IMPAX Asset Management

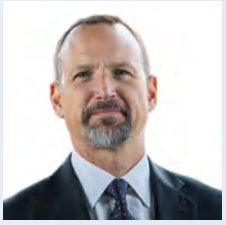
Climate change: the impact for investors

Julie Gorte and Charlie Donovan

IMPAX Asset Management

Julie Gorte, Ph.D.
SVP, Sustainable Investing

Julie oversees ESG-related research on prospective and current investments as well as the firm's shareholder engagement and public policy advocacy. Julie is also a member of the Impax Gender Analytics team.



Charlie Donovan
Senior Economic Advisor

Charlie Donovan is Senior Economic Advisor at Impax and Professor of Practice in the Department of Finance and Business Economics at the University of Washington. Charlie's role at Impax deepens the firm's expertise in understanding the opportunities arising from a global energy transition. He contributes to Impax's thought leadership initiatives and provides insights on North American policy developments to Impax's clients and investment teams.

Contents

Executive summary

- A growing body of research demonstrates the financial materiality of physical, transition and adaptation risks to companies, issuers and their investors.
- Investment to reduce or mitigate greenhouse gas (GHG) emissions will lower the costs of physical risks arising from climate change, but trillions of dollars must also be spent to adapt the global economy to the new climate regime.
- Though many experts believe markets are widely underestimating climate-related risks, studies show that lower-emitting companies and those with transition plans have delivered financial outperformance.

Introduction

We've come a long way in our understanding of the threats posed by climate change since scientists first established the greenhouse effect in the 19th century.[1]

Any intellectually honest enquiry into climate-related financial risks must start with a strong dose of humility. The Earth, the foundation of all economic activity, is incredibly complex. Estimating biophysical responses to human activities and the subsequent economic, political and social reactions to changes on a planetary scale is subject to great uncertainty. Indeed, in a world where economists have widely diverging views on something as immediate as next quarter's inflation, it's impossible to confidently predict the impacts of climate change on the global economy in a decade – or, for that matter, next week.

But try we must. As we describe in this review of industry and academic literature, altering the climate regime that humankind has inhabited since the dawn of modern civilisation will have profound effects on the global economy.[2] There is growing evidence that even some of the more startling figures for, say, loss in GDP over time may be a gross underestimation of the real cost to society from a new climate regime that is, on average, hotter, more violent and more volatile.

Our review of the state of knowledge about the financial impacts of man-made global warming for investors is divided into four sections:

1. Climate science that informs financial risk assessment
2. Estimates of the economic costs of climate change
3. The materiality of those economic costs to investors
4. The potential impact of climate risks on asset values

1 New Scientist, 2023: Eunice Newton Foote: The woman who discovered the greenhouse effect, and NASA Earth Observatory, 2000: Svante Arrhenius

2 NASA, 2014: NASA Global Climate Change – Vital Signs of the Planet, 2014: Climate change and the rise and fall of civilizations. Roughly 11,000 years ago the Earth entered into a relatively stable climate regime that in many ways allowed the human species to settle down and thrive.

1. What science tells us about the financial risks of climate change

Human civilisation is defined by a relatively stable period in the Earth's climate, but humans have disturbed that balance.

Many scientists call this era the 'Anthropocene' because, for the first time, one species has knowingly influenced the climate. Though the climate has changed many times over the planet's history, it has never changed at such a rapid rate (since humans have been around, at least).

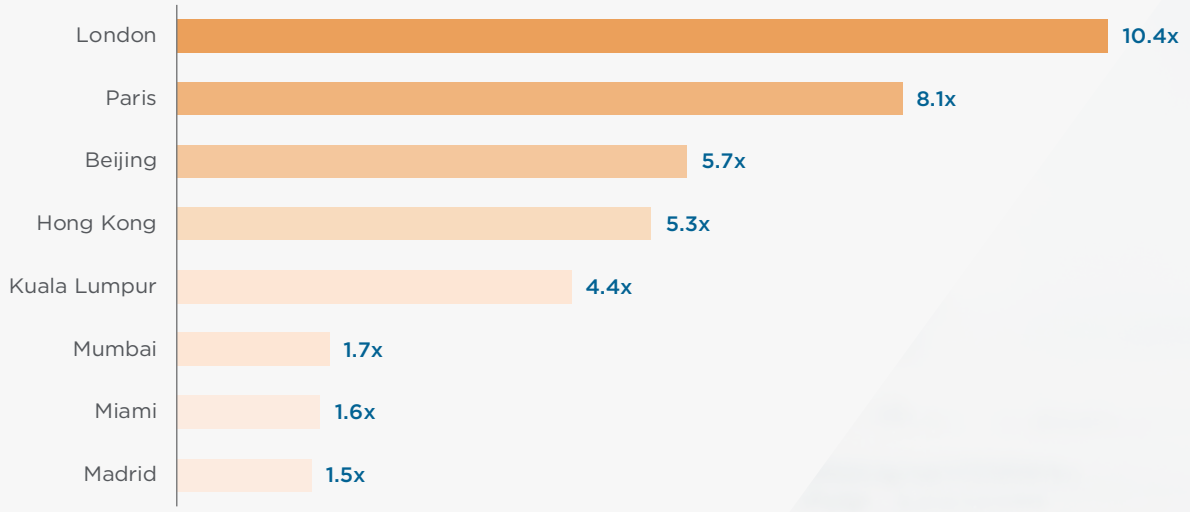
Key to understanding and gauging the risks arising from climate change is a focus on the right indicators.

