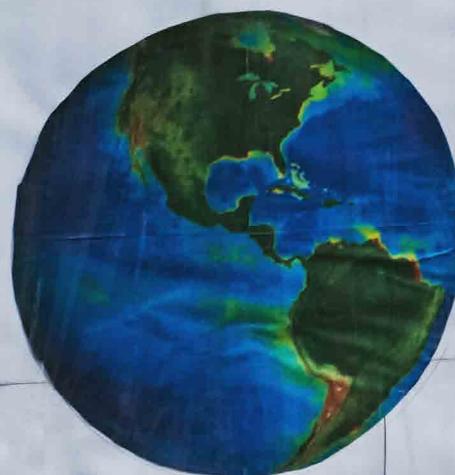


# Climate-Risk Disclosure: A Flimsy Pretext for a Green Power Grab

Rupert Darwall

There is

NO



PLANET B

Central banks and financial regulators are not being honest about their authority, expertise, and intent in pursuing mandatory climate-risk disclosures and risk models.

The Biden administration wants the Fed and the SEC to intervene in capital markets to push up the cost of capital for politically disfavored companies and push down such costs for favored ones in pursuit of the administration's climate policy objectives. Climate regulation is properly the province of Congress to legislate and the Environmental Protection Agency (EPA) to implement.

Nonetheless, the Biden administration is pushing the Fed and the SEC to engage in backdoor climate regulation, something that both give every sign of wanting to do. This requires both to argue that climate risk falls within their respective mandates for financial stability and investor protection.

This is implausible. The timescale for climate risks is well beyond any realistic assessment of financial stability risk and begs the question: Why the exclusive focus on climate and not on other risks, such as pandemics, cyber-security, trade and investment with China, or green stock bubbles, all of which pose greater risk to financial stability?

Neither is there evidence that climate-transition risk poses a threat to financial stability. Rather, it is a means for the Fed and the SEC to guide markets to their preferred view of the future. Far from protecting investors, the SEC's climate disclosures would systematically mislead them because they treat the world as a single regulatory space, a demonstrably false assumption.

Efficiently functioning capital markets are a major factor accounting for the superior performance of market economies over centrally planned ones. Subverting the role of investors and capital markets to price and allocate capital would move the U.S. economy further along the road to becoming a centrally planned economy.

[“Capitalism, Socialism and ESG”](#) (RealClear Foundation, May 2021) argued that Environmental, Social, and Governance (ESG) investing was about financial oligarchs usurping the functions of democratic institutions and the legitimacy of the ballot box by effectively making political and societal decisions themselves. Here, it is argued that central banks and financial regulators plan to overstep their mandates to subvert the efficient functioning of capital markets.

## ABOUT THE AUTHOR



Rupert Darwall is a senior fellow of the RealClearFoundation, researching such issues as energy and environmental policy and corporate governance. He previously worked as an investment analyst and in corporate finance, as well as serving as a special advisor to the UK's Chancellor of the Exchequer. The author of two books—*Green Tyranny* and *The Age of Global Warming*—and numerous think-tank reports, Darwall has also written for the *Wall Street Journal*, *The Hill*, and *Daily Telegraph*, among others.

Darwall can be contacted at [rdarwall@realclearfoundation.com](mailto:rdarwall@realclearfoundation.com)

**RealClearFoundation** is a nonprofit organization working in partnership with RealClearPolitics to mount journalistic and educational programs in the public interest.

# SUMMARY OF THE EXECUTIVE BRANCH'S EFFORTS TO LEVERAGE THE POWER OF THE FED AND THE SEC TO ACHIEVE ITS CLIMATE POLICY OBJECTIVES

## Background

On May 20, 2021, President Biden signed an Executive Order on a whole-of-government approach to advance climate financial-risk disclosure as part of his administration's goal of achieving net-zero greenhouse gas emissions by 2050. The order directs the Treasury secretary to engage with the chairman of the board of governors of the Federal Reserve System and the chair of the Securities and Exchange Commission on their current and proposed regulatory actions to mitigate climate-related financial risk and to report back to the president by November 16, 2021.

## The Issue

This puts the Fed and the SEC in a bind, as neither has a mandate to support the administration's economic policies or the elastic mandates of their European counterparts. To get around this, they must claim that climate change constitutes a systemic threat to financial stability, one that necessitates a bespoke disclosure regime to protect investors and climate-risk model requirements to protect large financial institutions. This creates tension and conflict between their hidden green mandates and the formal ones given to them by Congress.

## The Charge

Proposed actions by the Fed and the SEC—climate stress tests and mandatory climate financial-risk disclosures, respectively—make sense only if their true purpose is to restrict capital flows to certain firms in order to support the administration's goals of rapid decarbonization and net zero by 2050:

- *Climate stress tests* aim to raise the cost of capital for carbon-intensive activities designated by the Fed and divert capital flows toward low- and zero-carbon-emitting sectors, also selected by the Fed.
- *Climate-risk disclosures* are designed by the SEC to force specific tabulations of greenhouse gas emissions and those of suppliers and customers, as well as related risk disclosures, so that shareholders, interest groups, and others can enforce net-zero targets through proxy votes and other forms of engagement.\*

These objectives run contrary to the Fed's and the SEC's formal mandates. They necessarily embody consequential national policy decisions that can be made only at the direction of Congress and in cooperation with more relevant agencies, such as the EPA, the Department of Energy, and the Department of State.

Deliberately distorting U.S. capital markets to drive capital away from politically disfavored sectors and toward favored ones also subverts the core function of capital markets to price risk and allocate capital. Corporate emissions disclosures systematically mislead investors on the degree of climate regulatory risk posed by U.S. public companies because they treat the world as a homogenous regulatory space; the reality is that climate regulations, set and enforced by governments, are highly fragmented and vary by jurisdiction.

This jurisdictional asymmetry is reflected in the architecture of the Paris climate agreement, which is based on nationally determined contributions (NDCs). Additionally, climate disclosures involve matters

\* In this context, shareholders are not always what they appear to be. Index-fund providers such as BlackRock cast proxies in accordance with their commercial interests and political agendas, not those of the underlying beneficial owners.

of judgment and are, by their nature, uncertain—and are, as a result, subject to heightened litigation risk, which could have a chilling effect on business and investment. It's fair to assume that increased litigation risk will be of little or no concern to the SEC and will be welcomed by climate activists—but will harm the interests of long-term shareholders in U.S. public companies.

## The Evidence

The Fed and the SEC are compelled to claim that they are doing nothing more than adhering to the letter of their mandates. Such a claim is highly implausible for various reasons, including, most starkly, that their combined suite of policies is identical to those being pursued by central banks in Europe that openly cast themselves as climate warriors. In addition:

- Once past the division between physical climate risk and transition (i.e., climate-regulatory) risk, the concept of climate financial risk is too nebulous to have practical utility as a regulatory principle.
- To sustain the case that climate represents a systemic threat to financial stability, central bankers and regulators adopt a catastrophist framework of climate change that renders past climate data irrelevant and the future unforecastable. Catastrophism is spiced up with misleading claims of a rising trend in billion-dollar natural disasters (a practice endorsed by Treasury Secretary Janet Yellen), when what has driven the increase is not the incidence of extreme weather but the growth in wealth and economic activity in locations exposed to extreme weather.
- Climate catastrophism represents a departure from mainstream climate science—the 3,949 pages of the Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report contain only five mentions of catastrophe or catastrophic scenarios—and rests on the assumption that the climate system is inherently unstable and vulnerable to tipping points. One of the earliest tipping point is the complete disappearance of the Greenland ice sheet, which, the IPCC says, might happen over several millennia.
- Climate stress tests embodying assumptions about off-the-scale weather events compared with historical data require extreme telescoping of climate change, which, in turn, risks misleading market participants as to the genuine exposure of bank and corporate assets to climate change.
- To get around the obstacle of past climate data not conforming to a catastrophist narrative of climate change, regulators plan to use future climate scenarios—in effect, authorized versions of the future. The same is true of transition risk, which presumes a foreordained developmental path of the global economy to net-zero emissions. This undermines a core function of markets: to incorporate constantly evolving, sometimes diverging, assessments of the future into risk premiums and stock prices.
- Operationalizing the notion of physical climate risk depends on being able to attribute the cause of individual weather events to the enhanced greenhouse effect. Attribution methodologies cannot be verified, not least because the counterfactual of a preindustrial climate rolled forward to the present cannot be observed and therefore verified. This creates opportunities for motivated climate modelers to tilt the scales in mandatory climate disclosures and climate litigation.
- Apart from the reduced frequency of coldest temperatures, the signal of global warming is smaller than the envelope of natural variability, suggesting that climate

risk is hard to differentiate from weather risk and is a subset of weather risk. Because of the problematic methodology of climate attribution, putting climate-risk disclosures on a legal footing is likely to be a litigants' charter—making the threat of climate litigation a greater risk to corporations, and therefore to long-term investors, than climate risk itself.

- The alleged threat to financial stability represented by transition risk has all the appearance of a confected risk lacking any data. Historically, threats to financial stability have come from bubbles, not from sectors having corporate valuations sucked out of them. Since 2008, the oil and gas sector has shrunk by around 90% relative to the S&P 500, even as the output of the U.S. oil and gas industry soared. Germany's 1 trillion-euro (US\$1.16 trillion) *Energiewende* (energy transition) destroyed billions of euros of shareholder value of its three quoted utility companies—but the German stock market rose.

