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June 14, 2021

Via Electronic Submission

The Honorable Gary Gensler
Chair, U.S. Securities and Exchange Commission
100 F St., NE Washington, D.C. 20549-0609

Re: Public Input on Climate Change Disclosures

Dear Chair Gensler,

Thank you for the opportunity to provide public input on climate risk disclosure requirements. I write to submit the attached article, *Market Myopia's Climate Bubble*, forthcoming Fall 2021 in the Utah Law Review. In the Article, I argue that markets are not accurately assessing climate change-related risks for an array reasons, many of which would be partially addressed by a mandatory climate disclosure regime.

In particular, shareholders and analysts currently lack the fine-grained asset level data they need in order to make climate-risk assessments. Where corporate operations are located, the 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. Often, the information that is voluntarily disclosed aggregates data at too high a level, is given at widely varying time-scales that make comparison difficult, and fail to differentiate well between exposure and liability.

Further, market actors continue to rely on risk assessment methodologies that are outdated in a climate-changed world. 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 Additionally, corporate managers may continue to rely on outdated methods of risk assessment that suffer from a *duration mismatch*.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 are reassessed annually, and so could spike suddenly to reflect

unaccounted-for climate risk; yet they are nevertheless relied upon as a proxy for the cost of risk for investments with expected returns over many years.

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. An overemphasis on false precision provided by complicated models might obscure the usefulness of other methods of risk assessment and communication. In crafting disclosure regulation, the SEC should seek out climate-related expertise through interagency working groups, advisory boards, and staff hiring.

Finally, I wish to highlight that 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.

I welcome the opportunity to discuss these comments with the Commission or the Commission’s Staff. Thank you for your consideration.

Respectfully,

A handwritten signature in black ink, appearing to read "Madison Condon".

Madison Condon

cc: Hon. Hester Peirce, Commissioner, U.S. Securities and Exchange Commission
Hon. Elad Roisman, Commissioner, U.S. Securities and Exchange Commission
Hon. Allison Herren Lee, Commissioner, U.S. Securities and Exchange Commission
Hon. Caroline Crenshaw, Commissioner, U.S. Securities and Exchange Commission

MARKET MYOPIA'S CLIMATE BUBBLE

Madison Condon*

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 can exist at the level of individual assets, 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 fossil combustion. 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. Signals from the Biden Administration suggest that mandatory climate risk disclosure regulation from the Securities and Exchange Commission is forthcoming. This Article argues that climate risk disclosure is necessary, though alone not sufficient, to address the widespread disregard of corporate climate exposure.

* Associate Professor, Boston University School of Law. I am grateful for comments on earlier drafts from John Armour, Ryan Bubb, Caroline Cecot, Jill Fisch, Marcel Kahan, Upmanu Lall, Ann Lipton, Susan Permut, Richard Revesz, Ed Rock, Samantha Ross, Arden Rowell, Bernard Sharfman, Graham Steele, David Walker, Thom Wetzer, and Kathy Zeiler. This Article benefitted from presentation at the Sabin Colloquium on Innovative Environmental Law Scholarship, the National Business Law Scholars Conference, the Southern Economic Association Annual Meeting, the Boston Area Junior Faculty Roundtable, the Boston College Law Regulation and Markets Workshop, the Oxford Law and Business Workshop, the Wharton Conference on Financial Regulation, and the Society for Environmental Law and Economics Annual Meeting. Conner Kingsley, Jessica Rollén, Christopher Wingard, and Tyler Winterich provided excellent research assistance.

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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 infrastructure was located in coastal regions at risk to be inundated by sea-level rise as soon as the coming decade. 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 15 years.³ 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.⁴

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, had made any mention of sea-level rise.⁵ Their voluntary reporting of climate risks to the nonprofit CDP similarly omitted any mention of flood risk.⁶

* * *

A growing number of financial experts at institutions ranging from BlackRock, to McKinsey, to the U.S. Commodities Futures Trading Commission, have reached

¹ Alejandra Borunda, *The Internet Is Drowning*, NATIONAL GEOGRAPHIC (July 16, 2018).

² *Id.*

³ Ramakrishnan Durairajan, Carol Barford & Paul Barford, *Lights Out: Climate Change Risk to Internet Infrastructure*, ANRW '18: PROCEEDINGS OF THE APPLIED NETWORKING RESEARCH WORKSHOP 9 (2018).

⁴ *Id.*

⁵ CenturyLink, Inc., Annual Report (Form 10-K) (Feb. 22, 2019), <https://www.sec.gov/Archives/edgar/data/18926/000001892619000006/ctl2018123110k.htm>; AT&T, Inc., Annual Report (Form 10-K) (Feb. 20, 2019), <https://www.sec.gov/Archives/edgar/data/0000732717/000119312519045608/d705958d10k.htm>.

⁶ CenturyLink's 2017 voluntary disclosure of climate risks to the nonprofit Carbon Disclosure Project ("CDP"), the company made no mention of sea level rise. In 2018 it updated its disclosure to acknowledge rising sea levels as a long-term risk with an impact valued at \$2 million, *see CenturyLink - 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.

the conclusion that markets are not accurately assessing and pricing climate change-related risks. In April 2019, a coalition of 42 central banks recognized that “there is a strong risk that climate-related financial risks are not fully reflected in asset valuations.”⁷ Christine Lagarde recently warned that central bankers “will have to ask themselves” if they are “taking excessive risk by simply trusting mechanisms that have not priced in the massive risk that is out there.”⁸ 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.”⁹

Yet while the consensus (and evidence)¹⁰ 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?¹¹ 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].”¹² 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 impacts” of climate risks.¹³

First, shareholders and analysts currently lack the fine-grained asset-level data they need in order to make climate-risk assessments.¹⁴ Where corporate operations

⁷ NETWORK FOR GREENING THE FINANCIAL SYSTEM, A CALL FOR ACTION: CLIMATE CHANGE AS A SOURCE OF FINANCIAL RISK 4 (Apr. 2019) [hereinafter NGFS, CALL FOR ACTION].

⁸ Carolyn Look, *Lagarde Says ECB Needs to Question Market Neutrality on Climate*, BLOOMBERG (Oct. 14, 2020), <https://www.bloomberg.com/news/articles/2020-10-14/lagarde-says-ecb-needs-to-question-market-neutrality-on-climate>.

⁹ *Climate Change and Artificial Intelligence Seen as Risks to Investment Asset Allocation, Finds New Report by BNY Mellon Investment*, BLOOMBERG, (Sept. 16, 2019), <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>.

¹⁰ See *infra* section II.A.

¹¹ With the noted exception of Jakob Thomä & Hughes 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. SUS. FIN. & INVESTMENT 82 (2017).

¹² Brest, Gilson & Wolfson, *How Investors Can (and Can't) Create Social Value*, (European Corporate Governance Institute L. Working Paper No. 394, 2018), https://ecgi.global/sites/default/files/working_papers/documents/finalbrestgilsonwolfson.pdf.

¹³ *Id.*

¹⁴ *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

are located, the 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.¹⁵ Often, the information that is voluntarily disclosed aggregates data at too high a level, is given at widely varying time-scales that make comparison difficult, and fail to differentiate well between exposure and liability.¹⁶

Second, market actors continue to rely on risk-assessment methodologies that are outdated in a climate-changed world.¹⁷ 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 which may 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.¹⁸ Equity-based compensation and firm-specific executive remuneration metrics may encourage managers to focus on the

publicly known, or knowable with presently available data and analytical tools). *See, e.g.*, Ronald Gilson & Reinier Kraakman, *Market Efficiency after the Financial Crisis: It's Still a Matter of Information Costs*, 100 VA . L. REV. 313, 317 (2014) (discussing relationship between fundamental and informational efficiency).

¹⁵ *See, e.g.*, NGFS, CALL FOR ACTION, *supra* note X at 30; MANAGING CLIMATE RISK IN THE U.S. FINANCIAL SYSTEM, REPORT OF THE CLIMATE-RELATED MARKET RISK SUBCOMMITTEE, MARKET RISK ADVISORY COMMITTEE OF THE U.S. COMMODITY FUTURES TRADING COMMISSION 58 (2020) [hereinafter CFTC REPORT]; DEUTSCHE ASSET MANAGEMENT, MEASURING PHYSICAL CLIMATE RISKS IN EQUITY PORTFOLIOS 2 (Nov. 2017); WORLD BANK & WORLD WILDLIFE FUND, SPATIAL FINANCE: CHALLENGES AND OPPORTUNITIES IN A CHANGING WORLD EFI INSIGHT-FINANCE (2020).

¹⁶ *Infra* section II.B.1.

¹⁷ *Infra* section II.B.2. *Cf.* Gilson & Kraakman, *Market Efficiency After the Financial Crisis* *supra* note X 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).

¹⁸ *Infra* Section II.B.3. *See, e.g.*, John Armour, Jeffrey Gordon & Geeyoung Min, *Taking Compliance Seriously*, 37 YALE J. REG. 1, 26-31 (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).

short-term and neglect to prepare their companies for longer-term climate resilience.¹⁹

Fourth, many physical climate risks will occur within the relevant horizon for valuing securities but outside of conventional risk assessment horizons for investors.²⁰ 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.²¹ 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.²²

Fifth, decades-long disinformation campaigns have intentionally confused public understanding of the cause and effects of climate change.²³ 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.²⁴

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.²⁵ Under the Trump Administration several agencies took actions to limit shareholder oversight of climate risks, including blocking requests for climate

¹⁹ Cf. Michael Jensen, *Agency Costs of Overvalued Equity*, 34 FIN. MANAG. 5, 7 (2005).

²⁰ See, e.g., 2 DEGREE INVESTING INITIATIVE, ALL SWANS ARE BLACK: HOW THE SHORT-TERM FOCUS ON FINANCIAL ANALYSIS DOES NOT SHED LIGHT ON LONG TERM RISKS (Feb. 2017); Lynne Dallas, *Short-Termism, the Financial Crisis and Corporate Governance*, 37 J. CORP. L. 265, 267 (2012).

²¹ *Infra* section II.B.4.

²² See, e.g., Joe Rennison & Billy Nauman, *Vanguard 'Green' Fund Invests in Oil and Gas-Related Stocks*, FIN. TIMES (July 10, 2019); Adriana Robertson, *Passive in Name Only: Delegated Management and "Index" Investing*, 36 YALE J. ON REG. 795, 848 (2019).

²³ See, e.g., JANE MEYER, DARK MONEY 251-260 (2017); 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).

²⁴ *Infra* section II.B.5. See, e.g., Stephen J. Choi & A.C. Pritchard, *Behavioral Economics and the SEC*, 56 STANFORD L. REV. 8 (2003), citing Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 SCI. 1124, 1127-28 (1974).

²⁵ *Infra* section II.B.6.

disclosure and preventing investors from integrating climate risks into their market decisions.²⁶

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 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 15 years, for example, can be predicted with some certainty, and yet market actors nevertheless seem to disregard these projections when making asset-allocation decisions.²⁷

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 mis-allocation of investment resources.²⁸ 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 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. Growing calls for mandatory climate risk disclosure, trends in other countries, and signals from the Biden Administration, suggest a mandatory climate-risk disclosure regime may be forthcoming in the United States.²⁹ This

²⁶ Fair Access to Financial Services, 85 Fed. Reg. 75,261 (Nov. 25, 2020) (to be codified at 12 C.F.R. pt. 55); Brett McDonnell, Hari M. Osofsky, Jacqueline Peel, & Anita Foerster, *Green Boardrooms?* CONN. L. REV., *forthcoming* at 47 (2021).

²⁷ See, e.g., Theodore Shepherd, *Storyline Approach to the Construction of Regional Climate Change Information*, 475 PROC. R. SOC. A 1-2 (2019) (pointing out that “although there is high confidence in thermodynamic aspects of climate change (global warming, sea-level rise, atmospheric moistening, melting of ice), the levels of confidence concerning dynamical aspects of climate change, such as the location and strength of storm tracks, are much lower”).

²⁸ *Infra* section III.

²⁹ See e.g., Emily Glazer, *Companies Brace Themselves for New ESG Regulations Under Biden*, WALL ST. J. (Jan. 18, 2021), https://www.wsj.com/articles/companies-brace-themselves-for-new-esg-regulations-under-biden-11610719200?mod=searchresults_pos3&page=1; CERES, *Ceres Applauds SEC on Creating New Climate Position, Hiring Satyam Khanna* (Feb. 1, 2021), <https://www.ceres.org/news-center/press-releases/ceres-applauds-sec-creating-new-climate-position-hiring-satyam-khanna>; Kate Davidson, *Yellen is Creating a New Senior Treasury Post for Climate Czar*, WALL ST. J. (Feb. 12, 2021); Larry Elliott, *UK to Make Climate Risk Reports Mandatory for Large Companies* GUARDIAN (Nov. 9, 2020).

