 (reporting the other three reasons as (1) lack of data, (2) sophisticated long-term risk assessment is expensive and (3) methodological obstacles).

¹⁴⁷ ERNST & YOUNG, STUDY ON DIRECTORS' DUTIES AND SUSTAINABLE CORPORATE GOVERNANCE vi (2020); *cf.* Mark Roe, Holger Spamann, Jesse Fried & Charles Wang, *The Sustainable Corporate Governance Initiative in Europe*, YALE L. SCH. LEGAL SCHOLARSHIP REPOSITORY 133, 147 (2021) (arguing that this assertion is flawed as it misses the fact that “shares are increasingly owned by longer-term investors, even while the remaining short-term investors trade increasingly frequently and thus drive up the average turnover rate”). While Roe et al. are correct in their assessment of how this might affect corporate governance (managers are beholden to short- and long-term investors alike), it does not address how this dynamic is likely to affect myopic pricing.

¹⁴⁸ Warren Fiske, *Mark Warner Says Average Holding Time for Stocks Has Fallen to Four Months*, POLITIFACT (July 6, 2016), <https://www.politifact.com/factchecks/2016/jul/06/mark-warner/mark-warner-says-average-holding-time-stocks-has-f/> [<https://perma.cc/9GUM-R76S>].

¹⁴⁹ *Id.*; 2 DEGREE INVESTING INITIATIVE, THE LONG AND WINDING ROAD 11 (2017) (finding that the average share replacement rate for equity fund managers was 1.7 years).

four and a half months.¹⁵⁰ When investors hold stock for shorter periods of time, there is less demand for long-term risk analysis: the stock analyses are made considering performance projections over a much smaller window of time. The decision to buy or sell becomes increasingly divorced from an analysis of a stock's underlying fundamentals and based more upon "heterogeneous expectations about price movements."¹⁵¹ Former Delaware Supreme Court Chief Justice Leo Strine has commented that "actively traded funds turn over at a rate which makes it difficult to believe that their managers are basing their decisions on a genuine assessment of the corporations' long-term cash flow prospects as opposed to their speculation about where the market is heading."¹⁵² It has been empirically shown that increases in stock ownership by shorter-horizon investors are associated with reductions in longer-term investment spending and increased short-term earnings.¹⁵³ These cuts to spending, like reductions in research and development, lead to short-term increases in stock valuations that eventually decrease over time.¹⁵⁴

John Coffee details how in 2017, the hedge fund Elliot Management bought large stakes in NRG Energy, the second-largest producer of electricity in the U.S., in order to force sales of recently purchased solar and wind-based assets.¹⁵⁵ As part of its push to sell-off NRG's \$4 billion renewable energy business, Elliot placed a former utility regulator on the board who described himself as "battling this global warming hoax for [six] years now."¹⁵⁶ NRG's stock soared after the shake-up, and just months later, in early 2018, Elliott exited its position, selling 10 million shares

¹⁵⁰ Robin Greenwood & Michael Schor, *Hedge Fund Investor Activism and Takeovers* 13 (Harvard Bus. Sch. Working Paper Series, Paper No. 08-004, 2007), <https://www.hbs.edu/ris/Publication%20Files/08-004.pdf> [<https://perma.cc/QA9S-EN33>].

¹⁵¹ Dallas, *supra* note 22, at 300; *see also* Alfred Rappaport, *The Economics of Short-Term Performance Obsession*, 61 FIN. ANALYSTS J. 65, 66 (2005) ("The shorter the holding period, the more the beliefs of others rather than long-term fundamentals become central to investment decisions. High turnover thus sets the stage for short-term earnings-based decision making or momentum-motivated trading, which is not at all concerned with earnings.").

¹⁵² Leo E. Strine, Jr., *Can We Do Better by Ordinary Investors? A Pragmatic Reaction to the Dueling Ideological Mythologists of Corporate Law*, 114 COLUM. L. REV. 449, 478 (2014).

¹⁵³ Martijn Cremers, Ankur Pareek & Zacharias Sautner, *Short-Term Investors, Long-Term Investments, and Firm Value: Evidence from Russell 2000 Index Inclusions*, 66 MGMT. SCI. 4535, 4535 (2020).

¹⁵⁴ *Id.*; *see also* Patrick Bolton, José Scheinkman & Wei Xiong, *Executive Compensation and Short-Termist Behaviour in Speculative Markets*, 73 REV. ECON. STUD. 577, 598 (2006).

¹⁵⁵ John C. Coffee Jr., *The Agency Costs of Activism: Information Leakage, Thwarted Majorities, and the Public Morality* 36–37 (Eur. Corp. Governance Inst., Working Paper No. 373, 2017), https://scholarship.law.columbia.edu/faculty_scholarship/2057 [<https://perma.cc/BA38-PBBB>].

¹⁵⁶ Ed Crooks, *Activists Clash over Direction for NRG Energy*, FIN. TIMES (Apr. 10, 2017), <https://ft.com/content/89417ba2-1d3e-11e7-a454-ab04428977f9> [<https://perma.cc/H39Y-CPK8>].

of NRG, and pocketing more than a 100% return.¹⁵⁷ How less energy-diversified NRG will fare in the coming years, only time will tell, but this story is consistent with a market that undervalues climate-risk resilient assets. From the perspective of the hedge fund, it makes sense to force a company to sell assets that the market undervalues in the short term. But with carbon regulation increasingly inevitable, the sale may end up damaging NRG's long-term prospects.

The lack of demand for long-term risk analysis may be exacerbated by the rise of passive investment strategies, like indexing and exchange traded funds (ETFs).¹⁵⁸ At present, around half of U.S. stock held in investment funds is passively managed.¹⁵⁹ Passive investment means that the fund commits to matching and maintaining its portfolio to meet a certain stock index.¹⁶⁰ Because index funds “buy and hold” sections of the market, they have little need for expensive equity analyst recommendations on whether to buy or sell. Indexing has grown rapidly over the years, with hundreds of millions of dollars exiting active funds and entering passive

¹⁵⁷ FINTEL, *Elliott Management Corporation Ownership in NRG / NRG Energy Inc* (May 15, 2018), <https://fintel.io/so/us/nrg/elliott-management> [<https://perma.cc/5SN8-4NT8>]; Carleton English, *What Activist Elliott Management Looks for in a Utility Stock—and How Investors Can Take Advantage*, BARRON'S (July 3, 2020), <https://www.barrons.com/articles/beaten-down-utility-stocks-could-power-up-51593710476> [<https://perma.cc/4Q4P-TJAD>]; see also YAHOO! FINANCE, *NRG Energy, Inc.*, <https://yhoo.it/3lz4SMz> [<https://perma.cc/L9Z5-54AQ>] (showing that the price of NRG stock on the day Elliott obtained its shares—January 17, 2017—was between 16.11 and 16.45, and that the price of NRG stock on the day Elliott sold its 10 million shares—May 15, 2018—was between 33.71 and 33.98).

¹⁵⁸ This concern that the rise of indexing has drowned out the market drivers of supply and demand that are crucial for accurately pricing a stock has been expressed elsewhere, with varying degrees of hysteria. See Inigo Fraser-Jenkins, Paul Gait, Alla Harmsworth, Mark Diver, Sarah McCarthy, Robertas Stancikas, Alix Guerrini, Jonathan Absolon, Marion de Floris & Maureen Hughes, *The Silent Road to Serfdom: Why Passive Investing Is Worse than Marxism*, SANFORD C. BERNSTEIN & CO., LLC (Aug. 23, 2016) (warning that passive investing eliminates the mechanism which “optimize[s] the flows of capital in the real economy”); Jonathan Brogaard, Matthew Ringgenberg & David Sovich, *The Economic Impact of Index Investing*, 32 REV. OF FIN. STUD. 3461 (2019) (concluding from an empirical study of the impact of index investing on commodity price signals that “[c]onsistent with a feedback channel in which market participants learn from prices, our results suggest that index investing distorts the price signal thereby generating a negative externality that impedes firms’ ability to make production decisions”); Eric Belasco, Michael Finke & David Nanigian, *The Impact of Passive Investing on Corporate Valuation*, 38 MANAGERIAL FIN. 1067, 1080 (2011) (concluding from an empirical study that “the preference shift towards index fund investing is reducing the informational efficiency of stock prices”).

¹⁵⁹ John Detrixhe, *Half of US Stock Fund Assets Are Now Invested in Index Funds*, QUARTZ (May 20, 2019), <https://qz.com/1623418/index-funds-now-account-for-half-the-us-stock-market/> [<https://perma.cc/7HKN-4Z64>].

¹⁶⁰ See John H. Langbein & Richard A. Posner, *Market Funds and Trust Investment Law*, 1976 AM. B. FOUND. RES. J. 1, 1 (1976).

funds.¹⁶¹ As consumer demand for actively managed funds declines, so does the budget for equity research.¹⁶² The number of equity analysts employed by investment funds has steadily declined in recent years,¹⁶³ with the twelve largest investment banks employing 25% fewer analysts in 2019 as compared to 2011.¹⁶⁴ One report quoted an analyst as saying their “biggest and fastest growing client base is the hedge fund industry, which pushes analysts to be short-term.”¹⁶⁵

Index funds, unlike the buyers and sellers in an active market, are constrained by their investment strategy. They cannot sell out of a stock they believe is grossly overvalued. One index fund manager, in explaining his worry that the market misprices climate risk, acknowledges that his firm’s indexing strategy prevents the use of exit, which would otherwise drive down the price of an overinflated stock: “It’s of paramount importance to us that the market is able to reflect risk and opportunity in stock prices, particularly for our index funds, which don’t get to select the stocks they own.”¹⁶⁶ But if long-term investors think climate risks are

¹⁶¹ One investment research company dubbed the phenomenon “flowmageddon.” Russel Kinnel, *It’s Flowmageddon!*, MORNINGSTAR (Apr. 7, 2016), <https://www.morningstar.com/articles/747879/its-flowmageddon> [<https://perma.cc/XK7Q-VKW7>].

¹⁶² Robin Wigglesworth, *Final Call for the Research Analyst?*, FIN. TIMES (Feb. 7, 2017), <https://www.ft.com/content/85ee225a-ec4e-11e6-930f-061b01e23655> [<https://perma.cc/4KQ8-2MZ7>] (charting the decline in the number of total equity analysts employed, and attributing it, in part, to the competitive pressure from passive funds).

¹⁶³ Sarah Gordon, *Sellside Research Would Be Little Missed*, FIN. TIMES, (Feb. 6, 2017), <https://www.ft.com/content/0609b1b4-ec51-11e6-ba01-119a44939bb6> [<https://perma.cc/V S6Y-DP7V>] (referring to sellside analysts as “a dying breed”).

¹⁶⁴ Robin Wigglesworth & Philip Stafford, *Analyst Coverage Shrinks After Fee Shake-Up*, FIN. TIMES (Dec. 2, 2019), <https://www.ft.com/content/a85848e0-1507-11ea-9ee4-11f260415385> [<https://perma.cc/B8ML-VHRH>]; see also Justina Lee, *Analyst Jobs Vanish as a Perfect Storm Crashes into Research*, BLOOMBERG (Dec. 19, 2019), <https://www.bloomberg.com/news/articles/2019-12-19/analyst-jobs-vanish-as-a-perfect-storm-hits-wall-street-research> [<https://perma.cc/7U76-DF6C>] (reporting that spending on buy side research has fallen between 20% to 30%, and is likely to fall that much again in the near future, in part because “[m]achines are doing a lot more of the work and investors are piling into passive funds,” but also due to EU MiFID II regulations that require research costs to be separated from trading fees in client billing, forcing banks to directly justify the cost of research).

¹⁶⁵ NAQVI ET AL., *supra* note 22, at 59 (“The highest volume customers of sell-side equity research are hedge funds. This prevents a stronger focus on long-term risks.”).

¹⁶⁶ F. William McNabb III & Glenn Booraem, *Investment Stewardship 2017 Annual Report*, HARV. L. SCH. FORUM CORP. GOVERNANCE (Sept. 18, 2017), <https://corpgov.law.harvard.edu/2017/09/18/investment-stewardship-2017-annual-report/> [<https://perma.cc/KD 4Y-FCQG>]; see also *Examining the Macroeconomic Impacts of a Changing Climate: Hearing Before the Subcomm. on Nat’l Sec., Int’l Dev. and Monetary Pol’y*, 116th Cong. 48 (2019) (referencing testimony of Alicia Seiger, Managing Dir., Stanford Sustainable Fin. Initiative, stating that passive investors are exposed to systemic mispriced climate risks when active traders fail to trade on foreseeable climate risk information).

“substantially more financially material than do other investors,”¹⁶⁷ how are they to convince shorter-term traders to incorporate these risks into their trading strategy? One way might be to simply calculate and then publicly release information on climate-risk mispricing in the hope that the market responds. One of the first (and still best) studies of physical risk mispricing was produced by asset manager BlackRock.¹⁶⁸ While this public position on market risk from a sophisticated institution likely had some influence on price at some timescale, it's a clumsy mechanism that cannot be relied upon as a substitute for active trading.

Some corporate observers caution that short-term trading based on market volatility, rather than fundamental financial analysis, will lead to “herding effects,” in which individual investors make under-informed trades based on market responses to limited information, such as earnings reports.¹⁶⁹ This follow-the-leader game of stock valuation leads to distortions away from efficient pricing. Index investing is, in some sense, the ultimate herd. Recent studies provide some evidence that the growth of passive investing does in fact increase the potential for correlated market effects, but much more research on the issue is needed.¹⁷⁰

Concerns that the rapid rise of indexing will lead to inefficient markets are typically dismissed with the explanation that the remaining active funds will engage

¹⁶⁷ Philipp Kruger, Zacharias Sautner & Laura T. Starks, *The Importance of Climate Risks for Institutional Investors* 19 (Swiss Fin. Inst., Working Paper No. 18-58, 2019).

¹⁶⁸ See BLACKROCK, GETTING PHYSICAL, *supra* note 47.

¹⁶⁹ Scott Russell, *Regulation Fair Disclosure: The Death of the Efficient Capital Market Hypothesis and the Birth of Herd Behavior*, 82 B.U. L. REV. 527, 528 (2002); Dallas, *supra* note 22, at 315 (“Markets also absorb less diverse information when unsophisticated investors rely on certain public information, such as quarterly earnings, and the sophisticated investors follow this uninformed herd.”).