### **Climate Policy Matters: Green Hysteria Drives Overreach and Adverse Results**

It is generally accepted that the United States needs a coherent, forward-looking climate policy that takes account of the global and multi-jurisdictional nature of climate risk as well as the consequences of transition. It should also be clear that climate policy has important ramifications for monetary policy and for central banks. For example, rapid decarbonization by U.S. firms to meet net-zero targets will likely have negative impacts on macroeconomic variables, including inflation, productivity, income growth, and employment. Yet public discussion of this issue by the Fed (and other central banks) is nonexistent.

Central bankers appear to presume that the costs and risk of not pursuing rapid decarbonization would be so high that all costs of decarbonization—including the risk of policy-induced green bubbles—should be ignored. Rather than being objective and clear-eyed in discharging their core functions, central bankers in the U.S. and Europe ignore politically disfavored risk and have become cheerleaders for climate policy. Such myopia is a threat in itself to financial stability.

“Climate change is the Tragedy of the Horizon. We don’t need an army of actuaries to tell us that the catastrophic impacts of climate change will be felt beyond the traditional horizons of most actors—imposing a cost on future generations that the current generation has no direct incentive to fix.”

—Mark Carney, former governor of the Bank of England

“The available evidence indicates that sustained global warming greater than a certain threshold above pre-industrial [levels] would lead to the near-complete loss of the Greenland ice sheet over a millennium or more, causing a global mean sea level rise of about 7 m.”

—Intergovernmental Panel on Climate Change (2013)

## I. THE FED’S UNDISCLOSED MANDATE

Central bankers and financial regulators are mobilizing in the fight against climate change. Their weapons: mandatory climate-risk disclosures and climate stress tests. “Our planet is burning and we central bankers could look on our mandate and pretend that it is for others to act and that we should simply be followers. I don’t think so,” European Central Bank (ECB) president Christine Lagarde **declared** at a June 2021 Green Swan conference of central bankers and regulators.<sup>3</sup> Climate change is an existential threat and of “strategic importance for the ECB’s mandate,” Lagarde **told** the press conference announcing the ECB’s recent strategy review. “Climate action is squarely in the middle of our strategy.”<sup>4</sup> Britain formally **expanded** the Bank of England’s mandate to reflect the importance of the transition to an “environmentally sustainable and resilient net zero economy,” in a move **criticized** by a former governor of the bank, Lord Mervyn King, for putting at risk the bank’s independence.<sup>5</sup>

In the U.S., the duties of the Federal Reserve and the Securities and Exchange Commission (SEC) are constrained by Congress. Speaking at the same Green Swan conference as Lagarde, Federal Reserve Chairman Jerome Powell **denied** that climate change was a main consideration when formulating monetary policy. “At the Fed, we see our role [on climate] as an important one that is tied tightly to our existing mandate,” Powell said. “Our mandate hasn’t changed.... We don’t have a secondary mandate to support the economic policies of the government.”<sup>6</sup> To **misquote** the 1960s British model Mandy Rice-Davies, “Well, he would say that, wouldn’t he?” On climate policy, the Fed intends to do exactly what the Biden administration wants.

President Biden’s May 20, 2021, **Executive Order** directs a whole-of-government approach on climate-related financial risk. It sets out administration policy to advance “clear, intelligible, comparable, and accurate disclosure of climate-related financial risk” and “achieve our target of a net-zero emissions economy by no later than 2050.”<sup>7</sup> The order directs the secretary of the Treasury, as chair of the Financial Stability Oversight Council (FSOC), to engage with its **members**, who include the Fed and SEC chairs, and report to the president by mid-November on “the necessity of any actions to enhance climate-related disclosures by regulated entities” and “current approaches to incorporating the consideration of climate-related financial risk into their respective regulatory and supervisory activities.”

Despite claiming that they are doing nothing other than clinging to the letter of their mandates, between them, the Fed and the SEC propose to deploy the same suite of climate policies as their colleagues in Europe. As soon as it was clear that Donald Trump had lost the 2020 election, the Fed **joined** the Network for Greening the Financial System (NGFS; the clue is in the name), a club of central bankers and financial regulators. Founded by the Banque de France, it has the **aim** of “strengthening the global

response required to meet the goals of the Paris agreement and to enhance the role of the financial system to manage risks and to mobilize capital for green and low-carbon investments in the broader context of environmentally sustainable development.”<sup>8</sup>

As noted above, Fed chair Jerome Powell also spoke at the Green Swan conference. Organized by the Bank for International Settlements (BIS), the Banque de France, the IMF, and the NGFS, the conference held [discussions](#) on “the most feasible and concrete proposals for a more sustainable economy, financial sector and society.”<sup>9</sup> What was Powell doing there if his mandate precluded it?

Notwithstanding the restrictions on their mandates, the Fed and the SEC are embedded in international initiatives to align climate financial regulation. “These are global challenges for global markets that demand global solutions,” then-acting SEC chair Allison Heren Lee [said](#) of ESG and climate in March 2021.<sup>10</sup> Randal Quarles, the Fed vice chair for supervision, is also chair of the Financial Stability Board (FSB), established by the G20 in the wake of the 2008 financial crisis. “Given the global nature of climate change, this demands a coordinated international effort,” Quarles said in a [speech](#) on climate-related financial risk at the G20 Venice conference of finance ministers and central bank governors on climate change in July 2021.<sup>11</sup>

*So the Fed and the SEC are to pursue identical policies as their European counterparts, which are unconstrained by their broader mandates, whereas the Fed and the SEC are sticking to the letter of their narrow ones? It doesn't ring true.*

## II. A PRETEXT WITHOUT SUBSTANCE

The Fed and the SEC are motivated to assert that climate change represents a systemic threat to financial stability in order to claim climate change as part of their mandates; this report shows that the ostensible purpose of climate-risk disclosures and climate stress tests advanced by the SEC and the Fed makes no sense. The fundamental reason is that the concept of climate financial risk is too nebulous to have practical utility as a regulatory principle. Evidence for this argument comes from central bankers and regulators themselves. Once past the taxonomic bifurcation into physical risk and transition risk, they can't define climate finance risk with sufficient granularity to be meaningful. The physical climate system and the global economy present too many unknowns to give rise to a set of stable, coherent, and actionable definitions of climate financial risk.

In a presentation to the ECB as part of its [strategy review](#), Hoover Institution economist John Cochrane was unsparing in his criticism. “Let me speak out loud the unclothed emperor fact: Climate change does not pose any financial risk, at the one-, five- or even ten-year horizon at which one can conceivably assess the risk to bank assets,” Cochrane [told](#) the ECB. “Advanced economies and financial systems are remarkably impervious to weather.” Cochrane was equally critical of transition risk giving rise to impaired stranded assets as justifying regulatory intervention. “The main risk to fossil fuel companies is that regulators will destroy them, as the ECB proposes to do, a risk regulators themselves control.”<sup>12</sup>

The only way climate-risk disclosures and climate stress tests make sense is in furtherance of the Fed's and the SEC's undisclosed, unlegislated green mandate:

- To manipulate the capital markets in support of government decarbonization objectives; and
- To inject climate-policy objectives into corporate capital-allocation decisions by giving climate activists more leverage to enforce net-zero targets through proxy votes and other forms of engagement.

These policy goals do not form part of either’s formal mandate:

- The [SEC’s](#) mandate is to protect investors; to maintain fair, orderly, and efficient markets; and to facilitate capital formation. As we shall see, climate-risk disclosures misinform investors and make public markets less attractive to disfavored sectors, constraining investor choice and diversification.

Deliberately creating market distortions to affect the allocation of capital between sectors does not form part of the Fed’s [mandate](#) to promote maximum employment and price stability. Imposing inherently flawed, politically influenced, climate-risk screens subverts the function of capital markets to price risk and allocate capital. This is in neither organization’s mandate; indeed, it runs counter to them.

### III. THE GREEN SWAN’S TALE OF UNCERTAINTY

Evidence that the real purpose of climate financial risk is to enable central bankers and financial regulators to proactively affect capital flows toward green investments comes in two forms: direct and inferred. Last year, the BIS and the Banque de France published *The Green Swan: Central Banking and Financial Stability in the Age of Climate Change*. While central banks cannot be the only game in town, “it is in their interest to help mobilize all the forces needed to win this battle,” François Villeroy de Galhau, governor of the Banque de France, writes in the foreword.<sup>13</sup> The top bullet of *The Green Swan’s* executive summary then explains the motives of central bankers and regulators as reflecting “their desire to enhance the role of the financial system to manage risks and to mobilize capital for green and low-carbon investments.”<sup>14</sup> These are examples of direct evidence; it’s there in black and white.

The rest of this report mainly focuses on the inferred evidence. Were climate financial risk genuinely about threats to financial stability, its treatment in *The Green Swan* would be objective, supported by data and rigorous analysis; the concept of climate financial risk would be sufficiently hard-edged to comport satisfactorily with a uniform regulatory definition, and illustrative examples of threats to financial stability would be sufficiently credible and compelling to justify regulatory intervention. None of these holds for *The Green Swan’s* treatment of climate financial risk.