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.³⁰ In particular, an overemphasis on false precision provided by complicated models might obscure the usefulness of other methods of risk assessment and communication.³¹ 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.³² In crafting disclosure regulation, the SEC should seek out climate-related expertise through interagency working groups, advisory boards, and staff hiring.³³ 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.³⁴

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.³⁵ 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.

The Article proceeds as follows. Part II collects 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

³⁰ See e.g., Tanya Fielder et al., *Business Risk and the Emergence of Climate Analytics*, NATURE CLIMATE CHANGE (2021); Standards Overview, Sustainability Accounting Standards Bd.

³¹ See e.g., Fielder et al., *supra* note X.

³² See note X *infra*, discussing Allison Herren Lee, "Modernizing" Regulation S-K: Ignoring the Elephant in the Room SEC Public Statement (Jan. 30, 2020).

³³ See MADISON CONDON, SARAH LADIN, JACK LIENKE, MICHAEL PANFIL, & ALEXANDER SONG, MANDATING DISCLOSURE OF CLIMATE-RELATED FINANCIAL RISKS, INSTITUTE FOR POLICY INTEGRITY AND ENVIRONMENTAL DEFENSE FUND (2021).

³⁴ See section IV.A *infra*.

³⁵ CFTC REPORT, *supra* note X at X.

interest to correcting 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 mis-allocation 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.³⁶ Transition risk comes 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.³⁷ 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.³⁸ Liability risks are the potential that the parties that contribute to, or profit from, carbon emissions, are required at some point in the future to compensate those harmed by climate impacts.³⁹

³⁶ These are the categories identified by Mark Carney, the Governor of the Bank of England, *see* Mark Carney, Governor of the Bank of England, International Climate Risk Conference for Supervisors, De Nederlandsche Bank, Amsterdam: A Transition in Thinking and Action (Apr. 6, 2018).

³⁷ Christopher McGlade & Paul Ekins, *The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2°C*, 517 NATURE 187 (2015) (estimating that in order to keep warming below 2°C, “approximately 35% of current oil reserves, 50% of gas reserves, and nearly 90% of coal reserves are unusable”); Mark Lewis et al., *Energy Transition and Climate Change: Stranded Assets, Fossilised Revenues*, KEPLER CHEUVREUX 16 (2014) (calculating that if greenhouse gas are kept below 450ppm of CO2 equivalent in the atmosphere, the fossil fuel industry will lose \$28 trillion in projected revenue through 2035, with the oil industry experiencing a 22% total decline in revenues); EUROPEAN SYSTEMIC RISK BOARD, TOO LATE, TOO SUDDEN: TRANSITION TO A LOW-CARBON ECONOMY AND SYSTEMIC RISK, ESRB ASC REPORT No. 6 (Feb. 2016); Thomas Lee, *Fossil Fuel Stranded Assets: Efficient Market or Carbon Bubble?*, PENN WHARTON PUB. POL’Y INITIATIVE (April 12, 2017).

³⁸ 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, attempts to quantify specific costs to business. *See generally* THE RISKY BUSINESS PROJECT, RISKY BUSINESS: THE ECONOMIC RISKS OF CLIMATE CHANGE IN THE UNITED STATES (2014).

³⁹ Lawsuits against emitters are increasing in frequency and gaining more traction in the courts. *See, e.g.,* Mayor & City Council of Baltimore v. BP, 388 F. Supp 3d 538 (2019), *cert. granted*, 141 S. Ct. 222 (2020); Conservation Law Foundation v. ExxonMobil, No. 1:16-cv-11950-MLW Dkt. 29, (D. Mass. Sep. 13, 2017) (ruling that environmental group has sufficient standing to proceed with suit claiming that Exxon left its oil storage facilities vulnerable to flooding, despite its knowledge

Many leaders in the financial sector have voiced their concern that 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 assessing risk and dealing with crises, I'm struck by the similarities between the climate crisis and the financial crisis of 2008."⁴⁰ 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.⁴¹

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.⁴² 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

of climate change); Rebecca Hersher, *Supreme Court Considers Baltimore Suit Against Oil Companies Over Climate Change*, NPR (Jan. 19, 2021), <https://www.npr.org/2021/01/19/956005206/supreme-court-considers-baltimore-suit-against-oil-companies> (reporting that there have been more than 20 cases filed by state and local governments against fossil companies in recent years); *See generally* Michael Burger et al., *The Law and Science of Climate Change Attribution*, 45 COLUMBIA J. OF ENV'T L. 57 (2020) (discussing the state of attribution science and how it can lead to courts to imposing liability for climate change harms).

⁴⁰ Paulson, *supra*, note X.

⁴¹ BlackRock, *The Price of Climate Change*, *supra* note x.

⁴² Hana V. Vizcarra, *The Reasonable Investor and Climate-Related Information: Changing Expectations for Financial Disclosures*, 50 ENV'T L. REP. 10,106, 10,110 (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.").

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 dwarfed by this uncertainty.⁴³ 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 market 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.⁴⁴ 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.⁴⁵ 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.⁴⁶ 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."⁴⁷ Nevertheless, when these climate-sensitive bonds are compared to bonds issued by less climate-

⁴³ THE GREEN SWAN, *supra* note X, at 3; 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). Uncertainty is discussed further *infra* at X.

⁴⁴ BLACKROCK, GETTING PHYSICAL: SCENARIO ANALYSIS FOR ASSESSING CLIMATE-RELATED RISKS 1 (April 2019).

⁴⁵ *Id.* at 3.

⁴⁶ *Id.* at 10.

⁴⁷ *Id.*

vulnerable areas, their valuations do not reflect this difference in risk.⁴⁸ 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.⁴⁹ Similarly, the International Monetary Fund found that present market-implied equity risk premiums are consistently lower than premiums calculated via an asset pricing model that takes temperature-induced disaster risk into account.⁵⁰ It concluded that the discrepancy suggests “that equity markets may not currently price [physical] climate change risk.”⁵¹

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.⁵² 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.⁵³ Assets in the oil and gas industry, for example, lose 42.1% of their value by 2030.⁵⁴ 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%.⁵⁵

Substantial warming has already occurred—around 1.1°C as compared to preindustrial levels.⁵⁶ 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

⁴⁸ *Id.*

⁴⁹ *Id.*

⁵⁰ *Climate Change: Physical Risk and Equity Risk* in INT. MONETARY FUND, GLOBAL FINANCIAL STABILITY: MARKETS IN THE TIME OF COVID-19 (2020), <https://www.imf.org/en/Publications/GFSR/Issues/2020/04/14/global-financial-stability-report-april-2020#Chapter5>.

⁵¹ *Physical Risk and Equity Prices-Online Boxes 5.1-5.3*, 4 in INT. MONETARY FUND, GLOBAL FINANCIAL STABILITY: MARKETS IN THE TIME OF COVID-19 (2020), <https://www.imf.org/-/media/Files/Publications/GFSR/2020/April/English/onlinebox51.ashx>.

⁵² MERCER, INVESTING IN A TIME OF CLIMATE CHANGE: THE SEQUEL 8 (2019).

⁵³ *Id.* at 34.

⁵⁴ *Id.*

⁵⁵ *Id.* at 35.

⁵⁶ Richard J. Millar et al., *Emission Budgets and Pathways Consistent with Limiting Warming to 1.5°C*, 10 NATURE GEOSCIENCE 741 (Sept. 2017) (calculating warming since preindustrial to be 0.9 C); cf. Andrew P. Schurer et al., *Importance of the pre-industrial baseline for likelihood of exceeding Paris goals*, 7 NATURE CLIMATE CHANGE 563 (2017) (calculating warming since preindustrial times to be 1.2 C).

studies ask whether the market has efficiently anticipated and priced these changes. One recent study of publicly traded food companies in 31 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%.⁵⁷ Another looked at the growing frequency of extreme temperature events from 1995 to 2017, and found that high temperatures reduce revenues and operating incomes of individual firms.⁵⁸ Further, the greater the heat exposure, the greater equity analysts' estimates deviate from actual financial performance.⁵⁹ The authors conclude from their findings that "investors do not anticipate the repercussions of heat as a first-order physical climate risk."⁶⁰ The climate data firm 427 generates physical climate risk scores for individual firms based on their exposure to operational disruption risk.⁶¹ 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%.⁶²

⁵⁷ Harrison G. Hong, Frank Weikai Li & Jiangmin Xu, *Climate Risks and Market Efficiency*, JOURNAL OF ECONOMETRICS (forthcoming Sept. 2017); *see also* Mathias Kruttli, Brigitte Roth Tran, & Sumudu Watugala, Pricing Poseidon: Extreme Weather Uncertainty and Firm Return Dynamics, (EBRD Working Paper No. 229, 2019), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3451323 (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).

⁵⁸ Nora Pankratz, Rob Bauer & Jeroen Derwall, *Climate Change, Firm Performance, and Investor Surprises*, (European Center for Sustainable Finance, Working Paper 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3443146.

⁵⁹ *Id.*

⁶⁰ *Id.*; *see also* Alok Kumar, Wei Xin & Chendi Zhang, *Climate Sensitivity and Predictably Returns* (Working Paper 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3331872 (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*, (2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3480695 (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).

⁶¹ *See generally* FOUR TWENTY SEVEN, <https://427mt.com/> (last visited Jan 30., 2021).

⁶² Glen Gostlow, *Pricing Climate Risk* (London School of Economics and Political Science, Working Paper 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3501013 (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* (2020), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3506311&download=yes; Mats Andersson, Patrick Bolton & Frédéric Samama, *Hedging Climate Risk*, FINANCIAL ANALYSTS JOURNAL 7 (2016) (employing the Actuaries Climate Index to test for the impact of physical climate risk on

Evidence suggests that the housing market has begun to price in the risks of sea level rise, but that the risk is still undervalued.⁶³ There are reasons to expect these 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—within the lifespan of a 30-year mortgage issued today.⁶⁴ 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.⁶⁵ This means that highly-exposed homes are being covered by government insurance at heavily subsidized rates.⁶⁶ For another, there is no legal requirement to disclose flood history when selling a home. And Fannie Mae and Freddie Mac's governing regulations prohibit them from factoring natural disaster risk into their pricing of mortgages bought from banks.⁶⁷

Investors can only price the risks that 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

agriculture related stock returns and similarly finding that that a strategy of buying and selling based on climate risk scores would have generated positive returns).

⁶³ Markus Baldauf, Lorenzo Garlappi & Constantine Yannelis, *Does Climate Change Affect Real Estate Prices? Only if You Believe in It*, REV. FIN. STUDIES (forthcoming Sept. 2019) (available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3240200) (finding that homes vulnerable to sea level rise are priced at a discount only in those 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*, J. FIN. ECON (forthcoming) (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 REVIEW OF FINANCIAL STUDIES 1217 (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* (Chicago Booth, Working Paper No. 17-22, 2018).

⁶⁴ UNION OF CONCERNED SCIENTISTS, UNDERWATER: RISING SEAS, CHRONIC FLOODS, AND THE IMPLICATIONS FOR US COASTAL REAL ESTATE, 2 (2018).

⁶⁵ Kate Duguid, *Citing climate risk, investors bet against mortgage market*, REUTERS (Sept. 29, 2019); Jen Schwartz, *National Flood Insurance Is Underwater Because of Outdated Science*, SCIENTIFIC AMERICAN (Mar. 23, 2018).

⁶⁶ *Id.*

⁶⁷ 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 trillion⁶⁸), 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.⁶⁹ 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.⁷⁰

One recent example of this under-assessed and undisclosed climate risk comes from the California wildfires. In 2018, Pacific Gas and Electric voluntarily disclosed its climate-related risks to the nonprofit CDP (formerly the Carbon Disclosure Project).⁷¹ The company highlighted climate change driven increases in wildfire risk as a potential liability, and estimated its 2017 claim payouts at \$2.5 billion.⁷² 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.⁷³ PG&E's share price fell more than 80% in two months.⁷⁴

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, the rate of infectious diseases increases, energy transmission becomes less efficient, wasps nests the size of cars become more common.⁷⁵ And yet when voluntarily disclosing their environmental risks to CDP, more than 1,000 U.S. manufacturing companies report

⁶⁸ THE ECONOMIST INTELLIGENCE UNIT, *THE COST OF INACTION: RECOGNISING THE VALUE AT RISK FROM CLIMATE CHANGE* (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).

⁶⁹ 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).

⁷⁰ UNITED NATIONS ENVIRONMENT PROGRAMME FINANCE 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°).

⁷¹ *PG&E Corporation – Climate Change 2018*, CLIMATE DISCLOSURE PROJECT, https://www.cdp.net/en/formatted_responses/responses?campaign_id=62255737&discloser_id=774751&locale=en&organization_name=PG%26E+Corporation&organization_number=14678&program=Investor&project_year=2018&redirect=https%3A%2F%2Fcdp.credit360.com%2Fsurveys%2Fft9rgfbw%2F11971&survey_id=58150509 (last visited Jan. 20, 2021).