Extreme temperatures are more concerning than average temperatures

Average temperature increase over pre-industrial times has become a widely shared metric of man-made warming but, from the perspective of risk assessment, it is misleading. The real concern, in terms of human health and financial risk, is not average temperatures but the associated increase in the frequency of extreme temperatures. Extreme weather has been shown to reduce the productivity of labour, increase medical costs, disrupt global and local trade, and dampen investment.[3]

Take extreme heat, for example: a 2°C average increase may lead to a ten-fold increase in the occurrence of potentially deadly heat in places like London (see Figure 1). Significant changes in extreme heat conditions can already be discerned from our current level of average warming.

Figure 1: Increased frequency in mid-afternoon temperatures above 30°C, 2019-2023 vs 1950-1954



Source: Adapted from Financial Times analysis of ERA5 hourly data on land surface temperature, 1940-2023, based on 3pm local time temperatures.[4]

3 Cohen, P., 2023: The Economic Fallout From Extreme Heat Will Rise over Time, *The New York Times*

4 Burn-Murdoch, J., 20 July 2023: What we get wrong when we talk about global warming, *Financial Times*

GHG concentrations determine climatic changes, not GHG emissions

Similarly, while conversation usually centres around greenhouse gas (GHG) emissions, it's the concentrations of those gases in our atmosphere that are driving changes on land and in our oceans.

Carbon dioxide (CO_2), the most ubiquitous GHG, remains in the atmosphere for 300 to 1,000 years.[5] To use a household metaphor, climate change is like an overfilled bathtub running over: the risks of climate change are greater with every molecule of GHG emitted, represented by the open tap pouring still more water into the bathtub. First, we need to turn off that tap by curtailing emissions. Then, if we want to really avoid catastrophe, we also have to drain the tub.

Precautionary spending reduces long-term recovery spending

Finally, how we choose to cope with climate change matters. The more that societies invest in precautionary action, like eliminating GHG emissions and making our economies, businesses and infrastructures resilient to increasingly costly and frequent physical risks, the less that will need to be spent on rescue, emergency action and disaster relief. Every tenth of a °C in global temperature increases that can be averted through early and effective emissions mitigation could amount to billions of dollars' worth of savings in recovery spending. The more we plan for adapting to wilder weather, warmer and rising seas, bigger wildfires, more punishing heat and the spread of diseases and pathogens, the less we will be caught in a self-reinforcing cycle of short-term responses.

In the next section, we describe how economists have sought to translate future changes in the climatic regime into dollars and cents.

Carbon dioxide (CO_2), the most ubiquitous GHG, remains in the atmosphere for 300 to 1,000 years.[5]

5 Buis, A., 2019: The Atmosphere: Getting a Handle on Carbon Dioxide, *NASA Jet Propulsion Laboratory*

2. Estimates of the economic costs of climate change

In principle, the total economic cost of climate change is a simple summation of the damages it causes over time. Consider a thought experiment in which the world does nothing to slow global warming: what would be the associated losses above and beyond the damages that occur from 'normal' variability? This daunting calculation involves monumental questions. What would be the cost of abandoning every building less than a metre above a current high tide mark? What would we eat if oceans become too hot or acidified to support abundant marine life? How would populations and economies adjust to unprecedented migration from inhospitable lands?

The 2006 Stern Review[6] set out to bring more clarity and consensus to this debate and, at a minimum, convincingly demonstrated that the costs of addressing climate change are far lower than the costs of not acting. Yet, this answer leaves us with a new set of difficult questions:

1. What are the costs of minimising damages before they occur ('adaptation' spending)?
2. What are the costs associated with minimising the likelihood and/or magnitude of future damages ('mitigation' spending)?
3. What are the potential economic trade-offs and/or synergies between adaptation and mitigation spending?

The basic economic principle that we adhere to throughout this paper is that more (and better targeted) investment to reduce GHG emissions will translate into lower spending on preventing, managing and coping with the physical impacts of climate change. There is an important caveat, however, with respect to timing.

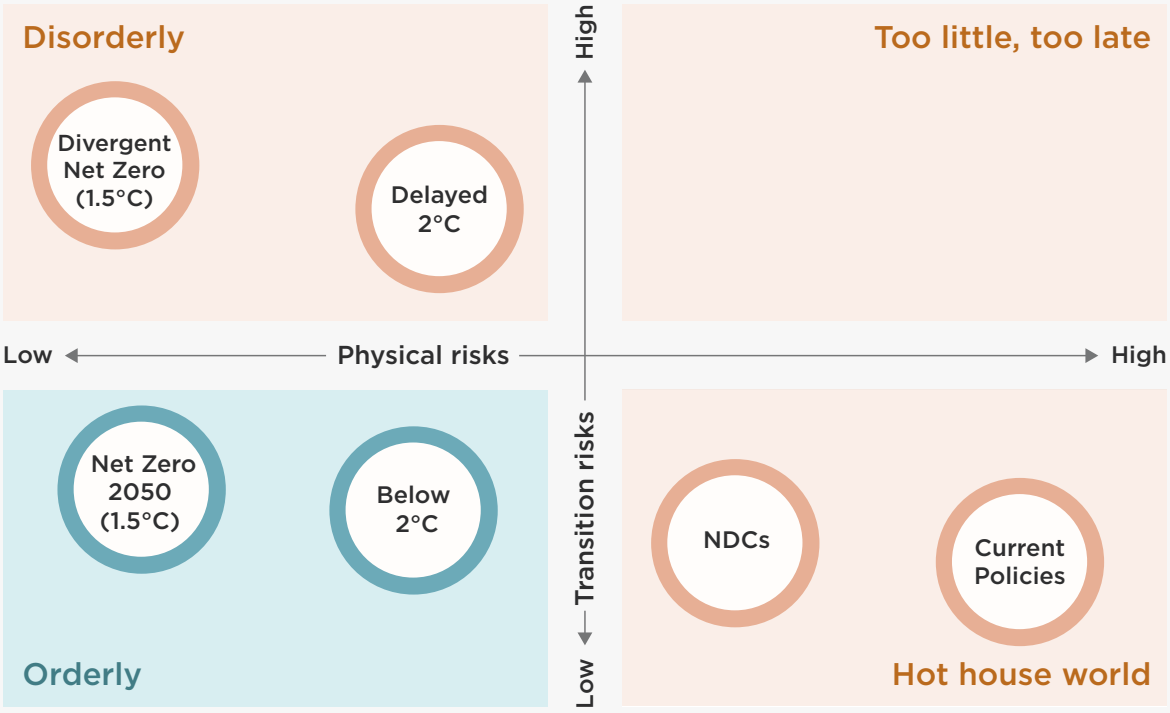
The world's major central banks have paid increasing attention to the economic stability risks associated with climate change in recent years. While this burst of attention and careful research is welcome, work by the Network for Greening the Financial System (NGFS) has reinforced the conventional view about the substitutability of mitigation and adaptation. This may prove too optimistic. There are many credible future scenarios – often ignored in policymaking – in which the world experiences both high transition risks and high physical risks.

