

# Climate Change Economics and Financial Impacts

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## The Cost of Climate Change

Climate change is perhaps the greatest threat to prosperity that humankind has ever faced. The World Meteorological Organization reported in 2021 that climate- and weather-related disasters have risen five-fold over the last half century, comprising 11,000 individual events, more than two million lives lost and \$3.64 trillion in losses.<sup>1</sup> This year, almost one in three Americans experienced a weather disaster,<sup>2</sup> and even the fact that these events are now mostly described as “weather disasters” rather than “acts of God” illustrates our new understanding that what’s happening isn’t some cosmic game of chance — we’re causing this. The Intergovernmental Panel on Climate Change (IPCC) issued its sixth assessment report on the physical science basis of climate change in 2021, and in contrast to past reports, in which warnings were couched in scientific estimates of uncertainty, the conclusions were written in plain language: “It is unequivocal that human influence has warmed the atmosphere, ocean and land ... The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years.”<sup>3</sup>

Climate change is not a distant threat: It is here now, and it’s costing us a lot. During the last several months alone,<sup>4</sup> we’ve seen deadly floods in western Europe, where as much as two months’ worth of rain fell in two days. Flooding also hit central China, where a three-day downpour delivered a year’s worth of rain in one city. A “heat dome” that enveloped much of the Pacific Northwest and Canada during the summer of 2021 caused several hundred deaths and damaged transportation infrastructures and crops. Fires forced evacuations and damaged property and infrastructure in the American west, the Mediterranean and Russia. One company has even been charged with manslaughter in the deaths of four people caught in a wildfire found to have been caused by company’s inadequate management of its transmission assets.<sup>5</sup> This is just a sampling of the impacts of climate change related extreme weather in 2021.

But today’s costs pale in comparison to what future costs and damages will be. A recent report from Swiss Re contained the sobering estimate that climate change could cost the world 10% of its total economic value by 2050 if we stay on our current warming trajectory.<sup>6</sup> Simulating the impacts of rising temperatures, Swiss Re found that global GDP would be 11-14% lower than in a world without climate change by midcentury. By contrast, and while it still would be costly to invest the money needed to prevent warming above 1.5°C — the threshold under which we must stay to avoid climate catastrophe — the negative impact on gross domestic product (GDP) is estimated to be only about 4.2% by midcentury. Investing in mitigation and adaptation is expensive — but only about a third as expensive as doing nothing.

The damages, costs and suffering caused by climate change can be mitigated because we have the capacity and the technology to prevent them from becoming significantly worse. Investing now in low-carbon technologies and solutions is, in fact, likely to be less expensive than coping with increasingly severe and frequent disasters and heat waves. The IPCC estimates<sup>7</sup> that it will take \$1.6 – 3.8 trillion every year to avoid surpassing 1.5°C in additional warming between now and 2050. That is a hefty price tag, but these investments will also create jobs and add to economic output, unlike the damages and losses incurred by extreme weather and the chronic effects of climate change. Investing in both mitigation of additional emissions and adaptation to the changes that are unavoidable will be a far less chaotic approach to the problem of climate change than simply awaiting the effects.

But investing in mitigation need not be expensive in terms of financial outcomes for both equity and fixed income investors — in fact, it should be profitable. This paper reviews recent evidence on the performance of portfolios and companies that lean into the transition to a low- or no-carbon economy. Investing in mitigation and low-carbon solutions, or at least incorporating both transition<sup>8</sup> and physical risks into investment portfolios, can provide competitive, if not superior, financial results to investors.

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<sup>1</sup> United Nations, “Climate and Weather related Disasters Surge Five-fold Over 50 Years, but Early Warnings Save Lives – WMO report,” UN News, Sept. 1, 2021.

<sup>2</sup> Sarah Kaplan and Andrew Ba Tran, “Nearly 1 in 3 Americans Experienced a Weather Disaster This Summer,” The Washington Post, Sept. 4, 2021.