⁷² Brad Plumer, *Companies See Climate Change Hitting Their Bottom Lines in the Next 5 Years*, N.Y. TIMES (June 4, 2019); *PG&E Corporation – Climate Change 2018*, *supra* note X.

⁷³ Russell Gold, *PG&E: The First Climate-Change Bankruptcy, Probably Not the Last*, THE WALL STREET J. (Jan. 18, 2019), [wsj.com/articles/pg-e-wildfires-and-the-first-climate-change-bankruptcy-11547820006](https://www.wsj.com/articles/pg-e-wildfires-and-the-first-climate-change-bankruptcy-11547820006).

⁷⁴ *Id.*

⁷⁵ Mariel Padilla, *Officials Warn of Wasp 'Super Nests' in Alabama*, N.Y. TIMES (June 30, 2019).

they anticipate no climate-related risks.⁷⁶ The Brookings Institution recently found that communities exposed to heightened physical risk fail to report that risk in their municipal bond disclosures.⁷⁷

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.⁷⁸ 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 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. In other cases, the data need 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.⁷⁹ Where corporate operations are

⁷⁶ CDP, MAJOR RISK OR ROSY OPPORTUNITY (2019) (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)).

⁷⁷ Parker Bolstad *et al.*, *Flying Blind: What Do Investors Really Know about Climate Change Risks in the U.S. Equity and Municipal Debt Markets?* (Hutchins Center, Working Paper No. 67, 2020), https://www.brookings.edu/wp-content/uploads/2020/09/WP67_Victor-et-al.pdf.

⁷⁸ Brest, Gilson, Gordon *supra*; Opinion, *Labor vs. the ESG Racket*, WALL ST. J. (Nov. 15, 2020) (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”).

⁷⁹ NGFS, CALL FOR ACTION *supra* note X 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).

located, the 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.⁸⁰ Many climate risks are local in nature, so assets must be evaluated geospatially.⁸¹ 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.⁸² Corporate reporting of climate risks are far more likely to come in a qualitative, descriptive form than a quantitative one.⁸³ And their assessment of risks occur at widely varying time-scales.⁸⁴ Further, many current models of climate risk fail to differentiate well between exposure and liability.⁸⁵ 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?⁸⁶ 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.⁸⁷ Corporations may rely on key infrastructure, like roads

⁸⁰ CFTC REPORT 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)”); DEUTSCHE ASSET MANAGEMENT, MEASURING PHYSICAL CLIMATE RISKS IN EQUITY PORTFOLIOS 2 (2017) (“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.”)

⁸¹ MCKINSEY GLOBAL INSTITUTE, CLIMATE RISK AND RESPONSE, PHYSICAL HAZARDS AND SOCIOECONOMIC IMPACTS 7 (2020).

⁸² State of 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>.

⁸³ Goldstein *et al. supra* note X at X; Bolstad *et al., supra* note X 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 scenarios analysis to model risk”).

⁸⁴ *Id.*

⁸⁵ Asset-level data conference; CFTC REPORT, *supra* note XX, 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.”)

⁸⁶ Example of desalination plants, asset-level data conference

⁸⁷ MCKINSEY GLOBAL INSTITUTE, *supra* note X, at 32.

and water utilities, that have unaddressed climate risk exposure, yet have operators who lack the resources or the mandate to even evaluate it.⁸⁸

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 projections of risk.⁸⁹ In the climate context, the future will look very different from the past in myriad ways. Historical data representing a relatively stable climate past cannot be relied upon to predict future risks.⁹⁰ Future expected risk has to be creatively modeled – a challenge given uncertainties regarding emissions levels, future regulation, changes to the earth's systems, and socioeconomic feedbacks.⁹¹ 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*.⁹²

⁸⁸ Sarah Whateley, Jeffrey 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 (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”).

⁸⁹ Patrick Temple-West, *When Climate Change Threat To Weather Needs a Stilted Response*, FIN. TIMES (Dec. 2, 2019), <https://www.ft.com/content/80547020-bdbf-11e9-9381-78bab8a70848>; MCKINSEY GLOBAL INSTITUTE, *supra* note X, 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 capabilities”); *see also* Colin Raymond *et al.*, *Understanding and Managing Connected Extreme Events*, 10 NATURE CLIMATE CHANGE 611-621 (2020).

⁹⁰ Bolton *et al.*, THE GREEN SWAN, CENTRAL BANKING AND FINANCIAL STABILITY IN THE AGE OF CLIMATE CHANGE, BANQUE DE FRANCE 21 (2020).

⁹¹ 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>.

⁹² MCKINSEY GLOBAL INSTITUTE, *supra* note X, at 31. 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

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 uncertain, and potentially catastrophic, they may lie in this 1% zone that is likely to be discounted by market actors as “unlikely.”⁹³ This “fat-tail risk” deviates from the normal distribution that market actors may be accustomed to rely on in their models.⁹⁴

A further potential for model risk comes from misjudging not only the increased frequency and severity of extreme climate events, but also their *correlation*.⁹⁵ 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

& Majid Ataee-Pour, *Risk-adjusted Discount Rate Estimation for Evaluating Mining Projects*, 4 FINSIA J. APPLIED FIN. 36, 36 (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. Kahan, *Securities Laws*, supra note X at X. 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 ENVIRNMENT’L ECON. INVESTMENT ASSESSMENT II 75 (2008).

⁹³ THE GREEN SWAN, supra note X 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 X.

⁹⁴ VIVIAN DÉPOUES ET AL., TOWARDS AN ALTERNATIVE APPROACH IN FINANCE TO CLIMATE RISKS: TAKING UNCERTAINTIES FULLY INTO ACCOUNT, INSTITUTE FOR CLIMATE ECONOMICS 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 (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.”).

⁹⁵ Cf. Gilson & Kraakman Market Efficiency After the Financial Crisis 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)

in the same season.⁹⁶ Due to climate-change, these physical risks may cluster in time and correlate across geographies in new and unanticipated ways.⁹⁷ 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.⁹⁸ Lael Brainard, Board Member of the Governing Board of the Federal Reserve, has noted this potential for unforeseen climate risk correlation and its resemblance to the 2008 mortgage crisis.⁹⁹

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.¹⁰⁰ A facility that was built to withstand a “100-year flood,” for example, may now have a much higher likelihood of failure.¹⁰¹ Tens of thousands of steel bridges in the U.S., for example, were built relying on design specifications for expansion and contraction based on estimated

⁹⁶ See, e.g., CFTC REPORT, *supra* note XX, at 33 (“Research suggests that bigger banks may be better able to offset temporary regional losses from natural disasters with earnings from other regions” (citing John Landon-Lane et al., *The Economics of Climate Change: Adaptations Past and Present: Droughts, Floods and Financial Distress in the United States* (Nat’l Bureau of Econ. Rsch., Working Paper No. 15596, 2011))).

⁹⁷ See e.g., Luc Bonnafous, Upmanu Lall & Jason Siegel, *An Index for Drought Induced Financial Risk in the Mining Industry*, 53 WATER RESOURCES RES. 1509-24 (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> (citing Camilo Mora et al., *Broad Threat to Humanity from Cumulative Climate Hazards Intensified by Greenhouse Gas Emissions*, 8 NATURE CLIMATE CHANGE 1062-1071 (2018), <https://www.nature.com/articles/s41558-018-0315-6>).

⁹⁸ 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> (citing Kai Kornhuber et al., *Amplified Rossby Waves Enhance Risk of Concurrent Heatwaves in Major Breadbasket Regions*, 10 NATURE CLIMATE CHANGE 48 (2020); Franziska Gaupp et al., *Changing Risks of Simultaneous Global Breadbasket Failure*, 10 NATURE CLIMATE CHANGE 54 (2020)).

⁹⁹ Lael Brainard, Governor, Bd. of Governors of the Fed. Res. Sys., Address at the Fed. Res. 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).

¹⁰⁰ MCKINSEY GLOBAL INSTITUTE, *supra* note X at 64.

¹⁰¹ See, e.g., Reza Marsooli et al., *Climate Change Exacerbates Hurricane Flood Hazards Along US Atlantic and Gulf Coasts in Spatially Varying Patterns*, NATURE COMMUNICATIONS (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).

temperature extremes that are now expected to be surpassed.¹⁰² 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.¹⁰³

Finally, some corporate managers, especially 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.¹⁰⁴ But insurance premiums are typically re-assessed and paid on an annual basis.¹⁰⁵ 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.¹⁰⁶ Relying on insurance to price risks of investments that are expected to reap returns decades into the future, leads to a "duration mismatch"¹⁰⁷ that may leave these assets stranded without insurance, leading to unrecoverable losses in the event of a disaster.¹⁰⁸

¹⁰² Susan Palu & Hussam Mahmoud, *Impact of Climate Change on the Integrity of the Superstructure of Deteriorated US Bridges*, 14 PLOS ONE (Oct. 2019); see also U.S. DEP'T OF ENERGY, U.S. ENERGY SECTOR VULNERABILITIES TO CLIMATE CHANGE AND EXTREME WEATHER (July 2013).

¹⁰³ AM. SOC'Y OF CIV. ENG'RS, 2017 INFRASTRUCTURE REPORT CARD 27 (2017) (listing 9.1% of bridges as structurally deficient). According to the GAO the figure is more like 25%. U.S. GOV'T ACCOUNTABILITY OFFICE, TRANSPORTATION INFRASTRUCTURE: INFORMATION ON BRIDGE CONDITIONS (2015).

¹⁰⁴ MCKINSEY GLOBAL INSTITUTE, *supra* note 59, at 126 (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 ENVIRONMENT AND PLANNING A: ECONOMY AND SPACE 1131 (Sep. 2020). (uncovering "a strong tendency among ... elected officials, planners, and real estate interests[] to assign re/insurers great responsibility for managing [Florida's] climate risk").

¹⁰⁵ TCFD 2019 STATUS REPORT, citing SWISS RE, 2018 FINANCIAL REPORT 177 (2018) ("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.").

¹⁰⁶ Jessica Shankleman, *Growing Climate Risks May Be 'Impossible to Model' – and Ultimately Uninsurable*, INSURANCE J. (Nov. 13, 2017).

¹⁰⁷ The term duration mismatch typically refers to when a company's liabilities are not closely linked in time with its assets United States. See generally CONG. OVERSIGHT PANEL, JUNE OVERSIGHT REPORT: THE AIG RESCUE, ITS IMPACT ON MARKETS, AND THE GOVERNMENT'S EXIT STRATEGY (2010).

¹⁰⁸ MCKINSEY GLOBAL INSTITUTE, *supra* note 59, at 46; see also Mark Carney, et al., *Transition in Thinking: The Impact of Climate Change on the UK Banking Sector*, BANK OF ENGLAND PRUDENTIAL REGULATION AUTHORITY (Sept. 2018) (arguing that while banks are aware that flood risk will increase, few have modelled effects on insurance premia of increased flood risk).

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.¹⁰⁹ 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.¹¹⁰ 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 of facilities. But managers that manage to a stock-price set by a myopic market are discouraged from making these investments in the short term.¹¹¹

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,¹¹² so in the interest of self-preservation she may focus on the demands of myopic shareholders while neglecting to spend resources assessing and mitigating longer term risks to the company.¹¹³ Further, executive remuneration is regularly linked with short-term metrics of firm performance, including through compensation in stock, or stock options.¹¹⁴ 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-

¹⁰⁹ See, e.g., Armour, Gordon & Min, *supra* note X 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. OF ECON. PERSPECTIVES 131 (2017).

¹¹⁰ William W. Bratton & Michael L. Watcher, *The Case Against Shareholder Empowerment*, 158 U. PA. L. REV. 653, 710-711 (2010).

¹¹¹ Armour et al., *supra* note X at X (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*, 183-185 (Harvard Univ. Press 2006).

¹¹² See, e.g., Tim S. Campbell & Anthony M. Marino, *Myopic Investment Decisions and Competitive Labor Markets*, 35 INT'L ECON. REV. 855 (1994); Bengt Holmstrom & Joan Ricart I Costa, *Managerial Incentives and Capital Management*, 101 Q. J. ECON. 835 (1986).

¹¹³ Marcel Kahan & Edward B. Rock, *Hedge Funds in Corporate Governance and Corporate Control*, 155 U. PA. L. REV. 1021, 1088 (2007).