Mitigation is necessary, but so is adaptation. Even if GHG emissions were to stop tomorrow, CO_2 remains in the atmosphere for centuries. If we don't adapt to the new climate regime we've already created, more will be spent reactively – and often chaotically – on disaster recovery after each crisis.

6 Stern, N., 2006: The Economics of Climate Change: The Stern Review

Figure 2: NGFS climate change and policy scenarios framework

The NGFS scenarios framework, illustrated below, summarises the physical and transition climate risk outcomes arising from three different climate policy scenarios – "orderly" scenarios, which assume tightening policies'; "disorderly" scenarios, which assume delayed or divergent policies; and "hot house world" scenarios, which assume patchy and insufficient policies.



Positioning of scenarios is approximate, based on an assessment of physical and transition risks out to 2100.

Source: Network for Greening the Financial System, 2021: NGFS Climate Scenarios for central banks and supervisors.
Positioning of scenarios is approximate, based on an assessment of physical and transition risks out to 2100.

On page 6, Table A summarises many of the major studies on the future economic costs of climate change, including estimates of costs to certain economies and sectors. Some studies refer to physical risks and damages, some are about adaptation, and some examine mitigation and the transition to a low-carbon economy. Some studies are global, others regional. All of them conclude that the costs of climate change are substantial and unavoidable.

To cite just two estimates, the costs of limiting global temperature increases to no more than 1.5°C to 2°C (above pre-industrial levels) range from US$3.5 trillion (trn) to over US$7trn annually.[7]

Estimates of the costs of physical climate risks vary widely, but the US Office of Management and Budget estimates that annual losses for the US alone total approximately US$2trn.[8] We might reduce the damages through investments that make existing assets more resilient to climate impacts, but that too is expensive: the annual bill for adapting to climate change could reach US$160bn to US$340bn by 2030, and climb to US$315bn to US$565bn by 2050.[9]

Climate change will cost us trillions of dollars. We can spend that money proactively and thoughtfully, or reactively and chaotically.

7 Laidlaw, J., 2022: On one end, trillions of dollars to invest in climate. On the other, huge and urgent need. How do we connect the dots? S&P Global. Ehlers, T. & Gardes-Landolfini, C., et al, 2022: How to Scale Up Private Climate Finance in Emerging Economies, International Monetary Fund Blog
8 Benshoff, L., 2022: The future cost of climate inaction? $2 trillion a year, says the government, National Public Radio
9 Rondeaux, C. & Salyk-Virk, M., 2022: Calculating the True Cost of Adaptation in Our Climate-Stressed Future, New America

Table A: Studies that estimate the costs of climate change

Author	Date	Estimate of costs/damages	Timeframe	Geography	Focus
International Monetary Fund	2023	Climate-induced temperature shocks have negative and lasting effect on real GDP growth in both developed and developing economies	Current	Global	Physical risk
United Nations	2022	US$160bn - US$340bn a year	Before 2030	Global	Adaptation
Nature	2022	Climate anomalies may reduce US agricultural productivity to pre-1980 levels	2022	US	Physical risk
Oxford Economics	2022	Achieving net zero could increase food production costs by up to 80%; 1% increase I temperature over a year increases food production cost by 0.5%-0.8%	2050	Southeast Asia	Transition cost
Vanguard	2022	2%-4% drag on global GDP by 2050 with small temperature rises; up to 10% of GDP lost with increases above 3°C	2050-2100	Global	All climate risks
Federal Reserve Board	2022	Value at risk of financial assets about US$2.5trn under 'business as usual' pathway	Current	Global	Physical risks and stranded assets
World Economic Forum	2022	GDP growth slowed by 0.15-0.25 percentage points annually in scenario designed to cut 25% of global emissions	2030	Global	Transition cost
International Monetary Fund	2022	US$6trn per year in private finance to substantially reduce GHG for decarbonized energy infrastructure; US$140bn - US$300bn a year to adapt to physical risk by 2030, rising to US$520bn -US$1.75trn after 2050	2030, 2050, 2100	Emerging economies	Mitigation and adaptation investments
Way, R. et al, University of Oxford	2022	Net present savings from a fast transition to zero carbon energy system: US$5trn-US$12trn	2070	Global	Zero carbon transition savings
UN Environment Programme	2021	US$280bn - US$500bn a year	2050	Developing countries	Adaptation
Swiss Re	2021	Global GDP 11%-14% lower than in a world without climate change	2050	Global	All climate risks
University of Oxford	2021	US$2.2trn for financial sector if companies in automotive, coal, oil & gas, and power industries delay climate action beyond 2026	2035	Global	Transition
Wolff, G.B., Taglipietra, S. and Lenaerts, K.	2021	Range from >US$2trn/year to US$5trn/year to reach net zero by mid-century	2020, 2030, 2040, 2050	Global	Mitigation investments
Mumtax, H. and Alessandri, P.	2021	A 1°C increase in temperature volatility causes a 0.9% decline in GDP growth and 1.3% increase in GDP volatility	1960-2005	Global	All climate risks
US Commodity Futures Trading Commission	2020	1.2% loss in GDP for every 1°C rise in temperature	2100	US	Physical risk