<sup>3</sup> Intergovernmental Panel on Climate Change, “Headline Statements from the Summary for Policymakers,” Sixth Assessment Report, Working Group 1 – The Physical Science Basis, Aug. 9, 2021.

<sup>4</sup> Agence France-Presse, “A Round-up of the World’s Worst Climate Change Events in 2021,” July 26, 2021.

<sup>5</sup> Ron Brackett, “PG&E Charged with Involuntary Manslaughter in California’s Zogg Fire That Killed Four People,” The Weather Channel, September 25, 2021.

<sup>6</sup> Swiss Re Institute, “The Economics of Climate Change: No Action Not an Option,” April 2021.

<sup>7</sup> Joeri Rogelj, Drew Shindell, and Kejun Jiang, et. al, “Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development,” IPCC, Chapter 2, Global Warming of 1.5°C, June 18, 2018.

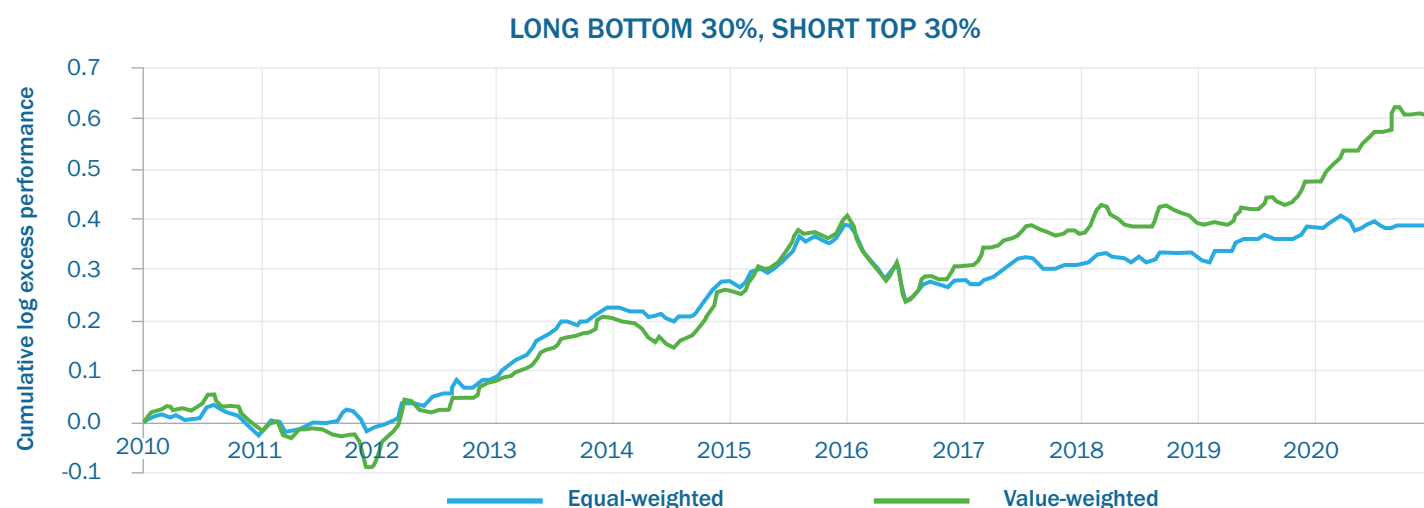
<sup>8</sup> Transition risks are primarily attached to larger emitters and involve risks of stranded assets as the world moves away from fossil fuels and toward alternative ways to produce energy, and the risk of cost increases and reduced competitiveness as rising carbon prices are incorporated into companies’ cost functions.