¹¹⁴ See, e.g., BEBCHUK & FRIED, *supra* note X; Steven N. Kaplan, *CEO Pay and Corporate Governance in the U.S.: Perceptions, Facts, and Challenges*, 25 J. APP. CORP. FIN. 8 (2013); Admati *supra* note X at 133.

term increases in earnings.¹¹⁵ Armour, Gordon, and Min show how options compensation, which becomes worthless if the stock falls below the strike price, mutes managers' personal exposure to downside risk.¹¹⁶ 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."¹¹⁷

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.¹¹⁸ Earnings manipulation is just one example of managers undertaking "signal jamming," or the massaging of financial metrics used by investors to assess risk.¹¹⁹ The coal company Peabody Energy may already provide an example of such agency costs in the climate context. In 2016, the New York attorney general announced it had reached a settlement with Peabody after an investigation revealed the many ways the company had withheld information from investors regarding internal projections for future coal demand.¹²⁰ 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."¹²¹ In another example of potential managerial manipulation, an Exxon whistleblower

¹¹⁵ Tomislav Ladika & Zacharias Sautner, *Managerial Short-termism and Investment: Evidence from Accelerated Option Vesting*, (U. of Amsterdam, Working Paper 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2286789; Alex Edmans, Vivian W. Fang & Katharina A. Lewellen, *Equity Vesting and Managerial Myopia*, 30 REV. FIN. STUDIES 2229 (2017). An oft-cited example of this effect is from a 2005 survey of corporate executives, 80 percent of whom admitted that they felt pressure to decrease spending in areas like research and development in order to meet quarterly earnings targets. John R. Graham, Campbell Harvey & Shiva Rajgopal, *The Economic Implications of Corporate Financial Reporting*, 40 J. ACCT. & ECON. 3, 32-35 (2005).

¹¹⁶ Armour, *supra* note X, at 20, 25.

¹¹⁷ *Id.* at 25.

¹¹⁸ Dallas, *supra* note X at 312.

¹¹⁹ *Id.*; Michael C. Jensen, *Paying People to Lie: The Truth About the Budgeting Process*, 9 EUR. FIN. MGMT. 379, 387 (2003).

¹²⁰ Press Release, N.Y. State Office 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).

¹²¹ Clifford Krauss, *Peabody Energy Agrees to Greater Disclosures of Financial Risks* N.Y. TIMES (Nov. 8, 2015), <https://www.nytimes.com/2015/11/09/business/energy-environment/peabody-energy-agrees-to-greater-disclosures-of-financial-risks.html#:~:text=Peabody%20Energy%2C%20the%20world's%20biggest,reduce%20demand%20for%20its%20product>.

claims the company deceptively overvalued one of its largest oil assets, and forced-out employees who objected to the figure as unrealistic.¹²²

Equity-overvaluation can drive managers to preference short-term performance metrics over long term value-creation in an effort to meet market expectations.¹²³ 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.”¹²⁴ 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.¹²⁵ This “overvaluation trap,” it has been argued, describes the decisions of oil executives to spend hundreds of billions of dollars, each year, on prospecting for new reserves, despite there being a 53 year supply of oil contained in the world’s existing 2 trillion barrels of reserves.¹²⁶ Oil companies derive most of their net present value from the future promised profitability of their reserves.¹²⁷ Any acknowledgement 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. (In 2004, under pressure from regulators, Shell downwardly adjusted its estimated proven reserves by 20%, and share prices fell 10%).¹²⁸ 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.¹²⁹

¹²² Christopher Matthews & Emily Glazer, *Exxon Draws SEC Prove Over Permian Basin Asset Valuation*, WALL ST. J. (Jan. 15, 2021).

¹²³ 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...”).

¹²⁴ Jensen, *Agency Costs of Overvalued Equity*, *supra* note X at 7.

¹²⁵ *Id.*; see also Kahan, *supra* note X at 1030-31 (describing a managers 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 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.

¹²⁶ Roger Martin & Alison Kemper, *The Overvaluation Trap*, HARV. BUS. REV. (Dec. 2015).

¹²⁷ Analysis from McKinsey 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).

¹²⁸ John Carey, *Shell: The Case of the Missing Oil*, BLOOMBERG BUSINESSWEEK, (Jan. 26, 2004) <https://www.bloomberg.com/news/articles/2004-01-25/shell-the-case-of-the-missing-oil>.

¹²⁹ CARBON TRACKER INITIATIVE, MEASURING COMMITMENT TO CLIMATE GOALS (2019), (identifying \$50 billion of investment since 2018 in major fossil projects that undermine climate

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.¹³⁰ This metric, along with the common practice of 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.¹³¹ 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.¹³² 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 mis-valuation.¹³³ But the past few decades have seen innovation

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).

¹³⁰ INSTITUTE FOR POLICY STUDIES, MONEY TO BURN: HOW CEO PAY IS ACCELERATING CLIMATE CHANGE, 13 (2015); *see also* ExxonMobil, 2015 Proxy Statement (Form DEF 14A) (April 14, 2015),

<http://www.sec.gov/Archives/edgar/data/34088/000119312515128602/d855824ddef14a.htm>

(citing the successful drilling of the first exploration well in the Russian Arctic as a basis for executive compensation decisions); ConocoPhillips, 2017 Proxy Statement, 86 (2017) (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); Simon Bowers & Harry Davies, *Oil Company Bosses’ Bonuses Linked to \$1tn Spending on Extracting Fossil Fuels*, GUARDIAN (May 25, 2015), <https://www.theguardian.com/environment/2015/may/25/oil-company-bosses-bonuses-1tr-spending-fossil-fuels>.

¹³¹ CARBON TRACKER INITIATIVE, PAYING WITH FIRE: HOW OIL AND GAS EXECUTIVES ARE REWARDED FOR CHASING GROWTH AND WHY SHAREHOLDERS COULD GET BURNED (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).

¹³² 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”).

¹³³ Sanford Grossman & Joseph Stiglitz, *On the Impossibility of Informationally Efficient Markets*, 70 AMER. ECON. R., 393 (1980).

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 counter-acting force to this short-termism.¹³⁴ But this debate has largely failed to grapple with another difference (besides horizon) between long-term institutional 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 determines share price.

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 make buy or sell recommendations employing risk analyses that fall within the three to five year mark.¹³⁵ 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.¹³⁶ 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.¹³⁷ The analysts reported that disconnect was due, in part, to lack of demand from investors.¹³⁸

Weak investor demand for long term risk analysis may be explained, in part, by the rise in short-term trading.¹³⁹ In 1960, the average share of stock was held for

¹³⁴ Compare Lucian A. Bebchuk et al., *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.”); 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).

¹³⁵ 2 DEGREE INVESTING INITIATIVE, ALL SWANS ARE BLACK IN THE DARK: HOW THE SHORT-TERM FOCUS ON FINANCIAL ANALYSIS DOES NOT SHED LIGHT ON LONG TERM RISKS 5 (2017).

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

¹³⁷ 2 DEGREE INVESTING, ALL SWANS ARE BLACK, *supra*, note X at 5 (explaining that retirement funds and insurers have long term liabilities and are “supposed to optimize their return on a 15-30 year horizon”).

¹³⁸ *Id* at 39. The other three reasons provided where, (1) lack of data, (2) sophisticated long-term risk assessment is expensive and (3) methodological obstacles.

¹³⁹ ERNST & YOUNG GLOBAL LIMITED, STUDY ON DIRECTORS' DUTIES AND SUSTAINABLE CORPORATE GOVERNANCE vi (2020); *cf.* Mark Roe et al., *Stock Market Short-termism's Impact* 12

eight years and four months.¹⁴⁰ Current estimates of average length of share hold-time range between four and eight months,¹⁴¹ with hedge fund holdings averaging four and a half months.¹⁴² 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."¹⁴³ 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."¹⁴⁴ It has been empirically shown that increases in stock ownership by shorter-horizon investors is associated with reductions in longer-term investment spending and increased short-term earnings.¹⁴⁵ These cuts to spending, like reductions in research and development,

(Eur. Corp. Governance Inst., Working Paper 426, 2018), https://ecgi.global/sites/default/files/working_papers/documents/finalroe.pdf (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.

¹⁴⁰ 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/>.

¹⁴¹ Leo E. Strine, *One Fundamental Corporate Governance Question We Face: Can Corporations Be Managed for the Long Term Unless Their Powerful Electorates Also Act and Think Long Term?*, 66 BUS. L. 1 (2010). One recent study found that the average share replacement rate for equity fund managers was 1.7 years. 2 DEGREE INVESTING INITIATIVE, *THE LONG AND WINDING ROAD* 11 (2017).

¹⁴² Robin Greenwood & Michael Schor, *Hedge Fund Investor Activism and Takeovers*, 13 (Harvard Bus. Sch. Working Paper Series, Paper No. 08-004, 2007), available at: <http://www.hbs.edu/research/pdf08-004.pdf>

¹⁴³ Dallas, *supra* note x at 300; see also Alfred Rappaport, *The Economics of Short-Term Performance Obsession*, 61 FIN. ANALYST J. 65, 69 (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.").

¹⁴⁴ Leo E. Strine, Jr., *Can We Do Better By Ordinary Investors? A Pragmatic Reaction to the Dueling Ideological Mythologists of Corporate Law*, 114 COLUMBIA L. REV. 449, 478 (2011).

¹⁴⁵ Martjin Cremers et al., *Short-Term Investors, Long-Term Investments, and Firm Value: Evidence from Russell 2000 Index Inclusions*, 66 MANAGEMENT SCIENCE 4535 (2020).

lead to short-term increases in stock valuations that eventually decrease over time.¹⁴⁶

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.¹⁴⁷ 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 6 years now.”¹⁴⁸ NRG's stock soared after the shake-up, and just months later, in early 2018, Elliott exited its position, selling 10 million shares of NRG, and pocketing a 130% return.¹⁴⁹ 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).¹⁵⁰ At present, around half of US stock held in investment funds are

¹⁴⁶ *Id.* See also Patrick Bolton, José Scheinkman & Wei Xiong, *Executive Compensation and Short-Termist Behaviour in Speculative Markets*, 73 REV. OF ECON. STUD. 577 (2006).

¹⁴⁷ 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 373, 36-37 (2017)), https://scholarship.law.columbia.edu/faculty_scholarship/2057.

¹⁴⁸ Ed Crooks, *Activists clash over direction for NRG Energy*, FIN. TIMES (Apr. 9, 2017), [ft.com/content/89417ba2-1d3e-11e7-a454-ab04428977f9](https://www.ft.com/content/89417ba2-1d3e-11e7-a454-ab04428977f9).

¹⁴⁹ FINTEL, *Elliott Management Corporation closes position in NRG / NRG Energy, Inc.* (May 15, 2018), <https://fintel.io/so/us/nrg/elliott-management>; 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>.

¹⁵⁰ 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 et al., *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*, REV. OF FIN. STUD. (forthcoming July 5, 2018) (available at: <https://ssrn.com/abstract=2663398>) (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 in financial markets 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, 1082 (2012) (concluding from

passively managed.¹⁵¹ Passive investment means that the fund commits to matching and maintaining its portfolio to meet a certain stock index.¹⁵² 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 funds.¹⁵³ As consumer demand for actively managed funds declines, so does the budget for equity research.¹⁵⁴ The number of equity analysts employed by investment funds has steadily declined in recent years,¹⁵⁵ with the 12 largest investment banks employing 25% fewer analysts in 2019 as compared to 2011.¹⁵⁶ 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.”¹⁵⁷

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:

empirical study that “the preference shift towards index fund investing is reducing the informational efficiency of stock prices”).

¹⁵¹ 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/>.

¹⁵² See John H. Langbein & Richard A. Posner, *Market Funds and Trust Investment Law*, 1976 AM. B. FOUND. RES. J. 1, 1 (1976).

¹⁵³ 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>.

¹⁵⁴ Robin Wigglesworth, *Final Call for the Research Analyst?*, FIN. TIMES (Feb. 7, 2017), <https://www.ft.com/content/85ee225a-ec4e-11e6-930f-061b01e23655> (charting the decline in the number of total equity analysts employed, and attributing it, in part, to the competitive pressure from passive funds).

¹⁵⁵ Sarah Gordon, *Sellside Research Would Be Little Missed*, FIN. TIMES, (Feb. 6, 2017), <https://www.ft.com/content/0609b1b4-ec51-11e6-ba01-119a44939bb6> (referring to sellside analysts as “a dying breed.”).

¹⁵⁶ Robin Wigglesworth & Philip Stafford, *Analyst Coverage Shrinks After Fee Shake-Up*, FINANCIAL TIMES (Dec. 2, 2019), <https://www.ft.com/content/a85848e0-1507-11ea-9ee4-11f260415385>; see also Justina Lee, *Analyst Jobs Vanish as a Perfect Storm Crashes Into Research* BLOOMBERG, <https://www.bloomberg.com/news/articles/2019-12-19/analyst-jobs-vanish-as-a-perfect-storm-hits-wall-street-research> (Dec. 19, 2019) (reporting that spending on buy side research has fallen 20% to 30%, and is likely to fall that much again in the near future, in part because “Machines are doing a lot more of the work and investors are piling into passive funds,” but also due to EU MiFID II regulations that requires research costs to be separated from trading fees in client billing, forcing banks to directly justify the cost of research).