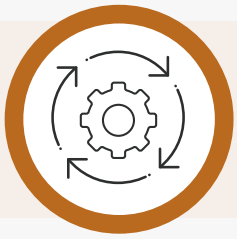
3. Are these costs material to investors?

Climate change creates a spectrum of risks, often classified as adaptation, physical and transition risks. These create a myriad of potential financial risks for investors and companies, as outlined in Figure 3 below.

Figure 3: Summary of adaptation, physical and transition climate risks

Adaptation risks

- Asset valuation
- Operational impairment
- Cost of business adjustments
- Regulatory changes
- Loss of subsidies



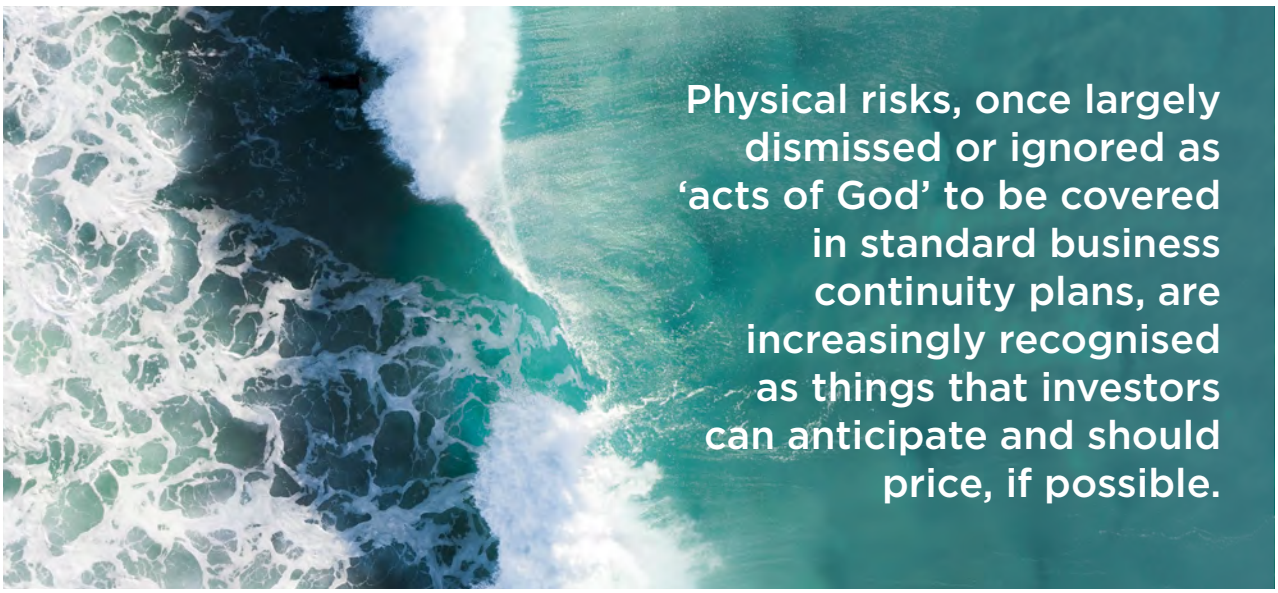
Transition risks

- Technology
- Regulation
- Commodity prices
- Consumer preferences
- Litigation

Physical risks

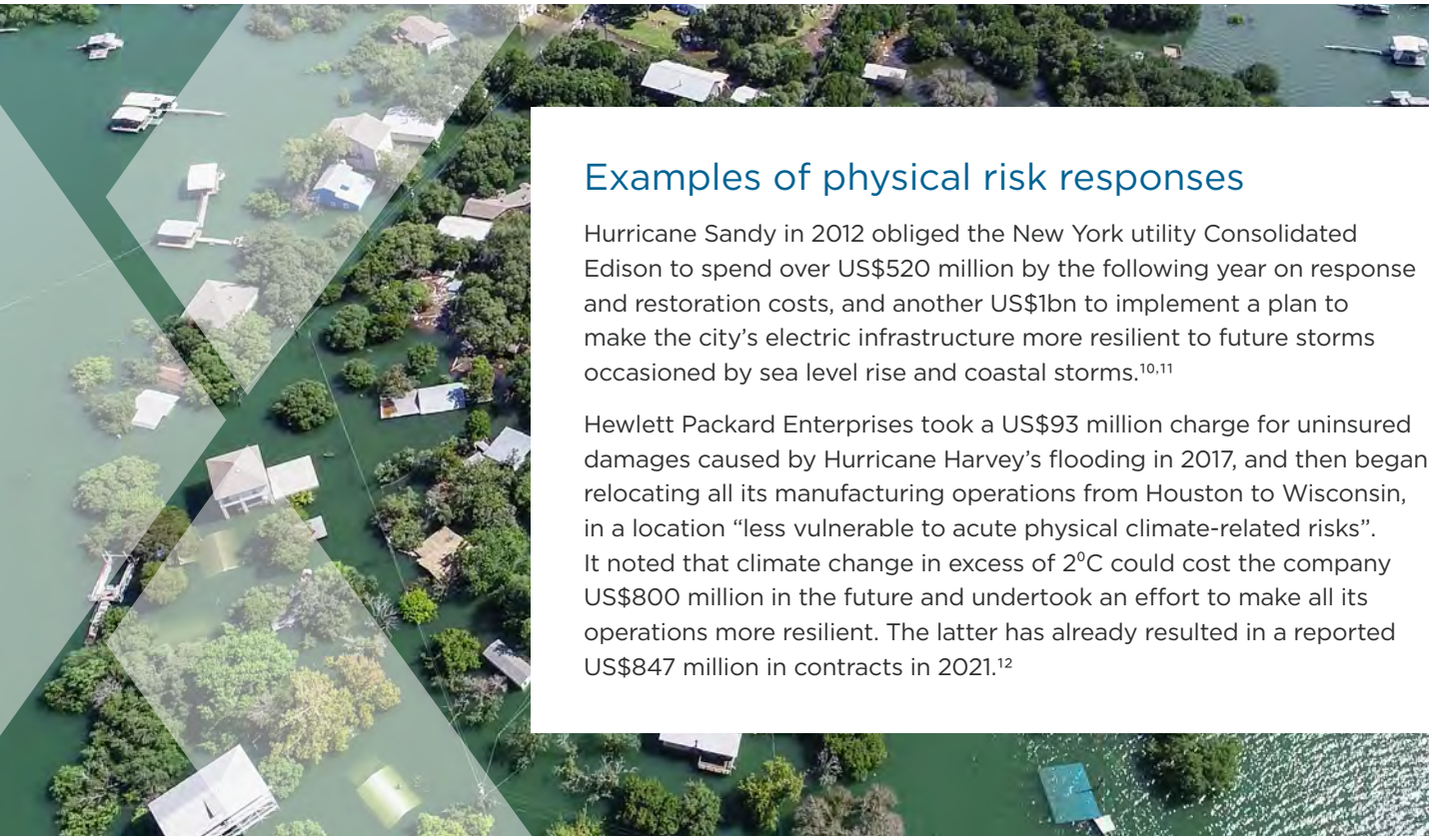
- Water stress
- Heat stress
- Sea level rises
- Extreme precipitation
- Extreme weather
- Expansion of disease / pest ranges

Source: Adapted from Buhr, B., 2023: Climate Risks: An Investor's Field Guide to Identification and Assessment



The materiality of physical risks

Physical risks, once largely dismissed or ignored as 'acts of God' to be covered in standard business continuity plans, are increasingly recognised as things that investors can anticipate and should price, if possible. Doing so will require more disclosure from companies – not only where their operations are located, but also how they are preparing for increasingly volatile weather and climate conditions that could affect operations. While it is rare to find disclosure of all this information on the part of any issuer, we do know that costs will be significant and, in many cases, material.



Examples of physical risk responses

Hurricane Sandy in 2012 obliged the New York utility Consolidated Edison to spend over US$520 million by the following year on response and restoration costs, and another US$1bn to implement a plan to make the city's electric infrastructure more resilient to future storms occasioned by sea level rise and coastal storms.[10,11]

Hewlett Packard Enterprises took a US$93 million charge for uninsured damages caused by Hurricane Harvey's flooding in 2017, and then began relocating all its manufacturing operations from Houston to Wisconsin, in a location "less vulnerable to acute physical climate-related risks". It noted that climate change in excess of 2^0C could cost the company US$800 million in the future and undertook an effort to make all its operations more resilient. The latter has already resulted in a reported US$847 million in contracts in 2021.[12]