## Incorporating Climate Change in Investing: Equities and Transition Risks

There is considerable evidence that investors are pricing transition risks and that the understanding of transition risks is becoming more nuanced and sophisticated in financial markets. The Grantham Institute,<sup>9</sup> for example, found that many stocks were re-priced following the successful outcome of COP 21 in 2015, which produced the Paris Agreement.<sup>10</sup> Using a novel dataset that employed empirical measures of US firms' environmental performance based on low-carbon patenting activities, revenues from green products, and emissions, the authors concluded that stock markets repriced firms that were more active in commercializing green goods and services following the announcement of the Paris Agreement. "Firms in the greenest decile in terms of green revenue share," they noted in the 2020 report, "significantly outperformed the market in the week following the agreement." The outperformance for the greenest firms was, on average, 10% higher in the days following the announcement. The sample baseline included information about publicly listed firms representing 98% of US market capitalization. However, the market did not necessarily reprice firms in lower quintiles, and there was no distinguishable market impact between higher and lower emitters, suggesting that even large emitters can be rewarded for making progress in developing greener products. That is perhaps not surprising, but it is a sign that the investment world is moving beyond simplistic indicators of climate risk and incorporating more sophisticated and impactful measures of progress.

The Grantham Institute's work is supported by other research demonstrating that decarbonization does not have to involve performance tradeoffs. In fact, several new studies show that carbon-sensitive portfolios may outperform less carbon-sensitive peers. A study<sup>11</sup> by four authors from BlackRock examined firms' performance using two climate-related signals: carbon emission intensities<sup>12</sup> and LEED building certifications. A portfolio that takes long positions in firms with lower carbon intensities (the bottom 30% of firms ranked by Scope 1 and 2 emissions intensity) and shorts firms with high emissions intensities (the top 30%) exhibits an alpha of 1.49% per year, and the returns are higher even after adjusting for sectors and firm characteristics. Similarly, LEED certifications were positively and significantly correlated with efficiencies in firm fundamentals, including return on assets, between 2010 and 2020. (See Figure 1, below.)

**FIGURE 1:** Returns of Low Minus High Emission-Intensive Companies



This figure plots the cumulative log excess performance of a long-short portfolio buying the least emission-intensive companies (in bottom 30% of carbon emission intensity) and selling the most emission-intensive companies (in the top 30% of carbon emission intensity) in the MSCI ACWI universe over the sample period from January 2010 to December 2020.

Source: Kazdin et. al, op. cit. 2021.

<sup>9</sup> Tobias Kruse, Myra Mohnen and Misato Sato, "Are Financial Markets Aligned with Climate Action? New Evidence from the Paris Agreement," Grantham Research Institute on Climate Change, Centre for Climate Change Economics and Policy Working Paper No. 364, Feb. 18, 2020.

<sup>10</sup> The Paris Agreement, announced in December 2015 following the 21st Conference of the Parties to the Kyoto Protocol, entered into force late in 2016 and is a legally binding international treaty whose goal is to limit future global warming to well below 2°C. See United Nations Climate Change, "The Paris Agreement."

<sup>11</sup> Joshua Kazdin, Katharina Schwaiger, Viktoria-Sophie Wendt and Andrew Ang, "Climate Alpha with Predictors Also Improving Firm Efficiency," Social Science Research Network, July 15, 2021.