¹⁵⁷ 2 DEGREE INVESTING, ALL SWANS, *supra*, note X at 59 (quoting an anonymous “Vice President of ESG Research,” as reporting that “The highest volume customers of sell-side equity research are hedge funds. This prevents a stronger focus on long-term risks.”)

“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.”¹⁵⁸ But if long-term investors think climate risks are “substantially more financially material than do other investors,”¹⁵⁹ 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.¹⁶⁰

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.¹⁶¹ This follow-the-leader game of stock valuation leads to distortions away from efficient pricing. Index investing, in some sense, is 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.¹⁶²

¹⁵⁸ F. William McNabb III & Glenn Booraem, *Investment Stewardship 2017 Annual Report*, HARV. L. SCH. FORUM CORP. GOV. (Sept. 18, 2017), <https://corpgov.law.harvard.edu/2017/09/18/investment-stewardship-2017-annual-report/>; see also *Examining the Macroeconomic Impacts of a Changing Climate, Prepared for the U.S. House of Representatives, Comm. on Fin. Services, Subcomm. on National Security, Int’l Dev. and Monetary Pol’y* (Sept. 11, 2019) (written testimony of Alicia Seiger, Managing Director, Stanford Sustainable Fin. Initiative) (testifying that passive investors are exposed to systemic mispriced climate risks when active traders fail to trade on foreseeable climate risk information).

¹⁵⁹ Krueger, Sautner & Starks, *supra* note X.

¹⁶⁰ See *Getting Physical*, *supra* note X.

¹⁶¹ 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 X 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.”)

¹⁶² Andrew Haldane, Exec. Director, Fin. Stability, Bank of England, *The Age of Asset Management?*, Address at the London Business School (Apr. 4, 2014), <http://www.bankofengland.co.uk/publications/Documents/speeches/2014/speech723.pdf>; Enrica Bolognesi & Andrea Zuccheri, *On the Efficiency of Benchmarks Composition: a Behavioural Perspective*, *Italian Association of Scholars of Economics and Management of Financial Institutions and Markets* (ADEIMF) (2008); Doron Israeli, Charles M. C. Lee & Suhas A. Sridharan, *Is there a dark side to exchange traded funds? An information perspective*, 22 REV. ACCOUNT 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 *On the ETF Divide*, 34 GRANT’S INTEREST RATE OBSERVER (Oct. 14, 2016) (using Exxon as an example of a stock that is overvalued as a result of ETF pricing, and pointing out that if you had shown a rational investor Exxon’s 2016 financial

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 in trading that will result in the accurate pricing of equity.¹⁶³ However, these active funds typically have a shorter holding period and investment horizon than index funds, and are interested in short-term, rather long-term profits.¹⁶⁴ 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.”¹⁶⁵ The company argues that their investor-customers make the decision as to which index best suits their needs. 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.¹⁶⁶

Further, the increasing flow of money into ESG investment products (\$20 billion in 2019 only)¹⁶⁷ suggests that investors are in fact waking up to climate-related risks and potential mispricing. But the main vehicle for ESG investing tends to be these “passive” funds that track an ESG index whose composition has been determined by companies’ ESG scores. These ESG metrics and indices have come

metrics back in 2013, they would have shorted the stock and yet lost money); Michael S. Piwowar, SEC, Commissioner, SEC-NYU Dialogue on Exchange-Traded Products (Sept. 8, 2017), <https://www.sec.gov/news/speech/speech-piwowar-2017-09-08> (former SEC Commissioner 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* 37 (Columbia Bus. School Research Paper No. 16-71, 2019) (finding that “ETF activity can improve short-run informational efficiency for underlying stocks”).¹⁶³ 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> (summarizing the argument that index funds make the market more efficient by removing inexperienced investors from the price-determining mechanisms of supply and demand).

¹⁶⁴ Strine, *Who Bleeds When the Wolves Bite?* *supra* at 1915.

¹⁶⁵ BLACKROCK, INDEX INVESTING SUPPORTS VIBRANT CAPITAL MARKETS, 14 (Oct. 2017).

¹⁶⁶ Robertson, *Passive in Name Only* *supra* note X at 848; Paul Mahoney & Adriana Robertson, *Advisers by Another Name*, UVA Law and Economics Paper Series 2021-01; see also Johannes Petry, Jan Fichtner & Eelke Heemskerk, *Steering Capital: The Growing Private Authority of Index Providers in the Age of Passive Asset Management*, REV. INT’L POLITICAL ECON (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”).

¹⁶⁷ CFTC REPORT, *supra* note X at 114, citing John Hale, *Sustainable Fund Flows in 2019 Smash Previous Records*, MORNINGSTAR (Jan 10, 2020).

under fire for misleading investors as to their methodology and composition.¹⁶⁸ 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.¹⁶⁹ This delegation may come with underexplored agency costs and third-party 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.¹⁷⁰ 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.¹⁷¹

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.¹⁷² 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?"¹⁷³

¹⁶⁸ 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 School Working Paper 5822-19, 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3438533 (finding that "ESG rating divergence is not merely driven by difference in opinions, but also by disagreements about underlying data.").

¹⁶⁹ Robertson, *supra* note X, at 848; see also Petry *et al.*, *supra* note X at 20.

¹⁷⁰ Rennison & Nauman, *supra* note X.

¹⁷¹ Adrienne Buller, *'Doing Well by Doing Good'? Examining the rise of ESG Investing*, COMMON-WEALTH (Dec. 12, 2020), <https://www.common-wealth.co.uk/reports/doing-well-by-doing-good-examining-the-rise-of-environmental-social-governance-esg-investing>.

¹⁷² Semi-strong form of efficiency see MOME

¹⁷³ Jeremy Grantham, *The Race for Our Lives*, GMO (June 25, 2018), <https://www.gmo.com/americas/research-library/the-race-of-our-lives-revisited/>.

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.¹⁷⁴ The Trump administration aided in this disinformation campaign. Federal agency websites have been overhauled to remove the term “climate change,” deleting whole documents and webpages on the issue.¹⁷⁵ 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.¹⁷⁶

These efforts have had a well-documented influence on public opinion.¹⁷⁷ While an increasing percentage of the population now agrees that climate change is occurring—primarily because of their direct observations of extreme weather—understanding of its causes and effects are poor. 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 declines in global sea-level.¹⁷⁸ Fifty-one percent thought that the ozone hole is the main cause of the greenhouse effect.¹⁷⁹

A recent survey asked 439 institutional investors about their assessment of climate related risks.¹⁸⁰ 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,

¹⁷⁴ ORESKES & CONWAY, *supra* note X; MEYER, *supra* note X. Academic economists have played an outsized role in downplaying the severity of the climate crisis. See Spencer Glendon, *A Price But at What Cost?*, <https://www.woodwellclimate.org/a-price-but-at-what-cost/> citing Nordhaus (saying 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* (arguing that “postponing the cost of curtailing emissions makes good sense: future generations will be able to bear such costs more easily”).

¹⁷⁵ ENVIRONMENTAL DATA & GOVERNANCE INITIATIVE, *CHANGING THE DIGITAL CLIMATE: HOW CLIMATE CHANGE WEB CONTENT IS BEING CENSORED UNDER THE TRUMP ADMINISTRATION* (2018).

¹⁷⁶ 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>.

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¹⁷⁸ 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. 1, 11-12 (2018).

¹⁷⁹ *Id.*

¹⁸⁰ Philipp Krueger, Zacharias Sautner & Laura T. Starks, *The Importance of Climate Risks for Institutional Investors* 27-28 (Eur. Corp. Governance Inst. Working Paper No. 18-58, 2019) (available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3235190).

warming by 2100 would likely reach 2.8°C.¹⁸¹ 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.¹⁸²

CEOs of American companies are disproportionately old, white, male, and conservative, as compared to the general population.¹⁸³ So are their boards.¹⁸⁴ Numerous studies have shown that this demographic is especially likely to deny the existence of climate change, or to downplay its effects.¹⁸⁵ In a 2018 poll, only 18% of Republicans in the baby boomer generation and older believed that the earth was warming due to human activity.¹⁸⁶ Sitting board members and executives of major financial institutions have come under fire for their record as climate deniers.¹⁸⁷

¹⁸¹ CLIMATE ACTION TRACKER, *Temperatures: Addressing Global Warming*, <https://climateactiontracker.org/global/temperatures/>, (last visited Jan. 22, 2020).

¹⁸² Alastair Marsh, *'Portfolio Warming' Is the New Climate Anxiety for Fund Managers* BLOOMBERG (Feb. 24, 2021).

¹⁸³ 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>; Claire Zillman, *The Fortune 500 Has More Female CEOs Than Ever Before*, FORTUNE (May 16, 2019), <https://fortune.com/2019/05/16/fortune-500-female-ceos/#:~:text=In%20the%20latest%20Fortune%20500,a%20whole%3B%20just%206.6%25.> (As of June 2019, just 33 of the Fortune 500 CEOs were women, and women comprised only 25% of Fortune 500 boards.)

¹⁸⁴ Alma Cohen, Moshe Hazan, Roberto Tallarita & David Weiss, *The Politics of CEOs*, 11 J. OF LEGAL ANALYSIS 2 (Eur. Corp. Governance Inst., Working Paper No. 450, 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3355690 (“We find that 58% of CEOs are Republicans (so defined), while only 18% are Democrat (and the remaining 24% Neutral). Furthermore, Republican CEOs lead companies with more than twice the asset value of companies led by Democratic CEOs.”)

¹⁸⁵ Aaron M. McCright & Riley E. Dunlap, *Cool Dudes: The Denial of Climate Shange Among Conservative White Males in the United States*, 21 GLOBAL 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, and male counterparts, respectively”); see also PWC, *THE COLLEGIALITY CONUNDRUM: FINDING BALANCE IN THE BOARDROOM* 19, 32 (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 49% 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)).

¹⁸⁶ Cary Funk & Brian Kennedy, *How Americans see climate change and the environment in 7 charts*, PEW RESEARCH CENTER (Apr. 21, 2020).

¹⁸⁷ <https://www.bloomberg.com/news/articles/2020-02-14/climate-skeptic-asset-managers-face-pressure-to-reveal-donations>; <https://foe.org/news/environmental-groups-call-jpmorgan-chase-drop-climate-denier-lee-raymond-board/>.

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 continue.¹⁸⁸ This bias may influence shareholders to undervalue the significance of climate risk.¹⁸⁹

The rational assessment of climate risk is further muddled by the very nature of information about climate change. Behavioral psychology tells us that information is complicated and “difficult to decipher” is more likely to be discarded as untrue.¹⁹⁰ 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.¹⁹¹ But, by definition, these high-impact low-probability events are unlikely to occur frequently. Investors and managers, failing to find examples of these events in their everyday lives, may irrationally devalue serious climate risks to their companies and portfolios.¹⁹²

Rational decision making is also stymied by a myopic focus on immediate rewards irrespective of the long-term consequences of those rewards.¹⁹³ Market actors are predisposed to prefer short term goal gratification regardless of its long

¹⁸⁸ See William Samuelson & Richard Zeckhauser, *Status Quo Bias in Decision Making*, J. OF RISK & UNCERTAINTY 7 (1988).

¹⁸⁹ Katie Critchlow, *Irrational Apathy: Investigating behavioural economic explanations for the Carbon Bubble* (2016) (dissertation London School of Economics Dissertation) (available at https://www.academia.edu/16319184/Investigating_behavioural_biases_and_the_carbon_bubble); see generally Elke U. Weber, *What shapes perceptions of climate change?*, 1 WILEY INTERDISC. REVS.: CLIMATE CHANGE 332 (2010).

¹⁹⁰ 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).

¹⁹¹ Choi & Pritchard, *Behavioral Economics and the SEC*, *supra* note X (citing Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 SCI. 1124, 1127-28 (1974)).

¹⁹² *Id.* at 12; Cass Sunstein, *The Availability Heuristic, Intuitive Cost-benefit Analysis, and Climate Change*, 77 CLIMATIC CHANGE 195, 195-196 (2006).

¹⁹³ Lisa Zaval & James F. M. Cornwell, *Cognitive Biases, Non-Rational Judgments, and Public Perceptions of Climate Change*, OXFORD RESEARCH ENCYCLOPEDIA OF CLIMATE SCIENCE 10 (2016) (citing George Loewenstein & Drazen Prelec, *Anomalies in Intertemporal Choice: Evidence and an Interpretation*, 107 QUARTERLY J. ECON. 573 (1992)).

term consequences.¹⁹⁴ This “present-bias” also inhibits people from accurately considering future benefits with upfront costs.¹⁹⁵ 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.¹⁹⁶ 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.¹⁹⁷ 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 weighting of their probability of occurrence.¹⁹⁸ Thus, managers may overweight 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 share 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.”¹⁹⁹ 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

¹⁹⁴ Walter Mischel & Ebbe Ebbesen, *Attention in Delay of Gratification*, 16 J. PERSONALITY SOCIAL PSYCHOLOGY 329-337 (1970).