¹⁷⁰ Andrew G. Haldane, Exec. Dir., Fin. Stability, Bank of England, Address at the London Business School: The Age of Asset Management? (Apr. 4, 2014), <http://www.bankofengland.co.uk/publications/Documents/speeches/2014/speech723.pdf> [<https://perma.cc/5HWE-W9Q7>]; Enrica Bolognesi & Andrea Zuccheri, *On the Efficiency of Benchmarks Composition: A Behavioural Perspective* ITALIAN ASS'N OF SCHOLARS OF ECON. AND MGMT. OF FIN. INST. AND MKT. (2008); Doron Israeli, Charles M. C. Lee & Suhas A. Sridharan, *Is There a Dark Side to Exchange Traded Funds? An Information Perspective*, 22 REV. ACCT. STUD. 1048, 1078 (2017) (presenting empirical analyses which support the conclusion that increased ETF ownership leads to less analyst coverage of underlying securities and a decrease in firm-specific information being integrated into stock prices); see also Michael S. Piwowar, Comm'r, Sec. & Exch. Comm'n, SEC-NYU Dialogue on Exchange-Traded Products (Sept. 8, 2017), <https://www.sec.gov/news/speech/speech-piowar-2017-09-08> [<https://perma.cc/5LH3-4UWL>] (describing the evidence on whether passive investing leads to reduced market efficiency as “mixed”); cf. Lawrence Glosten, Suresh Nallareddy & Yuan Zou, *ETF Activity and Informational Efficiency of Underlying Securities*, 67 MGMT. SCI. 22, 44 (2021) (“ETF activity can improve short-run informational efficiency for underlying stocks.”).

in trading that will result in the accurate pricing of equity.¹⁷¹ However, these active funds typically have a shorter holding period and investment horizon than index funds and are interested in short-term rather than long-term profits.¹⁷² BlackRock responds to allegations that its ETFs distort efficient stock pricing by pointing out that there is an “extremely diverse” set of indexes: ones with “a broad market focus, others with a geographic focus, and still others with a sector-specific focus.”¹⁷³ The company argues that their investor-customers make the decision as to which index best suits their needs.¹⁷⁴ The implication is that this asset allocation decision itself affects price efficiency, as it reflects investor demand. A counter-response to this defense is that price efficiency is about individual stocks, not baskets of stocks. Or, if we take BlackRock’s argument that index selection is just another form of active management—impacting price efficiency—then perhaps index providers should be regulated as financial advisors.¹⁷⁵

Further, the increasing flow of money into ESG investment products (\$20 billion in 2019 alone)¹⁷⁶ suggests that investors are waking up to climate-related risks and potential mispricing. But the main vehicle for ESG investing tends to be “passive” funds that track an ESG index whose composition has been determined by companies’ ESG scores. These ESG metrics and indices have come under fire for misleading investors as to their methodology and composition.¹⁷⁷ Here, the question arises as to how much of an informed decision an investor is making when allocating assets to these bundles of stocks. As Adriana Robertson has argued, the investor is, in a way, delegating asset allocation decisions to the creator of the ESG index.¹⁷⁸ This delegation may come with underexplored agency costs and third-party

¹⁷¹ See Myles Udland, *The Laziest Investing Argument in the World Gets Blown Up*, BUS. INSIDER (May 2, 2016), <http://www.businessinsider.com/passive-investing-makes-markets-more-efficient-2016-5> [<https://perma.cc/J4BT-FPCP>] (summarizing the argument that index funds make the market more efficient by removing inexperienced investors from the price-determining mechanisms of supply and demand).

¹⁷² Strine, *supra* note 142, at 1915.

¹⁷³ BLACKROCK, INDEX INVESTING SUPPORTS VIBRANT CAPITAL MARKETS 14 (2017).

¹⁷⁴ *Id.* at 8, 14.

¹⁷⁵ Robertson, *supra* note 24, at 848; Paul G. Mahoney & Adriana Z. Robertson, *Advisers by Another Name*, U. VA. SCH. L., L. & ECON. PAPER SERIES 2021-01 (2021); see also Johannes Petry, Jan Fichtner & Eelke Heemskerk, *Steering Capital: The Growing Private Authority of Index Providers in the Age of Passive Asset Management*, 28 REV. INT’L POL. ECON. 1, 3 (2019) (arguing that index providers “steer capital with their indices as inclusions of firms or countries to an index can lead to inflows of billions of US\$ while exclusions can cause large quasi-automatic outflows”).

¹⁷⁶ CFTC REPORT, *supra* note 17, at 114 (citing Jon Hale, *Sustainable Fund Flows in 2019 Smash Previous Records*, MORNINGSTAR (Jan 10, 2020)).

¹⁷⁷ ESG scores from the main five ESG data providers are uncorrelated for any given company. Florian Berg, Julian F. Koelbel & Roberto Rigobon, *Aggregate Confusion: The Divergence of ESG Ratings* 31 (MIT Sloan Sch. Working Paper, Paper No. 5822-19, 2019) (“ESG rating divergence is not merely driven by differences in opinions, but also by disagreements about underlying data.”).

¹⁷⁸ Robertson, *supra* note 24, at 848; see also Petry et al., *supra* note 175, at 20.

mediation that obscures price efficiency. Vanguard's ESG US Stock ETF was called out by the *Financial Times* for including companies like Kinder Morgan and Marathon Petroleum, despite claiming to “specifically exclude” fossil fuels.¹⁷⁹ One analysis of funds offered in the UK found that more than one-third of those marketed as climate or low-carbon focused nevertheless contained oil and gas stocks.¹⁸⁰

5. *Misinformation and Biases*

In order for the market to be efficient under the ECMH, it must incorporate all publicly available information into share prices.¹⁸¹ But what if the market is broadly failing to make informed assessments, despite available information? Billionaire investor Jeremy Grantham has repeatedly argued that the market is failing to reasonably account for expected climate impacts:

[T]his is the first time in history, I believe, where a significant chunk of the US investment community does not believe in the most important factor that will affect [the energy] sector – climate change. Why? Because we have had a 30-year, well-funded program to make the problem of climate change seem vague, distant, and problematic. . . . How many [climate] deniers does it take to distort the price? How can this not affect the market's probabilities of carbon taxes, energy regulations, and other important factors?¹⁸²

Over the last few decades, fossil-fuel companies, related industries, and their allies have gone to great lengths to spread misinformation and doubt about the existence and impacts of climate change.¹⁸³ The American Petroleum Institute has

¹⁷⁹ Rennison & Nauman, *supra* note 24.

¹⁸⁰ Adrienne Buller, *‘Doing Well by Doing Good’? Examining the Rise of ESG Investing*, COMMON-WEALTH 23–24 (Dec. 12, 2020), <https://www.common-wealth.co.uk/reports/doing-well-by-doing-good-examining-the-rise-of-environmental-social-governance-esg-investing> [<https://perma.cc/555W-JNYM>].

¹⁸¹ When Eugene Fama first introduced his influential hypothesis, he divided the ECMH into three versions: the “weak,” “semi-strong,” and “strong” forms of the hypothesis. Under the strong form, prices reflect all relevant public and non-public information; under the semi-strong form, prices reflect all relevant public information (meaning insider trading can reap profits); and under its weak form, the hypothesis holds that price history cannot be used to predict future price movements. Eugene Fama, *Efficient Capital Markets: A Review of Theory and Empirical Work*, 25 J. FIN. 383 (1970). *See also* Gilson & Kraakman, *The Mechanisms of Market Efficiency*, *infra* note 213, at 554–56, and Gilson & Kraakman, *Market Efficiency After the Financial Crisis*, *supra* note 16.

¹⁸² JEREMY GRANTHAM, GMO, *THE RACE OF OUR LIVES REVISITED* 32–33 (2018), <https://www.gmo.com/americas/research-library/the-race-of-our-lives-revisited/> [<https://perma.cc/38VT-G9LC>].

¹⁸³ *See generally* ORESKES & CONWAY, *supra* note 25; MEYER, *supra* note 25. Academic economists have played a role in downplaying the severity of the climate crisis.

been funding climate disinformation and opposition for decades, including currently through social media.¹⁸⁴ The Trump administration aided in this disinformation campaign when federal agency websites were overhauled to remove the term “climate change,” deleting whole documents and webpages on the issue.¹⁸⁵ The head of the Environmental Protection Agency said in a 2017 CNBC interview that he does not believe carbon dioxide to be a “primary contributor” to global warming.¹⁸⁶

These efforts have had a well-documented influence on public opinion.¹⁸⁷ While an increasing percentage of the population now agrees that climate change is occurring—primarily because of their direct observations of extreme weather—the public’s understanding of its causes and effects is poor.¹⁸⁸ In a 2018 survey in Germany, only 31% of respondents correctly answered “no” to the question of whether ocean evaporation due to higher temperatures was predicted to lead to

See Spencer Glendon, *A Price, but at What Cost?*, WOODWELL CLIMATE RSCH. CTR. (Feb. 18, 2019), <https://www.woodwellclimate.org/a-price-but-at-what-cost/> [<https://perma.cc/XY4-XRYD>] (quoting William Nordhaus as stating that the difference between a climate and no-climate scenario is so small you “can barely spot the difference” on a growth chart); see also THOMAS SCHELLING, *COSTS & BENEFITS OF GREENHOUSE GAS REDUCTION* 19 (1998) (“I am not disappointed that no one is making progress on reducing emissions now because I think that within the next twenty years, we will have a better understanding of the effects of carbon emissions on the global climate.”).

¹⁸⁴ See generally Benjamin Franta, *Early Oil Industry Disinformation on Global Warming*, 30 ENV’T POL’Y 663 (2021) (finding that “the American Petroleum Institute was promulgating false and misleading information about climate change in 1980, nearly a decade earlier than previously known”); Emma Newburger, *Democrats Call on Oil Companies to Testify on Climate Disinformation*, CNBC (Sept. 16, 2021, 2:54 PM), <https://www.cnn.com/2021/09/16/democrats-to-investigate-oil-companies-over-climate-disinformation.html> [<https://perma.cc/HV96-STUZ>]; Hiroko Tabuchi, *In Your Facebook Feed: Oil Industry Pushback Against Biden Climate Plans*, N.Y. TIMES (Sept. 30, 2021), <https://www.nytimes.com/2021/09/30/climate/api-exxon-biden-climate-bill.html> [<https://perma.cc/AJC6-6GRC>].

¹⁸⁵ ENV’T DATA & GOVERNANCE INITIATIVE, *CHANGING THE DIGITAL CLIMATE: HOW CLIMATE CHANGE WEB CONTENT IS BEING CENSORED UNDER THE TRUMP ADMINISTRATION* 25–26 (2018).

¹⁸⁶ Coral Davenport, *E.P.A. Chief Doubts Consensus View of Climate Change*, N.Y. TIMES (Mar. 9, 2017), <https://www.nytimes.com/2017/03/09/us/politics/epa-scott-pruitt-global-warming.html> [<https://perma.cc/G64Z-K6U5>].

¹⁸⁷ See, e.g., Phoebe Keane, *How the Oil Industry Made Us Doubt Climate Change*, BBC NEWS (Sept. 20, 2020), <https://www.bbc.com/news/stories-53640382> [<https://perma.cc/TVN9-PFVV>].

¹⁸⁸ Robinson Meyer, *The Unprecedented Surge in Fear About Climate Change*, THE ATLANTIC (Jan. 23, 2019), <https://www.theatlantic.com/science/archive/2019/01/do-most-americans-believe-climate-change-polls-say-yes/580957/> [<https://perma.cc/3BR5-5A9Y>].

declines in global sea level.¹⁸⁹ Fifty-one percent thought that the ozone hole is the main cause of the greenhouse effect.¹⁹⁰

A recent survey asked 439 institutional investors about their assessment of climate related risks.¹⁹¹ Forty percent of the respondents indicated that they expected more than 2°C of warming by the end of the century, and just 12% expected an increase of more than 3°C. This means 60% of institutional investors believe warming will stay below 2°C despite the evidence that even if all countries were to fully meet their emissions targets and pledges under the Paris Agreement, warming by 2100 would likely reach 2.4°C.¹⁹² Their beliefs are misaligned not only with scientific projections, but also with their own portfolio allocations, most of which hold fossil assets that, if correctly valued, are aligned with a world headed to at least 3°C.¹⁹³

CEOs of American companies are disproportionately old, white, male, and conservative compared to the general population.¹⁹⁴ So are their boards.¹⁹⁵ Numerous studies have shown that this demographic is especially likely to deny the existence of climate change, or to downplay its effects.¹⁹⁶ In a 2018 poll, only 18%

¹⁸⁹ Monika Taddicken, Anne Reif & Imke Hoppe, *What Do People Know About Climate Change — and How Confident are They? On Measurements and Analyses of Science Related Knowledge*, 17 J. SCI. COMM'N 1, 11–12 (2018).

¹⁹⁰ *Id.* at 13.

¹⁹¹ See Philipp Kruger, Zacharias Sautner & Laura T. Starks, *The Importance of Climate Risks for Institutional Investors* 27–28 (Swiss Fin. Inst., Working Paper No. 18-58, 2019).

¹⁹² *Temperatures: Addressing Global Warming*, CLIMATE ACTION TRACKER, <https://climateactiontracker.org/global/temperatures/> [<https://perma.cc/MU8W-BNUS>] (last updated May 2021).

¹⁹³ Alastair Marsh, 'Portfolio Warming' Is the New Climate Anxiety for Fund Managers, BLOOMBERG, (Feb. 23, 2021), <https://www.bloomberg.com/news/features/2021-02-23/climate-change-s-impact-on-portfolios-is-axa-s-mega-investors-new-anxiety> [<https://perma.cc/UZ3J-AERC>].

¹⁹⁴ Jeff Green, Jordyn Holman & Janet Paskin, *America's C-Suites Keep Getting Whiter (and More Male, Too)*, BLOOMBERG (Sept. 21, 2018), <https://www.bloomberg.com/news/articles/2018-09-21/america-s-c-suites-keep-getting-whiter-and-more-male-too> [<https://perma.cc/YN94-N7VP>]; Claire Zillman, *The Fortune 500 Has More Female CEOs than Ever Before*, FORTUNE (May 16, 2019, 4:30 AM), <https://fortune.com/2019/05/16/fortune-500-female-ceos/> [<https://perma.cc/2MYL-CZB5>] (stating that as of June 2019, just 33 of the Fortune 500 CEOs were women, and women comprised only 25% of Fortune 500 boards).

¹⁹⁵ Alma Cohen, Moshe Hazan, Roberto Tallarita & David Weiss, *The Politics of CEOs*, 11 J. LEGAL ANALYSIS 2 (Eur. Corp. Governance Inst., Working Paper No. 450, 2019) (“We find that more than 57 percent of CEOs are Republicans (so defined), 19 percent are Democrats (so defined), and the rest are Neutral (so defined) Furthermore, Republican CEOs lead companies with almost twice the asset value of companies led by Democratic CEOs.”).

¹⁹⁶ Aaron M. McCright & Riley E. Dunlap, *Cool Dudes: The Denial of Climate Change Among Conservative White Males in the United States*, 21 GLOB. ENV'T'L CHANGE 1–2 (2011) (summarizing literature “finding that self-identified liberals, non-whites, and females are more likely to express concern about global warming than are their conservative, white,

of Republicans in the baby boomer generation and older believed that the earth was warming due to human activity.¹⁹⁷ Sitting board members and executives of major financial institutions have come under fire for their record as climate deniers.¹⁹⁸

Even when market actors have access to valid information concerning climate risks, their risk-assessment judgment is still tempered by persistent cognitive biases. Climate change, a long-term process not easily discernable in our daily lives, poses a challenge to accurate human threat assessment for a number of reasons. Psychological research has demonstrated that humans suffer from a status quo bias, whereby we not only prefer current conditions but also irrationally assume they will

and male counterparts, respectively”); *see also* PWC, THE COLLEGIALLY CONUNDRUM: FINDING BALANCE IN THE BOARDROOM 19, 26 (2019) (finding that “64% of female directors think investors are giving environmental/sustainability issues the right amount of attention, compared to just 33% of male directors,” and that 50% of all directors indicated that environmental expertise was either “not very important” or “not at all important” to include in a board’s competencies—it was ranked the least important out of 13 categories of expertise).