*The Green Swan* borrows its title from Nassim Nicholas Taleb’s *The Black Swan* but owes more to the work of the late Harvard economist Martin Weitzman. “Climate-related risks typically fit fat-tailed distributions: both physical and transition risks are characterized by deep uncertainty and nonlinearity, their chances of occurrence are not reflected in past data, and the possibility of extreme values cannot be ruled out,” is a sentence that is almost a direct quotation from Weitzman’s 2009 [paper](#) “On Modeling and Interpreting the Economics of Catastrophic Climate Change” that is cited in *The Green Swan*.<sup>15</sup>

#### What Weitzman Was Doing

Weitzman’s approach rests on the assumption that the climate system is dangerously unstable, in which small perturbations can be magnified by strings of cascading positive feedbacks. “What we do know about climate science and extreme tail probabilities is that planet Earth hovers in an unstable trigger-prone ‘whipsaw’ ocean-atmosphere system,” Weitzman argued.<sup>16</sup> Two points can be noted:

- *First*, mainstream estimates of the climate sensitivity of carbon dioxide (the amount of warming resulting from a doubling of carbon dioxide in the atmosphere) already incorporate assumptions on positive feedbacks.

- *Second, The Green Swan* shoehorns climate-transition risk, which relates to the economic consequences of decarbonization, into Weitzman’s assumption about the instability of the climate system, as if putting climate in front of transition—an economic process—magically confers fat-tail risks on policy-driven responses to climate change. There is no justification for this, and none is offered. As we shall see, in the one instance where the authors attempt to demonstrate a causal relationship between the two, they make a complete hash of it.

Weitzman himself acknowledged that his analysis ventures far beyond mainstream climate science, as his aim was to illustrate the mathematical impact of a non-zero probability of catastrophic risk on economic welfare. “There exists here a very long chain of tenuous inferences fraught with huge uncertainties in every link,” Weitzman wrote.<sup>17</sup>

These small probabilities of what amounts to huge climate impacts occurring at some indefinite time in the remote future are wildly uncertain, unbelievably crude ballpark estimates—most definitely *not* based on hard science.<sup>18</sup>

Weitzman did not hide the conjectural nature of his characterization of climate risk that he made as part of his argument that traditional cost-benefit analysis does not adequately weigh very small probabilities of catastrophic impacts in a far distant future:

As we move toward probabilities in the periphery of the distribution, however, we are increasingly moving into the unknown territory of subjective uncertainty where our probability estimate of the probability distributions themselves becomes increasingly diffuse because the frequencies of rare events in the tails cannot be pinned down by previous experiences or past observations.<sup>19</sup>

## A Catastrophic Choice

Whereas Weitzman clearly signaled his divergence from the mainstream of climate science, the government and regulatory side of the financial community has absorbed Weitzman’s catastrophic risk framework but, unlike him, does not acknowledge its departure from mainstream climate science. Indeed, *The Green Swan* talks of central bankers and regulators having a role of “enlightened doomsaying.”<sup>20</sup> Treasury Secretary Janet Yellen [speaks](#) of climate change as “an existential risk to our future economy and way of life.”<sup>21</sup> The word “existential” does not appear once in the 3,949 pages of Working Group I’s contribution to the IPCC’s Sixth Assessment Report; “catastrophe” or “catastrophic” appears only five times, the first mention being a discussion of catastrophe in the news media, and there are no mentions concerning Yellen’s existential catastrophizing (e.g., a reference to a “catastrophic” flood in the uninhabitable Atacama Desert in Chile—see Appendix I).

But the adoption of catastrophism (“our planet is burning”) by policymakers has unacknowledged consequences:

- It makes the future unpredictable and therefore renders physical climate-risk disclosures meaningless; and
- It requires a drastic telescoping of climate-change timescales—from centuries and millennia to decades—for bank stress tests to capture the possibility of climate catastrophe.

## A Climate of Unpredictability

*The Green Swan* develops Weitzman’s argument that past climate observations offer no guide to the probability of future extreme weather events. However, it entirely omits the speculative context and the timescale of what Weitzman calls “the tiny probabilities of nightmare impacts” being possible on a “timescale of centuries.”<sup>22</sup> These omissions matter. The pattern in policy discussions about climate change is that baseless assertions made by apparently authoritative sources quickly become immutable climate “truths” that are then repeated ad nauseam.

Untethered from empirical data, all analysis is pitched into a maelstrom of uncertainty (Appendix II lists 20 mentions of uncertainty in *The Green Swan*). This, it is argued, requires an “epistemological break,” which central bankers and financial regulators are to provide by devising forward-looking climate scenarios.<sup>23</sup> In effect, these scenarios will constitute authorized views of the future, irrespective of their plausibility or probability, so that extreme climate scenarios become regulatory tools to influence the allocation of capital in policy-favored directions, in the words of *The Green Swan*, “to potentially create catalytic change.”<sup>24</sup>

*Imposing government-approved climate scenarios subverts the function of markets to make their own assessment of risk and allocate capital accordingly.*

## Timescales: To Infinity and Beyond

In his 2015 [speech](#) “Breaking the Tragedy of the Horizon—Climate Change and Financial Stability,” Mark Carney highlighted the misalignment of political and capital-market timescales with the impacts of climate change. “The horizon for monetary policy extends out to 2–3 years. For financial stability it is a bit longer, but typically only to the outer boundaries of the credit cycle—about a decade,” Carney said, omitting investors such as pension funds, whose liabilities stretch out for decades.<sup>25</sup>

“There’s a lot to like about climate stress tests,” Jerome Powell [exclaimed](#) at the June 2021 Green Swan conference.<sup>26</sup> “I suspect climate stress tests may be the most powerful tool to nudge the financial system,” Huw van Steenis [wrote](#) about the conference in his *Financial Times* column.<sup>27</sup> Van Steenis, a banker who worked with Carney on setting up the Task Force on Climate-Related Financial Disclosures (TCFD), thinks that climate stress tests are likely to be “highly catalytic in repricing the cost of capital between companies.” Higher capital requirements for banks and insurers with higher risk loans are likely, van Steenis reckons. “Climate stress tests will influence the cost of capital and investors will want to get ahead of them,” he concluded, illustrating how expectations of central bank climate actions could affect companies’ cost of capital.

“Exceeding climate tipping points could lead to catastrophic and irreversible impacts,” the authors of *The Green Swan* write, but they do not provide so much as an illustrative timeline.<sup>28</sup> A map of potential tipping cascades shows the Greenland ice sheet as one of the earliest, which Weitzman suggested was possible on “a timescale of centuries” in the context of a 10°C–20 °C rise in average global temperature over two centuries—a temperature rise, it should be pointed out, that is an extreme outlier, derived, as it is, from Weitzman’s “unbelievably crude ballpark estimates.”<sup>29</sup>

By contrast, the Intergovernmental Panel on Climate Change’s (IPCC’s) Fifth Assessment Report (2013) put the timescale in terms of a millennium rather than centuries:

The available evidence indicates that sustained global warming greater than a certain threshold above pre-industrial [levels] would lead to the near-complete loss of the Greenland ice sheet over a millennium or more, causing a global mean sea level rise of about 7 m. Studies with fixed ice-sheet topography indicate the threshold is greater

than 2°C but less than 4°C (*medium confidence*) of global mean surface temperature rise with respect to pre-industrial.<sup>30</sup>

In this year’s Sixth Assessment Report, the IPCC is even more cautious:

At sustained warming levels between 2°C and 3°C, there is limited evidence that the Greenland and West Antarctic Ice Sheets will be lost almost completely and irreversibly over multiple millennia; both the probability of their complete loss and the rate of mass loss increases with higher surface temperatures (*high confidence*). At sustained warming levels between 3°C and 5°C, near-complete loss of the Greenland Ice Sheet and complete loss of the West Antarctic Ice Sheet is projected to occur irreversibly over multiple millennia (*medium confidence*).<sup>31</sup>

It is ludicrous to stress-test bank balance sheets against the impact of something that the IPCC says might occur a millennium or two in the future—but when it comes to greening the financial system, to borrow from Chairman Powell, there is a lot to like about catastrophic climate scenarios.

## IV. EXTREME WEATHER AND CLIMATE CHANGE ATTRIBUTION

Mandating physical climate-risk disclosures depends on there being a reliable and empirically verifiable methodology for unambiguously distinguishing extreme weather events caused by human greenhouse gas emissions and those that would have occurred in its absence—i.e., weather risk. The current state of knowledge about the climate system is unable to provide such certainty (recall the references to uncertainty in *The Green Swan*). It is conceivable that it never will because there is no way of empirically verifying climate-model projections of what the weather would be without an enhanced greenhouse effect. This matters because mandating disclosures implies the possibility of creating legal liability if the disclosure is subsequently deemed not “correct.”

This risk is magnified by the pervasive politicization of climate-change attribution. Understandably, advocates of aggressive climate policy seize on extreme weather events to dramatize the effects of climate change. Speaking at the White House Earth Day virtual climate summit, President Biden [remarked](#):

We have a role to play in making sure that material climate risks to financial systems are measured, disclosed, and mitigated. If Wall Street is pumping billions of dollars into business that could be turned upside down when the next storm comes—and we know there will be more storms—Wall Street needs to make clear the risk it’s taking on.<sup>32</sup>

One implication of the president’s remarks is the idea that *all* storms are caused by man-made climate change—which is obviously absurd—or, more plausibly, that physical climate risk is merely weather risk by another name.