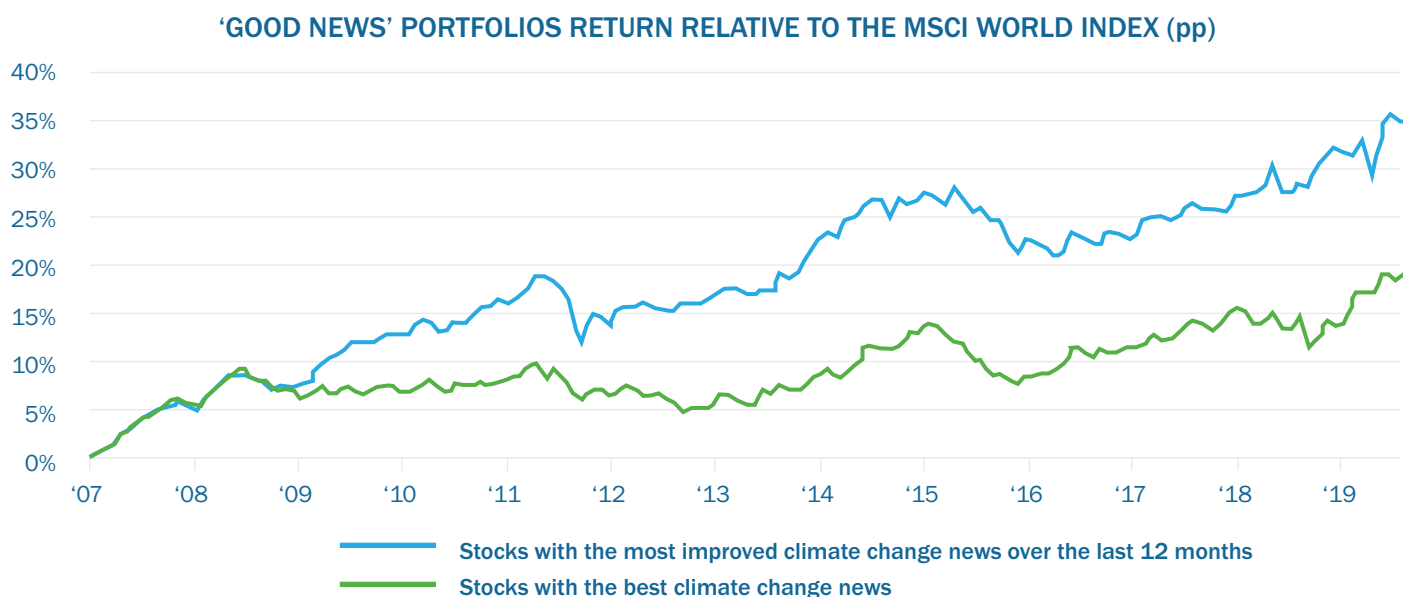
<sup>12</sup> The study included carbon intensities based on Scope 1 and Scope 2 emissions.

This approach is similar to one taken by researchers at Harvard Business School in 2019,<sup>13</sup> who found that portfolios that “lowered carbon emissions more aggressively performed better.” Using the authors’ concept of decarbonization factors and constructing portfolios that take long positions in low carbon intensity sectors and short positions in high carbon intensity sectors provided significantly positive alphas when buys and sells were coordinated with institutional flows into the factors.

Other approaches have proven to be interesting as well. Atanasova and Schwartz examined North American fossil oil firms between 1999 and 2018 and documented that the growth of fossil fuel reserves has a negative relationship with firm value.<sup>14</sup> During the approximately two decades of the study’s timeframe, fossil fuel stocks had periods of both outperformance and underperformance, and thus the overall outcome showing underperformance from adding to reserves is noteworthy. When the authors decomposed reserves into developed and undeveloped, it was clear that the negative impact of reserves growth was due to firms adding to undeveloped reserves. This finding is a new development in the past decade; in the past, additions to reserves were associated with increasing value for oil companies.

Taken together, these studies suggest that investors do see climate change as a material set of risks — and in the case of energy firms, even an existential one. More evidence supporting this view comes from an analysis<sup>15</sup> of climate-related news from companies. In “Climate Change and Corporates: Past the Tipping Point with Customers and Stock Markets,” Luke Templeman and Jim Reid found that companies that announced good news related to climate, such as reductions in emissions or the adoption of an emissions reduction target, outperformed a global index (the MSCI World Index), and those announcing improvements in their climate profiles outperformed even more than those with good news. (See Figure 2.) Between 2007 and 2019, stocks of companies with the most positive news regarding climate change outperformed the index by 20 percentage points, or an annual growth rate of 6.4% compared with 5.6% for the index.

**FIGURE 2: Climate News and Financial Performance**



Source: Templeman and Reid, *op. cit.*, 2019.

The Templeman-Reid paper also notes that consumer behaviors are changing in ways that investors and companies should be aware of. Consumer boycotts, which have historically had little to no impact on corporate revenues, may have more impact in the age of climate change; approximately a third of consumers surveyed noted that they have stopped buying products from companies following bad environmental press about the company.