¹⁹⁷ Cary Funk & Brian Kennedy, *How Americans See Climate Change and the Environment in 7 Charts*, PEW RSCH. CNTR. (Apr. 21, 2020), <https://www.pewresearch.org/fact-tank/2020/04/21/how-americans-see-climate-change-and-the-environment-in-7-charts/> [<https://perma.cc/RA43-DX4F>].

¹⁹⁸ Saijel Kishan, *Climate Skeptic Asset Managers Face Pressure to Reveal Donations*, BLOOMBERG GREEN (Feb. 14, 2020), <https://www.bloomberg.com/news/articles/2020-02-14/climate-skeptic-asset-managers-face-pressure-to-reveal-donations> [<https://perma.cc/NX5D-RVTZ>] (discussing investment chief of Harris Associates previous denials of the existence of global warming); *Environmental Groups Call for JPMorgan Chase to Drop Climate Denier Lee Raymond From Board*, FRIENDS OF THE EARTH (Feb. 25, 2020), <https://foe.org/news/environmental-groups-call-jpmorgan-chase-drop-climate-denier-lee-raymond-board/> [<https://perma.cc/6QPF-ANBA>] (discussing the request by environmental groups to JP Morgan to remove ExxonMobil CEO from the bank’s board of directors).

continue.¹⁹⁹ This bias may influence shareholders to undervalue the significance of climate risk.²⁰⁰

The rational assessment of climate risk is further muddled by the very nature of information about climate change. Behavioral psychology tells us that information that is complicated and “difficult to decipher” is more likely to be discarded as untrue.²⁰¹ Market actors suffer from a number of heuristics, or mental shortcuts, which can derail the rational processing of complicated information. First, the availability heuristic may cause people to excessively discount the possibility of “black swan” climate events unless they’ve recently encountered salient examples of such events.²⁰² But, by definition, these high-impact, low-probability events are unlikely to occur frequently. Investors and managers, failing to find examples of

¹⁹⁹ The status quo bias has been experimentally demonstrated many times. *See, e.g.,* Daniel Kahneman, Jack L. Knetsch & Richard H. Thaler, *Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias*, J. ECON. PERSP. 193, 197–98 (1991) (discussing experiments demonstrating status quo bias); William Samuelson & Richard Zeckhauser, *Status Quo Bias in Decision Making*, 1 J. RISK & UNCERTAINTY 7 (1988) (finding through a series of decision-making experiments that individuals disproportionately stick with the status quo). However, some have more recently argued that status quo bias can be rational in some circumstances. *See, e.g.,* Jacob M. Nebel, *Status Quo Bias, Rationality, and Conservatism about Value*, 125 ETHICS 449, 475 (2015) (finding status quo bias may be rational under the conservative principle to “preserve valuable things”); Scott Eidelman & Christian S. Crandall, *Bias in Favor of the Status Quo*, 6 SOC. & PERSONALITY PSYCH. COMPASS 270, 270–71 (2012) (finding some cognitive and informational limitations may rationally justify continuation of the status quo).

²⁰⁰ Katie Critchlow, *Irrational Apathy: Investigating Behavioural Economic Explanations for the Carbon Bubble* (2016) (Masters dissertation, London School of Economics Dissertation), https://www.academia.edu/16319184/Investigating_behavioural_biases_and_the_carbon_bubble [<https://perma.cc/YF33-J35Y>]; *see generally* Elke U. Weber, *What Shapes Perceptions of Climate Change?*, 1 WILEY INTERDISC. REVS.: CLIMATE CHANGE 332, 336 (2010) (discussing possible reasons behind the low levels of concern among Americans toward climate change as an immediate risk).

²⁰¹ ADAM SZYSZKA, *BEHAVIORAL FINANCE AND CAPITAL MARKETS: HOW PSYCHOLOGY INFLUENCES INVESTORS AND CORPORATIONS* (2013) (citing Rolf Reber & Norbert Schwarz, *Effects of Perceptual Fluency on Judgments of Truth*, 8 CONSCIOUSNESS & COGNITION 338 (1999)); *see also* Stephan Lewandowsky, Ulrich K. H. Ecker, Colleen M. Seifert, Norbert Schwarz & John Cook, *Misinformation and Its Correction: Continued Influence and Successful Debiasing*, 13 PSYCH. SCI. PUB. INT. 106, 117 (2012) (finding people often prefer simpler rather than complex explanations and that “[w]hen misinformation is corrected with an alternative, but much more complex, explanation, people may reject it in favor of a simpler account that maintains the misinformation”).

²⁰² Choi & Pritchard, *supra* note 26; *see also* Thorsten Pachur, Ralph Hertwig & Florian Steinmann, *How Do People Judge Risks: Availability Heuristic, Affect Heuristic, or Both?*, 18 J. EXPERIMENTAL PYSCH.: APPLIED 314, 314 (2012) (finding availability heuristic “conformed to people’s responses best” regarding perception of certain health care risks).

these events in their everyday lives, may irrationally devalue serious climate risks to their companies and portfolios.²⁰³

Rational decision-making is also stymied by a myopic focus on immediate rewards irrespective of the long-term consequences of those rewards.²⁰⁴ Market actors are predisposed to prefer short-term goal gratification regardless of its long-term consequences.²⁰⁵ This “present-bias” also inhibits people from accurately considering future benefits with upfront costs.²⁰⁶ This bias may be particularly disastrous in the context of climate change, where adaptation may require significant capital expenditures in the near term in exchange for mitigated losses (or gains relative to competitors) farther in the future.

Individuals are influenced by the availability heuristic—the tendency to give greater importance to events that happened recently or that are easier to recall.²⁰⁷ For this reason, market actors are most likely to imagine a future that looks similar to the recent past, even if it means ignoring broader scientific understanding.²⁰⁸ Daniel Kahneman and Amos Tversky’s Prospect Theory suggests that company executives may be reluctant to spend upfront capital on climate adaptation measures, even if those measures save the company money in the long run. Under Prospect Theory’s certainty effect, individuals put more weight on outcomes that are certain, and less weight on outcomes that are unlikely, discounting them by more than the rational

²⁰³ Choi & Pritchard, *supra* note 26, at 12; Cass R. Sunstein, *The Availability Heuristic, Intuitive Cost-benefit Analysis, and Climate Change*, 77 CLIMATIC CHANGE 195, 195–196 (2006) (discussing American attitudes towards regulations in response to climate change as opposed to European’s “Precautionary Principle”).

²⁰⁴ Lisa Zaval & James F. M. Cornwell, *Cognitive Biases, Non-Rational Judgments, and Public Perceptions of Climate Change*, OXFORD RSCH. ENCYCLOPEDIA CLIMATE SCI. 10 (Nov. 2016) (citing George Loewenstein & Drazen Prelec, *Anomalies in Intertemporal Choice: Evidence and an Interpretation*, 107 Q. J. ECON. 573 (1992)); *see also* Natalie L. Denburg & William M. Hedgcock, *Age-Associated Executive Dysfunction, the Prefrontal Cortex, and Complex Decision Making*, in AGING AND DECISION MAKING: EMPIRICAL AND APPLIED PERSPECTIVES 1, 92 (Thomas M. Hess, JoNell Strough & Corinna E. Löckenhoff eds., 2015) (reaffirming tendency of “temporal discounting” whereby “individuals tend to have difficulty delaying gratification and would rather delay negative consequences”).

²⁰⁵ Walter Mischel & Ebbe B. Ebbesen, *Attention in Delay of Gratification*, 16 J. PERSONALITY SOC. PSYCH. 329 (1970); *see also* Denburg & Hedgcock, *supra* note 204, at 92.

²⁰⁶ Zaval & Cornwell, *supra* note 204, at 10; *see also* Leonhard K. Lades, *Towards an Incentive Salience Model of Intertemporal Choice*, 33 J. ECON. PSYCH. 833 (2012) (reaffirming finding that “as the future becomes present over time, the individuals’ intertemporal preferences change towards preferring immediate payoffs”).

²⁰⁷ Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 SCI. 1124, 1127–28; *see also* Pachur et al., *supra* note 202, at 314.

²⁰⁸ Choi & Pritchard, *supra* note 26, at 8 (“The availability heuristic may lead people to discount excessively the possibility of losses from high magnitude but low probability risks if such a loss has not occurred recently.” (citing Tversky & Kahneman, *supra* note 207, at 1127–28)).

weighing of their probability of occurrence.²⁰⁹ Thus, managers may overweigh the costs of adaptation measures in the present, which have a certain, known price tag, and underweight expected future climate damages whose magnitude and timing is more uncertain.

Managers may be subject to cognitive biases that encourage them to withhold stock value-decreasing information. Donald Langevoort argues that, even in the absence of intentional misrepresentation, managers “may subconsciously perceive information in a way, if at all possible, that permits them to maintain consistency with their self-image of efficacy and control, thereby justifying (to themselves and others) preservation of their positions and status.”²¹⁰ In the face of great uncertainty around the future of carbon regulation, managers may disregard future scenarios for decreased oil demand that are well within the realm of possibility and focus instead on more favorable predicted pathways.²¹¹ The *Wall Street Journal* reports that an

²⁰⁹ Amos Tversky & Daniel Kahneman, *The Framing of Decisions and the Psychology of Choice*, 211 SCI. 453, 454 (1981) (arguing that the certainty effect is shown when people prefer certain outcomes and underweight outcomes that are only probable); Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, 47 ECONOMETRICA 263 (1979); see also Mara Mather, Nina Mazar, Marissa A. Gorlick, Nichole R. Lighthall, Jessica Burgeno, Andrej Schoeke & Dan Ariely, *Risk Preferences and Aging: The “Certainty Effect” in Older Adults’ Decision Making*, 27 PSYCH. & AGING 801, 811 (2012) (reaffirming the certainty effect and finding that “older adults seem to weigh certainty more heavily than younger adults do. This finding suggests that older adults are even more susceptible to what Kahneman and Tversky (1979) termed the Certainty Effect”). The certainty effect can contribute to market actors seeking risk when one of their options is a sure loss (e.g., an upfront capital expenditure or the abandonment of a project).

²¹⁰ Donald C. Langevoort, *Organized Illusions: A Behavioral Theory of Why Corporations Mislead Stock Market Investors (and Cause Other Social Harms)*, 146 U. PA. L. REV. 101, 144 (1997); see also Tom Y. Chang, David H. Solomon & Mark M. Westerfield, *Looking for Someone to Blame: Delegation, Cognitive Dissonance, and the Disposition Effect*, 71 J. FIN. 267, 299 (2016) (finding that “The idea that investors may change their beliefs or take costly actions to preserve their sense of self-identity may seem odd in a financial setting, but would not be surprising to many social psychologists”).

²¹¹ In 2016, a small group of Exxon shareholders expressed concern that the company was “eroding shareholder value” through investments in capital projects that would be unprofitable in “a low carbon demand scenario.” They noted that Exxon’s capital expenditures had grown “9 percent from 2005 to 2014, coinciding with a 1 percent net income decline” and that Exxon had cut capital distributions to shareholders (through both dividends and buybacks) by 25% in the preceding year. ExxonMobil Shareholder Resolution, Item 10—Increase Capital Distributions (2016), <https://www.sec.gov/Archives/edgar/data/34088/000119312516539460/d14941ddef14a.htm> [https://perma.cc/CLW8-WC9D]. Similarly concerned shareholders of Chevron pointed to a Chatham House report that concluded “the only realistic option” for oil majors is to provide cash to shareholders and “shrink into the remaining areas of operation . . . where they can earn an acceptable return.” The report noted that this action “would require a major change in [firms’] corporate culture.” Natasha Lamb, Letter to Chevron Shareholders to Vote “For” Proposal 9, (May 11, 2016), <https://www.sec.gov/Archives/edgar/data/93410/000121465916011452/d511161px14a6g.htm> [https://perma.cc/Z7A4-9BP4].

Exxon geoscientist claims he lost his job after he challenged senior executives by asking the following during a 2020 employee townhall meeting: “We acknowledge the need to reduce our emissions, yet they are set to increase by at least 20% over the next five years In the end, wouldn’t you agree that this is a problem of behaviors and leadership?”²¹²

While the ECMH accepts that human traders have irrational biases, these biases are characterized as random and therefore cancel one another out, “leaving price to reflect a single, best-informed aggregate forecast.”²¹³ Of course, in the situation where investor biases are not in fact random, but aligned, they will not cancel-out; they will aggregate and influence the market price.²¹⁴

6. Corporate Opposition / Regulatory Capture

Shareholders concerned about climate risk have begun to press for disclosure directly from companies themselves. Their efforts, however, face opposition from corporate management, not only directly, but also through industry influence on government regulators.²¹⁵

²¹² Christopher M. Matthews, *Exxon Used to Be America’s Most Valuable Company. What Happened?*, WALL ST. J. (Sept. 13, 2020), <https://www.wsj.com/articles/exxon-used-to-be-americas-most-valuable-company-what-happened-oil-gas-11600037243> [<https://perma.cc/7T4U-BF2H>].

²¹³ Ronald J. Gilson & Reinier H. Kraakman, *The Mechanisms of Market Efficiency*, 70 VA. L. REV. 549, 581 (1984) [hereinafter Gilson & Kraakman, *The Mechanisms of Market Efficiency*] (“Although each trader’s own forecasts are skewed by the unique constraints on his or her judgment, other traders will have offsetting constraints. As trading proceeds, the random biases of individual forecasts will cancel one another out, leaving price to reflect a single, best-informed aggregate forecast.”).

²¹⁴ ANDREI SHLEIFER, *INEFFICIENT MARKETS: AN INTRODUCTION TO BEHAVIORAL FINANCE* 12 (2000) (“Recall that the second line of defense of the efficiency markets theory is that the irrational investors, while they may exist, trade randomly, and hence cancel each other out. . . . The psychological evidence shows precisely that people do not deviate from rationality randomly, but rather most deviate in the same way.”); see also Gilson & Kraakman, *The Mechanisms of Market Efficiency*, *supra* note 213, at 581 (explaining that unsystematic bias “washes out” over trading).