Far worse, given her responsibility for the financial system and her background as a serious economist, is what Treasury Secretary Janet Yellen [said](#) the day before the president’s remarks. Recalling her role in the Clinton administration trying to sell the Kyoto Protocol, Yellen said that it was known then that the potential cost of climate change was significant: “Of course, we know what the trajectory has been ever since. Over the past 30 years, the incidence of natural disasters has dramatically increased and the actual and future potential cost to the economy has skyrocketed.”<sup>33</sup>

Yellen’s claim on the incidence of natural disasters is false, and her ascribing increased costs to extreme weather is misleading. The 2006 [Hohenkammer Consensus Statement](#) of 32 leading climate experts

declared: “Analyses of long-term records of disaster losses indicate that societal change and economic development are the principal factors responsible for the documented increasing losses to date.”<sup>34</sup>

In July 2021 [testimony](#) to the Senate Committee on Banking, Housing, and Urban Affairs, Roger Pielke Jr., who helped organize the Hohenkammer symposium, showed how Yellen’s claim of spiraling costs from climate change is misleading:

- Data and evidence indicate that since at least 1990 (about when global data on disaster losses is judged to become reliable) the economic damages associated with extreme weather have in fact decreased when measured in the context of global GDP.<sup>35</sup>

Pielke condemned the National Oceanic and Atmospheric Administration (NOAA) for its “billion-dollar disasters” dataset, which provides the basis for claims such as Yellen’s. “What the dataset actually shows,” Pielke explains, “is a combination of poor methodology and the consequences of a growing society, with more people and property in locations exposed to loss from extreme weather. It is not an indicator of climate change. Climate data, not economic data, should be used for that purpose.”<sup>36</sup>

Thus a \$600 million hurricane in 1985 (Hurricane Kate) would have been about a \$2 billion hurricane today, but that fact is not included in NOAA’s dataset. “Every time you see this dataset invoked as evidence of human caused climate change you should think instead about the state of scientific integrity in U.S. federal science agencies,” Pielke commented.<sup>37</sup> Similar criticism can be leveled at officials who fail to carry out even minimal due diligence on NOAA’s misleading dataset while preparing the ground for mandatory climate disclosures.

As for Yellen’s assertion of a dramatic increase in natural (presumably, she means weather-related) disasters, Pielke points out that neither hurricanes nor major hurricane landfalls have increased in the U.S. over the past century.<sup>38</sup>

In his book *Unsettled*, Steven Koonin, a theoretical physicist and former Obama administration Department of Energy undersecretary, notes that the IPCC in its Fifth Assessment Report expressed:

- *Low confidence* regarding the *sign* of trend in the magnitude and/or frequency of floods on a global scale
- *Low confidence* in a global-scale observed trend in drought or dryness since the mid-20th century
- *Low confidence* in large-scale changes in the intensity of extratropical cyclones since 1900<sup>39</sup>

Reviewing U.S. temperature data, Koonin concluded that temperature extremes in the contiguous U.S. had become less common and somewhat milder since the late nineteenth century.<sup>40</sup> By this point, a cynic might surmise that the sparseness of data in *The Green Swan* and that report’s contention that observed climate trends offer no guide to the future can be explained by the lack of empirical data to fit its narrative of incipient climate catastrophe.

Even if climate data were showing worsening trends, it would not be sufficient to establish the cause as man-made climate change. Any definition of physical climate risk presupposes the existence of a reliable scientific methodology to attribute *individual* weather events to man-made climate change. Requiring climate-risk disclosure in the absence of one would result in regulators such as the SEC inducing corporations to mislead investors. This is more than just a steep hill to climb. Koonin quotes the World Meteorological Organization: “[A]ny single event, such as a severe tropical cyclone [hurricane or typhoon], cannot be attributed to human-induced climate change, given the current status of scientific understanding.”<sup>41</sup>

Koonin goes further, commenting on weather-event attribution studies: “As a physical scientist, I’m appalled that such studies are given credence, much less media coverage. A hallmark of science

is that conclusions get tested against observations. But that’s virtually impossible for weather attribution studies.”<sup>42</sup>

In an April 2021 [paper](#) for the Global Warming Policy Foundation, William M. Briggs, a statistician and philosopher of science, observes that attribution studies typically attempt to compare probabilities of extreme weather events in the current human-influenced climate against a conjectural natural climate—which, as Briggs notes, is “the climate that we don’t live in and which cannot be observed.”<sup>43</sup>

Briggs identifies other obstacles to this approach:

- Model-based attribution claims assume perfect models. “The models can’t be ‘good enough’—they have to be flawless to have a definite meaning. Since models are imperfect, this is *never* the case.”<sup>44</sup>
- Climate models are coarse and designed to be global or large-scale; yet they are extrapolated to local events—“a dicey move given that surface and other characteristics are dramatically different at small scales.”<sup>45</sup>
- Attribution claims change, depending on the climate model used. Each model purports to represent the climate as it is now and as it would have been—but “they can’t all be right, and it remains a possibility none of them are.”<sup>46</sup>

Briggs highlights the difficulties in analyzing low-frequency events when estimates of their probabilities are naturally small:

Small probabilities, estimated from rare frequencies, are well known to be more variable and are much harder to estimate reliably. They are prone to larger swings in the estimation process. This is critical, because even small changes to estimated probabilities of extreme events in the actual and natural climates can lead to wild swings in attribution claims. Indeed, the more extreme the event is, the wilder these swings are.<sup>47</sup>

## Long-Term Persistence and Natural Variability

There is a further problem with probabilistic attribution techniques: the natural behavior of the climate system itself. Koonin notes that climate data show clear patterns. Even before human influences began to take effect, climate history is not “just a jumbled sequence of random values”—the assumption underlying probabilistic attribution methodologies.<sup>48</sup> Sequences of climate phenomena are not like coin tosses or a random walk. As an example, Koonin shows a graph of 650 years of river-depth readings for the River Nile that show clear trends and patterns, evidence of a phenomenon called long-term persistence or long memory.<sup>49</sup> (Long-term persistence is not discussed by the IPCC in its Sixth Assessment Report.)

The importance of understanding past patterns of weather extremes is the theme of a [presentation](#) given by climate scientist Judith Curry to the U.S. Federal Energy Regulatory Commission in June 2021. Curry argued that the 1-in-10- or 1-in-20-year standards are not much help in planning when, for example, Texas has seen three 500-year floods during 2015–17. A 100-year event is based on estimated probabilities that assume stationarity of the climate record, Curry said.

However, the climate is not stationary on any time scale—apart from the secular trend of global warming, there is multi-decadal to millennial scale natural climate variability that provides an envelope for decadal and interannual climate variability.<sup>50</sup>

For example, in assessing the vulnerability to hurricanes of a new power plant in the Gulf of Mexico, a risk assessment had calculated a 100-year storm surge to be 10.1 feet and a 500-year storm surge to be 13 feet.

But the historical record showed a 12-foot surge near the planned location in the 1920s and an estimated 15-foot surge from a hurricane in the 1840s, when the climate was significantly cooler than it is now.

Neither conventional statistics on return periods nor climate model-driven expectations of slightly more intense hurricanes by 2100 provide a complete picture of what the power plant may be facing over the next 30–50 years from a hurricane storm surge.<sup>51</sup>

What about the influence of global warming in changing the intensity or frequency of extreme weather events? Curry asks.

Apart from the reduced frequency of the coldest temperatures, the signal of global warming in the statistics of extreme weather events remains much smaller than that from natural climate variability, and is expected to remain so at least until the second half of the 21st century. Rather than focusing on the relatively small and uncertain impacts of global warming on extreme events, a broader range of extreme weather events from the historical record can provide a better basis for avoiding “big surprises.”<sup>52</sup>

## Implications for Climate-Risk Disclosure

Curry’s conclusion has direct application to the debate on climate-risk disclosures. According to the FSB’s July 2021 [road map](#) on climate-related financial risks: “The goal of international initiatives in the area of financial disclosures is globally consistent, comparable, and decision-useful public disclosures by firms of their climate-related financial risks.”<sup>53</sup>

The TCFD also emphasizes decision usefulness; its [website](#) states: “The TCFD recommendations are designed to solicit consistent, decision-useful, forward-looking information on the material financial impacts of climate-related risks and opportunities.”<sup>54</sup>

Curry’s analysis demonstrates three things:

- *First*, contrary to the advice of *The Green Swan* climate financial-risk experts, the record of past extreme weather events is critical to understanding likely future ones.
- *Second*, climate-risk disclosures are not decision-useful and can be misleading because they exclude the wider envelope of extreme weather events due to natural variability as indicated by the historical record.
- *Third*, physical climate risk is a subset of weather risk.

Why, then, mandate climate disclosures and not material weather risk? The FSB has the answer. “Over time,” the FSB says, “progress in identifying and addressing climate-related financial risks will support a shift towards sustainable finance,” an admission that climate-risk disclosure is, in reality, a tool of climate policy.<sup>55</sup>

This comes at a price. Mandating climate-risk disclosure will create a litigants’ charter. There is no water-tight definition of physical climate risk and no empirically verifiable attribution methodology to distinguish a human-caused extreme weather event from a natural one. As Heritage Foundation senior fellow David Burton says in his [response](#) to the SEC’s request for comments on mandatory climate disclosure, it would result in

much higher litigation risk and expense as private lawsuits are filed challenging the veracity of climate disclosures. These lawsuits are virtually assured since virtually no climate models have accurately predicted future climate and the economic and financial projections based on these climate models are even more uncertain.

Litigation outcomes would be as uncertain as the underlying climate science, economics and the associated financial projections. This would harm investors and entrepreneurial capital formation.<sup>56</sup>

Decision-useful really means litigation-friendly. By mandating disclosures for physical climate risk that are likely to fall within the envelope of natural variability, the SEC would expose issuers and investors to the greater uncertainties of climate litigation risk. Containing this risk would require the SEC to design a comprehensive disclosure regime and provide guidance that enables issuers and the courts to distinguish unambiguously and verifiably between extreme weather events caused by human-induced climate change (the enhanced greenhouse effect) and those that are natural. This is beyond the bounds of current scientific knowledge.