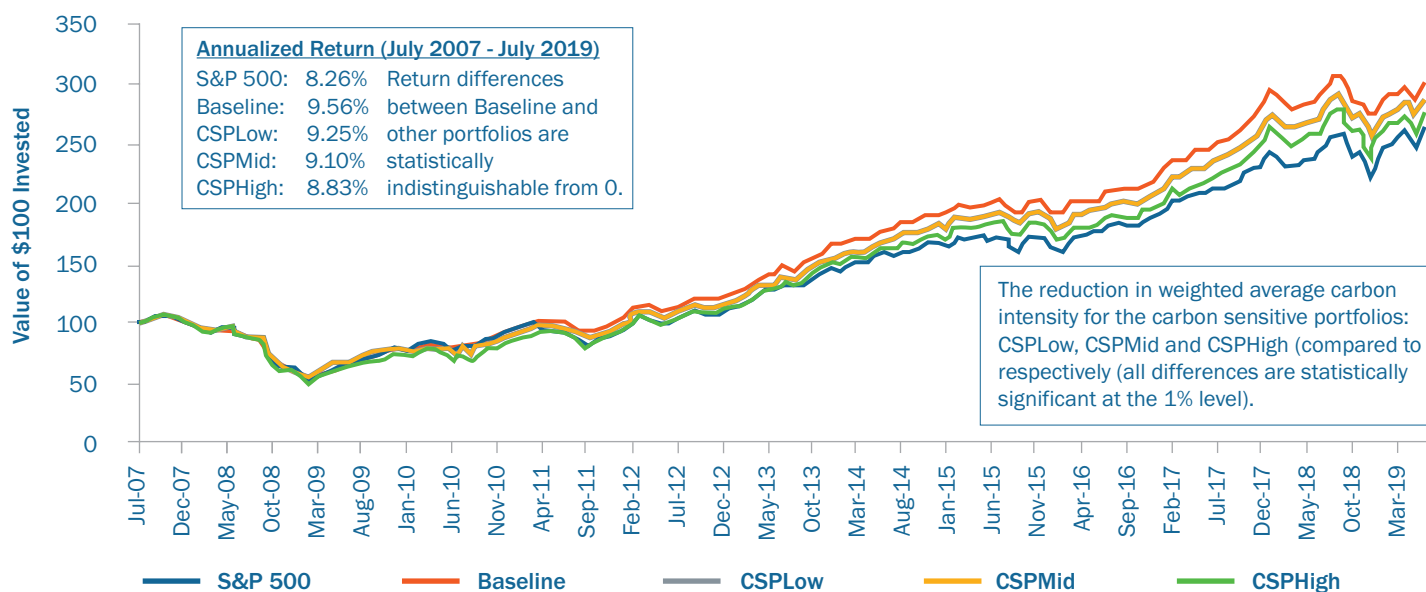
<sup>13</sup> Alex Cheema-Fox, Bridget LaPerla, George Serafeim, David Turkington and Hui (Stacie) Wang, “Decarbonization Factors,” Harvard Business School, Sept. 23, 2019.

<sup>14</sup> Christina V. Atanasova and Eduardo S. Schwartz, “Stranded Fossil Fuel Reserves and Firm Value,” National Bureau of Economic Research, Nov. 2019.

<sup>15</sup> Luke Templeman and Jim Reid, “Climate Change and Corporates: Past the Tipping Point with Customers and Stock Markets,” Deutsche Bank Research, September 2019.

To be sure, no portfolio outperforms in all circumstances, and there are times when carbon-sensitive portfolios may underperform. But evidence over longer time spans shows that there is no sacrifice of returns for a climate-sensitive portfolio. S&P Global’s work<sup>16</sup> spanned the period from 2007 to 2019 and compared three increasingly carbon-sensitive portfolios to the performance of the S&P 500, finding that all three of the carbon-sensitive portfolios they constructed outperformed the S&P 500. (See Figure 3.)