²¹⁵ In 2016 the SEC sought guidance on the need for updated rules on environmental risk disclosure. In the thousands of comments the agency received, investors were generally in favor of “more extensive and rule-like disclosure” while corporations were opposed. Business and Financial Disclosure Required by Regulation S-K: Concept Release, 81 Fed. Reg. 23916-01 (Apr. 22, 2016) (to be codified at 17 C.F.R. pt. 210, 229, 230, 232, 239, 240 & 249); Virginia Harper Ho, *Disclosure Overload? Lessons for Risk Disclosure & ESG Reporting Reform from the Regulation S-K*, 65 VILL. L. REV. 67 (2020). A 2019 report by PwC found a wide disparity between investor and director concerns related to climate change risk. In survey responses, 56% of directors indicated they thought institutional investors were devoting too much attention to environmental issues. This was true even though only 50% of directors agreed that their board “has a strong understanding of the ESG issues impacting

In response to growing shareholder support for climate disclosure resolutions, the National Association for Manufacturers (NAM) funded the formation of the Main Street Investors Coalition, a group that advocates against the influence of institutional shareholders and their focus on ESG issues.²¹⁶ Many fossil fuel executives, including those of Exxon and Shell, sit on NAM's board of directors.²¹⁷ The Coalition's executive director has argued that shareholder climate risk disclosure resolutions are motivated by asset managers' personal "political objectives" rather than genuine concern for assessing investment risk.²¹⁸ SEC Commissioner Hester Pierce has similarly spoken about shareholder advocacy for heightened environmental disclosures, suggesting such advocacy is motivated by "public shaming" rather than interest in informed investing.²¹⁹

The Coalition was a vocal supporter of several Trump-era regulations that have the net effect of making it harder for investors to reflect climate risk in their asset allocation decisions.²²⁰ Under Trump, the SEC finalized two rules that limit investor power to press for climate risk disclosure from companies: one that limits the ability of investors to propose and re-propose shareholder resolutions,²²¹ and another that increases issuer power relative to proxy advisory firms that counsel institutional

their company" and only 34% said that "ESG is regularly a part of the board's agenda." *The Collegiality Conundrum: Finding Balance in the Boardroom*, PWC'S 2019 ANNUAL CORPORATE DIRECTORS SURVEY at 4, 20, <http://www.circulodedirectores.org/wp-content/uploads/2019/12/pwc-2019-annual-corporate-directors-survey-full-report-v2.pdf> [<https://perma.cc/CSY8-K2TA>].

²¹⁶ Andrew Ross Sorkin, *What's Behind a Pitch for the Little-Guy Investor? Big Money Interests*, N.Y. TIMES (July 24, 2018), <https://www.nytimes.com/2018/07/24/business/deal-book/main-street-investors-coalition.html?searchResultPosition=1> [<https://perma.cc/EL87-YYT5>].

²¹⁷ Susan Moran, *Most Oil Giants Still Fighting Shareholder Pressure to Address Climate*, THE CLIMATE DOCKET (Apr. 11, 2019), <https://www.climatedocket.com/2019/04/11/most-oil-giants-still-fighting-shareholder-pressure-to-address-climate/> [<https://perma.cc/YZ78-LKPQ>].

²¹⁸ George David Banks, Opinion, *Environmental Shareholder Resolutions Will Never Deliver the Climate Consensus that America Needs*, WASH. EXAM'R (June 13, 2018), <https://www.washingtonexaminer.com/opinion/op-eds/environmental-shareholder-resolutions-will-never-deliver-the-climate-consensus-that-america-needs> [<https://perma.cc/E67Y-9LWG>].

²¹⁹ Hester M. Peirce, Comm'r, SEC, *Scarlet Letters: Remarks Before the American Enterprise Institute* (June 18, 2019).

²²⁰ Jon Hale, *Sustainability Matters: New SEC Rule Weakens Influence of Main Street Investors*, MORNINGSTAR (Sept. 24, 2020), <https://www.morningstar.com/articles/1002322/sustainability-matters-new-sec-rule-weakens-influence-of-main-street-investors> [<https://perma.cc/R5XW-D7QL>].

²²¹ Press Release, SEC, *SEC Adopts Amendments to Modernize Shareholder Proposal Rule* (Sept. 23, 2020).

investors on shareholder votes.²²² In addition, the Department of Labor amended regulations under the Employment Retirement Income Security Act to require that retirement plan fiduciaries exclusively consider “financial factors” relevant to the economic value of an investment.²²³ And the Office of the Comptroller of the Currency finalized a rule prohibiting large banks from excluding categories of industries, like fossil fuels, from their loan business.²²⁴ Outside of official rulemaking, the SEC granted an unprecedented amount of company requests to exclude shareholder proposals related to climate change from the proxy process, meaning they never went to a vote.²²⁵

C. Market Failure

While a growing number of investors argue that climate risks remain mispriced, they cannot correct the mispricing on their own. Informed investors are limited in their ability to arbitrage away mispricings, particularly those that are widespread and for which the timing of market correction is difficult to predict.²²⁶ While investors have made some progress in getting corporations to disclose climate-related risks under voluntary frameworks, these frameworks are insufficient as they provide

²²² See Press Release, Allison Herren Lee, Comm’r, SEC, Paying More for Less: Higher Costs for Shareholders, Less Accountability for Management (July 22, 2020) (arguing that the rule will lead to “less accountability on climate risk”); see also Press Release, Robert J. Jackson Jr., Comm’r, SEC, Statement on Proposals to Restrict Shareholder Voting (Nov. 5, 2019) (voting against the proposals and warning that this limiting of shareholder influence “makes it easier for insiders to run public companies in a way that favors their own private interests over those of ordinary investors”).

²²³ 29 C.F.R. §§ 2509, 2550 (2020); Press Release, Ceres, Ignoring Overwhelming Opposition, Labor Department adopts new rule that will impair ESG investing (Oct. 30, 2020) (discussing how an earlier version of the rule proposed directly prohibited the consideration of ESG factors).

²²⁴ Fair Access to Financial Services, 85 Fed. Reg. 75,261 (Nov. 25, 2020) (to be codified at 12 C.F.R. pt. 55); Eric Rosenbaum, *Trump Bank Regulator’s New Rule Incurs Wall Street and Climate Investor Ire on His Way Out the Door*, CNBC (Jan. 14, 2021), <https://www.cnbc.com/2021/01/14/trump-bank-regulator-incurs-wall-street-ire-on-way-out-the-door.html> [<https://perma.cc/93BT-ZEYW>].

²²⁵ McDonnell et al., *supra* note 28, at 8 (citing Majority Action, Climate Change in the Boardroom: How Asset Manager Voting Shaped Corporate Climate Action in 2019, <https://www.majorityaction.us/asset-manager-report> [<https://perma.cc/M6U3-MURY>]); Steven Mufson, *Exxon Shareholders Want Action on Climate Change. The SEC Calls It Micromanagement.*, WASH. POST (May 8, 2019), https://www.washingtonpost.com/national/health-science/exxon-shareholders-want-action-on-climate-change-sec-calls-it-micromanagement/2019/05/08/de283bf4-6c49-11e9-a66d-a82d3f3d96d5_story.html [<https://perma.cc/C6DV-LGTT>].

²²⁶ See, e.g., Gilson & Kraakman, *Market Efficiency After the Financial Crisis*, *supra* note 16, at 373 (“Prices in markets without an effective arbitrage mechanism incorporate public information very slowly.”).

broad discretion to issuers and little assurance as to the accuracy of the information provided.

1. *Inability of the Market to Self-Correct*

If there is in fact systemic and irrational investor bias, the ECMH posits that rationally informed arbitrageurs will exploit the mispricing, reaping a profit while bringing prices back to fundamental values.²²⁷ However, practical limits to arbitrage in the real world mean that the knowledge that asset valuations ignore climate risks does not necessarily enable an investor to make a profitable trade on that information, particularly without knowledge of *when* these risks will be exposed and repriced.

The capital asset pricing model (CAPM) is the most widely used model for calculating the equilibrium price of stocks. It assumes that all investors have access to the same publicly available information and that all investors have homogeneous expectations about future valuations. In the real market, however, investors have access to different amounts of information and may form different forecasts about the future.²²⁸ When shareholders harbor increasingly heterogeneous expectations about the future, “one would expect increasingly inefficient prices, at least as judged by the yardstick of the CAPM.”²²⁹ Bill Bratton and Michael Wachter have explained that heterogeneity in shareholder expectations is more likely to occur in situations when shareholders face uncertainty in predicting the future, such as “when there is a change in technology, when glamour companies emerge, or when companies running newer businesses with less established track records become an important part of the market.”²³⁰ Climate change presents a similar shift in the status quo that impedes reliable forecasting.

Even if some groups of shareholders are informed, the speculative aspect of stock price fluctuations might lead them to hold on to their stock rather than sell, knowing that climate skeptics and backward-facing algorithms are going to maintain demand in the immediate future. A well-informed investor may suspect, or even know, that a stock is overvalued and deviating from the true value diminished by climate risk, but she may nevertheless be powerless to influence the trends of the market.²³¹

²²⁷ See SHLEIFER, *supra* note 214, at 4; Gilson & Kraakman, *The Mechanisms of Market Efficiency*, *supra* note 213, at 581.

²²⁸ Gilson & Kraakman, *The Mechanisms of Market Efficiency*, *supra* note 213, at 577.

²²⁹ *Id.* at 561–62 n.41 (citing Stephen Figlewski, *Information Diversity and Market Behavior*, 37 J. FIN. 87, 101 (1982) (“heterogeneous expectations as obstacles to short and long run equilibrium prices”)); see also Edward M. Miller, *Risk, Uncertainty, and Divergence of Opinion*, 32 J. FIN. 1151, 1153–54 (1977) (noting badly informed investors tend to overprice risky assets).

²³⁰ Bratton & Wachter, *supra* note 118, at 707.

²³¹ ROBERT J. SHILLER, *IRRATIONAL EXUBERANCE* 197 (3d ed. 2015) (“[I]f indeed one knew today that the market would do poorly over the next ten or twenty years, but did not

Why aren't savvy investors shorting stocks misvalued due to climate risk? And shouldn't this shorting mechanism itself move prices closer to fundamental value? Some investors are in fact banking on the mispricing. David Burt, profiled in Michael Lewis's book *The Big Short*, is known for having predicted the 2008 subprime crisis and helping Cornwall Capital make millions of dollars through shorting the market.²³² He has recently appeared in headlines again, this time for heading an investment firm whose strategy is betting against residential mortgage-backed securities with exposure to coastal regions at risk from extreme weather events.²³³

But beyond these asset-specific shorting strategies, a large literature on the "limits to arbitrage" details why informed arbitrageurs are very limited in their ability to correct broad market mispricings.²³⁴ Arbitrageurs can't short the whole market, and they lack the resources to correct market-, or even industry-wide bubbles.²³⁵ Mere knowledge that the market is out of step with reality and behaving like a bubble is not enough—a trader must also have some ability to predict just

know exactly when it would begin to do poorly and could not prove one's knowledge to a broad audience, then there would be no way to profit significantly from this knowledge.").

²³² Geoff Dembicki, *A 'Big Short' Investor's New Bet: Climate Change Will Bust the Housing Market*, VICE (Nov. 1, 2019), <https://www.vice.com/en/article/wjwy9/a-big-short-investors-new-bet-climate-change-will-bust-the-housing-market> [<https://perma.cc/Q4EQ-5BZN>].

²³³ Kate Duguid, *Citing Climate Risk, Investors Bet Against Mortgage Market*, REUTERS (Sept. 29, 2019) (quoting David Burt, "The market's failure to integrate climate science with investment analysis has created a mispricing phenomenon that is possibly larger than the mortgage credit bubble of the mid-2000s"); Diana Olick, *Former Subprime Player Claims He Can Now Short the Mortgage Market for Climate and Covid Risks*, CNBC (Nov. 23, 2020), <https://www.cnn.com/2020/11/23/shorting-mortgage-market-covid-19-climate-risks.html> [<https://perma.cc/37ZM-AQL9>].

²³⁴ See, e.g., Jeff Schwartz, *Fairness, Utility, and Market Risk*, 89 OR. L. REV. 175, 208–13 (2010) (summarizing the literature).

²³⁵ See SHLEIFER, *supra* note 214, at 13–14

An arbitrageur who thinks that stocks as a whole are overpriced cannot sell short stocks and buy a substitute portfolio, since such a portfolio does not exist. The arbitrageur can instead simply sell or reduce exposure to stocks in the hope of an above-market return, but this arbitrage is no longer even approximately riskless, especially since the average expected return on stocks is high and positive. If the arbitrageur is risk averse, his interest in such arbitrage will be limited. With a finite risk-bearing capacity of arbitrageurs as a group, their aggregate ability to bring prices of broad groups of securities into line is limited as well.

Of course, when we get into the realm of quasi-arbitrage, where the relative prices of broad groups of securities seem to be out of whack, the risks become even more substantial. . . . As long as arbitrageurs have short horizons and so must worry about liquidating their investment in a mispriced asset, their aggressiveness will be limited even in the absence of a fundamental risk. *Id.* at 51.

when the market will come to its senses and the bubble will burst.²³⁶ Without this, they will be left holding a short position that requires substantial funds to hold, funds that their clients are uncomfortable, or incapable of, holding over long periods of time.²³⁷

2. Moral Hazard

Even if markets—that is, managers of financial institutions—could correct the mispricing, their own motivation to do so may be muted by expectations of government bailout. As argued by Graham Steele, banks and other institutions may fail to price in climate-related tail-risks for precisely this reason: that in the event of catastrophic loss, they expect the government to provide funds rather than letting a systemically important financial institution fail.²³⁸ This moral hazard may limit the motivations of market actors to fully account for catastrophic climate risks.²³⁹ Bank executives' lack of incentive to “self-insure”²⁴⁰ against climate risks is arguably even more acute than their non-financial CEO peers.²⁴¹

3. Failures of Voluntary Disclosure Standards

Shareholders, especially institutional investors, have woken up to the likely mispricing of climate risk in recent years.²⁴² And they have begun to demand the information they need for risk assessment via voluntary disclosures, through open letters to CEOs and votes in favor of disclosure proxy proposals.²⁴³ The private

²³⁶ Schwartz, *supra* note 234, at 213; Robert J. Shiller, *From Efficient Markets Theory to Behavioral Finance*, 17 J. ECON. PERSP. 83, 9697 (2003); SHLIEFER, *supra* note 214, at 156–74.

²³⁷ SHLIEFER, *supra* note 214, at 182.

²³⁸ Graham Steele, *Confronting the “Climate Lehman Moment”: The Case for Macroprudential Climate Regulation*, 30 CORNELL J. L. & PUB. POL'Y 109, 137–40 (2020). Steele also points out that the six largest U.S. banks are responsible for 37% of global fossil fuel financing since the signing of the Paris Agreement. *Id.* at 117 n.34.

²³⁹ BOLTON ET AL., *supra* note 46, at 9 (referring to potential for central banks to become “climate rescuers of last resort”).

²⁴⁰ *21st Century Economy: Protecting the Financial System from Risks Associated with Climate Change: Hearing Before the S. Comm. on Banking, Hous. & Urb. Affs.*, 117th Cong. 14 (2021) (statement of Greg Gelzinis, Associate Director of Economic Policy for Center for American Progress).

²⁴¹ *Cf.* Section II.B.3, *supra* note 20.

²⁴² BLACKROCK, *GETTING PHYSICAL*, *supra* note 47.

