# Taming unsustainable finance: the perils of modern risk management

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## 1. Introduction

Orthodox financial market analysis regards the financial system as a composition of institutions and markets, whose fundamental function is to transfer funds between agents for investment and consumption. Financial capital is provided by investors to intermediaries, and allocated to projects based upon expected risk-adjusted future returns. At the heart of the intermediary model lies the agency problem arising from the separation of funds from capital providers to capital allocators. Capital providers have lower levels of information, infrastructural support and investment expertise than allocators. The methods traditionally relied upon to address this asymmetry are to require disclosure and heightened transparency in investment chains, and mandating or encouraging the use of gatekeepers, giving providers the necessary and assured information on which to base their choices of intermediary. Legal norms have evolved to reduce the prospect of allocators engaging in conflicts of interest. Soft laws have also developed to provide best-practice recommendations and governance principles. Mono-dimensionally, this improves allocative efficiency as intermediaries cater to the rational preferences of fund providers, whilst insulating financial institutions from accusations that providers' funds are being misallocated.

Identifying such information and governance failures and how they might be avoided has been one of the cornerstones of corporate and financial law scholarship.[1] As a result, the impact of financial markets upon corporate sustainability is usually discussed in these terms. In this chapter, we argue that this approach insofar as it is applied to financial markets and sustainability is likely to prove deficient; instead, the time is right to explore new ways of thinking about the challenges posed by these 'weak forms' of sustainability, which continue to emphasise maximisation of financial performance and the supposed necessity of improving flows of information to better manage risk. We focus on the challenges posed to risk management from anthropogenic-led climate change, although

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[1] R. La Porta, F. Lopez-de-Silanes, A. Shleifer and R. Vishny 'Investor Protection and Corporate Governance' (2000) 58 *Journal of Financial Economics*, 3.

broader lessons in relation to the other eight, currently identified, planetary boundaries – as well as the social dimensions of unsustainable finance – may be drawn from the analysis.[2]

Our thesis is underpinned by two contentions. First, we posit that the conventional microeconomics based trust placed in regulatory techniques such as disclosure and transparency in financial markets – designed to reduce information asymmetry – is unlikely to deliver sustainability in substantive form because of the institutional structure of financial intermediaries, which is characterised by a compounded agency problem. This refers in particular to the separation of ultimate beneficiaries of capital pools from decision-making in allocation of that capital. In the absence of a revolutionary shift in equity holding structures, to reduce the prevalence of the intermediary function, efforts to 'green' decision-making in financial markets are likely to fail. Second, we argue that both capital providers and allocators make a category error when they rely on axioms from the modern risk management paradigm to quantify the financial risks to their asset portfolios from crossing planetary boundaries. Such a category error arises from the flawed assumption that risks of these types can be modelled accurately, when strong evidence suggests that such risks are so indeterminate that they may overwhelm standard risk management tools.

Accordingly, we argue that, due to the aforementioned factors, the financial system will always fail to fully internalise externalities, either because of its institutional structure, or because it lacks the capacity to do so. This analysis leads us to consider in Section 4 direct regulatory intervention, in particular designed to focus on the *sources* of finance for much of these investments. We discuss three policy prescriptions, namely: raising the capital requirements on assets with so-called 'brown' credentials; re-calibration of bank stress tests to reflect the uncertain financial implications of climate damage; and pivoting bank bond buying programmes toward green financial assets, where feasible. We argue that such interventions would act as supply-side brakes on the flow of finance to climate-damaging activities, making such ventures more costly to fund, whilst boosting the attractiveness of green projects to investors. Such recommendations have considerable promise to address directly the primary investment channels through which activities contributing to climate change are financed, while sidestepping some of the compounded agency problems we identify.

[2] See B. Sjåfjell and C. Bruner, 'Corporations and Sustainability', Ch. 1 in this volume.

## 2. Finance as usual

### *2.1. The state of play*

'Green markets' have experienced impressive growth in recent years: the green bond market, for example, has grown from effectively zero issuance in 2008 to total approximately US$100 billion in 2017, with the European Union (EU) and China leading the way.[3] According to the OECD, the global green bond market might reach US$700 billion in annual issuance in four markets by 2030 (China, Japan, the EU, and the USA).[4] The EU has been especially active in promoting the development of financial markets and instruments to encourage green technologies. The Capital Markets Union project has provided a platform for the leveraging of new financial instruments, including asset-backed securities (ABS)[5] and new green mortgage criteria.[6] Indicatively, global annual issuance of green ABS could reach up to US$380 billion per annum by 2035, for renewable energy, energy efficiency and low emission automobiles.[7]

Yet, investment in transitioning to a lower-carbon economy in line with international commitments remains too slow to avoid a continuance of negative effects from an altered environment. Even the EU – viewed as a global leader in tackling climate change – has conceded that it is not on track to meet its required €11.2 trillion 2030 energy policy targets. The current annual deficit is approximately €180 billion, or €1.8 trillion between 2021 and 2030.[8] Moreover, as we argue in this chapter, relying on private market mechanisms to determine efficient capital allocation vis-à-vis sustainable finance, fails to fully reflect the risks that unsustainable investments pose. Put simply, it relegates the role of financial markets and institutions to that of an epistemic system designed simply to facilitate investment in the most 'efficient' manner possible. This can be seen from the manner in which the case for sustainable investment is often made. In most instances, the market case for investing in sustainable ventures is made based upon two very narrow criteria: (i) that portfolios comprised of sustainable businesses generally offer superior (or at least comparable) returns to those containing