## V. TRANSITION RISK

The second basket of climate risk relates to the transition of the global economy from one deriving about 80% of its energy from hydrocarbons to one in which hydrocarbons contribute an insignificant proportion of global energy consumption by 2050. Transition risk refers to the potential value destruction inflicted on businesses and their assets on the assumption that this transition takes place on the prescribed timescale. Sectors most exposed to this risk are hydrocarbon producers (principally oil and gas companies); consumers of hydrocarbon energy, where the ease of substitutability is low—notably, transportation and other energy-intensive industries, which can expect to face much higher energy costs; and agriculture and food producers. The concept of transition risk thus embodies a deterministic view of the future: that the future is foreseeable and has been foreseen.

In his chapter on price theory in *The General Theory of Employment, Interest, and Money*, John Maynard Keynes contrasts the simple model of an economy where all things are foreseen with the problems of a real-world economy. “It is when we have made this transition that the peculiar properties of money as link between the present and the future must enter our calculations,” he writes. Keynes emphasizes the point two sentences later. “Money in its significant attributes is, above all, a subtle device for linking the present to the future.”<sup>57</sup>

The function of capital markets is to allocate capital to where it’s likely to be used most productively by incorporating constantly evolving expectations of the future into the prices of securities. It is what distinguishes capitalist economies from centrally planned ones and their politically ordained path of economic development. Experience shows the superiority of market-based economies over planned ones, largely because of the role of money and capital markets in adapting to an unknowable future. Climate-transition risk presumes that the future, or at least a major part of the economic future, is preordained and thus known. Adopting this assumption into the regulation of financial markets marks a major departure for central banks and financial regulators. Interfering in the core function of capital markets will have unintended, likely destabilizing, consequences that conflict with their financial-stability mandates.

Practitioners justify this radical policy shift on two grounds:

- *First*, alignment with the goals of the [Paris agreement](#), which are to hold average global temperature to well under a 2°C increase from preindustrial levels and to pursue efforts to limit the rise to 1.5°C—such efforts to include making “finance flows compatible with a pathway toward low greenhouse gas emissions and climate-resilient development.”<sup>58</sup>
- *Second*, dying sectors that are to be killed off by the economic transition required by the Paris agreement pose risks to financial stability—thus, intervention by central banks and financial regulators is required.

## The Paris Agreement and Net Zero

The Paris agreement outlined an emissions trajectory to achieve a balance between anthropogenic emissions and removals of greenhouse gases (i.e., net zero) in the second half of this century.<sup>59</sup> Subsequently, the IPCC in its 2018 [1.5°C special report](#) brought forward the timetable for achieving net zero to 2050. The Paris agreement emissions trajectory is not binding on the parties to it (nation-states plus the EU), and the IPCC net-zero target has no legal standing. Nevertheless, net zero by 2050 is widely interpreted as binding on the publicly traded corporations of the West.

The significance of the Paris agreement is in formalizing the abandonment of multilateral approaches to decarbonization. The agreement embodies the climate equivalent of Mikhail Gorbachev's [Sinatra Doctrine](#) in allowing individual parties to the agreement to “do it their way”—unilateralism. Though Paris was hailed as a game-changer in the fight to save the planet, its reality is rather different. Just as Gorbachev's Sinatra Doctrine was an admission that the Soviet Union had lost the Cold War, the Paris agreement signaled that the West had given up on having a global decarbonization regime, with credible sanctions against free-riding (do-nothing countries obtaining the climate benefits generated by do-something countries that incurred all the policy costs).\*

Instead, the agreement's principal binding requirements are for parties to submit, every five years, nationally determined contributions (NDCs), with each subsequent NDC being more ambitious than the previous. Although the Paris agreement and the IPCC set global targets, the only legally binding ones are those set by national (plus the EU) or subnational governments. Even countries like Britain that have written the goal of net zero into domestic law have not legislated the means.

The failure of the Paris agreement to address, let alone solve, the free-rider problem makes it highly unlikely that global net zero will be achieved on anything like the timescale laid down by the IPCC. Nonetheless, the financial community, led by BlackRock and large institutional investors, is in the process of creating a parallel jurisdictional universe to that of governments and nation-states to enforce net zero by 2050 on publicly traded corporations.

*In reality, mandatory disclosure of transitional risk is not about giving investors data to inform their investment decisions; it is about forcing corporations to provide information that will be used to discipline them in Wall Street's parallel jurisdictional universe.*

The truth of this proposition is easily demonstrated. The key metrics likely to be covered by disclosure requirements are corporations' Scope 1–3 emissions and their plans to reduce them.\*\* These feature prominently in the SEC's March 2021 [public consultation](#) on climate-change disclosures.<sup>60</sup>

In an October 2020 keynote [speech](#) to the European Central Bank, climate economist William Nordhaus argued that the key to obtaining sharp reductions in carbon dioxide emissions is putting a high price on them. The reality, Nordhaus says, is that carbon prices are “fragmented and very low.”<sup>61</sup> As shown in **Table 1**, carbon prices vary widely by jurisdiction, ranging from \$127 per ton of CO<sub>2</sub> in Sweden to no price at all on 80% of global emissions.

\*In 2017, Martin Weitzman wrote a paper critical of the Paris climate agreement for failing to solve the free-rider problem. “The core weakness of the COP21 Paris Agreement is essentially the same as the core weakness of the Kyoto Protocol. Neither approach addresses the central problem of freeriding on an international public good of great importance”; Martin L. Weitzman, “On a World Climate Assembly and the Social Cost of Carbon,” May 21, 2017, p. 5, [https://scholar.harvard.edu/files/weitzman/files/economica\\_revision.on-wca-scc.pdf](https://scholar.harvard.edu/files/weitzman/files/economica_revision.on-wca-scc.pdf).

\*\*Scope 1 emissions are those directly emitted by the corporation from owned or controlled sources; Scope 2 emissions represent those emitted from the energy consumed by the corporation; and Scope 3 emissions are those from a corporation's suppliers and its customers.

**TABLE 1. THE CARBON PRICE LANDSCAPE (2019)**

Region	Percent of region emissions covered by price	Carbon price \$/tCO <sub>2</sub>	Effective price \$/tCO <sub>2</sub>	% of global emissions
Sweden	40	127	50.8	<1
Norway	60	59	35.4	<1
Switzerland	33	96	31.7	<1
British Columbia	70	26	18.2	<1
France	33	50	16.5	1
California	85	16	13.6	2
EU ETS	43	25	10.8	8
Japan	70	3	2.1	5
Argentina	20	6	1.2	<1
Chinese cities	40	3	1.2	1
Northeast U.S.	18	5	0.9	1
Mexico	45	1	0.5	1.5
Uncovered	100	0	0.0	80
<b>Global average</b>			<b>1.7</b>	

Source: William Nordhaus, keynote speech, ECB Conference on Monetary Policy, October 19, 2020, <https://www.youtube.com/watch?v=G3eve1fXdY4>

The average global price in 2019 of \$1.70 per ton of carbon dioxide calculated by Nordhaus contrasts starkly with the IPCC’s estimates of the prices needed for the 1.5°C pathway and net zero by 2050, which, for 2030, range from \$135 per ton to \$6,050 per ton (in 2010 dollars).<sup>62</sup>

Two conclusions are evident from these data:

- The impact of climate policies on businesses varies widely between jurisdictions, with most of the globe seeing no effective decarbonization policies in terms of carbon prices.
- The global economy is way off the 1.5°C pathway. Even jurisdictions with the highest effective carbon prices are pricing their emissions far below the lowest carbon prices needed to achieve net zero by 2050.

Laws and regulations in the form of taxes, product and process bans, tradable permits, and so forth are enacted solely by governments and are limited to their respective jurisdictions. Transition risk therefore varies from jurisdiction to jurisdiction. Corporate disclosures based on the assumption of a homogenous global regulatory space, as proposed by the SEC and the TCFD, would therefore give investors a highly distorted and misleading impression of firms’ exposure to regulatory risk and the business risk from the transition to a net-zero world.

Taking these disclosures at face value would be to misunderstand their real purpose. In July 2021, the Institutional Investors Group on Climate Change (IIGCC)—“Our mission is to support and enable the investment community in driving significant and real progress by 2030 towards a net zero and resilient future”—issued a statement saying that it expects companies to disclose net-zero transition plans. The group, whose members are mostly based in Europe and hold over \$14 trillion in assets under management, says that transition plans should be provided within the overarching framework of TCFD reporting

recommendations.<sup>63</sup> Companies will be required to name a director responsible for the net-zero transition plan. “This enables investors to determine which Board directors, in addition to the Chair, should be engaged with and potentially (as a last resort) voted against when a plan has not been provided or implementation is insufficient,” according to the statement.<sup>64</sup>

No pretense is made that these requirements have anything to do with maximizing shareholder returns or protecting long-term business value.\* “If we stand any chance of closing the gap between current carbon emissions and meeting the goals of the Paris Agreement, the transition to net zero has to be scientifically credible,” says Yo Takatsuki, J. P. Morgan Asset Management’s EMEA Head of Investment Stewardship. “Responsibility, accountability and delivery of a credible net zero transition plan, coupled with the provision of good quality data, must therefore be implemented by the Board of investee companies.”<sup>65</sup>

*If transition-risk disclosure were genuinely to inform investors, it would be broken down by jurisdiction. The reason it doesn’t is that its purpose is not to report on transition risk but to enforce the transition.*

## VI. CENTRAL BANKERS VS. CAPITAL MARKETS

In his 2015 “Tragedy of the Horizon” speech, Mark Carney identified transition risk, which he defined as the financial risks that could result from the adjustment to a lower carbon economy, as a threat to financial stability. “Changes in policy, technology and physical risks could prompt a reassessment of the value of a large range of assets as costs and opportunities become apparent,” Carney said.