²⁴³ *See, e.g.*, David Vetter, *Wielding \$9 Trillion, Investors Warn Firms from BP to BMW to Get Real on Climate Change*, FORBES (Nov. 16, 2020 4:47 PM), <https://www.forbes.com/sites/davidvetter/2020/11/16/wielding-9-trillion-investors-warn-firms-from-bp-to-bmw-to-get-real-on-climate-change/?sh=1e931ee37ea0> [https://perma.cc/8ALY-PRBK]; Jackie Cook & Tom Lauricella, *How Big Fund Families Voted on Climate Change: 2020 Edition*, MORNINGSTAR (Sept. 28, 2020), <https://www.morningstar.com/articles/1002749/how-big->

sector has come to something of a consensus around the default standard for a voluntary disclosure regime: the Task Force on Climate-Related Disclosure (TCFD) produced a reporting framework in 2017 that is meant to be “widely adoptable” and “applicable to organizations across all sectors and jurisdictions.”²⁴⁴ The framework recommends eleven categories of disclosure, organized under four core elements covering governance, strategy, risk management, and metrics and targets.²⁴⁵ Some investors and experts have pushed for companies to report against industry-specific standards in addition to their TCFD disclosures.²⁴⁶

Voluntary reporting frameworks, however, are an imperfect solution to the problem of inadequate climate risk disclosures. Without enforcement and standardization, companies can pick and choose which reporting frameworks, or categories of risk within those frameworks, they disclose. This is particularly evident in the voluntary disclosure of fossil fuel companies to CDP, who report “more opportunities than risks from climate change.”²⁴⁷ As of 2018, the average voluntarily complying company provided less than four of the eleven disclosure metrics recommended under the TCFD.²⁴⁸ Firms have been particularly slow to employ scenario analysis and discuss climate-related operational risk—just 9% discussed the resilience of their business models to climate change.²⁴⁹ And disclosures are far more likely to dwell on transition risks than discuss physical risks.²⁵⁰ These voluntary disclosures remain nonstandardized and are difficult for stakeholders to analyze and compare across companies.²⁵¹ A large number of companies simply do not report climate risks through voluntary frameworks or otherwise. One third of

fund-families-voted-on-climate-change-2020-edition [https://perma.cc/4YLB-2GDC] (showing average shareholder support for climate-risk disclosure requests climbed to an all-time high in 2020); VANGUARD GROUP, CLIMATE RISK GOVERNANCE: WHAT VANGUARD EXPECTS OF COMPANIES AND THEIR BOARDS (2020).

²⁴⁴ TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, FINAL REPORT: RECOMMENDATIONS OF THE TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES iii (2017). The TCFD’s 2020 Status Report found that 1,344 corporations globally have expressed support for its recommendations, including 219 U.S. companies. *See* TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, 2020 STATUS REPORT 68 (2020). Financial institutions managing \$150 trillion have also stated support for the TCFD. *Id.*

²⁴⁵ *Id.* at 10.

²⁴⁶ *See SASB Standards*, SUSTAINABILITY ACCOUNTING STANDARDS BOARD, <https://www.sasb.org/standards/download/> [https://perma.cc/8BKF-GJJM] (last visited Aug. 8, 2021).

²⁴⁷ CDP, *supra* note 83, at 7.

²⁴⁸ TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, 2019 STATUS REPORT 7 (“[O]nly around 25% of companies disclosed information aligned with more than five out of the 11 recommend disclosures and only 4% of companies disclosed information aligned with at least 10 of the recommended disclosures.”).

²⁴⁹ *Id.*; *see also infra* note 297 (discussing scenario analysis and its utility in detail).

²⁵⁰ Bolstad et al., *supra* note 84, at 3.

²⁵¹ *See, e.g.,* Letter from Jean M. Hynes, *supra* note 89; Virginia Harper Ho, *Modernizing ESG Disclosure*, U. ILL. L. REV. (forthcoming May 2021), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3845145 [https://perma.cc/2QVS-S8ZR].

S&P 500 companies do not disclose their own (Scope 1) emissions, a relatively uncomplicated metric.²⁵²

Further, voluntary climate reporting is subject to a lower level of scrutiny than mandatory financial disclosure, which may impact the quality of the information provided. Among the S&P 500 companies, most sustainability and environmental disclosures lack external assurance, and the vast majority of external assurance is done on only a fraction of the information provided.²⁵³ As a result of the lack of third-party audits, investors are hesitant to rely on current climate disclosure packaged in “sustainability” reports. Under a mandatory framework required by the SEC, this reporting would be reviewed by SEC staff for compliance.²⁵⁴

III. SOCIETAL HARM OF CLIMATE RISK UNDERASSESSMENT

Two types of harms are generated by the under-assessment of climate risk: (1) the negative effects of climate change itself, as the mispricing of climate risk in the present leads to an inefficient allocation of investment capital; and (2) systemic risk to the financial system. If investors fail to demand risk assessment from companies, managers may be left unpunished by the market when they build homes and hotels in hurricane-prone regions too close to the shore or build bridges to withstand a “100-year-flood” based on a grossly unrepresentative historical record. This misinvestment imposes costs not just on the company and the investor but on the communities harmed by collapsing bridges and hotel evacuees.

A. Climate Damage

If the stock market fails to respond to poor managerial decisions like building in flood plains or mis-forecasting supply chain disruptions, capital will be allocated inefficiently.²⁵⁵ This is harmful not just to investors, but to everyone who relies on

²⁵² *How Much Can Financiers Do About Climate Change?*, THE ECONOMIST (June 20, 2020), <https://www.economist.com/briefing/2020/06/20/how-much-can-financiers-do-about-climate-change> [<https://perma.cc/KT9V-VW78>].

²⁵³ Jon Lukomnik, *State of Integrated and Sustainability Reporting 2018*, HARV. L. SCH. F. ON CORP. GOVERNANCE 3 (2018), <https://corpgov.law.harvard.edu/2018/12/03/state-of-integrated-and-sustainability-reporting-2018/> [<https://perma.cc/X967-QCGJ>] (describing how 36% of sustainability reports include external assurances and that about 90% of those assurances pertains to only some data).

²⁵⁴ Jill E. Fisch, *Making Sustainability Disclosure Sustainable*, 107 GEO. L.J. 924, 961–62 (2019).

²⁵⁵ Zohar Goshen & Gideon Parchomovsky, *The Essential Role of Securities Regulation*, 55 DUKE L.J. 711, 720 (2006) (“Accurate pricing is essential for achieving efficient allocation of resources in the economy.”); cf. Lynn A. Stout, *The Unimportance of Being Efficient: An Economic Analysis of Stock Market Pricing and Securities Regulation*, 87 MICH. L. REV. 613, 642–44 (1988) (arguing that “efficient stock markets may be neither necessary nor sufficient for the proper allocation of capital among corporations” partly because most capital is raised outside of the equity markets).

the goods and services these companies provide as well as those harmed by the externalities they generate. Disclosure of risk enhances “efficiency by improving corporate decisions relating to which proposed new investment projects in the economy are selected for implementation and how already existing projects are operated.”²⁵⁶ The majority of new public company investment comes from internally generated capital rather than funds raised from investors through financial instruments.²⁵⁷ Shareholders monitor the allocation of this capital through corporate governance mechanisms—oversight of managers and directors—rather than project-specific evaluation, and many of these mechanisms rely on share price as a proxy of success. As argued by Kevin Haerberle, inaccurate stock prices thwart shareholders from monitoring management and the use of corporate funds and reduce “the efficiency with which society allocates its scarce capital.”²⁵⁸

For example, oil and gas companies are currently allocating large up-front capital to the exploration and development of extraction projects that many argue are not net present value justified given projections of future demand in a carbon-regulated world.²⁵⁹ Were carbon risks to be accurately priced, it is likely that many of these projects would not be greenlit. One recent report calculates that between 40% and 50% of ExxonMobil’s upstream capital expenditure through 2025 will be spent on developing fossil resources that will be unsellable in a world that effectively implements regulation to limit warming to 2°C.²⁶⁰ Nevertheless, once these projects have been brought online, the expense of development will be a sunk cost. Oil and gas companies may decide to continue to process and sell fossil fuels at slightly above cost in order to recoup some, but not all, of the money spent, rather than abandoning the project entirely. For this reason, the mispricing of carbon risk in the present inefficiently subsidizes the future production of fossil fuels.²⁶¹

Similarly, managers unpunished by the market have little incentive to invest in adaptation measures and may neglect to spend money on elevating their factory,

²⁵⁶ Merritt B. Fox, *Civil Liability and Mandatory Disclosure*, 109 COLUM. L. REV. 237, 253 (2009).

²⁵⁷ See Kevin Haerberle, *Stock-Market Law and the Accuracy of Public Companies’ Stock Prices*, 2015 COLUM. BUS. L. REV. 121, 138 (2015).

²⁵⁸ *Id.*

²⁵⁹ Martin & Kemper, *supra* note 134, at 335.

²⁶⁰ CARBON TRACKER INITIATIVE, 2 DEGREES OF SEPARATION: TRANSITION RISK FOR OIL AND GAS IN A LOW CARBON WORLD 7 (2017).

²⁶¹ See, e.g., Andrea Liesen, *Climate Change and Financial Market Efficiency*, 54 BUS. & SOC’Y 511, 531 (2014) (“In the state of inefficiency evidenced in this research, the stock market does not correctly incorporate the climate-change-induced systematic risk of European companies when allocating ownership of capital stock. As the (incorrect) valuation of financial assets strongly affects the investments in assets in the real economy . . . capital is allocated inefficiently.”); Robert J. Barro, *The Stock Market and Investment*, 3 REV. FIN. STUD. 115, 130 (1990) (finding that changes in stock market prices “have a great deal of explanatory power for the growth rate investment”); see also Kahan, *supra* note 100, at 1039–41 (explaining that misvalued stock prices can lead to the use of an inaccurate discount rate in assessing potential investment projects “which, in turn, lead to inefficient capital budgeting decisions”).

investing in alternative energy sources, or researching heat-resistant crops.²⁶² Poor capital-allocation decisions made today will have long-lasting effects, particularly for projects involving infrastructure construction or purchases of equipment with long lifetimes and infrequent turnovers.²⁶³

B. Systemic Risk

One harm that stems from the failure to assess climate risk is the systemic nature of the risk itself.²⁶⁴ The primary way that academics and regulators have discussed the systemic nature of climate risk is through its possibility to cause a contagion of financial failures.²⁶⁵ If certain industry stocks are indeed overvalued due to the financial sector's failure to account for climate risk, the market may gradually adjust the mispricing in a slow price decline as it incorporates new information. Or, the market may correct suddenly, resulting in chain-reaction effects throughout the financial world. The more asset prices diverge from fundamentals, the higher the likelihood of a large and sudden realignment, *a.k.a.*, a bubble burst.²⁶⁶ A recently published "climate stress test of the financial system" calculated that six percent of the average investment fund's equity holdings are in the fossil fuel

²⁶² See, e.g., Jill E. Fisch, *Measuring Efficiency in Corporate Law: The Role of Shareholder Primacy*, 31 J. CORP. L. 637, 672 (2006); see also Bratton & Wachter, *supra* note 118, at 701–02 ("Contrariwise, if the market expects a company to invest in a line of business that the market believes will be highly profitable in the future, the managers will feel pressured to make the market-favored investment even if they understand that it is suboptimal based on their superior, contrarian information.").

²⁶³ See JAMES H. WILLIAMS, BENJAMIN HALEY & RYAN JONES, POLICY IMPLICATIONS OF DEEP DECARBONIZATION IN THE UNITED STATES 54 (2015).

²⁶⁴ See KERN ALEXANDER, RAHUL DHUMALE & JOHN EATWELL, GLOBAL GOVERNANCE OF FINANCIAL SYSTEMS: THE INTERNATIONAL REGULATION OF SYSTEMATIC RISK 24 (2006) (explaining that excessive risk taking on the part of networked individual financial actors can result in societal harms such as bank runs and currency collapse and that these "excessive costs of risk [] can be shifted onto society at large as a negative externality"); Michiel Bijlsma, Jeroen Klomp & Sijmen Duineveld, *Systemic Risk in the Financial Sector: A Review and Synthesis*, CPB NETH. BUREAU FOR ECON. POL'Y ANALYSIS 24–27 (2010) (describing how the interconnectedness of the financial sector means that an underpricing of risk can lead to a systemic risk for the whole sector and constitutes an externality); see also Dallas, *supra* note 22, at 267 (linking the financial crisis to short-termism of financial institutions).

²⁶⁵ Mark Carney, Resolving the Climate Paradox, Remarks at the Arthur Burns Memorial Lecture in Berlin (Sept. 22, 2016) (transcript available in the Bank of England online) ("Minsky moment"); Steele, *supra* note 238, at 136 ("interrelated risks of climate change can manifest and spread in a variety of contexts, including lending; securities, derivatives, and commodities dealing, underwriting, trading, and investing; and insurance underwriting").

²⁶⁶ See Dallas, *supra* note 22, at 315; Raghuram G. Rajan, *Has Financial Development Made the World Riskier?*, 1, 21–23, 25 (Nat'l Bureau of Econ. Rsrch., Working Paper No. 11728, 2005), https://www.nber.org/system/files/working_papers/w11728/w11728.pdf [<https://perma.cc/YKP9-SU98>].

industry, while an additional thirty-six percent are in “climate-policy relevant” sectors, including utilities, mining, housing, and transport.²⁶⁷ If each of these industries has failed to assess and disclose their exposure to climate risk, this amounts to a great deal of unaccounted risk that accumulates at the portfolio level.²⁶⁸

Mark Carney, former Governor of the Bank of England, has referenced the need to avoid “a climate Minsky moment,” cautioning that “sharp changes in valuations” of energy company securities due to unanticipated market and regulatory changes can have domino-effects throughout the financial sector.²⁶⁹ Several heads of other central banks agree with him that a “sudden collapse in asset prices” is possible.²⁷⁰ Sarah Breeden, the head of International Banks Supervisor at the Bank of England, has said that transition risk alone could constitute up to a \$20 trillion loss to the financial system.²⁷¹ Particular attention has been paid to the risks of a bubble in the coastal housing market, and relatedly, the municipal bond market.²⁷²

There have been attempts at predicting how the financial sector will react to climate-induced economic losses.²⁷³ One recent paper models how climate change induced reduction in labor productivity and capital stock could impact the stability

²⁶⁷ Stefano Battiston, Antoine Mandel, Irene Monasterolo, Franziska Schütze & Gabriele Visentin, *A Climate Stress-test of the Financial System*, 7 NATURE CLIMATE CHANGE 283, 283–84 (2017).

²⁶⁸ Steven L. Schwarcz, *Systemic Risk*, 97 GEO. L.J. 193, 198 (2008) (explaining that systemic risk can derive from aggregate risk taking on the part of many individuals because “like a tragedy of the commons, no individual market participant has sufficient incentive, absent regulation, to limit its risk taking in order to reduce the systemic danger to other participants and third parties”).

²⁶⁹ Carney, *supra* note 265; HYMAN P. MINSKY, *STABILIZING AN UNSTABLE ECONOMY* (2008).