**FIGURE 3:** Value of \$100 Invested in Carbon-sensitive Portfolios (July 2007 – July 2019)



Source: S&P Global Market Intelligence Quantamental Research. For all exhibits, all returns and indices are unmanaged, statistical composites and their returns do not include payment of any sales charges or fees an investor would pay to purchase the securities they represent. Such costs would lower performance. It is not possible to invest directly in an index. Past performance is not a guarantee of future results. Data as of 08/31/2019. Oyeniyi and Tortoriello, *op. cit.*, December 2019.

The authors also noted that the low carbon portfolios had other desirable characteristics from a risk point of view, including reductions in water use, air pollutant releases and waste generated.

## Activism

Every equity investor can weigh in on corporate governance and strategic initiatives through the proxy. Both fixed income and equity investors can and often do initiate dialogues with companies over issues of concern, and increasingly that includes concerns about climate risks. There is evidence that shareholder and bondholder interest in climate change has increased, and this is illustrated by the 2020 proxy season. Average shareholder support in the US for proxy resolutions concerning reporting on climate risks, disclosing emissions and setting emissions reduction targets, and lobbying related to public policy on climate change increased dramatically in 2020, averaging 52.6% support for such proposals, compared with 28.5% in 2019.<sup>17</sup> Ten climate-related shareholder proposals achieved majority votes in support of these activities, up from three in 2020 and zero in 2019. The spike in investor concern over climate change also took the form of governance changes; in 2021, a six-month-old hedge fund that owned 0.02% of the shares of oil major ExxonMobil initiated an activist campaign that succeeded in putting three climate experts on the company’s board, against the company’s wishes.<sup>18</sup> Climate risk has clearly crossed the financial Rubicon to become a material consideration in finance.

<sup>16</sup> Temi Oyeniyi and Richard Tortoriello, “The ‘Trucost’ of Climate Investing: Managing Climate Risks in Equity Portfolios,” S&P Global Market Intelligence, December 2019.

<sup>17</sup> Hazel Bradford, “Climate Tops Proxy Season in Proposals, Success Rate,” Pensions & Investments, June 28, 2021.

<sup>18</sup> Samantha Subramanian, “Engine No. 1: The little hedge fund that shook big oil,” Quartz, May 28, 2021.

Empirical support for that idea comes from Flammer, Toffel and Viswanathan’s paper on shareholder activism and climate risk.<sup>19</sup> The authors found that shareholder activism is successful in eliciting greater disclosure of firms’ climate risks and that firms that disclose more information about climate risks following shareholder engagements achieved higher valuations after disclosure between 2010 and 2016.

## Fixed Income and Climate Risk

Climate risks have implications for fixed income investors as well as equity investors. In the period following the Paris Agreement (post-2015), firms that were more exposed to physical climate risk experienced reduced leverage, in part due to demand effects — firms’ optimal leverage decreases with greater exposure to physical risk — and in part because lenders increase credit spreads when lending to firms with the greatest risk.<sup>20</sup>

Kacperczyk and Peydró<sup>21</sup> show similar results, finding that firms with higher Scope 1 emissions receive less bank credit, while those with lower Scope 1 emissions receive more bank financing, even after controlling for differences in the debtors’ fundamentals. The authors believe this reflects banks’ preferences for financing green investments. While they do not necessarily see these differences reflecting climate risk differentials, others do. Gianfrate<sup>22</sup> examined companies in the Bloomberg Barclays Aggregate Bond Index that issued investment grade fixed-rate corporate bonds between 2007 and 2017, finding that companies with greater emissions are seen as more likely to default, all else being equal, and that exposure to carbon risk affects the credit worthiness of the issuers. Seltzer, Starks and Zhu<sup>23</sup> make a similar observation, finding that firms with greater climate and environmental regulatory risks have lower credit ratings and higher yield spreads. That is particularly true for firms located in jurisdictions that have stricter regulatory enforcement. This may be particularly true for any firm with fossil fuel reserves that may become stranded assets; between 2002 and 2016, banks charged significantly higher loan spreads to energy companies with fossil fuel reserves even before the Paris Agreement was reached in 2015, and those spreads increased after the Paris Agreement was announced in 2015.<sup>24</sup>