The speed at which such re-pricing occurs is uncertain and could be decisive for financial stability.... Risks to financial stability will be minimized if the transition begins early and follows a predictable path, thereby helping the market anticipate the transition to a 2-degree world.<sup>66</sup>

What Carney describes is a process of change familiar in capitalist economies. Capitalism is a process of change, to quote Joseph Schumpeter,

that incessantly revolutionizes the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in.<sup>67</sup>

By contrast, Carney’s is a public-sector bureaucrat’s view that sees capitalism itself as a threat to financial stability, where investors need to have their hands held by central bankers and financial regulators who understand markets and the future better than investors do.

### Justification Without Numbers

The notion of transition risk posing a systemic threat is inherently implausible in that the sectors supposedly threatening systemic stability constitute a rapidly shrinking share of equity capital markets. From the peak shortly before the 2008 financial crisis to August 2021, the S&P oil and gas sector has declined by 69.7%.\*\* Over the same period, the S&P 500 has risen by 250% (**Table 2**). This divergence means that the weighting of the oil and gas exploration and production sector in the S&P 500 has already

\*Typically, in investment firms, matters such as governance and how to vote proxies are the responsibility of separate stewardship teams that are not responsible for investment decisions or accountable for investment performance.

\*\*This fall in stock market valuations is not a reflection of any energy transition or physical shrinkage of the sector. In fact, U.S. output of crude oil more than doubled, rising from 1.829 trillion barrels of oil in 2008 to 4.129 trillion barrels in 2020; the output of natural gas (gross withdrawals) rose by 159%, from 25,636 trillion cubic feet in 2008 to 40,689 trillion cubic feet in 2020; EIA, <https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=p&t=s=mcrcpus1&f=a> and <https://www.eia.gov/dnav/ng/hist/n9010us2a.htm>.

shrunk more than 10-fold—without triggering a financial crisis. In 2008, ExxonMobil was still the largest U.S. company by market capitalization. Since then, its stock price has fallen by more than one-third and its market capitalization ranking tumbled to number 28, just ahead of Cisco and Netflix.<sup>68</sup>

**TABLE 2. PERFORMANCE OF OIL AND GAS SECTOR VS. S&P 500 (2008–21)**

	Jun 1, 2008	Aug 2, 2021	Change
<b>S&amp;P oil &amp; gas exploration and production</b>	281.12	85.10	-69.7%
<b>S&amp;P 500</b>	1,267.38	4,436.52	250.1%
<b>ExxonMobil Corp (\$)</b>	88.13	57.86	-34.3%

Source: market.ft.com

Conceptually, it is hard to conjure up a “climate Minsky moment”<sup>69</sup> from sectors in long-term stock market decline that can threaten financial stability, when historically, it has been the opposite—stock market bubbles fueled by excessive leverage. Indeed, *The Green Swan* has had its wings clipped: that report cites a study showing that oil and gas stock valuations are driven primarily by commercially proven reserves monetized over the next 10–15 years and not by resources that could be stranded longer term. “If this is true, the market mispricing of fossil fuel assets may not be as large as often expected,” it concedes.<sup>70</sup>

Even though financial markets produce acres of data, the discussion of transition risk in *The Green Swan* is striking for its dearth of data—on the grounds, it asserts, that transition risks are currently low, “given the lack of ambitious policies on a global scale.”<sup>71</sup> This argument is feeble, considering that:

- Lack of global scale indicates something about the reality of the global energy transition—or rather, its absence.
- Germany passed its first Renewable Energy Act in 2000, and the cost of its *Energiewende*, which was **estimated** in 2013 at about 1 trillion euros (US\$1.16 trillion) by the end of the 2030s, can hardly be described as unambitious.<sup>72</sup> From a peak in January 2008 to August 2015, the three quoted German power-generating companies lost 59%–85% of their market value. Nonetheless, the DAX 30 index of German blue-chip companies rose by 39%.<sup>73</sup>

*The Green Swan* itself provides further evidence that transition is a contrived systemic risk. Descending from the level of data-free abstraction, it provides one example of an interaction between climate physical risk and transition risk:

[E]xtreme weather events could have major impacts on socioeconomic systems and lead to unexpected new regulations (such as the Fukushima Daiichi accident leading to an unexpected ban of nuclear plants in Germany).<sup>74</sup>

Three points should be noted about this example of alleged combined climate risk leading to the closure of Germany’s principal source of non-weather-dependent, zero-emissions electricity:

- *First*, the Fukushima accident was caused by a tsunami. Tsunamis are not weather events: they are caused by earthquakes. Did the authors of *The Green Swan* not know this?
- *Second*, investors were fully aware that German nuclear policy had been in flux before the accident. In 2002, Gerhard Schröder’s Red-Green coalition passed legislation to phase out nuclear power by 2021. Six months before the Fukushima accident, Angela Merkel’s government had decided to delay the closures by about 12 years, but the post-Fukushima review reversed this proposed extension.

- *Third*, in March 2021, the German government agreed to **pay** €2.4 billion (US\$2.8 billion) compensation to the owners of the nuclear power stations in settlement of the compensation claims that they were pursuing through the domestic and international courts.<sup>75</sup>

This conflation of a non-climate physical event and the closure of climate-friendly, zero-emissions nuclear capacity shows that the definition of climate-transition risk can encompass practically anything. Climate-transition risk is in the eye of the beholder—yet mandating disclosure will expose companies to arbitrary interpretations of an ill-defined concept, requiring them to foresee an unknowable future with perfect clarity, even though the central bank authors of *The Green Swan* are incapable of analyzing the recent past using the very risk framework that they want to impose on business and finance.

A pattern in climate change is for plausible but baseless assertions—often little more than catchy sound bites—to escape rigorous analysis and become part of the climate regulatory template. Ideas first propounded by Mark Carney in 2015 and amplified in *The Green Swan* are on the verge of becoming part of the international regulatory framework, as can be seen from this extract from the FSB’s July 2021 road map for addressing climate-related financial risk:

Climate-related risks may be highly non-linear, and their effects on the financial system subject to substantial uncertainty and tail-risk. But it is foreseeable that some combination of physical and transition effects will occur.<sup>76</sup>

Every assertion in these two sentences is questionable. None is supported by evidence. A combination of physical and transition risk is foreseeable. If it is foreseeable, why not say what it is? The only justification for these assertions is that they have been said before, in what has become cut-and-paste policymaking.\* It is reminiscent of the title of William Nordhaus’s famous 1973 [review](#) of *Limits to Growth*, “Measurement Without Data”—except that here, there is neither measurement nor data.

## VII. CENTRAL BANKS’ GREEN BIAS

What the authors of *The Green Swan* do furnish is ample evidence of the greening of central banks. At times, their rhetoric is hard to distinguish from that of Greenpeace. Climate change is only the tip of the iceberg, the authors claim. “Other biogeochemical cycles than the carbon cycle that are critical to life on Earth are also being altered, and may present even higher risks than climate change.”<sup>77</sup> Recycling the “limits to growth” arguments that Nordhaus had critiqued, runaway consumption by a growing global population in a world of limited resources is “now posing an existential threat. In this context, avoiding the unmanageable risks that may arise if we cross different planetary boundaries requires nothing less than creating a stabilized Earth pathway.”<sup>78</sup>

Bringing the economic system back within the Earth’s “sustainability limits” could entail “re-evaluating the notion of endless economic growth.”<sup>79</sup> The way in which accounting norms incorporate (or do not incorporate) environmental dimensions is critical, as such norms broadly reflect what is valued in society. The authors proceed to argue that “it therefore remains critical to integrate biophysical indicators into existing accounting frameworks to ensure that policymakers and firm managers systematically include them in their risk management practices over different time horizons.”<sup>80</sup>

Central banks’ green overreach has a policy cost in the form of diluting their core policy function. Only central banks manage monetary policy. They should be the chief repository of thinking about monetary policy. *The Green Swan*’s focus is on what central banks can do to support the transition to net zero, not on the implications of net-zero policies for monetary policy. Setting interest rates, *The Green Swan*

\*Thus, in *A call for action Climate change as a source of financial risk* (April 2019), on page 1 under the bullet point “Foreseeable nature,” the NGFS had opined two years earlier: “there is a high degree of certainty that some combination of physical and transition risks will materialize in the future.”

says, near to or below zero “is probably the greatest contribution from central banks to governments’ capability to play their role in combating climate change.”<sup>81</sup> The report devotes a half-page discussion to the potential physical impacts of climate change on monetary policy, concluding with an admission that studies on the impact of climate change on monetary stability are “still at an early stage.”<sup>82</sup> But there is not a word on the possible consequences of climate-change *policies* on macroeconomic variables and on the conduct of monetary policy.

This should ring alarm bells. Switching to zero-emissions technologies requires more capital which is then used less efficiently, raising costs and shrinking the economy’s productive potential. In a recent [interview](#), [Jeffrey Ubben](#), the activist investor appointed to the board of ExxonMobil and a board member of WWF, spoke of de-fossilizing as ideological. “It is prohibitively expensive today. This is what the politicians and the [environmental] NGOs do not talk about.”