²⁷⁰ Mark Carney, François Villeroy de Galhau & Frank Elderson, Opinion, *The Financial Sector Must Be at the Heart of Tackling Climate Change*, THE GUARDIAN (Apr. 17, 2019, 1:00PM), <https://www.theguardian.com/commentisfree/2019/apr/17/the-financial-sector-must-be-at-the-heart-of-tackling-climate-change> [<https://perma.cc/PBB2-TEPZ>]; see also GLENN D. RUDEBUSCH, FRBSF ECONOMIC LETTER: CLIMATE CHANGE AND THE FEDERAL RESERVE (2019) (“climate-based risk could threaten the stability of the financial system as a whole.”); Margherita Giuzio, Dejan Krusec, Anouk Levels, Ana Sofia Melo, Katri Mikkonen & Petya Radulova, *Climate Change and Financial Stability*, FIN. STABILITY REV. (2019).

²⁷¹ See Sarah Breeden, *Avoiding the Storm: Climate Change and the Financial System*, Address at the Official Monetary & Financial Institutions Forum in London (Apr. 15, 2019).

²⁷² See, e.g., Eben Harrell, *Are We on the Verge of Another Financial Crisis?*, HARV. BUS. REV. (Dec. 18, 2020) (“Tax-advantaged fixed-income instruments, such as municipal bonds, are a big part of many people’s retirement portfolios (and many insurance companies’ reserves.)”).

²⁷³ See, e.g., EUR. SYSTEMIC RISK BD., *supra* note 40, at 13 (modelling asset revaluation in response to global 2°C climate policy and finding that “major stock market indexes might fall by 15–20%”); see also UNIV. OF CAMBRIDGE INST. OF SUSTAINBL’Y LEADERSHIP, UNHEDGEABLE RISK: HOW CLIMATE CHANGE SENTIMENT IMPACTS INVESTMENT 6 (2015).

of the global banking system.²⁷⁴ In the model, climate impacts increase the frequency of firm bankruptcies and unpaid loans, requiring banks to be bailed out by governments, as overall macroeconomic growth slows due to warming.²⁷⁵ Under such a scenario, this banking instability can lead to financial crises amounting to 30% of GDP.²⁷⁶

The systemic risk literature, however, is limited by its focus on the financial sector and contagion. Climate change poses a risk to factors of production and to growth itself (labor, for example, becomes less productive in hotter temperatures). It, therefore, constitutes a macroeconomic risk that may or may not be labeled “systemic,” depending on whether that term can be applied to the real economy. Further, contagion can exist in the real economy—think of the supply chain effects of a major port being wiped out (or even the 1970s oil crisis).²⁷⁷ Climate risks, therefore, certainly constitute a *systematic* risk (as in broadly affecting the economy and non-diversifiable), even if one remains skeptical of the prospects of financial contagion.²⁷⁸

IV. RECOMMENDATIONS

A wide range of proposals have begun to appear for encouraging market actors to include climate in their assessment of financial risks, including integrating climate

²⁷⁴ See Francesco Lamperti, Valentina Bosetti, Andrea Roventini & Massimo Tavoni, *The Public Costs of Climate-Induced Financial Instability*, 9 NATURE CLIMATE CHANGE 829 (2019); see also Louison Cahen-Fourot, Emanuele Campiglio, Elena Dawkins, Antoine Godin & Eric Kemp-Benedict, *Capital Stranding Cascades: The Impact of Decarbonisation on Productive Asset Utilization*, INST. ECOL. ECON., Paper No. 18 (2019) (modeling possible cascades of stranded assets that travel through multiple industries and impacting the financial sector).

²⁷⁵ See *id.* at 829–30.

²⁷⁶ See *id.* at 831. Cf. Christina Parajon Skinner, *Central Banks and Climate Change*, 75 VAND. L. REV. (forthcoming 2021) (manuscript at 17–21) (arguing that banks do not hold sufficient amounts of carbon intensive credit assets for physical or transition risks to threaten their solvency in times of stress).

²⁷⁷ Thanks to Onur Özgöde for discussion on this point. See also Onur Özgöde, *The Emergence of Systemic Risk: The Federal Reserve, Bailouts, and the Monetary Government at the Limits*, SOCIO-ECON. REV. (2021) (providing historical overview of the development of the concept of “systemic risk”).

²⁷⁸ See Madison Condon, *Externalities and the Common Owner*, 95 WASH L. REV. 1, 17 (2020); RICHARD A. BREALEY, STEWART C. MYERS & FRANKLIN ALLEN, PRINCIPLES OF CORPORATE FINANCE 168–70 (Brent Gordon et al. eds., McGraw-Hill Irwin 10th ed. 2011) (describing the difference between firm-specific idiosyncratic risk, and portfolio-wide systematic market risk); Jeffrey Gordon, *Systematic Stewardship*, COLUM. L. & ECON. (Forthcoming Feb. 14, 2021), <https://ssrn.com/abstract=3782814> [<https://perma.cc/9VGR-YESX>].

risks into prudential regulation and stability monitoring,²⁷⁹ amending fiduciary duties of CEOs and asset managers,²⁸⁰ and integrating climate risks into central bank asset purchases.²⁸¹ The CFTC’s 2020 report on Managing Climate Risk in the U.S. Financial System alone lists 53 distinct recommendations for regulators to take; A comprehensive discussion of recommendations is therefore beyond the scope of this Article.²⁸² One particular intervention, a mandatory climate risk disclosure regime, has been increasingly demanded by regulators, nonprofits, and investors alike.²⁸³ Indeed, a proposed rule on mandatory climate risk disclosure is expected from the Securities and Exchange Commission by the end of 2021.²⁸⁴ As such, the following section briefly explores how a disclosure regime might address the market-wide neglect of climate risks. No amount of disclosure, however, can protect the market from climate change. The only path toward financial stability requires halting emissions. Beyond the “market failure” of emissions externalities, there is a limit to what increased disclosure can facilitate in the face of unhedgeable systemic risks.

²⁷⁹ See Steele, *supra* note 238; see also Gregg Gelzimis, *Addressing Climate-Related Financial Risk Through Bank Capital Requirements*, CTR. AM. PROGRESS (May 11, 2021, 12:01 AM), <https://www.americanprogress.org/issues/economy/reports/2021/05/11/498976/addressing-climate-related-financial-risk-bank-capital-requirements/> [<https://perma.cc/7RHX-Q36B>].

²⁸⁰ *Fact Sheet: Modernizing Fiduciary Duty*, REGENERATIVE CRISIS RESPONSE COMMITTEE, <https://regenerativecrisisresponsecommittee.org/press/factsheet-fiduciaryduty> [<https://perma.cc/2MGK-8BRA>]; BOLTON ET AL., *supra* note 46, at 62; see also *Guardrails to Protect the Commons*, SHAREHOLDER COMMONS, <https://theshareholdercommons.com/guardrails/> [<https://perma.cc/64F6-PQY2>] (last visited Aug. 8, 2021).

²⁸¹ CFTC REPORT, *supra* note 17, at 45; Matthew Razzano, *Going Green: The Federal Reserve’s Legal Authority to Combat Climate Change*, HARV. ENV’T L. REV. (Apr. 11, 2020), <https://harvardelr.com/2020/04/11/going-green-the-federal-reserves-legal-authority-to-combat-climate-change/> [<https://perma.cc/U2LN-ZHNK>].

²⁸² CFTC REPORT, *supra* note 17.

²⁸³ Simon Jessop & Matthew Green, *BlackRock CEO Backs Mandatory Climate Reporting, Urges U.S. Action*, REUTERS (Nov. 10, 2020, 10:38 AM), <https://www.reuters.com/article/uk-climate-change-blackrock-idUKKBN27Q2TS> [<https://perma.cc/C3YE-U9YW>]; see Press Release, Allison Herren Lee, SEC Comm’r, “Modernizing” Regulation S-K: Ignoring the Elephant in the Room (Jan. 30, 2020), <https://www.sec.gov/news/public-statement/lee-mds-2020-01-30> [<https://perma.cc/Q9P2-5QAX>]; Mindy S. Lubber, *Requiring Disclosure of Climate Change Risks Makes Sense for Investors, Companies, and the U.S. Economy*, CERES (July 17, 2019), <https://www.ceres.org/news-center/blog/requiring-disclosure-climate-change-risks-makes-sense-investors-companies-and-us> [<https://perma.cc/JB2W-S7TG>].

²⁸⁴ Public Statement, Lee, *supra* note 32; Quinson, *supra* note 32.

A. Update Disclosure Requirements

As discussed elsewhere, the SEC already has the statutory authority to enact a mandatory climate risk disclosure regime.²⁸⁵ Issuing climate risk disclosure regulations falls within the SEC's self-defined "core mission to promote investor protection, market efficiency and competition, and capital formation."²⁸⁶ Systematic integration of climate risks by financial actors can help prepare corporations and the broader economy for both the green transition and physical resilience.²⁸⁷ A mandatory disclosure regime can help overcome both managerial and investor biases.²⁸⁸ The famous adage "you can't manage what you don't measure" holds here: the very process of collecting information and assessing resilience may help managers respond to previous underpriced and unaddressed risks.²⁸⁹ Disclosure may

²⁸⁵ Condon et al., *supra* note 36 (citing Business and Financial Disclosure Required by Regulation S-K, Release No. 33-10064, 81 Fed. Reg. 23,915, 23,969-973 (Apr. 13, 2016) (citing Sections 7, 10, and 19(a) of the Securities Act of 1933, 15 U.S.C. §§ 77g(a)(10), 77j, and 77s(a); and Sections 3(b), 12, 13, 14, 15(d), and 23(a) of the Securities and Exchange Act of 1934, 15 U.S.C. §§ 78c(b), 78l, 78m(a), 78n(a), 78o(d), and 78w(a)); *see also* CFTC REPORT, *supra* note 17, at 93 ("Section 302 of [the Sarbanes-Oxley Act of 2002] discusses disclosure controls including the requirement to establish, maintain, and regularly evaluate the effectiveness of the issuer's disclosure controls and to have corporate officers certify that such controls are in place. Building on this, Exchange Act Rules 13a-14 and 15d-14 require that the issuer's principal executive officer and principal financial officer certify that the financial statements and other financial information included in the report do not omit a material fact.")).

²⁸⁶ Virginia Harper Ho, "Comply or Explain" and the Future of Nonfinancial Reporting, 21 LEWIS & CLARK L. REV. 317, 340-41 (2017) (citing Business and Financial Disclosure Required by Regulation S-K: Concept Release, 81 Fed. Reg. 23,916, 23,917, 23,922 & n.6 & n.55 (Apr. 22, 2016)); *see also* Zohar Goshen & Gideon Parchomovsky, *The Essential Role of Securities Regulation*, 55 DUKE L.J. 711, 715 (2006) (asserting that the essential role of "securities regulation is . . . to facilitate and protect the work of inform[ed] traders" that leads to the production of more information about firms' values).

²⁸⁷ J.D. Farmer, C. Hepburn, M. C. Ives, T. Hale, T. Wetzler, P. Mealy, R. Rafaty, S. Srivastav & R. Way, *Sensitive Intervention Points in the Post-Carbon Transition*, 364 SCIENCE 132, 132-34 (2019) (arguing that "[r]elatively modest changes to financial accounting rules or disclosure guidelines regarding climate change risks could have outsized effects").

²⁸⁸ *See, e.g.*, George Loewenstein, Cass R. Sunstein & Russell Golman, *Disclosure: Psychology Changes Everything*, 6 ANN. REV. ECON. 391 (2014); Choi & Pritchard, *supra* note 26, at 60-66 (arguing that because biases may persist even if there is accurate countervailing information disclosure may need to be supplemented by other regulatory action such as adjusting the definitions of materiality, creating antifraud liability, or educating investors).

²⁸⁹ *See, e.g.*, Hillary A. Sale & Donald C. Langevoort, "We Believe": Omnicare, Legal Risk Disclosure and Corporate Governance, 66 DUKE L.J. 763, 786-88 (2016) (arguing, in keeping with a 'information-forcing-substance theory,' that disclosure forces managers to attend to "underlying details" and promotes conversations between directors, officers, and

also facilitate the construction and monitoring of ESG metrics and indices designed to reduce exposure to climate risk.²⁹⁰

However, even under a mandatory disclosure regime, corporate managers maintain their share-price-based incentives to potentially obscure future risks. The SEC must develop the expertise to evaluate whether climate-related claims about the future are misleading, a task that will require a substantial investment in hiring and collaboration with climate experts. Any mandatory climate risk disclosure regime has to meet climate science where it is. Regulators must pay particular attention to the spatial and temporal scales of requested disclosures and ensure they are both scientifically feasible and tailored to industry-specific needs.²⁹¹ In particular, an overemphasis on false precision provided by complicated models might obscure the usefulness of other methods of risk assessment and communication.²⁹² This fact should inform how the SEC decides to structure climate risk disclosure compliance, including balancing the pros and cons of principles-based versus line-item disclosures.²⁹³ In crafting disclosure regulation, the SEC

peers, about risk assessment). Of course, biases may persist even in the face of accurate countervailing information. *See also* Choi & Pritchard, *supra* note 26, at 32 (indicating biases may persist even in the face of accurate countervailing information).

²⁹⁰ John Coffee, *The Future of Disclosure: ESG, Common Ownership, and Systematic Risk* (ECGI Working Paper 541/2020), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3678197 [<https://perma.cc/HHN6-ZTLP>]; Mahoney & Robertson, *supra* note 175, at 46–47. *See also* Madison Condon, *The Sprawling Problem of Financial Greenwashing*, in *BUSINESS LAW AND THE TRANSITION TO THE NET ZERO CARBON ECONOMY* (Andrea Engert, Luca Enriques, Georg Ringe, Umakanth Varottil and Thom Wetzer eds., forthcoming 2021).

²⁹¹ Not all risk assessment requires the use of global climate models, which are in fact poorly suited to assessing sub-regional and asset-level risk exposures in the near-term. *See* Tanya Fiedler, Andy J. Pitman, Kate Mackenzie, Nick Wood, Christian Jakob & Sarah E. Perkins-Kirkpatrick, *Business Risk and the Emergence of Climate Analytics*, *NATURE CLIMATE CHANGE* 11, 87–94, 90–92 (2021).

²⁹² *Id.*; Financial regulators are correct in calling for “future research . . . to go further and develop models and measures of [climate-related risks] that can be applied to individual assets.” Luiz Awazu Pereira da Silva, *Remarks at the Conference of the Central Banks and Supervisors Network for Greening the Financial System: Research on Climate-Related Risks and Financial Stability: An “Epistemological Break”?* (Apr. 17, 2019), https://www.bis.org/speeches/sp190523.htm#_ftn8 [<https://perma.cc/9CHD-UMDU>]. Climate risk data firms like Four Twenty Seven—bought by Moody’s in 2019—specialize in this type of short-term physical risk assessment. *See Banks Are Getting Interested in Big Data to Figure Out Their Climate Risk*, *MARKETPLACE TECH* (Dec. 1, 2020), <https://www.marketplace.org/shows/marketplace-tech/banks-are-getting-interested-in-big-data-to-figure-out-their-climate-risk-2/> [<https://perma.cc/E2H8-VV2G>]. There may be a need for a government role in fostering this project, which will require “substantial new investment in high performance computing, climate model design and a long-term investment in climate science capability.” Fiedler et al., *supra* note 291, at 89.