¹⁹⁵ Zaval & Cornwell, *supra* note X, at X.

¹⁹⁶ Tversky & Kahneman, *Judgment Under Uncertainty* *supra* note X at 1127-28.

¹⁹⁷ Choi & Pritchard, *supra* note X at 12 (“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 X at 1127-28.

¹⁹⁸ Amos Tversky & Daniel Kahneman, *The Framing of Decisions and the Psychology of Choice* 211 (4481) SCIENCE 453-458 (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). 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).

¹⁹⁹ Donald C. Langevoort, *Organized Illusions: A Behavioral Theory of Why Corporations Misdlead Stock Market Investors (and Cause Other Social Harms)*, 146 U. PA. L. REV. 101 (1997).

possibility, and focus instead on more favorable predicted pathways.²⁰⁰ The *Wall Street Journal* reports that an Exxon geoscientist lost his job after he challenged senior executives: “We acknowledge the need to reduce our emissions, yet they are set to increase by at least 20% over the next five years,” he asked at a town hall meeting in 2020. “In the end, wouldn’t you agree that this is a problem of behaviors and leadership?”²⁰¹

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.”²⁰² 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.²⁰³

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.²⁰⁴

²⁰⁰ 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 percent in the preceding year. 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.”

²⁰¹ Christopher M. Matthews, *Exxon Used to be America’s Most Valuable Company. What Happened?*, WALL ST. J. (Sept. 13, 2020).

²⁰² Ronald J. Gilson & Reinier H. Kraakman, *The Mechanisms of Market Efficiency*, 70 VIRGINIA L. REV 549, 581 (1984) (“Although each trader’s own forecasts are skewed by the unique constraints on his or her judgment, other traders will have offsetting constraints. The random biases of individual forecasts will cancel one another out, leaving price to reflect a single, best-informed aggregate forecast.”)

²⁰³ ANDREI SCHLEIFER, *INEFFICIENT MARKETS: AN INTRODUCTION TO BEHAVIORAL FINANCE* 12 (Oxford Univ. Press 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, *Mechanisms of Market Efficiency supra* note X at X (explaining that unsystematic bias “washes out” over trading).

²⁰⁴ 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 (Apr. 22, 2016);

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. Many fossil fuel executives, including those of Exxon and Shell, sit on NAM's board of directors.²⁰⁵ 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.²⁰⁶ SEC Commissioner Hester Pierce has similarly spoken out against shareholder advocacy for heightened environmental disclosures, arguing they are motivated by "public shaming" rather than interest in informed investing.²⁰⁷

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. 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,²⁰⁸ and another that increases issuer power relative to proxy advisory firms that counsel institutional investors on shareholder votes.²⁰⁹ 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

Virginia Harper Ho, *Disclosure Overload? Lessons for Risk Disclosure & ESG Reporting Reform from the Regulation S-K Concept Release*, 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 their company" and only 34% said that "ESG is regularly part of the board's agenda." PWC'S 2019 ANNUAL CORPORATE DIRECTORS SURVEY at 4, 20.

²⁰⁵ Susan Moran, *Most Oil Giants Still Fighting Shareholder Pressure to Address Climate*, THE CLIMATE DOCKET (Apr. 11, 2019).

²⁰⁶ George David Banks, *Environmental Shareholder Resolutions Will Never Deliver the Climate Consensus that America Needs*, WASH. EXAMINER (June 13, 2018).

²⁰⁷ Hester M. Peirce, Comm'r, SEC, *Scarlet Letters: Remarks before the American Enterprise Institute* (June 18, 2019).

²⁰⁸ Press Release, SEC, *SEC Adopts Amendments to Modernize Shareholder Proposal Rule* (Sept. 23, 2020).

²⁰⁹ See Press Release, Allison Herren Lee, Comm'r, SEC, *Paying More For Less: Higher Costs for Shareholders, Less Accountability for Management* (July 22, 2020) (dissent arguing that the rule will lead to "less accountability on climate risk"). SEC Commissioner Robert Jackson, who voted against the proposals, warned 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." Press Release, Robert J. Jackson Jr., Comm'r, SEC, *Statement on Proposals to Restrict Shareholder Voting* (Nov. 5, 2019).

economic value of an investment.²¹⁰ 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.²¹¹ 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.²¹²

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.²¹³ And while investors have made some progress in getting corporations to disclose climate-related risks under voluntary frameworks, these frameworks are insufficient as they provide broad discretion to issuers and little assurance as to accuracy of the information provided.

1. *Inability of 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.²¹⁴ However, practical limits to arbitrage in the real world means 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.

²¹⁰ 29 C.F.R. pts. 2509, 2550 (2020); Press Release, Ceres, Ignoring overwhelming opposition, Labor Department adopts new rule that will impair ESG investing (Oct. 30, 2020). An earlier version of the rule proposed directly prohibiting the consideration of ESG factors.

²¹¹ 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).

²¹² Brett McDonnell, Hari M. Osofsky, Jacqueline Peel, & Anita Foerster, *Green Boardrooms?* CONN. L. REV., *forthcoming* at 47 (2021), *citing* Majority Action, *Climate Change in the Boardroom: How Asset Manager Voting Shaped Corporate Climate Action in 2019* at 8; Steven Mufson, *Exxon Shareholders Want Action on Climate change. The SEC Calls It Micromanagement.*, WASH. POST (May 8, 2019).

²¹³ See, e.g., Gilson & Kraakman, *Market Efficiency After the Financial Crisis*, *supra* note X at 333.

²¹⁴ See SHLEIFER, *supra* note X, at 4; Gilson & Kraakman, *Mechanisms of Market Efficiency*.

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.²¹⁵ When shareholders hold increasingly heterogeneous expectations about the future, “one would expect increasingly inefficient prices, at least as judged by the yardstick of the CAPM.”²¹⁶ 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.”²¹⁷ Climate change presents a similar shift in the status quo that impedes reliable forecasting.

Even if some group 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.²¹⁸

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.²¹⁹ He has recently appeared in headlines again, this time for heading an investment firm whose strategy is betting against residential mortgage-

²¹⁵ Gilson & Kraakman, *Mechanisms of Market Efficiency supra* note X at 577.

²¹⁶ *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) (“badly informed investors tend to overprice risky assets”).

²¹⁷ Bratton & Wachter, *supra* note X at 707.

²¹⁸ ROBERT J. SCHILLER, *IRRATIONAL EXUBERANCE* 197 (Princeton Univ. Press; 3rd ed. 2015) (“If indeed one knew today that the market would do poorly over the next ten or twenty years, but did not 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.”).

²¹⁹ 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/wjwyy9/a-big-short-investors-new-bet-climate-change-will-bust-the-housing-market>.

backed securities with exposure to coastal regions at risk from extreme weather events.²²⁰

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.²²¹ Arbitrageurs can’t short the whole market, and they lack the resources to correct market-, or even industry-wide bubbles.²²² 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 when the market will come to its senses and the bubble will burst.²²³ 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.²²⁴

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

²²⁰ Kate Duguid, *Citing Climate Risk, Investors Bet Against Mortgage Market*, REUTERS (Sept. 29, 2019) (He tells prospective clients “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 Quick, *Former Subprime Player Claims He Can Now Short the Mortgage Market for Climate and Covid Risks*, CNBC (Nov. 23, 2020).

²²¹ See, e.g., Jeff Schwartz, *Fairness, Utility, and Market Risk*, 89 OR. L. REV. 175, 208-213 (2010) (summarizing literature).

²²² See SHLEIFER, *supra* note X, 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.”); *id.* at 51 (“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.”)

²²³ Schwartz, *supra* note X at 213; Robert J. Shiller, *From Efficient Markets Theory to Behavioral Finance*, 17 J. ECON. PERSP. 83, 96-97 (2003); SHLIEFER, *supra* note X at 156-74.

²²⁴ SHLIEFER, *supra* note X at 182

a systemically important financial institution fail.²²⁵ This moral hazard may limit the motivations of market actors to fully account for catastrophic climate risks.²²⁶ Bank executives lack of incentive to “self-insure”²²⁷ against climate risks is arguably even more acute than their non-financial CEO peers.²²⁸

3. *Failures of Voluntary Disclosure Standards*

Shareholders, especially institutional investors, have woken up to the likely mispricing of climate risk in recent years.²²⁹ 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.²³⁰ The private 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.”²³¹ The framework recommends eleven categories of disclosure, organized under four core elements covering governance, strategy, risk management, and metrics and

²²⁵ Graham Steele, *Confronting the ‘Climate Lehman Moment’: The Case for Macroprudential Climate Regulation*, 30 CORNELL J. L. & PUB. POL’Y 109, 137-140 (2020). Steele also points out that the six largest U.S. banks are responsible for 37 percent of global fossil fuel financing since the signing of the Paris Agreement. Steele at 117 note 34 citing Rainforest Action Network, *Banking on Climate Change 6* (2019), https://www.ran.org/wp-content/uploads/2019/03/Banking_on_Climate_Change_2019_vFINAL1.pdf

²²⁶ Bolton et al., *The Green Swan* supra note X at 9 (referring to potential for government entities to become “climate rescuers of last resort”).

²²⁷ Greg Gelzini’s testimony to Senate Banking, Housing, and Urban Affairs Committee

²²⁸ Cf. Section X supra.

²²⁹ BLACKROCK, *GETTING PHYSICAL*, supra note X.

²³⁰ 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), <https://www.forbes.com/sites/davidrvetter/2020/11/16/wielding-9-trillion-investors-warn-firms-from-bp-to-bmw-to-get-real-on-climate-change/?sh=1e931ee37ea0>; 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-fund-families-voted-on-climate-change-2020-edition> (showing average shareholder support for climate-risk disclosure requests climbed to an all-time high in 2020); THE VANGUARD GROUP, INC., *CLIMATE RISK GOVERNANCE: WHAT VANGUARD EXPECTS OF COMPANIES AND THEIR BOARDS* (2020).

²³¹ TASK FORCE ON CLIMATE-RELATED FIN. DISCLOSURES, *FINAL REPORT: RECOMMENDATIONS OF THE TASK FORCE ON CLIMATE-RELATED FIN. DISCLOSURES* iii (2017). The TCFD’s 2020 Status Report found that 1,340 corporations globally have expressed support for its recommendations, including 219 U.S. companies. Financial institutions managing \$150 trillion have stated support for the TCFD, including X sovereign wealth funds and the world’s largest asset managers. See TASK FORCE ON CLIMATE-RELATED FIN. DISCLOSURES, *2020 STATUS REPORT* 68 (2020).

targets.²³² Some investors and experts have pushed for companies to report against industry-specific standards in addition to their TCFD disclosures.²³³

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.”²³⁴ As of 2018, the average voluntarily complying company provided less than 4 of the 11 disclosure metrics recommended under the TCFD.²³⁵ 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.²³⁶ And disclosures are far more likely to dwell on transition risks than discuss physical risks.²³⁷ These voluntary disclosures remain nonstandardized, and are difficult for stakeholders to analyze and compare across companies.²³⁸ A large number of companies simply do not report climate risks through voluntary frameworks or otherwise. One third of S&P 500 companies do not disclose their own (Scope 1) emissions, a relatively uncomplicated metric.²³⁹

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.²⁴⁰ 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

²³² *Id.* at 10.

²³³ SASB

²³⁴ CDP, MAJOR RISK OR ROSY OPPORTUNITY 7 (2019).

²³⁵ TASK FORCE ON CLIMATE-RELATED FIN. DISCLOSURES, 2019 STATUS REPORT 7 (2019) (“only 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.”).

²³⁶ *Id.* Scenario analysis and its utility is discussed in detail, *infra*, at X.

²³⁷ Parker Bolstad et al., *supra* note X at 3.

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²³⁹ *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>.

²⁴⁰ Jon Lukomnik, *State of Integrated and Sustainability Reporting 2018*, HARV. L. SCH. F. CORP. GOVERNANCE (Dec. 3, 2018), <https://corpgov.law.harvard.edu/2018/12/03/state-of-integrated-and-sustainability-reporting-2018/> (reporting that only 36% of sustainability report include external assurance and about 90% of that assurance pertains to only some data).

required by the SEC, this reporting would be reviewed by SEC staff for compliance.²⁴¹

III. SOCIETAL HARM OF CLIMATE RISK UNDERASSESSMENT

Two types of harms are generated by the under-assessment of climate risk: (1) systemic risk to the financial system; and (2) the negative effects of climate change itself, as the mispricing of climate risk in the present leads to an inefficient allocation of investment capital. 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.²⁴² This is harmful not just to investors, but to everyone who relies on 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.”²⁴³ The majority of new public company investment comes from internally generated capital rather than funds raised from investors through financial instruments.²⁴⁴ 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 Haeberle, inaccurate stock prices thwart

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²⁴² 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 MICHIGAN 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).