## Physical Risk: Is It Being Priced?

Most of the studies discussed above concern transition risk — the possibility that regulation of emissions may be imposed, or tightened, in ways that will increase the costs of particularly large emitters, as well as vulnerability to reputational risk and litigation risk. But what about physical risk? One of the above-mentioned papers<sup>25</sup> shows that there is at least some sensitivity in financial markets to physical risk, but pricing physical risks is not yet routine on financial markets.

In part, that is because investors lack the information they need to price physical risks accurately, or at least confidently. To do so requires that investors have up-to-date information on the specific locations of key company assets, not only the company’s own assets (owned or leased) but also key nodes in companies’ value chains, such as dependence on suppliers with high vulnerability to physical risks and physical infrastructures that form part of the company’s value chain.

This work is beginning, though. In the past couple of years, all the credit rating agencies have begun work to understand physical risks more accurately and consider exposures to physical hazards in credit ratings. Recent work by Koelbel, Leippold, Rillaert and Wang<sup>26</sup> notes that credit default swaps with shorter maturities have lower CDS spreads than those with longer maturities, reflecting the market’s judgment that physical risks are more likely to occur — and cause damage — over longer time spans. Pricing these risks, the authors note, is “driven by risk considerations, not ethical tastes.”

However, investors are still limited by information availability in pricing physical risks in equities, as well as bond markets. Good risk pricing depends not only on knowing how much of any company’s operation is dependent on assets or

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<sup>19</sup> Caroline Flammer, Michael W. Toffel, and Kala Viswanathan, “Shareholder Activism and Firms’ Voluntary Disclosure of Climate Change Risks,” Harvard Business School, March 17, 2021.

<sup>20</sup> Edith Ginglinger and Quentin Moreau, “Climate Risk and Capital Structure,” European Corporate Governance Institute, Feb. 12, 2019.

<sup>21</sup> Marcin T. Kacperczyk and José-Luis Peydró, “Carbon Emissions and the Bank-Lending Channel,” Social Science Research Network, September 1, 2021.

<sup>22</sup> Gianfranco Gianfrate, “Climate Change and Credit Risk,” Journal of Cleaner Production, EDHEC-Risk Institute Working Paper, Social Science Research Network, May 2020.

<sup>23</sup> Lee Seltzer, Laura T. Starks and Qifei Zhu, “Climate Regulatory Risks and Corporate Bonds,” Nanyang Business School Research Paper No. 20-05, Last revised May 7, 2021.

<sup>24</sup> Manthos D. Delis, Kathrin de Greiff, Maria Iosifidi and Steven Ongena, “Being Stranded with Fossil Fuel Reserves? Climate Policy Risk and the Pricing of Bank Loans,” Swiss Finance Institute Research Paper Series No. 18-10, July 12, 2021.

<sup>25</sup> Ginglinger and Moreau, op. cit.

<sup>26</sup> Julian Koelbel, Markus Leippold, Jordy Rillaert and Qian Wang, “How Disclosing Transition and Physical Climate Risks Affect Credit Default Swaps,” PRI Blog, April 8, 2021.

institutions vulnerable to increasing risk of loss or impairment because of the effects of a warming globe, but on the company's own assessment of its vulnerabilities and plans to increase resilience, adapt to, or mitigate those risks. Impax has found, through an engagement with companies in the S&P 500 regarding physical risk, that very few companies appear to have thought through the implications of physical risk, and even fewer have developed and disclosed plans to deal with those risks.