²⁹³ SEC Commissioner Allison Herren Lee dissented from the SEC’s recent update to regulation S-K, arguing that the SEC’s “broad, principles-based ‘materiality’ standard” was failing to produce the “consistent, reliable, and comparable” information that investors want,

should draw on climate-related expertise at other federal agencies through interagency working groups and advisory boards.²⁹⁴

1. *Dealing with Uncertainty*

Issuers opposed to heightened climate risk disclosure requirements have sometimes argued that the large amounts of uncertainty around climate change make forward-looking disclosures impossible or misleading.²⁹⁵ And climate scientists themselves have warned that reliance on global climate models for pricing short-term business risk can be misguided.²⁹⁶ Central bank authorities have also cautioned that due to complexity and non-linearity, potential unknown tipping points, and fat-tailed risks, macroeconomic models of long-term climate impacts cannot necessarily be relied upon to target policy goals.²⁹⁷ However, as engineers focused on adaptation

especially with regard to climate risks. Public Statement, Lee, *supra* note 32. It's true that the broad principles-based standard gives managers too much discretion to withhold information. See *supra* Section II.B.2. However, some consideration must be made to whether specific, quantitative line-item disclosures are appropriate for certain forms of climate risk. This determination must be made in consultation with climate scientists and accounting experts. In some cases, quantitative disclosures may mask uncertainty, and may require contextual information like assumptions made, or error bars in order to better inform investors.

²⁹⁴ See, e.g., EPA SCIENCE ADVISORY BOARD (SAB), <https://yosemite.epa.gov/sab/sabpeople.nsf/WebCommittees/BOARD> [<https://perma.cc/FF92-UL5W>] (last visited Aug. 15, 2021) (In 1978, upon congressional direction, the EPA established the EPA Science Advisory Board to “advise the agency on broad scientific matters” as well as review scientific information used for agency programs and regulations); see also Condon et al., *supra* note 36. President Biden has convened an Interagency Working Group on the Social Cost of Greenhouse Gases that draws from expertise across more than a dozen agencies. Technical Support Document, Interagency Working Group on Social Cost of Greenhouse Gases, *Interim Estimates Under Executive Order 13990* (Feb. 2021), https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf?source=email [<https://perma.cc/C99D-9G4Z>].

²⁹⁵ Greg Baer, *BankThink: Climate Risk Test Asks Banks to Look Too Far Down the Road*, AMERICAN BANKER (Nov. 30, 2020, 10:55 AM), <https://www.americanbanker.com/opinion/climate-risk-test-asks-banks-to-look-too-far-down-the-road> [<https://perma.cc/9C4D-CSE2>].

²⁹⁶ Fiedler et al., *supra* note 291, at 91.

²⁹⁷ BOLTON ET AL., *supra* note 46, at 3 (citing Martin L. Weitzman, *On Modeling and Interpreting the Economics of Catastrophic Climate Change*, 91 REV. OF ENV'T ECON. & POL'Y 1 (2009); Martin L. Weitzman, *Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change*, 5 REV. OF ENV'T ECON. & POL'Y 1 (2011)); cf. BOLTON ET AL., *supra* note 46, at 24 (“This does not mean that the development of forward-looking methodologies is not useful. On the contrary, non-financial and financial firms alike will increasingly need to rely on them to explore their potential vulnerabilities. But for central banks, regulators and supervisors concerned about the resilience of the system as a whole, the development of forward-looking, scenario-based methodologies should be assessed with

have warned, regulators should avoid the conflation of “deep uncertainty as to the distant future with potentially predictable, uncertainty as to the near future.”²⁹⁸

One means of facilitating disclosure in the face of longer-term uncertainty is through scenario analysis, which delivers information about risk exposures in different future possible states of the world without assigning probability to those futures.²⁹⁹ This method helps to deliver information to investors without glossing over the high degree of uncertainty when estimating energy sector transitions, warming pathways, and climate responses. The SEC should consider whether to construct and provide specific scenarios for companies to report against.³⁰⁰ When the choice of scenario is left up to issuer discretion, they may choose scenarios favorable to their prospects: cherry-picking future warming pathways or regulatory (in)action favorable to their companies’ future.³⁰¹

a more critical stance.”); M. Alexander Pearl, *The (Next) Big Short and the End of the Anthropocene*, 3 UTAH L. REV. 383, 417 (2019) (arguing that climate models parallel models in the subprime mortgage crisis which often failed of models to adequately incorporate complexity and systemic risks).

²⁹⁸ James Doss-Gollin, David Farnham, Michelle Ho & Upmanu Lall, *Adaptation over Fatalism: Leveraging High-Impact Climate Disasters to Boost Societal Resilience*, 4 J. WATER RESOURCES PLAN. MGMT. 146, 2 (2020) (pointing out that “successful identification and prediction of climate on subseasonal to decadal timescales . . . can be used to inform the development of tools to alleviate the impact of weather and climate hazards”).

²⁹⁹ TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, THE USE OF SCENARIO ANALYSIS IN DISCLOSURE OF CLIMATE-RELATED RISKS AND OPPORTUNITIES 2 (2017).

³⁰⁰ CFTC REPORT, *supra* note 17, at 74 n.5 (“One option for standardizing baseline projections would be to calibrate a model to a projection from the U.S. Energy Information Administration’s Annual Energy Outlook. These projections, however, apply only to fossil fuel-related CO₂ emissions and thus would not include projections of other gases and sources in the United States.”).

³⁰¹ Kate Mackenzie, *The Trouble with Climate Scenarios Is Everyone Has Their Own*, BLOOMBERG (Aug. 7, 2020), <https://www.bloomberg.com/news/articles/2020-08-07/the-trouble-with-climate-change-scenarios-is-everyone-has-their-own> [<https://perma.cc/XC2C-CHKP>]. Indeed, the NYAG found that Peabody Energy disclosed the results of only one of three International Energy Agency scenarios it had analyzed—the scenario with the largest projected coal demand due to global climate regulation failure. *See* Press Release, N.Y. State Office of the Att’y Gen., *supra* note 128. The investigation found that in its projections of the future, Peabody frequently referred in public statements to results of only one of the [International Energy Agency] IEA’s three scenarios for worldwide coal demand: the ‘Current Policies Scenario,’ a status-quo scenario that predicts rising future demand for coal based on an assumption that governments will fail to adopt any new policies or regulations to reduce the amount of climate change pollution—even policies and regulations that the IEA deems governments are likely to adopt. In doing so, Peabody failed to disclose the IEA’s other two scenarios, which are much less favorable projections of world coal demand by the IEA. There are also complaints from investors that even when companies use the same scenarios they often report different types of information gleaned from the analysis, making it very hard to compare disclosures across companies. Margaret Peloso, *Panel 2: The Current*

However, as leading practitioner Margaret Peloso has warned, standardizing scenarios can also mask uncertainty.³⁰² She notes that the vast majority of U.S. oil and gas companies reporting under the TCFD framework use the IEA energy demand scenarios, in part because of investor expectations. These scenarios predict an orderly transition away from fossil fuels, a “robust” demand for natural gas through 2040, and largely ignore potential short-term stressors.³⁰³ Universal reliance on one projection of future transition pathways could, in fact, amplify the harmful effects of a surprised market, rather than diminish them. Peloso encourages thinking of scenario analysis “as a tool for imagination” in which corporate resilience is strengthened through the consideration of a wide variety of scenarios: short-term, long-term, and those that include potential “double black swan” events.³⁰⁴ She warns that if you “reduce scenario analysis to a cookbook,” you constrain the creative thinking necessary for imagining the potential for multiple and converging climate-related risks.³⁰⁵

2. *Engaging with Auditors and PCAOB*

Securities regulators face a balancing challenge when designing disclosure regimes: how to give investors the information they need without either

State of Corporate Climate Disclosure and Applications, YOUTUBE (Oct. 6, 2020), <https://youtu.be/caxY0jIM0b8> [<https://perma.cc/8Y7G-WHWT>] [hereinafter *Margaret Peloso at Corporate Climate Risk*]; CFTC REPORT, *supra* note 17, at 81 (arguing that regulators “should develop and prescribe a consistent and common set of scenarios and assumptions” which would allow for “better comparability across results and encourage the development of universal scenario analysis capabilities”).

³⁰² *Margaret Peloso at Corporate Climate Risk*, *supra* note 301.

³⁰³ *Id.* (noting that none of [Peloso’s] clients in the oil and gas industry were using scenarios that came close to capturing the price-stress experienced by the collapse of OPEC in early 2020). The IEA’s past scenarios have been criticized for poorly anticipating how quickly renewable energy became cost-competitive. *See, e.g.*, Simon Evans, ‘*Profound Shifts Underway in Energy System, Says IEA World Energy Outlook*’, CARBON BRIEF (Nov. 13, 2019, 8:20 AM), <https://www.carbonbrief.org/profound-shifts-underway-in-energy-system-says-iea-world-energy-outlook> [<https://perma.cc/8PLS-NJW2>]; Gero Rueter, *Is the IEA Underestimating Renewables?*, DEUTSCHE WELLE (Mar. 3, 2018), <https://www.dw.com/en/is-the-iea-underestimating-renewables/a-43137071> [<https://perma.cc/V59Z-JGA2>].

³⁰⁴ A “black swan” event, as popularized by Nassim Nicholas Taleb, is an extreme low probability event that is challenging to predict with traditional financial models. *See* Editorial, *Black Swans are Difficult to Predict but We Still Need Maths in Finance*, CITYAM, (Feb. 10, 2013, 9:15 PM), <https://www.cityam.com/black-swans-are-difficult-predict-we-still-need-maths-finance/> [<https://perma.cc/5SPN-VG2D>] (explaining “[a] black swan is an event that is so unprecedented it is impossible to predict. Black swans, Taleb argues, are what matter, yet they are precisely what our best mathematical models are unable to anticipate. This is a problem for financial modelling, Taleb says.” (citing NASSIM N. TALEB, *THE BLACK SWAN* (2d ed. 2010))).

³⁰⁵ *Margaret Peloso at Corporate Climate Risk*, *supra* note 301.

overwhelming them with data or revealing competitive trade secrets. Auditors play a key role in this balancing act. And while climate change can materially impact many of the disclosure metrics already required in official financial statements, the U.S. auditing industry is prey to many of the same myopic drivers discussed previously.³⁰⁶ Even those companies that voluntarily report under the TCFD framework, and include climate in management's discussion of risk, fail to clarify whether their financial reporting considers these risks.³⁰⁷ The investor advocacy organization Climate Action 100+ has found that while companies are increasingly adopting "net zero" targets, very few have allocated internal capital to projects that reflect these goals.³⁰⁸

The Public Company Accounting Oversight Board (PCAOB) was established by the Sarbanes-Oxley Act of 2002 to oversee the audits of public companies.³⁰⁹ PCAOB Board Member Robert Brown has argued that auditors are failing to include climate-related risks in their discussions of Critical Audit Matters (CAMs), meant to point out aspects of the audit that "involved especially challenging, subjective, or complex auditor judgment."³¹⁰ Because climate-related risks to companies are

³⁰⁶ See, e.g., Erik F. Gerding, *The Next Epidemic: Bubbles and the Growth and Decay of Securities Regulation*, 38 CONN. L. REV. 393, 426 (2006) (noting that Enron and similar scandals resulted, in part, from conflicts of interest that misaligned the incentives of auditors to perform their gatekeeping role); see also J. Robert Brown, Jr., *Revealing ESG in Critical Audit Matters*, HARV. L. SCH. F. ON CORP. GOVERNANCE (Nov. 19, 2020) <https://corpgov.law.harvard.edu/2020/11/19/revealing-esg-in-critical-audit-matters/> [<https://perma.cc/ZL3L-ZLPU>].

³⁰⁷ THE INSTITUTIONAL INVS. GRP. ON CLIMATE CHANGE, INVESTOR EXPECTATIONS FOR PARIS-ALIGNED ACCOUNTS 4 (2020) <https://www.iigcc.org/download/investor-expectations-for-paris-aligned-accounts/?wpdmdl=4001&refresh=6113153773aa51628640567> [<https://perma.cc/FEC5-XY3X>] (arguing that "there is little evidence that companies are taking decarbonisation or the physical impacts from climate change into account as they draw up their financial statements. This is true even where their strategic report or management discussion detail climate risks as recommended by the Task Force on Climate-related Financial Disclosures (TCFD)").

³⁰⁸ Press Release, Climate Action 100+, Climate Action 100+ Issues Its First-Ever Net Zero Company Benchmark of The World's Largest Corporate Emitters (Mar. 22, 2021), <https://www.climateaction100.org/news/climate-action-100-issues-its-first-ever-net-zero-company-benchmark-of-the-worlds-largest-corporate-emitters/> [<https://perma.cc/RJ59-XNN8>].

³⁰⁹ See Steven B. Harris, Public Company Accounting Oversight Board, Remarks on The Sarbanes-Oxley Act of 2002: Ten Years Later (Sep. 24, 2012), https://pcaobus.org/news-events/speeches/speech-detail/remarks-on-the-sarbanes-oxley-act-of-2002-ten-years-later_438 [<https://perma.cc/R5SV-2TDZ>] (stating that "[the Sarbanes-Oxley Act] established the PCAOB, ending more than 100 years of self-regulation by the accounting profession").

³¹⁰ CAMs provide a means for the auditor to speak directly to the investor, whereas the rest of the financial statement comes from management and rests on management's assumptions. PUB. CO. ACCOUNTING OVERSIGHT BD., THE AUDITOR'S REPORT ON AN AUDIT OF FINANCIAL STATEMENTS WHEN THE AUDITOR EXPRESSES AN UNQUALIFIED OPINION 1,

“highly dependent upon the particular assumptions used by management,” you might expect them to be discussed in CAMs covering the reasonableness of assumptions related to asset lives or commodity prices, yet very few mention climate.³¹¹

The SEC should work together with the PCAOB to encourage auditor oversight and assurance of corporate climate risk reporting, including that the reporting is consistent with disclosed financial statements.³¹² The PCAOB should develop resources and guidance for assisting auditors in this role and using tools like scenario analysis. Through its oversight of the Financial Accounting Standards Board, the SEC should ensure that climate risk considerations are included in U.S. generally accepted accounting principles (GAAP).³¹³ As the *Financial Times* recently argued, climate risks may be uncertain, “but so is the time value of money.”³¹⁴ Making informed calls in the face of uncertainty is a part of the auditor’s job. There should be scrutiny as to whether these firms have staff capable of overseeing claims about emissions reductions, including carbon capture.³¹⁵

Release No. 2017-001 (Jun. 1, 2017), https://pcaob-assets.azureedge.net/pcaob-dev/docs/default-source/rulemaking/docket034/2017-001-auditors-report-final-rule.pdf?sfvrsn=14ad22c9_0 [<https://perma.cc/FEC5-XY3X>].

³¹¹ See Brown, *supra* note 306.

³¹² Samantha Ross, *The Role of Accounting and Auditing in Addressing Climate Change*, CTR. FOR AM. PROGRESS: ECON., 7 (Mar. 1, 2021, 6:00 AM), <https://www.americanprogress.org/issues/economy/reports/2021/03/01/496290/role-accounting-auditing-addressing-climate-change/> [<https://perma.cc/8TJ4-T67S>] (arguing that “[t]he commission has not followed through on the guidance to deliver a meaningful improvement on the depth, clarity, consistency, comparability, or reliability of disclosure, either in the narrative portion of companies’ SEC filings or in their financial statements”).