The materiality of transition risks

Other risks arise from the low-carbon transition, or the changes in companies' prospects and financial results that come from the transition to a low-carbon economy. For example, many companies have taken impairments to assets made less valuable, or even unsellable, due to concerns over high emissions.[13] At a global scale, investors have been demanding carbon premiums for higher-emitting firms since the landmark Paris Agreement of 2015, particularly in countries with stricter climate policies.[14] This also implies a higher cost of capital for the largest emitters.

A growing body of research demonstrates the financial materiality of transition risks. Lower corporate emissions, for instance, have been shown to be positively and significantly correlated with higher excess returns and productivity. For companies managing LEED (Leadership in Energy and Environmental Design) buildings, lower emissions intensity is also associated with greater firm efficiency, as measured by indicators

10 Pentland, W., 2013: Superstorm Sandy Was Super Expensive for Con Edison, *Forbes*
11 Dawsey, J., 2013: ConEd Storm Plan to Cost $1billion, *The Wall Street Journal*
12 Gold, R., 14 March 2021: Companies' Climate Risks Are Often Unknown. Here's How One Opened Up. The Wall Street Journal
13 S&P Global, 2020: US coal companies reduced estimated asset value by at least $1.08B in Q2
14 Bolton, P. & Cacperczyk, M., 2023: Global Pricing of Carbon-Transition Risk, *The Journal of Finance*
15 Kazdin, J. & Schwaiger, K., et al, 2021: Climate Alpha with Predictors also Improving Firm Efficiency, *The Journal of Impact and ESG Investing*

like gross profitability and return on assets.[15] Unsurprisingly, this kind of performance can manifest itself in other ways: companies with lower emissions have also been found to be less likely to default on their debts, particularly since the Paris Agreement. The 2015 climate summit also marked the turning point when firms with higher carbon footprints began receiving lower credit ratings than firms with lower emissions.[16]

Climate risk and company performance

There is also mounting evidence that financial markets, companies and investors are increasingly attuned to the financial materiality of climate risk as well as policy advances that address it.