²⁴³ Merritt B. Fox, *Civil Liability and Mandatory Disclosure*, 109 COLUM. L. REV. 237, 253 (2009).

²⁴⁴ See Kevin S. Haeberle, *Stock-Market Law and the Accuracy of Public Companies' Stock Prices*, COLUM. BUS. L. REV. 121, 138 (2015).

shareholders from monitoring management and the use of corporate funds, and reduce “the efficiency with which society allocates its scarce capital.”²⁴⁵

For example, oil and gas companies are currently allocating large up-front capital to the exploration and development of extractive projects that many argue are not net present value justified given projections of future demand in a carbon regulated world.²⁴⁶ 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.²⁴⁷ 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.²⁴⁸

Similarly, managers unpunished by the market have little incentive to invest in adaptation measures, and may neglect to spend money on elevating their factory, or investing in alternative energy sources, or researching heat resistant crops.²⁴⁹ Poor capital-allocation decisions made today will have long-lasting effects,

²⁴⁵ *Id.*

²⁴⁶ Martin & Kemper, *supra* note x.

²⁴⁷ CARBON TRACKER INITIATIVE, 2 DEGREES OF SEPARATION: TRANSITION RISK FOR OIL AND GAS IN A LOW CARBON WORLD 24 (2017) (predicting that Exxon is the most exposed of the world’s oil and gas firms to wasted capital expenditure if the atmospheric CO₂ concentration is kept below 450 ppm).

²⁴⁸ See Andrea Liesen, *Climate Change and Financial Market Efficiency*, 54 BUS. & SOCIETY 511, 531 (2015) (explaining, “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 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, *Securities Laws*, *supra* note X, 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”).

²⁴⁹ See, e.g., Jill E. Fisch, *Measuring Efficiency in Corporate Law: The Role of Shareholder Primacy*, 31 J. CORP. L. 637, 672 (2006) (describing “the connection between overvalued stock and value-destroying decisionmaking”); see also Bratton & Wachter, *supra* note X at X (“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.”)

particularly for projects involving infrastructure construction or purchases of equipment with long lifetimes and infrequent turnovers.²⁵⁰

B. SYSTEMIC RISK

One harm that stems from the failure to assess climate risk is the systemic nature of the risk itself.²⁵¹ 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.²⁵² 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.²⁵³ A recently published "climate stress test of the financial system" calculated that 6 percent of the average investment fund's equity holdings are in the fossil fuel industry, while an additional 36 percent are in "climate-policy relevant" sectors, including utilities, mining, housing, and transport.²⁵⁴ 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.²⁵⁵

²⁵⁰ JAMES WILLIAMS ET AL., SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK, POLICY IMPLICATIONS OF DEEP DECARBONIZATION IN THE UNITED STATES 54 (2015).

²⁵¹ See KERN ALEXANDER, RAHUL DHUMALE & JOHN EATWELL, GLOBAL GOVERNANCE OF FINANCIAL SYSTEMS: THE INTERNATIONAL REGULATION OF SYSTEMATIC RISK 24 (Oxford Univ. Press 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" are "shifted onto society at large as a negative externality."); MICHEL BUILSMA ET AL., CPB DOCUMENT NO. 210, SYSTEMIC RISK IN THE FINANCIAL SECTOR: A REVIEW AND SYNTHESIS, 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 X at 267 (linking the financial crisis to short-termism of financial institutions).

²⁵² Markey Carney ("Minsky moment"); Steele, *supra* note X 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").

²⁵³ See Dallas, *supra* note X at 315; Raghuram Rajan, *Has Financial Development Made the World Riskier?* 1, 21-23 (Nat'l Bureau of Econ. Research, Working Paper No. 11728, 2005), https://www.nber.org/system/files/working_papers/w11728/w11728.pdf.

²⁵⁴ Stefano Battison et al., *A Climate Stress-test of the Financial System*, 7 NATURE CLIMATE CHANGE 283, 283-84 (2017).

²⁵⁵ 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").

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.²⁵⁶ Several heads of other central banks agree with him that a “sudden collapse of asset prices” is possible.²⁵⁷ 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.²⁵⁸ Particular attention has been paid to the risks of a bubble in the coastal housing market, and relatedly, the municipal bond market.²⁵⁹

There have been attempts at predicting how the financial sector will react to climate-induced economic losses.²⁶⁰ One recent paper models how climate change induced reduction in labor productivity and capital stock could impact the stability of the global banking system.²⁶¹ 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.²⁶² Under such a scenario, this banking instability can lead to financial crises amounting to 30% of GDP.²⁶³

²⁵⁶ Mark Carney, Governor of the Bank of Eng., Chair of the Fin. Stability Bd., Arthur Burns Memorial Lecture in Berlin: Resolving the Climate Paradox (Sept. 22, 2016); HYMAN P. MINSKY, *STABILIZING AN UNSTABLE ECONOMY* (2008).

²⁵⁷ Mark Carney et al., *The Financial Sector Must Be at the Heart of Tackling Climate Change*, THE GUARDIAN (Apr. 17, 2019), <https://www.theguardian.com/commentisfree/2019/apr/17/the-financial-sector-must-be-at-the-heart-of-tackling-climate-change>; *see also* GLENN D. RUDEBUSCH, FED. RES. BANK OF S.F. ECONOMIC LETTER: CLIMATE CHANGE AND THE FED. RESERVE (2019) (“climate-based risk could threaten the stability of the financial system as a whole.”); MARGHERITA GIUZIO ET AL., EUROPEAN CENTRAL BANK, CLIMATE CHANGE AND FINANCIAL STABILITY (2019).

²⁵⁸ Sarah Breeden, Exec. Dir., Int’l. Banks Supervision at the Bank of Eng., Address at the Official Monetary & Financial Institutions Forum in London (Apr. 15, 2019).

²⁵⁹ *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).”)

²⁶⁰ *See, e.g.*, European Systemic Risk Board, *supra*, note X 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 percent”). *see also* UNIV. OF CAMBRIDGE INST. OF SUSTAINABILITY LEADERSHIP, UNHEDGEABLE RISK: STRESS TESTING SENTIMENT IN A CHANGING CLIMATE (2015).

²⁶¹ 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 et al., *Capital Stranding Cascades: The Impact of Decarbonisation on Productive Asset Utilization* (Ecol. Econ, Papers 18, WU Vienna University of Econ. & Bus. 2019) (modeling possible cascades of stranded assets that travel through multiple industries and impacting the financial sector).

²⁶² *Id.* at 829-830.

²⁶³ *Id.* at 831. *Cf.* Christina Skinner, Central Banks and Climate Change 21-30 (Nov. 24, 2020) (unpublished) (on file at

This 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).²⁶⁴ 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.²⁶⁵

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 risks into prudential regulation and stability monitoring,²⁶⁶ amending fiduciary duties of CEOs and asset managers,²⁶⁷ and integrating climate risks into central bank asset purchases.²⁶⁸ 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.²⁶⁹ One particular intervention, a mandatory

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3703142&download=yes (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)

²⁶⁴ 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”).

²⁶⁵ *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 (10th Ed. 2011) (describing difference between firm-specific idiosyncratic risk, and portfolio-wide systematic risk).

²⁶⁶ Graham Steele, *Confronting the ‘Climate Lehman Moment’: The Case for Macroprudential Climate Regulation*, 30 CORNELL J. L. & PUB. POL’Y 109 (2020).

²⁶⁷ *Fact Sheet: Modernizing Fiduciary Duty*, REGENERATIVECRISISRESPONSECOMMITTEE.ORG, <https://regenerativecrisisresponsecommittee.org/recentwork/factsheet-fiduciaryduty>; THE GREEN SWAN, *supra* note X, at 50, 65; *see also* *Guardrails to Protect the Commons*, THESHAREHOLDERCOMMONS.COM, <https://theshareholdercommons.com/guardrails/>.

²⁶⁸ CFTC REPORT, *supra* note X, 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/>.

²⁶⁹ CFTC REPORT, *supra* note X at 45.

climate risk disclosure regime, has been increasingly demanded by regulators, non-profits, and investors alike.²⁷⁰ And signs from the Biden Administration suggest that there is support for new SEC regulation mandating disclosure of climate risks.²⁷¹ 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.

A. UPDATE DISCLOSURE REQUIREMENTS

As discussed elsewhere, the SEC already has the statutory authority to enact a mandatory climate risk disclosure regime.²⁷² 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.”²⁷³

²⁷⁰ Simon Jessep & Matthew Green, *BlackRock CEO backs mandatory climate reporting, urges U.S. action*, REUTERS (Nov. 10, 2020), <https://www.reuters.com/article/uk-climate-change-blackrock-idUKKBN27Q2TS>; See Press Release, Allison Herren Lee *supra* note XX; Lee 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>

²⁷¹ Emily Glazer, *Companies Brace Themselves for New ESG Regulations Under Biden*, WALL ST. J. (Jan. 18, 2021), https://www.wsj.com/articles/companies-brace-themselves-for-new-esg-regulations-under-biden-11610719200?mod=searchresults_pos3&page=1; Press Release, Ceres, Ceres applauds SEC on creating new climate position, hiring Satyam Khanna (Feb. 1, 2021), <https://www.ceres.org/news-center/press-releases/ceres-applauds-sec-creating-new-climate-position-hiring-satyam-khanna>.

²⁷² MADISON CONDON, SARAH LADIN, JACK LIENKE, MICHAEL PANFIL, & ALEXANDER SONG, INSTITUTE FOR POLICY INTEGRITY AND ENVIRONMENTAL DEFENSE FUND, *MANDATING DISCLOSURE OF CLIMATE-RELATED FINANCIAL RISKS (2021)* (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 X at 93 (describing Section 302 of Sarbanes-Oxley as setting out requirements related to 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.” Further, “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.”).

²⁷³ 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,

Systematic integration of climate risks by financial actors can help prepare corporations and the broader economy for both the green transition and physical resilience.²⁷⁴ A mandatory disclosure regime can help overcome both managerial and investor biases.²⁷⁵ 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 under-priced and unaddressed risks.²⁷⁶ Disclosure may also facilitate the construction and monitoring of ESG metrics and indices designed to reduce exposure to climate risk.²⁷⁷

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.²⁷⁸ In particular, an overemphasis on false precision provided by complicated models might obscure the usefulness of other methods of risk assessment and

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).

²⁷⁴ J.D. Farmer et al., *Sensitive Intervention Points in the Post-Carbon Transition*, 364 SCIENCE 132-134 (2019) (arguing that “Relatively modest changes to financial accounting rules or disclosure guidelines regarding climate change risks could have outsized effects.”).

²⁷⁵ *See, e.g.*, George Loewenstein et al., *Disclosure: Psychology Changes Everything*, 6 ANN. REV. ECON. 391 (2014); Choi & Pritchard, *Behavioral Economics and the SEC* *supra* at 60, 66 (arguing that because “biases may persist even in the face of 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).

²⁷⁶ *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 peers, about risk assessment). Of course, biases may persist even in the face of accurate countervailing information. Stephen J. Choi & A.C. Pritchard, *Behavioral Economics and the SEC*, 56 STAN. L. REV. 1, 74 (2003).

²⁷⁷ 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; Or aid in their direct regulation. Mahoney & Robertson, *supra* note X at X; [Rauterberg Index Theory on regulating indexes?].

²⁷⁸ 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* Fiedler et al., *supra* note X at 90.

communication.²⁷⁹ 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.²⁸⁰ In crafting disclosure regulation, the SEC should draw on climate-related expertise at other federal agencies through interagency working groups and advisory boards.²⁸¹

1. Dealing With Uncertainty

Issuers opposed to heightened climate risk disclosure requirements have sometimes argued that the large amounts of uncertainty around climate change makes forward-looking disclosures impossible, or misleading.²⁸² And climate

²⁷⁹ *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, Deputy Gen. Manager of the BIS, 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) (transcript available at https://www.bis.org/speeches/sp190523.htm#_ftn8). 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/>. 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 X.

²⁸⁰ 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, especially with regard to climate risks. Press Release from Allison Herren Lee, SEC Comm’r, “Modernizing” Regulation S-K: Ignoring the Elephant in the Room (available at <https://www.sec.gov/news/public-statement/leemda-2020-01-30>). It’s true that the broad principles based standard gives managers too much discretion to withhold information. *See* section X *supra*. 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.