³¹³ The IFRS is proposing to establish a Sustainability Standards Board. If the SEC were to partner in this project, it could be a step toward convergence of GAAP and IFRS standards. See Fin. Acct. Standards Bd., *Comparability in International Accounting Standards – A Brief History*, <https://www.fasb.org/jsp/FASB/Page/SectionPage&cid=1176156304264> [<https://perma.cc/UB2F-GJF9>] (last visited Aug. 8, 2021).

³¹⁴ Editorial, *Time to Clean Up Climate Reporting Standards*, FIN. TIMES, 3 (Feb. 2, 2021), <https://www.ft.com/content/4f4a8485-4ced-4228-8ce2-ec199d40829c> [<https://perma.cc/6HA5-3KVC>].

³¹⁵ Auditing giant PwC is reportedly planning to hire more than 100,000 employees as it expects ESG demand to grow. Jessica DiNapoli, *PwC Planning to Hire 100,000 over Five Years in Major ESG Push*, REUTERS (June 15, 2021, 3:50 PM MDT), <https://www.reuters.com/business/sustainable-business/pwc-planning-hire-100000-over-five-years-major-esg-push-2021-06-15/> [<https://perma.cc/GAM9-TPT4>] (reporting that PwC is also increasing trainings on climate risk).

3. *Provision of Climate-Risk Assessment Tools and Data*

Information asymmetries are typically thought of in corporate disclosure theory as one-way.³¹⁶ But climate risk is a case in which the information breakdown happens in two directions. Investors do not have information on exactly where assets are, where suppliers are based, what route supply chains travel over, or what design specifications were used to build key infrastructure. A manager knows these facts better than shareholders but doesn't necessarily understand the predictive science of climate impacts any better. If behavioral biases and informational transaction costs are getting in the way of the average company and the average shareholder assessing their risk exposure, there is a role for regulators to lower these costs of information acquisition. At the minimum, there should be a website where you can plug in an address or coordinates and see what sea level rise will be under different levels of warming or expected number of days over threshold temperatures. Civil society has begun to fill this void, but the resources and authority of the federal government are sorely needed.³¹⁷

The SEC's Division of Economic and Risk Analysis (DERA) serves as the SEC's "think tank" and is tasked with integrating financial economics and data analytics "into the core mission of the SEC."³¹⁸ DERA's Offices of Risk Assessments and Data Science facilitate enforcement by "developing analytical approaches, methods, and models in order to identify trends, risks, or potential securities law violations in the capital markets."³¹⁹ The SEC should build institutional competency within DERA and its offices, and work with other agencies, including the Financial Stability Oversight Council, to provide climate-risk information and assessment tools to investors and the public.³²⁰

³¹⁶ See, e.g., Joseph A. Franco, *Why Antifraud Prohibitions Are Not Enough: The Significance of Opportunism, Candor and Signaling in the Economic Case for Mandatory Securities Disclosure*, 2 COLUM. BUS. L. REV. 223, 278 (2002) (arguing for mandatory securities disclosure to address information asymmetries in the wake of Enron).

³¹⁷ See CFTC Report, *supra* note 17, at 60 ("The challenge ahead will be to balance both the public and private objectives in the interests of both transparency and innovation."); see also U.S. GLOB. CHANGE RSCH. PROGRAM, OUR CHANGING PLANET: THE U.S. GLOBAL CHANGE RESEARCH PROGRAM FOR FISCAL YEAR 2020 (2020) https://downloads.globalchange.gov/ocp/ocp2020/Our-Changing-Planet_FY-2020.pdf [<https://perma.cc/2GEZ-LKXE>].

³¹⁸ DERA is involved in both rulemaking and enforcement, and its duties include "identifying and analyzing issues, trends, and innovations in the marketplace" and "working with outside experts in academia and industry to strengthen the Commission's foundation of market knowledge." U.S. SEC. & EXCH. COMM'N, ABOUT DIVISION OF ECONOMIC AND RISK ANALYSIS, <https://www.sec.gov/dera/Article/dera-about.html#.YT53CQTbri4> [<https://perma.cc/2637-6327>] (last visited Aug. 8, 2021).

³¹⁹ *Id.*

³²⁰ The important question of just what the science of climate forecasting can tell us at given temporal and geographic scales underlies many avenues of regulation. Just to mention two: (1) Determining what information can reasonably be demanded of issuers when designing physical risk disclosure and stress testing requirements; and (2) Monitoring

B. Limits of Disclosure

While accurate disclosure of climate risks can help make individual companies and investors more prepared for the physical risks of climate change and can smooth, and perhaps hasten, the transition to a net-zero economy, it alone cannot correct the most significant “market failure” of climate change externalities: unregulated emissions. As Bolton *et al.* point out: “climate-related risks will remain unhedgeable as long as system-wide transformations are not undertaken.”³²¹ With supply chain risks, for example, the knowledge that your local port has a high risk of being wiped out by a hurricane has limited use when shipping alternatives do not exist.³²² However, a better market understanding of the risks of climate change may help to reduce political opposition to emissions regulations, as market actors become more aware of the economic costs of failing to regulate emissions.

The CFTC’s report on Managing Climate Risk in the U.S. Financial System acknowledges that disclosure alone cannot address “the heart of the matter,” which is unabated greenhouse gas emissions.³²³ Direct regulation of emissions is necessary.³²⁴ What the CFTC does not note, however, is that direct regulation is required to address physical risks and adaptation deficits as well, not just mitigation deficits. A wide range of market actors suffer from the myopic tendencies discussed

climate services providers in the interest of investor protection, checking that consultants and advisors are not overpromising what science can deliver. FSOC or another centralized research center within the administration’s financial regulation authority should be tasked with acquiring expertise in this area that it can then use to advise other agencies. *Cf.* Hilary Allen, *Resurrecting the OFR*, J. CORP. LAW. (forthcoming 2021), <https://ssrn.com/abstract=3727585> [<https://perma.cc/BTZ7-5GKB>] (arguing that the Office of Financial Research should serve as a centralized data hub, assuming its intended role as central research center for understanding and supporting the regulation of systemic financial risks).

³²¹ BOLTON ET AL., *supra* note 46, at 43 (arguing that “current efforts aimed at measuring, managing and supervising climate-related risks will only make sense if they take place within an institutional environment involving coordination with monetary and fiscal authorities, as well as broader societal changes”).

³²² *See, e.g.*, Merritt B. Fox, *Civil Liability and Mandatory Disclosure*, 109 COLUM. L. REV. 237, 253 (2009) (“Issuer disclosure may reduce risk—on average bringing price closer, on one side or the other, to actual value—but it reduces only *unsystematic* risk.”).

³²³ CFTC REPORT, *supra* note 17, at xix.

³²⁴ The CFTC Report’s first recommendation to regulators is to “establish a price on carbon.” *Id.* at vi. However, “carbon prices alone may not suffice to shift individual behaviour and firms’ replacement of physical capital towards low-carbon alternatives until infrastructures suited for alternative energies are in place. For instance, building an efficient public transit system may be a precondition to effective taxation of individual car use in urban areas.” BOLTON ET AL., *supra* note 46, at 56–57 (citing Signe Krogstrup & William Oman, *Macroeconomic and Financial Policies for Climate Change Mitigation: A Review of the Literature* (IMF, Working Paper No. 19/185, 2019); *Id.* at 28 (arguing that past energy transformations were brought about not just by changes in relative pricing, but were also heavily influenced by socioeconomic, geopolitical, and institutional systems).

in this Article. Governments have an urgent role to play in ensuring that credit rating agencies, zoning laws, professional organizations, building codes, and municipalities are considering and responding to climate risks. Australian insurance giant Suncorp, for example, has argued for its government to impose “compulsory adoption” of climate change adaptation plans on corporations.³²⁵ It and AIG have both called for governments to invest resources in climate adaptation, including flood infrastructure, updated building codes, and longer-term climate adaptation planning.³²⁶ U.S. regulators should consider a program of infrastructure audits.³²⁷

Disclosure is further insufficient because individual steps taken to limit the risk exposure of certain assets may counter-productively contribute to overall risk in the system. This can happen in both financial markets and the real economy.³²⁸ Individual adaptation to climate change, like the construction of seawalls, may lead to the generation of broader systemic risks. The “levee effect” describes how flood protection infrastructure can encourage more people to locate in a risky area, increasing the damage that occurs when the infrastructure fails.³²⁹ Relatedly, Zac Taylor has argued that Florida’s booming insurance-linked securitization market “defers risk management responsibilities to external capital providers, and by extension deepens the long-term exposure” of the state economy to climate risk.³³⁰ The ability to purchase annual insurance today may encourage development in areas better left unbuilt. An alternative model, Taylor argues, should emphasize “risk reduction over risk transfer.”³³¹ Climate adaptation requires planning at the national level, including plans for managed retreat.³³²

³²⁵ James Fernyhough, *Suncorp Calls for Climate Action as Profits Slump*, FIN. REV. (Feb. 14, 2019, 4:59 PM), <https://www.afr.com/companies/financial-services/suncorp-interim-profit-slumps-45pc-20190213-h1b7pj> [<https://perma.cc/83L8-GGR6>].

³²⁶ James Fernyhough & Angela Macdonald-Smith, *Suncorp to Stop Insuring Oil and Gas*, FIN. REV. (Apr. 21, 2020, 9:39 PM), <https://www.afr.com/companies/financial-services/suncorp-to-stop-insuring-oil-and-gas-20200821-p55nww> [<https://perma.cc/P3P7-QT3W>].

³²⁷ Bolstad et al., *supra* note 84.

³²⁸ See generally BOLTON ET AL., *supra* note 46, at 42 (noting the economic risk associated with developing financial products, such as weather derivatives, in response to climate-related risks).

³²⁹ See, e.g., Graham A. Tobin, *The Levee Love Affair: A Stormy Relationship?*, 31 J. AM. WATER RES. ASS’N 359 (1995).

³³⁰ Taylor, *supra* note 112, at 1145.

³³¹ *Id.* (arguing that this could be done by, e.g., “prioritizing investment in institutions and infrastructures that reduce the material exposure of communities through anti-poverty measures, retrofits, retreat, and reinvigorated growth management practices”).

³³² See John Carey, *Managed Retreat Increasingly Seen as Necessary in Response to Climate Change’s Fury*, 117 PROC NAT’L ACAD. SCI. U.S. AM. 13182, 13182 (2020) (arguing that “managed retreat presents numerous complex challenges—legal, logistical, ethical, political, financial, and architectural”).

C. Shareholders

As discussed *supra*, firm directors and managers are typically compensated via stock or stock options in order to incentivize maximization of the share price. However, as argued by Lynn Stout: “[i]f market prices do not closely reflect actual expected risks and returns, [a] single-minded focus on share price is a recipe for mismanagement.”³³³ Shareholders, as monitors of corporate management, should examine the metrics by which executive compensation is determined and push for the removal of those that distort managers away from long-term stewardship.³³⁴ Investors increasingly advocate for the integration of climate-related metrics in executive remuneration.³³⁵ According to a 2020 PWC survey, 34% of directors said they would support linking executive compensation directly to ESG metrics.³³⁶ Further, shareholders have the power to influence board composition. Increasing board competency on climate change may also help to oversee that management is investigating and disclosing relevant risks.³³⁷

Large institutional shareholders should have a particular interest in how climate constitutes a systematic risk to their portfolios, as these unhedgeable risks cannot be diversified away.³³⁸ These institutions have already been advocating for increased disclosure of climate risks. While they may not rely on the information to make trades, they should integrate climate risks into their governance oversight of portfolio companies. This may include taking a portfolio perspective and seeking direct mitigation of climate risk itself through pressuring companies to reduce their emissions.³³⁹

³³³ Lynn Stout, *The Mechanisms of Market Inefficiency: An Introduction the New Finance*, 28 J. CORP. L. 635, 639 (2003).

³³⁴ Armour et al., *supra* note 20, at 11.

³³⁵ Aileen Boniface & Jeremy Apple, *E&S Metrics in Executive Compensation: What Do Investors Really Care About?*, CLERMONT PARTNERS 1 (July 8, 2020), <https://www.clermontpartners.com/blog/es-metrics-in-executive-compensation-what-do-investors-really-care-about/> [<https://perma.cc/2HGT-42H2>] (explaining that “[i]n 2016, 23% of remuneration shareholder proposals were E&S-related, whereas in 2020 thus far 55% of remuneration proposals have been E&S-related”).

³³⁶ Paula Loop, Paul DeNicola & Barbara Berlin, *How Does the Board Oversee ESG?*, HARV. L. SCH. F. ON CORP. GOVERNANCE 4 (Dec. 21, 2020), <https://corpgov.law.harvard.edu/2020/12/21/how-does-the-board-oversee-esg/> [<https://perma.cc/357U-J4ZN>].

³³⁷ Shareholders can also demand that boards include at least one member with climate expertise and that specific board committees are tasked with different aspects of climate risk oversight. *Id.* at 1. (“Ultimately, ESG issues will be relevant to all committees. For example, the nominating and governance committee will be interested in the shareholder engagement element, while the compensation committee will be interested in accountability through compensation. The audit committee will be interested in the disclosure, messaging, and metrics . . . [and whether] committee charters and proxy disclosures been updated to transparently disclose to shareholders and other stakeholders the board’s allocation of ESG oversight responsibility.”).

³³⁸ See Coffee, *supra* note 290; Condon, *supra* note 278.

³³⁹ See Condon, *supra* note 278, at 19.

V. CONCLUSION

After the 2011 Fukushima disaster, the U.S. Nuclear Regulatory Commission directed the (mostly corporate) operators of America's sixty nuclear power plants to assess their exposure to flood risk.³⁴⁰ Of these, the Commission found that fifty-four of the plants were not designed to handle their *current* flood risks, including nineteen whose designs could not withstand possible present-day storm surges.³⁴¹ The assessment did not extend to consider future climate risks. The rest of corporate America lacks an industry-focused regulator to mandate hazard assessment, and yet is similarly exposed to the risks of obsolete designs colliding with a changing natural world. This Article has sought to expose *why* climate risks remain unassessed and unpriced by the market. An updated mandatory climate risk disclosure regime, designed in consultation with climate scientists and auditing professionals, is a necessary first step toward preparing the economy for climate change.

³⁴⁰ Christopher Flavelle & Jeremy C.F. Lin, *U.S. Nuclear Power Plants Weren't Built for Climate Change*, BLOOMBERG (Apr. 18, 2019, 4:00 AM), <https://www.bloomberg.com/graphics/2019-nuclear-power-plants-climate-change/> [<https://perma.cc/2JPK-F2X9>]; *US Nuclear Power Policy*, WORLD NUCLEAR ASS'N, <https://www.world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power-policy.aspx> [<https://perma.cc/JT86-J4L9>] (last updated Aug. 8, 2020).

³⁴¹ Flavelle & Lin, *supra*, note 340, at 4.