While the Paris Agreement concerns real actions to reduce emissions, financial markets around the world are also incorporating climate risks and opportunities through new or proposed disclosure requirements. The US Securities and Exchange Commission's (SEC) climate reporting rule proposal in 2022 prompted scrutiny over whether existing disclosures of climate-related information had financial value. It turns out that most companies in the S&P 500 Index already report some climate-related information in their annual reports, having a positive impact on financial performance.[17] Even for companies with above-median emissions, climate reporting earns a valuation premium compared with companies that say nothing.[18]

While most of the literature concerns impacts of various types of climate risk on companies, other issuers can also be affected. The yields on both municipal bonds and sovereign bonds also show that investors are factoring in climate risks.[19] Countries with lower emissions have lower borrowing costs, all other things being equal, reflecting better management of transition risks.

Table B, on page 10, lists studies that demonstrate quantitative links between financial performance and the low-carbon transition.

Physical risk can clearly affect company performance. Climate change is creating both acute risks – such as severe storms, flooding, droughts, wildfires, hurricanes and cyclones – and chronic risks, like sea level rise, extreme heat and the enlarged ranges of disease and pest vectors. Every year, we can expect tens to hundreds of billions of dollars' worth of insured losses from events and conditions like these.

Exposure to extreme heat over the past two-plus decades has been found to have reduced companies' revenues and operating income in over 93 countries.[20] Heat stress can also increase municipal bond yield spreads, making debt more expensive for cities that are more vulnerable to the impact of climate change.[21] But while we know where cities are, we often do not know where major company assets or supply chain dependencies are located. This means that physical climate risks are not reliably anticipated by corporate investors. This is why Impax petitioned the SEC to require that companies report the locations of assets whose loss or damage could be a material event.[22]

The rising impacts of physical climate-related risk raise the spectre of systemic risk. In the 1980s, there were on average four weather disasters in the US a year that cost more than US$1bn. Now, there are 20.[23] Severe natural disasters have caused 2% average losses in GDP per capita in countries more vulnerable to them, and those losses persist for five years on average.[24]

Finally, litigation is also emerging as a transition risk for companies, especially those that are more carbon intensive. Climate litigation has proliferated recently, with the number of cases growing to over 200 in 2021. Increasingly, these lawsuits are filed against companies, with negative impacts on valuations. Filings and unfavourable court decisions in past litigation have reduced firms' market values by an average of 0.4%, exceeding 1.5% in some instances.[25]

16 Faralli, M. & Ruggiero, F., 2023: The Rise of Climate Risks: Evidence on Firms' Expected Default Frequencies
See also Shah, A., et al, 2023: Green Performance Since the Paris Agreement, *Jefferies*
17 Hampton, D. & Li, V., 2023: Corporate Disclosure of Climate Change Risk – A Pilot Study, *Journal of Accounting, Ethics and Public Policy*
18 Subramanian, S., et al, 2022: Midterm Elections weigh on ESG sentiment, *Bank of America Global Research*
19 Collender, S. & Gan, B., et al, 2022: Climate Transition Risk in Sovereign Bond Markets
20 Pankratz, N. & Bauer, R., et al, 2022: Climate Change, Firm Performance, and Investor Surprises
21 Acharya, V. & Johnson, T., et al, 2022: Is Physical Climate Risk Priced? Evidence from Regional Variation in Exposure to Heat Stress, *NBER Working Paper 30445*
22 Gorte, J., 2022: What investors need from corporate climate disclosures
23 Smith, A.B., 2023: 2022 U.S. billion-dollar weather and climate disasters in historical context, *NOAA*
(The costs have been adjusted for inflation)
24 Lian, W. & Moran, J. et al, 2022: Natural Disasters and Scarring Effects, *IMF Working Paper No. 2022/253*
25 Sato, M. & Gostlow, G., et al, 2023: Impacts of climate litigation on firm value

Table B: Studies focusing on impacts of climate risks on financial performance

Publication	Date	Timeframe	Geography	Focus
Faralli, M. and Ruggiero, F.	2023	2008-2019	US, UK, Eurozone, Japan	Emissions and default frequency
Hampton, D. and Li, V.	2023	2019-2021	US	Emissions disclosure and total revenue/assets
Sato, M. et al	2023	2005-2021	Global	Climate litigation and firm value
Fitch Ratings	2023	2023-2035	n/a	Transition risk and credit ratings
Zhou, X., Caldecott, B. and Shrimali, G.	2023	2000-2019	Global	Transition risk and cost of debt
Bauer, M., Huber, D., Rudebusch, G.D. and Wilms, O.	2023	2010-2021	US	Emissions and stock returns
Sautner, Z., Van Lent, L., Vilkov, G. and Zhang, R.	2023	2002-2020	Global	Transition and physical risk and options pricing
Lin, Z. and Shi, S.	2023	2000-2021	Global	Emissions and M&A strategy
Wang, X. and Panagiotopoulos, A.	2023	2022	Global	Emissions and cumulative returns
Bolton, P. and Kacperczyk, M.	2023	2001-2018	Global	Transition risk and carbon premium
Acharya, V.V. et al	2022	2008-2021	US	Physical risk, bond yields and expected stock returns
Lian, W., Moran, J.R. and Vishvesh, R.	2022	1980-2020	Caribbean	Physical risk and GDP
Cevik, S. and Miryugin, F.	2022	1997-2019	Global	Physical risk and access to debt finance
Collender, S. et al.	2022	1999-2020	Global	Transition risk and sovereign bond spreads
Kazdin, J., Schwaiger, K., Wendt, V-S. and Ang, A.	2021	2010-2020	US	Emissions and excess return
Pankratz, N.M.C., Bauer, R. and Derwall, J.	2019	1995-2019	Global	Physical risks and revenue/ income