My goal is to use the existing infrastructure, whether it’s the ammonia infrastructure, or the hydrocarbon infrastructure, and put the carbon back in the ground to allow the more expensive new infrastructure like green ammonia and green hydrogen to be layered in over time as it becomes economic. To me, that is the only way you do not shock the global economy and have prices go up too fast. ESG is very inflationary to be honest with you.<sup>83</sup>

Honesty is the quality most absent in central bankers’ case for climate-risk disclosures. Honesty would compel them to say: “We don’t have a mandate to do this; the timescale for climate risk is well beyond any honest assessment of financial stability risks; climate financial risk is too nebulous to be operationalized as a regulatory principle; and the real purpose of mandatory climate disclosures is not to report, but to enforce climate discipline—which our mandates preclude us from doing.”

## APPENDIX I: CATASTROPHE IN THE IPCC SIXTH ASSESSMENT REPORT

Other studies show that people react differently to climate change news when it is framed as a <b>catastrophe</b> (Hine et al., 2015), as associated with local identities (Sapiains et al., 2016), or as a social justice issue (Howell, 2013).	Para. 1.2.3.4, on media coverage, pp. 1–35
Both paleoclimate data and modelling experiments suggest that the timing and speed of the transition was spatially heterogeneous ( <i>high confidence</i> ), with northern Saharan locations becoming drier thousands of years before more equatorial locations (Shanahan et al., 2015; Tierney et al., 2017; Dallmeyer et al., 2020). These observations are consistent with theoretical studies suggesting that spatial heterogeneity and diversity in ecosystems can mitigate the probability of <b>catastrophic change</b> (Van Nes and Scheffer, 2005; Bathiany et al., 2013). Conversely, low ecosystem diversity can produce local or regional “hot spots” of abrupt change such as those seen in some paleoclimate records (Claussen et al., 2013).	p. 8.113
Deforestation in the Amazon also raises the probability of <b>catastrophic fires</b> (Brando et al., 2014).	p. 8.112
The combination of two or more—not necessarily extreme—weather or climate events that occur: i) at the same time, ii) in close succession, or iii) concurrently in different regions, can lead to extreme impacts that are much larger than the sum of the impacts due to the occurrence of individual extremes alone. This is because multiple stressors can exceed the coping capacity of a system more quickly. The contributing events can be of similar types (clustered multiple events) or of different types (Zscheischler et al., 2020). <b>Many major weather- and climate-related catastrophes</b> are inherently of a compound nature (Zscheischler et al., 2018). This has been highlighted for a broad range of hazards, such as droughts, heat waves, wildfires, coastal extremes, and floods (Westra et al., 2016; AghaKouchak et al., 2020; Ridder et al., 2020).	p. 11.106
<b>Record, catastrophic, unprecedented, and once-in-a-century flooding events</b> have also been reported in recent decades in the tributaries of the Amazon river or along its mainstream (Sena et al., 2012; Espinoza et al., 2013; Marengo et al., 2013; Filizola et al., 2014), in Argentinean rural and urban areas (Barros et al., 2015), in the lower reaches of the Atrato, Cauca and Magdalena rivers in Colombia (Hoyos et al., 2013; Ávila et al., 2019), in basins whose mainstreams flow through important metropolitan areas such as Concepción, Chile (Rojas et al., 2017), and even in one of Earth’s driest regions, the Atacama Desert (Wilcox et al., 2016).	p. 12.60

Source: IPCC, *Climate Change 2021: The Physical Science Basis. Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (August 2021)

## APPENDIX II: UNCERTAINTY IN THE GREEN SWAN

However, integrating climate-related risk analysis into financial stability monitoring is particularly challenging because of <b>the radical uncertainty</b> associated with a physical, social and economic phenomenon that is constantly changing and involves complex dynamics and chain reactions.	p. iii
But the book also recognises the limitations of our models, which may not be able to accurately predict the economic and financial impact of climate change because of the complexity of the links and the intrinsic non-linearity of the related phenomena. Nevertheless, despite <b>the high level of uncertainty</b> , the best scientific advice today suggests that action to mitigate and adapt to climate change is needed.	p. vii
—Foreword by Agustín Carstens, BIS General Manager	
In <b>this context of deep uncertainty</b> , traditional backward-looking risk assessment models that merely extrapolate historical trends prevent full appreciation of the future systemic risk posed by climate change.	p. 1
Climate-related risks typically fit fat-tailed distributions: both physical and transition risks are characterised by <b>deep uncertainty</b> and nonlinearity, their chances of occurrence are not reflected in past data, and the possibility of extreme values cannot be ruled out (Weitzman, 2009, 2011).”	p. 3
That is, there is certainty about the need for ambitious actions despite <b>prevailing uncertainty</b> regarding the timing and nature of impacts of climate change.	p. 3
Acknowledgment of <b>deep uncertainty</b> and need for structural change to preserve long-term climate and financial stability.	p. 4
There is still <b>considerable uncertainty</b> on the effects of climate change and on the most urgent priorities.	p. 5
However, such a task presents a significant challenge: traditional approaches to risk management consisting in extrapolating historical data based on assumptions of normal distributions are largely irrelevant to assess future climate-related risks. Indeed, both physical and transition risks are characterised by <b>deep uncertainty</b> , nonlinearity and fat-tailed distributions.”	p. 10
While their use by financial institutions and supervisors will become critical, it should be kept in mind that scenario-based analysis will not suffice to preserve financial stability in the age of climate change: the <b>deep uncertainty</b> at stake and the need for a structural transformation of the global socioeconomic system mean that no single model or scenario can provide sufficient information to private and public decision-makers (although new modelling and analytical approaches will be critical to embrace the uncertain and nonequilibrium patterns involved).	p. 10

Finally, climate change is characterised by <b>deep uncertainty</b> : assessing the physical risks of climate change is subject to uncertainties related to climate patterns themselves, their potentially far-reaching impacts on all agents in the economy, and complex transmission channels (NGFS (2019a,b)), especially in the context of globalised value chains; transition risks are also subject to <b>deep or radical uncertainty</b> with regard to issues such as the policies that will be implemented (e.g., carbon pricing versus command-and-control regulations), their timing, the unpredictable emergence of new low-carbon technologies or changes in preferences and lifestyles that could take place.	p. 21
[R]ecently emerged methodologies aim to assess climate-related risks while relying on the fundamental hypothesis that, given the lack of historical financial data related to climate change and the <b>deep uncertainty</b> involved, new approaches based on the analysis of prospective scenarios are needed.	pp. 21–22
First, the materialisation of physical and transition risks depends on multiple nonlinear dynamics (natural, technological, societal, regulatory and cultural, among others) that interact with each other in complex ways and are subject to <b>deep uncertainty</b> .	p. 23
However, estimating precisely the current value of fossil fuel assets that may be stranded in the future is an exercise <b>replete with uncertainty</b> .	p. 24
Nevertheless, the <b>deep uncertainty</b> related to physical and transition risks means that both the neoclassical approach of most IAMs and alternative approaches such as demand-led and non-equilibrium models will remain unable to capture many forces triggered by climate change.	p. 27
<b>Deep uncertainty</b> exists with regard to the biogeochemical processes potentially triggered by climate change.	p. 27
“Scenarios are not associated with probabilities, nor do they represent a collectively exhaustive set of potential outcomes or actual forecasts” (Trucost ESG Analysis, 2019, p. 39). Their “results are subject to a <b>high degree of uncertainty</b> ” (Zhou et al., 2019, p. 3) and cannot be allocated probabilities of occurrence, i.e., they should be assessed with extreme caution by finance supervisors engaged in financial stability monitoring.	pp. 35–36
In short, accounting for the multiple transmission channels of climate-related risks across firms, sectors and financial contracts while reflecting a structural change of economic structures remains a task <b>filled with uncertainty</b> .	p. 42
Nevertheless, the descriptive and normative power of these alternative approaches remain limited by the sources of <b>deep and radical uncertainty</b> related to climate change discussed above.	p. 43
[T]he second avenue from the perspective of maintaining system stability consists in “going beyond models” and in developing more holistic approaches that can better embrace <b>the deep or radical uncertainty</b> of climate change as well as the need for system-wide action.	p. 43
Embracing <b>deep or radical uncertainty</b> therefore calls for a second “epistemological break” to shift from a management of risks approach to one that seeks to assure the resilience of complex adaptive systems in the face of such uncertainty.	p. 48

Source: Luiz Awazu Pereira da Silva et al., *The Green Swan: Central Banking and Financial Stability in the Age of Climate Change* (January 2020)