²⁸¹ *See e.g., EPA Science Advisory Board (SAB)*, YOSEMITE.EPA.GOV, <https://yosemite.epa.gov/sab/sabpeople.nsf/WebCommittees/BOARD> (last visited Feb. 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); Condon et al, *supra* note X, at X; The IWG on the SCC is presently...

²⁸² Peabody Energy Settlement; Greg Baer, *BankThink: Climate Risk Test asks Banks to Look Too Far Down the Road*, AMERICAN BANKER (Nov. 30, 2020), <https://www.americanbanker.com/opinion/climate-risk-test-asks-banks-to-look-too-far-down-the-road>.

scientists themselves have warned that reliance on global climate models for pricing short-term business risk can be misguided.²⁸³ Central bank authorities, too have 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.²⁸⁴ However, as engineers focused on adaptation have warned, regulators should avoid the conflation of “deep uncertainty as to the distant future with potentially predictable, uncertainty as to the near future.”²⁸⁵

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.²⁸⁶ This method helps to deliver information to investors without glossing over the high degree of uncertainty when estimating energy sector transitions, warming pathways, and climactic responses. The SEC should consider whether or not to construct and provide specific scenarios for companies to report against.²⁸⁷ When the choice of scenario is left up to issuer discretion, they may choose

²⁸³ Fiedler et al., *supra* note X at X.

²⁸⁴ THE GREEN SWAN, *supra* note X, 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.* THE GREEN SWAN, *supra* note X, 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 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).

²⁸⁵ 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 (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”); *see also* Theodore *supra* note X at X.

²⁸⁶ TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, THE USE OF SCENARIO ANALYSIS IN DISCLOSURE OF CLIMATE-RELATED RISKS AND OPPORTUNITIES (2017).

²⁸⁷ CFTC Report, *supra* note X at 74 n. 5 (The CFTC suggests that “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.”)

scenarios favorable to their prospects: cherry-picking future warming pathways or regulatory (in)action favorable to their companies' future.²⁸⁸

However, as leading practitioner Margaret Peloso has warned, standardizing scenarios can also mask uncertainty.²⁸⁹ 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.²⁹⁰ 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. She warns that if you “reduce scenario analysis to a cookbook” you constrain the

²⁸⁸ Kate Mackenzie, *The Trouble with Climate Change 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>. 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. Press Release, N.Y. State Office of the Att’y Gen., *supra* note 93. 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. Institute for Policy Integrity, *Margaret Peloso at Corporate Climate Risk: Assessment, Disclosure, and Action, Panel 2: The Current State of Corporate Climate Disclosure and Applications*, YOUTUBE (Oct. 2, 2020), <https://youtu.be/caxY0jIM0b8>; CFTC REPORT *supra* note X 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”).

²⁸⁹ *Margaret Peloso at Corporate Climate Risk, supra* note 245.

²⁹⁰ *Id.* (Peloso noting that none of her 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, CARBONBRIEF (Nov. 13, 2019), <https://www.carbonbrief.org/profound-shifts-underway-in-energy-system-says-iea-world-energy-outlook>; Gero Rueter, *Is the IEA underestimating renewables?*, DEUTSCHE WELLE (Mar. 3, 2018), <https://www.dw.com/en/is-the-iea-underestimating-renewables/a-43137071>.

creative thinking necessary for imagining the potential for multiple and converging climate-related risks.²⁹¹

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 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 *infra*.²⁹² 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.²⁹³

The Public Company Accounting Oversight Board (PCAOB) was established by the Sarbanes-Oxley Act of 2002 to oversee the audits of public companies. 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.”²⁹⁴ Because climate-related risks to companies are “highly dependent upon the particular assumptions used by management,” you might expect them to be discussed in CAMs covering the reasonableness of

²⁹¹ Regulators should consider requiring that all underlying assumptions used to construct scenarios be disclosed, including metrics such as economic life of assets and the percentage of valuation that can be attributed to future growth. See PCAOB

²⁹² AUSTRALIAN ACCOUNTING STANDARDS BOARD, CLIMATE-RELATED AND OTHER EMERGING RISKS DISCLOSURES: ASSESSING FINANCIAL STATEMENT MATERIALITY USING AASB/IASB PRACTICE STATEMENT 2 (2019) (“The potential financial implications arising from climate-related and other emerging risks may include, but are not limited to: asset impairment; changes in the useful life of assets; changes in the fair valuation of assets due to climate-related and emerging risks; increased costs and/or reduced demand for products and services affecting impairment calculations and/or requiring recognition of provisions for onerous contracts; potential provisions and contingent liabilities arising from fines and penalties; and changes in expected credit losses for loans and other financial assets.”)

²⁹³ THE INSTITUTIONAL INVESTORS GROUP ON CLIMATE CHANGE, INVESTOR EXPECTATIONS FOR PARIS-ALIGNED ACCOUNTS 4 (2020).

²⁹⁴ THE AUDITOR'S REPORT ON AN AUDIT OF FINANCIAL STATEMENTS WHEN THE AUDITOR EXPRESSES AN UNQUALIFIED OPINION, PCAOB Release No. 2017-001 (PUB. CO. ACCOUNTING OVERSIGHT BD. 2017). 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.

assumptions related to asset lives or commodity prices, yet very few mention climate.²⁹⁵

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.²⁹⁶ 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).²⁹⁷ As the *Financial Times* recently argued, climate risks may be uncertain, “but so is the time value of money.”²⁹⁸

3. Provision of Climate-Risk Assessment Tools and Data

Information asymmetries are typically thought of in corporate disclosure theory as one-way.²⁹⁹ 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 the suppliers are based, what route supply chains travel over, 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

²⁹⁵ Id.

²⁹⁶ Samantha Ross, Role of Accounting and Assurance in Addressing Climate Risk, W.P. (2021).

²⁹⁷ Samantha Ross, Ceres Report. 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 *Comparability in International Accounting Standards – A Brief History*, FASB.ORG, <https://www.fasb.org/jsp/FASB/Page/SectionPage&cid=1176156304264> (last visited Jan. 30, 2020).

²⁹⁸ Opinion, *Time to Clean up Climate Reporting Standards*, FIN. TIMES (Feb. 2, 2021), <https://www.ft.com/content/4f4a8485-4eed-4228-8ce2-ec199d40829c>.

²⁹⁹ 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*, COLUM. BUS. L. REV. 223, 278 (2002) (arguing for mandatory securities disclosure to address information asymmetries in the wake of Enron).

temperatures. Civil society has begun to fill this void, but the resources and authority of the federal government are sorely needed.³⁰⁰

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."³⁰¹ DERA's Offices of Risk Assessments and Data Science facilitate enforcement by "developing customized, analytic tools and analyses to proactively detect market risks indicative of possible violations."³⁰² 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.³⁰³

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."³⁰⁴ 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

³⁰⁰ See CFTC Report, *supra* note X 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. GLOBAL CHANGE RESEARCH PROGRAM, OUR CHANGING PLANET: THE U.S. GLOBAL CHANGE RESEARCH PROGRAM FOR FISCAL YEAR 2020, https://downloads.globalchange.gov/ocp/ocp2020/Our-Changing-Planet_FY-2020.pdf.

³⁰¹ U.S. SECURITIES & EXCHANGE COMM'N, ABOUT THE DIVISION OF ECONOMIC AND RISK ANALYSIS, <https://www.sec.gov/dera/Article/dera-about.html#:~:text=The%20Division%20of%20Economic%20and,making%2C%20enforcement%2C%20and%20examination>, (last visited Jan. 30, 2020). 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."

³⁰² *Id.*

³⁰³ Oversight of climate services...

³⁰⁴ THE GREEN SWAN, *supra* note X at 4; *Id.* 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")

exist.³⁰⁵ However, a better market understanding of the risks of climate change may help to reduce political opposition to emissions regulations 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," unabated greenhouse gas emissions.³⁰⁶ Direct regulation of emissions is necessary.³⁰⁷ 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 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.³⁰⁸ 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.³⁰⁹ U.S. regulators should consider a program of infrastructure audits.³¹⁰

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 the financial and real economies.³¹¹

³⁰⁵ 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.").

³⁰⁶ CFTC Report, *supra* note X at xix.

³⁰⁷ The CFTC Report's first recommendation to regulators is listing "establish a price on carbon." *Id.* at 9. 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." THE GREEN SWAN, *supra* note X, at 56-57 (citing Signe Krogstrup and William Oman, *Macroeconomic and Financial Policies for Climate Change* (IMF, Working Paper No. 19/185, 2019); *Id.* at 28 (arguing that past energy transformation were brought about not just by changes in relative pricing, but were also heavily influenced by socioeconomic, geopolitical, and institutional systems).

³⁰⁸ James Fernyhough, *Suncorp Calls for Climate Action as Profits Slump*, FIN. REV. (Feb. 14, 2019), <https://www.afr.com/companies/financial-services/suncorp-interim-profit-slumps-45pc-20190213-h1b7pj>.

³⁰⁹ James Fernyhough & Angela Macdonald-Smith, *Suncorp to Stop Insuring Oil and Gas*, FIN. REV. (Apr. 21, 2020), <https://www.afr.com/companies/financial-services/suncorp-to-stop-insuring-oil-and-gas-20200821-p55nwu>.

³¹⁰ Parker Bolstad et al., *supra* note X.

³¹¹ THE GREEN SWAN, *supra* note X at 42 ("Another risk may have to do with the development of financial products in response to climate-related risks, such as weather derivatives: these may help

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.³¹² 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.³¹³ 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.”³¹⁴ Climate adaptation requires planning at the national level, including plans for managed retreat.³¹⁵

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: “If market prices do not closely reflect actual expected risks and returns, [a] single-minded focus on share price is a recipe for mismanagement.”³¹⁶ 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.³¹⁷ Investors are increasingly advocating for the integration of climate-related metrics in executive remuneration.³¹⁸ According to a 2020 PWC survey, 34% of directors

individual institutions hedge against specific climate-related risks, but they can also amplify systemic risk” (citing (NGFS (2019b, p 14))).

³¹² See, e.g., Graham A. Tobin, *The Levee Love Affair: A Stormy Relationship?*, 31 J. OF AM. WATER RESOURCES ASSN 359 (1995).

³¹³ Taylor, *supra* note 105 at 1145.

³¹⁴ 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”).

³¹⁵ John Carey, *Core Concept: Managed Retreat Increasingly Seen as Necessary in Response to Climate Change's Fury*, 117 PROC. OF THE NAT'L ACAD. OF SCI. OF THE U.S. OF AM. 13,182 (2020).

³¹⁶ Lynn Stout, *Mechanisms of Market Inefficiency: An Introduction the New Finance*, 28 J. CORP. L. 635, 639 (2003).

³¹⁷ Armour et al, *supra* note X at X.

³¹⁸ Aileen Boniface & Jeremy Apple, *E&S Metrics in Executive Compensation: What Do Investors Really Care About?*, CLERMONT PARTNERS (July 8, 2020), <https://www.clermontpartners.com/blog/es-metrics-in-executive-compensation-what-do-investors-really-care-about/>.

said they would support linking executive compensation directly to ESG metrics.³¹⁹ 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.³²⁰

Large institutional shareholders should have a particular interest in how climate constitutes a systematic risk to portfolios, as these unhedgeable risks cannot be diversified away.³²¹ 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.³²²

V. CONCLUSION

After the 2011 Fukushima disaster, the U.S. Nuclear Regulatory Commission directed the (mostly corporate) operators of America's 60 nuclear power plants to assess their exposure to flood risk.³²³ Of these, the Commission found that 54 of the plants were not designed to handle their *current* flood risks, including 19 whose designs could not withstand possible present-day storm surges.³²⁴ 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 changed natural world.

³¹⁹ Paula Loop et al., *How Does the Board Oversee ESG?*, HARV. L. SCH. F. ON CORP. GOVERNANCE (Dec. 21, 2020), <https://corpgov.law.harvard.edu/2020/12/21/how-does-the-board-oversee-esg/>.

³²⁰ 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.* (“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... Have committee charters and proxy disclosures been updated to transparently disclose to shareholders and other stakeholders the board’s allocation of ESG oversight responsibility?”).

³²¹ Coffee, *The Future of Disclosure*, supra note X; Condon, *Externalities and the Common Owner*, supra note X.

³²² Condon, *Externalities and the Common Owner*, supra note X at X.

³²³ Christopher Flavelle & Jeremy Lin, *U.S. Nuclear Power Plants Weren't Built for Climate Change*, BLOOMBERG (Apr. 18, 2019), <https://www.bloomberg.com/graphics/2019-nuclear-power-plants-climate-change/>; *US Nuclear Power Policy (Updated Aug. 2020)*, WORLD-NUCLEAR.ORG, <https://www.world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power-policy.aspx>.

³²⁴ Flavelle & Lin, supra note X.

Market Myopia's Climate Bubble

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.