4. Are investors pricing climate risks efficiently?

It is safe to say from the literature that while many investors are beginning to price climate risks, prediction is an inherently imperfect activity, as noted by many original thinkers from Niels Bohr to Yogi Berra.

Pricing climate risks adds extra dimensions to the difficulty of financial forecasting. Our ability to price risks depends on understanding the Earth's climate systems and how they affect dynamics like the weather and sea levels. It also involves calculating how people and economic systems will respond to climate risks, for which history offers very little insight. Moreover, it is certain that our climate future will be significantly different than our past, which removes a key part of the scaffolding on which we build any future prediction.

There are other challenges too. One recent paper notes that there are three major challenges in pricing climate risks: first, our limited ability to use traditional risk-sharing and hedging instruments to mediate risks; second, uncertainty about climate risks themselves and the policies adopted to deal with the climate emergency; and third, the limited

Our ability to price risks depends on understanding the Earth's climate systems and how they affect dynamics like the weather and sea levels.

information available to investors.[26] Moreover, some of the assumptions made in modelling damages are highly questionable as well, with too little attention to outcomes that would qualify as 'extreme', or in the tails of a standard distribution.[27] These difficulties lead many experts to believe that investors are widely underestimating the potential or likely damages of climate change.

That said, we do have some insight. Fitch Ratings announced in 2023 that almost one-fifth of global companies might see downgraded ratings by 2035 depending on their vulnerability to transition risks.[28] Moreover, climate's impact on debt markets can also be economy-wide. Between 1997 and 2019, non-financial firms that were more vulnerable to climate risks (both transition and physical) faced difficulties in accessing debt markets even at higher interest rates.[29] But there is also upside: while countries' more stringent climate and energy policies lower capital flows into fossil fuel producers, they also lower capital costs for renewables companies.[30]

We also know that lower-emissions firms have been outperforming for some time. Critics of the SEC rule have often cited financial performance figures from 2021 and 2022, when the energy sector outperformed, yet the energy sector has been the worst performer of any sector in the S&P 500 Index over the last 10 years.[31] Within the G7 nations, companies with lower-emissions have provided better returns for their investors than high-emissions companies over much of the past decade.[32]

Even among high emitters, better management of transition risk can be a plus. Low-carbon transition strategies also provided better returns for companies in the energy sector, compared with fossil fuel companies with weaker transition strategies or none at all.[33] Among utilities, cleaner power generation provided 54% higher returns compared with peers with the highest carbon emissions over the past four years.[34]

Climate impacts and materiality also show up in mergers and acquisitions (M&A). Starting with the premise that M&A activity is generally motivated more by the possibility of generating premiums than by avoiding risk, a recent study found that better performance in reducing emissions was associated with greater initiation of M&A deals; the same was true of higher spending on environmental research and development (R&D). Moreover, that R&D also has a "sustainable and gradual growth effect", signalling that markets and companies regard the low-carbon transition as a long-term value driver.[35] More evidence supporting that view comes from earnings calls, where information on exposures to climate change is used for pricing in options and equity markets.[36]

26 Eren, E. & Merten, F., et al, 2022: Pricing of climate risks in financial markets: a summary of the literature, Bank for International Settlements Papers No. 130
27 Nordhaus, W.D. & Moffatt, A., 2017: A Survey of Global Impacts of Climate Change: Replication, Survey Methods, and a Statistical Analysis, National Bureau of Economic Research Working Paper 23646
28 Fitch Ratings, 2023: Corporate Climate Vulnerability Scores Overview: Climate Vulnerability Scores Calculated for All Rated Non-Financial Corporates
29 Cevik, S. & Miryugin, F., 2022: Rogue Waves: Climate Change and Firm Performance, IMF Working Papers
30 Zhou, X. & Caldecott, B., et al, 2023: An Empirical Analysis of Climate and Environmental Policy Risk, the Cost of Debt and Financial Institutions' Risk Preferences
31 Lazy Portfolio ETF, as of 31 August 2023: S&P 500 Sector Returns
32 Bauer, M., Huber, D., et al, 2023: Where is the Carbon Premium? Global Performance of Green and Brown Stocks, CESifo Working Paper no. 10246
33 Wang, X. & Panagiotopoulos, A., 2023: Did Low-Carbon-Transition Strategies Differentiate Energy Companies? MSCI
34 Stevenson, A.J., 2023: Cleanest Utilities a Boon to Investors, Bloomberg
35 Lin, Z & Shi, S., 2023: Acquire or Not? Does Corporate Carbon Performance Matter?
36 Sautner, Z. & van Lent, L., et al, 2023: Firm-level Climate Change Exposure, European Corporate Governance Institute – Finance Working Paper No. 686/2020, TRR 266 Accounting for Transparency Working Paper No. 33

Summary

Political rhetoric about climate change can be deceptive. At the moment, there is widespread agreement that the SEC will be sued if it issues a new rule requiring greater disclosure of climate-related risks on the grounds that sustainability considerations are not financially relevant. For investors, however, climate change is clearly relevant. Ignoring it is not an option: its financial impacts are already apparent, and will only grow.