## Systemic Risks

In the past couple of decades, we've evolved from understanding climate risk as a strictly regulatory matter to one that brings a spectrum of risks and opportunities, spanning all classes of investment. That thought evolution continues: Now we are starting to think through the systemic risks of climate change. In the past, it was rare when any natural disaster had broad enough impacts to harm entire economies for more than a few months. In today's world, we are seeing multiple states, nations and regions experiencing the impacts of a changing climate concurrently: Widespread flooding and wildfires affecting multiple continents during the summer of 2021 are just two examples. Moreover, impacts on the oceans could have significant effects on financial markets in the future, not only because hotter, more acidic seas may impair economies dependent on fishing and other ocean services, but because of impacts on biodiversity that we are only beginning to understand in marine ecosystems.

Departments of defense in many countries regard climate change as a threat multiplier, because when peoples' lives are disrupted due to prolonged droughts or sea level rise, the result can be conflict or mass migration, and both can be economically disruptive on a scale far greater than the local area. Damage to global supply chains for key commodities such as food, semiconductors and minerals can have economic impacts that are detectable in the GDP of countries and the globe.

As a result of this emerging understanding of systemic risks, central banks have become far more interested in climate change, and many are developing policy tools to try to address these systemic risks. One recent paper<sup>27</sup> estimates that in circumstances when greener firms very much outperform browner ones, losses for European banks (and even global losses) could be substantial should investors fail to price climate risks properly. The authors call for the introduction of climate stress tests for systemically important financial institutions, something that a few central banks are already starting to implement.

An article in *The Economist*<sup>28</sup> notes that where this kind of stress testing has been implemented, indications that climate change could have major impacts on financial health is "underwhelming," but it also cautions that that finding is very dependent on the quality of the stress tests themselves. The article describes three channels through which climate change could have financial impact: transition risks (including the possibility of companies defaulting on loans or bonds or share price collapses for big emitters), physical risks and the possibility that climate change could trigger swings in asset prices. The article mentions that the economic losses of weather-related catastrophes have trebled as a share of global GDP already and could become far more impactful in the future, especially if we are unable to keep emissions at levels that would keep additional warming to less than 1.5°C.

## Conclusion

Financial regulators in many nations are taking increased notice of the impacts of climate change, and we often hear rumblings that they should not dip toes into the waters of "special interests" or "non-financial" matters. That is just politics. Political actors may be able to portray climate change as a partisan issue or a special interest without any pecuniary impact — but financial markets do not have that luxury. The evidence is mounting that climate change poses a great many risks, and financial markets are pricing those risks into securities markets today. Investors that ignore this suite of risks are increasingly likely to have a series of unpleasant and more frequent surprises — and there are few things investors like less than surprises. Our job is to foresee the future and construct portfolios that will prosper under the conditions of the future. We cannot afford to be surprised more often than we must be.

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<sup>27</sup> Alessi Lucia, Elisa Ossola and Roberto Panzica, "The Greenium Matters: Greenhouse Gas Emissions, Environmental Disclosures, and Stock Prices," University of Milan Bicocca Department of Economics, Management and Statistics, Sept. 13, 2019.

<sup>28</sup> "The Economist," "Could Climate Change Trigger a Financial Crisis?," Sept. 4, 2021.

## Disclosures

The **MSCI ACWI (Net) Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed and emerging markets. The MSCI ACWI consists of 50 country indexes comprising 23 developed and 27 emerging market country indexes. The developed market country indexes included are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom and United States. The emerging market country indexes included are: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Kuwait, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Qatar, Russia, Saudi Arabia, South Africa, Taiwan, Thailand, Turkey and United Arab Emirates. Performance for the MSCI ACWI Index is shown “net,” which includes dividend reinvestments after deduction of foreign withholding tax.

The **S&P 500 Index** is an unmanaged index of large capitalization common stocks.

The **Bloomberg Barclays US Aggregate Bond Index** is a broad base index, maintained by Bloomberg L.P. often used to represent investment grade bonds being traded in United States.

One cannot invest directly in an index.

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