## ENDNOTES

- 1 Mark Carney, "Breaking the Tragedy of the Horizon—Climate Change and Financial Stability," September 29, 2015, <https://www.bankofengland.co.uk/-/media/boe/files/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability.pdf?la=en&hash=7C67E785651862457D99511147C7424FF5EA0C1A>.
- 2 IPCC, *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, p. 1140, [https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5\\_Chapter13\\_FINAL.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter13_FINAL.pdf).
- 3 Quoted in Jeff Cox, "Powell Says Climate Change Is Not a Main Factor in the Fed's Policy Decisions," CNBC, June 4, 2021, <https://www.cnbc.com/2021/06/04/powell-says-climate-change-is-not-a-main-factor-in-the-feds-policy-decisions.html>.
- 4 ECB press conference, July 8, 2021, <https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210708~ab68c3bd9d.en.html>.
- 5 Rishi Sunak, letter to Andrew Bailey, remit for the Monetary Policy Committee (MPC), March 3, 2021, [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/965782/2021\\_MPC\\_remit\\_FINAL\\_1\\_March\\_.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/965782/2021_MPC_remit_FINAL_1_March_.pdf); House of Lords debate on the Budget Statement, March 12, 2021, Hansard Col. 1914, <https://hansard.parliament.uk/Lords/2021-03-12/debates/7B8D47C7-DE8F-4C19-9198-8100A136BBBF/details#contribution-13E2E0D5-6680-44DB-A19C-C62E14BB63C8>.
- 6 Cox, "Powell Says Climate Change Is Not a Main Factor."
- 7 The White House, "Executive Order on Climate-Related Financial Risk," May 20, 2021, <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/05/20/executive-order-on-climate-related-financial-risk>.
- 8 Network for Greening the Financial System (NGFS), <https://www.ngfs.net/en/about-us/governance/origin-and-purpose>.
- 9 Bank for International Settlements (BIS), [https://www.bis.org/events/green\\_swan\\_2021/overview.htm](https://www.bis.org/events/green_swan_2021/overview.htm).
- 10 SEC, "A Climate for Change: Meeting Investor Demand for Climate and ESG Information at the SEC," March 15, 2021, <https://www.sec.gov/news/speech/lee-climate-change>.
- 11 Randal Quarles, "Disclosures and Data: Building Strong Foundations for Addressing Climate-Related Financial Risks," July 11, 2021, <https://www.federalreserve.gov/newsevents/speech/files/quarles20210711a.pdf>.
- 12 John Cochrane, "Challenges for Central Banks," John Cochrane's blog, October 20, 2020, <https://johnhcochrane.blogspot.com/2020/10/challenges-for-central-banks.html>.
- 13 Luiz Awazu Pereira da Silva et al., *The Green Swan: Central Banking and Financial Stability in the Age of Climate Change* (January 2020), p. viii.
- 14 *Ibid.*, p. 1.
- 15 *Ibid.*, p. 3.
- 16 Martin L. Weitzman, "On Modeling and Interpreting the Economics of Catastrophic Climate Change," *Review of Economics and Statistics* 91, no. 1 (February 2009): 14, [https://dash.harvard.edu/bitstream/handle/1/3693423/Weitzman\\_OnModeling.pdf?sequence=2](https://dash.harvard.edu/bitstream/handle/1/3693423/Weitzman_OnModeling.pdf?sequence=2).
- 17 *Ibid.*, p. 5.
- 18 *Ibid.*, p. 4. Emphasis in the original.
- 19 *Ibid.*, p. 12.
- 20 Pereira da Silva et al., *The Green Swan*, p. 8.
- 21 Janet Yellen, "Climate Action and the Institute of International Finance," April 21, 2021, <https://secjanetyellen.medium.com/climate-action-and-the-institute-of-international-finance-1e06b9db2105>.
- 22 Weitzman, "On Modeling and Interpreting the Economics of Catastrophic Climate Change," p. 5.
- 23 Pereira da Silva et al., *The Green Swan*, pp. 21–22.
- 24 *Ibid.*, p. 51.
- 25 Carney, "Breaking the Tragedy of the Horizon."
- 26 Cox, "Powell Says Climate Change Is Not a Main Factor."
- 27 Huw van Steenis, "Prepare for Impact on Banks from Green Stress Tests," *Financial Times*, June 17, 2021, <https://www.ft.com/content/68ebd27a-232e-413a-95c8-3b3dd267daba>.
- 28 Pereira da Silva et al., *The Green Swan*, p. 3.
- 29 Weitzman, "On Modeling and Interpreting the Economics of Catastrophic Climate Change," pp. 5 and 1.
- 30 IPCC, *Climate Change 2013*, p. 1140.
- 31 IPCC, *Climate Change 2021: The Physical Science Basis. Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Box TS9.
- 32 The White House, "Remarks by President Biden at the Virtual Leaders Summit on Climate Session 2: Investing in Climate Solutions," April 22, 2021,

<https://www.whitehouse.gov/briefing-room/speeches-remarks/2021/04/22/remarks-by-president-biden-at-the-virtual-leaders-summit-on-climate-session-2-investing-in-climate-solutions>.

33 Yellen, “Climate Action and the Institute of International Finance.”

34 Peter Höpfe and Roger Pielke Jr., eds., “Climate Change and Disaster Losses Workshop: Understanding and Attributing Trends and Projections,” May 25–26, 2006, [https://sciencepolicy.colorado.edu/research\\_areas/sparc/research/projects/extreme\\_events/munich\\_workshop/ccdl\\_workshop\\_brochure.pdf](https://sciencepolicy.colorado.edu/research_areas/sparc/research/projects/extreme_events/munich_workshop/ccdl_workshop_brochure.pdf).

35 Roger Pielke Jr., “Statement of Dr. Roger Pielke Jr. to the Committee on Banking, Housing, and Urban Affairs of the United States Senate,” July 20, 2021, p. 4, <https://www.banking.senate.gov/imo/media/doc/Pielke%20Testimony%207-20-21.pdf>.

36 *Ibid.*, p. 5.

37 *Ibid.*, p. 6.

38 *Ibid.*, p. 8.

39 Steven E. Koonin, *Unsettled: What Climate Science Tells Us, What It Doesn't, and Why It Matters* (2021), p. 100.

40 *Ibid.*, p. 109.

41 *Ibid.*, p. 101.

42 *Ibid.*

43 William M. Briggs, *The Climate Blame Game: Are We Really Causing Extreme Weather?* (2021), p. 3, <https://www.thegwpf.org/content/uploads/2021/04/Briggs-Climate-Attribution.pdf>.

44 *Ibid.*, p. 5.

45 *Ibid.*, p. 4.

46 *Ibid.*, p. 5.

47 *Ibid.*, p. 8.

48 Koonin, *Unsettled*, p. 31.

49 *Ibid.*, fig. 1.2.

50 Judith Curry, “Climate Change, Extreme Weather, and Electric System Reliability,” *Climate Etc.* blog, June 27, 2021, <https://judithcurry.com/2021/06/27/climate-change-extreme-weather-and-electric-system-reliability>.

51 *Ibid.*

52 *Ibid.*

53 FSB, *FSB Roadmap for Addressing Climate-Related Financial Risks* (July 7, 2021), p. 3, <https://www.fsb.org/2021/07/fsb-roadmap-for-addressing-climate-related-financial-risks>.

54 See <https://www.tcfhub.org/recommendations>.

55 FSB, *FSB Roadmap for Addressing Climate-Related Financial Risks*, p. 3.

56 David Burton, “Re: Comments on Climate Disclosure,” June 13, 2021, <https://www.sec.gov/comments/climate-disclosure/cll12-8914466-244728.pdf>.

57 John Maynard Keynes, *The General Theory of Employment, Interest, and Money* (1st ed., 1936; 1973), p. 294.

58 UNFCCC, Paris Agreement (2015), Article 2.1 (a) and (c), [https://unfccc.int/files/meetings/paris\\_nov\\_2015/application/pdf/paris\\_agreement\\_english\\_.pdf](https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf).

59 *Ibid.*, Article 4.1.

60 SEC, “Public Input Welcomed on Climate Change Disclosures,” March 15, 2021, <https://www.sec.gov/news/public-statement/lee-climate-change-disclosures>.

61 William Nordhaus, keynote speech, ECB Conference on Monetary Policy, October 19, 2020, <https://www.youtube.com/watch?v=G3eve1fxdY4>.

62 IPCC, *Special Report: Global Warming of 1.5°C* (2018), p. 152.

63 IIGCC press release, “\$14 trillion Investors Call for Consistency on ‘Corporate Net Zero Alignment Plans’ and Director Accountability on Climate Targets,” July 30, 2021, <https://www.iigcc.org/news/usd-14-trillion-investors-call-for-consistency-on-corporate-net-zero-alignment-plans>.

64 *Ibid.*

65 *Ibid.*

66 Carney, "Breaking the Tragedy of the Horizon."

67 Joseph A. Schumpeter, *Capitalism, Socialism and Democracy* (1943; 1974), p. 83.

68 As at August 9, 2021, <https://companiesmarketcap.com/usa/largest-companies-in-the-usa-by-market-cap>.

69 Pereira da Silva et al., *The Green Swan*, p. 7.

70 *Ibid.*, p. 24.

71 *Ibid.*, p. 21.

72 Reuters, "German 'Green Revolution' May Cost 1 Trillion Euros—Minister," February 20, 2013, <https://www.reuters.com/article/us-germany-energy-idUSBRE91J0AV20130220>.

73 Rupert Darwall, *Green Tyranny* (2017), p. 150.

74 Pereira da Silva et al., *The Green Swan*, p. 79.

75 Bloomberg, "Germany Compensates Utilities \$2.9 Billion for Nuclear Exit," March 5, 2021, <https://www.bloomberg.com/news/articles/2021-03-05/germany-to-pay-energy-companies-2-9-billion-for-nuclear-exit>.

76 FSB, *FSB Roadmap for Addressing Climate-Related Financial Risks*, p. 1.

77 Pereira da Silva et al., *The Green Swan*, p. 82.

78 *Ibid.*, p. 79.

79 *Ibid.*, p. 63.

80 *Ibid.*, p. 64.

81 *Ibid.*, p. 57.

82 *Ibid.*

83 Patrick Temple-West, Kristen Talman, and Gillian Tett, "Jeff Ubben: Engine No. 1 Model Is 'Not Enough to Create Lasting Change,'" *ft.com*, August 6, 2021, <https://www.ft.com/content/be37a9f2-5a1e-4705-aaf0-b86456c58f12>.

**RealClear** Foundation