Climate change creates a wide range of adaptation, physical and transition risks, and these can have material impacts on companies, investors, financial institutions and entire economies. Those risks will only increase unless and until we stem GHG emissions (turn off the tap) and then begin to reduce GHG levels in the atmosphere (drain the tub). We know how to reduce emissions and, while it will cost trillions of dollars over the next few decades, it will cost even more, financially and in lives, if we do nothing.

We can choose to make those expenditures with plans and foresight, or we can choose to do it chaotically and retroactively by responding to disaster after disaster. Doing so with foresight, however, requires information, and the world's financial authorities are now taking steps to require greater reporting of climate-related risks and vulnerabilities. It's not a moment too soon.

Important information

This material is being provided for informational purposes only. The material is not intended for use by persons in jurisdictions which prohibit or restrict the distribution of the material and in certain countries, the material is provided upon specific request. Under no circumstances should the material, in whole or in part, be copied or redistributed without consent from Impax. The material does not constitute a distribution, an offer, an invitation, recommendation or solicitation to sell or buy any securities in any jurisdiction.

Impax Asset Management Group plc includes Impax Asset Management Ltd, Impax Asset Management (AIFM) Ltd., Impax Asset Management Ireland Ltd, Impax Asset Management LLC, and Impax Asset Management (Hong Kong) Limited (together, "Impax").

Impax Asset Management Ltd, Impax Asset Management (AIFM) Ltd and Impax Asset Management LLC are registered as investment advisers with the U.S. Securities and Exchange Commission ("SEC"), pursuant the Investment Advisers Act of 1940 ("Advisers Act"). Registration with the SEC does not imply a certain level of skill or training.

Impax Asset Management Ltd & Impax Asset Management (AIFM) are authorized and regulated by the Financial Conduct Authority. Impax Asset Management Ireland Ltd is authorized and regulated by the Central Bank of Ireland

(Reference No: C186651).

The statements and opinions expressed are those of the author, as of the date provided, and may not reflect current views. While the author has used reasonable efforts to obtain information from reliable sources, we make no representations or warranties as to the accuracy, reliability or completeness of third-party information presented herein. Any forward-looking statements or forecasts are based on assumptions and actual results are expected to vary. References to specific securities are for illustrative purposes only and should not be considered as a recommendation to buy or sell. This material may not be relied upon as constituting any form of investment advice and prospective investors are advised to ensure that they obtain appropriate independent professional advice before making any investment decision.

Australia – This Document is being made available by Impax Asset Management Limited. Impax Asset Management Limited is exempt from the requirement to hold an Australian financial services license in respect of the financial services it provides to wholesale investors in Australia and is regulated by the Financial Conduct Authority of the United Kingdom under the laws of the United Kingdom which differ from Australian laws. This document is only to be made available to 'wholesale investors' under the Corporations Act 2001 (Cth) receiving this document in Australia. Impax Asset Management Limited is exempt from the requirement to hold an Australian financial services license by operation of ASIC Class Order 03/1099: UK FCA regulated financial service providers, as modified by ASIC Corporations (Repeal and Transitional) Instrument 2016/396

Canada – The Document is being provided by Impax Asset Management Limited. This entity is not registered as an adviser in Canada and would provide any investment advice to you pursuant either to the terms of the "international adviser exemption" from registration or the "international sub-adviser exemption" from registration in the applicable jurisdiction(s) of Canada. Disclosure about such entity's non-resident and unregistered status in Canada will be provided at the time of onboarding.

EEA – The Paper is only being made available to and is only directed at persons in member states of the European Economic Area (the "EEA") who are professionals, defined as Eligible Counterparties, or Professional Clients, as defined by the applicable jurisdiction. Under no circumstances should any information contained in this Paper be regarded as an offer or solicitation to deal in investments in any jurisdiction.

Israel – No licence with the ISA. Neither Impax Asset Management Limited nor Impax Asset Management (AIFM) Limited ("**Impax**") have not been licenced by the Israel Securities Authority ("**ISA**") under the Israeli Regulation of Investment Advice, Investment Marketing and Portfolio Management Law, 5755-1995 (the "**Investment Advice Law**"). As such, Impax does not hold any insurance in Israel as generally prescribed by the ISA for Israeli-licenced entities.

UK – The Paper is only being made available to and is only directed at persons in the United Kingdom who are professionals, defined as Eligible Counterparties, or Professional Clients, within the meaning of the rules of the Financial Conduct Authority. Under no circumstances should any information contained in this Paper be regarded as an offer or solicitation to deal in investments in any jurisdiction.

Past performance does not guarantee future results.

Nothing presented herein is intended to constitute investment advice and no investment decision should be made solely based on this information. Nothing presented should be construed as a recommendation to purchase or sell a particular type of security or follow any investment technique or strategy. Information presented herein reflects Impax Asset Management's views at a particular time. Such views are subject to change at any point and Impax Asset Management shall not be obligated to provide any notice. Any forward-looking statements or forecasts are based on assumptions and actual results are expected to vary. While Impax Asset Management has used reasonable efforts to obtain information from reliable sources, we make no representations or warranties as to the accuracy, reliability or completeness of third-party information presented herein. No guarantee of investment performance is being provided and no inference to the contrary should be made.

Climate change: the impact for investors

IMPAX ASSET MANAGEMENT

clientservices@impaxam.com

Impax Asset Management

impaxam.com

241LDNH/r (10/24)