[3] Climate Bonds Initiative, Green Bonds Market Summary: Q3 2017, climatebonds.net/resources/reports/green-bonds-market-summary-q3-2017-0. See S. Park 'Green bonds and beyond: debt financing as a sustainability driver', Ch. 42 in this volume.
[4] G20, Green Finance Synthesis Report, 5 September 2016.
[5] European Commission, Proposal for a Regulation of The European Parliament and of The Council laying down common rules on securitisation and creating a European framework for simple, transparent and standardised securitisation, Brussels, 30.9.2015 COM(2015) 472 final 2015/0226 (COD).
[6] European Commission and DG Climate Action, Shifting Private Finance Toward Climate-Friendly Investments, March 2015.
[7] OECD, Green bonds: Mobilising the debt capital markets for a low-carbon transition, December 2015.
[8] European Commission, Sustainable finance: Commission's Action Plan for a greener and cleaner economy, Brussels, 8 March 2018.

less sustainable investments[9]; and (ii) that investing in such businesses earns a 'sustainability premium' from the market, in the form of reputational enhancements and other such soft measures of desirability.[10]

### *2.2. Weak sustainability, agency and their problematics*

The 'constructive ambiguity'[11] of sustainability makes the concept flexible, as it can be translated into a range of actions adapted to the needs and possibilities of a diverse set of stakeholders. This ambiguity can be seen in the discussion regarding *weak* versus *strong* sustainability.[12] Weak sustainability builds on business as usual, a strong belief in technological solutions for environmental problems and the shortage of raw materials, as technological progress is assumed to continually generate technical solutions to the environmental problems caused by the increased production of goods and services.[13] It relies mostly on reporting and transparency, which comprise key planks of modern risk management and investor governance.[14] It also tacitly assumes that environmental costs and liabilities can be allocated amongst market actors, based upon existing environmental laws, private contracts, and court judgments.

If we take corporate governance as an example: such law and regulation is to an extent based on relationships between the shareholders as investors and the firm and the corporate board collecting and managing these investments for the firm's benefit. In the era of dispersed ownership, most types of equity investors, marginal traders and institutional investors are represented by a group of agents that can be called 'money managers'.[15] Research demonstrates, for example, that in many jurisdictions, including European markets, fund managers control large swathes of equity markets. In the UK, fund managers control over one-third of the market.[16] Managers and board members of firms accordingly transact with largely anonymous shareholders, represented by these money managers; these managers buy and sell securities frequently, focusing on quarterly results to keep management

[9] See Morgan Stanley, Sustainable Reality: Understanding the Performance of Sustainable Investment Strategies, Institute for Sustainable Investing, March 2015.
[10] T. Whelan and C. Fink 'The Comprehensive Business Case for Sustainability' (1986) *Harvard Business Review*, 21 October 2016, hbr.org/2016/10/the-comprehensive-business-case-for-sustainability.
[11] J. Robinson, 'Squaring the circle? Some thoughts on the idea of sustainable development' (2004) 48 *Ecological Economics*, 369, 374.
[12] E. Neumayer, *Weak Versus Strong Sustainability: Exploring the Limits of Two Opposing Paradigms* (Cheltenham: Edward Elgar Publishing, 2003).
[13] P. Ekins, S. Simon, L. Deutsch, C. Folke and R. De Groot, 'A framework for the practical application of the concepts of critical natural capital and strong sustainability' (2003) 44 *Ecological Economics*, 165.
[14] N. Roome, 'Looking Back, Thinking Forward: Distinguishing Between Weak and Strong Sustainability' in P. Bansal and A.J. Hoffman (eds.), *The Oxford Handbook of Business and the Natural Environment* (Oxford: Oxford University Press, 2011).
[15] H.P. Minsky, 'Money Manager Capitalism' (1989), Hyman P. Minsky Archive, Paper 13.
[16] Investment Association, Asset Management in the UK 2016-17, September 2017.

sharp and exerting pressure to keep the companies concerned growing. The investment supply chains are long and complex, with numerous intermediaries standing between the ultimate beneficiary and the company, with investors willing to trade out of securities rapidly and in volume.[17]

There is strong evidence that notwithstanding their remoteness from investment decisions, most capital providers would prefer their funds not to exploit their fellow citizens or the planet in an unsustainable way.[18] Yet, in many cases these investors are 'forced capitalists',[19] for instance employees bound to invest through an employer-provided pension plan. For the majority of such investors, the mechanisms available either for divestment or voice are extremely limited. In this environment, investments are themselves short-sighted; although some institutional investors such as pension funds *may* have longer-term investment horizons (although this does not always prevent rapid turnover of equity holdings), their investment preferences are counterbalanced by larger money managers such as mutual funds, whose investment patterns are much more short-term. In the USA for example, the shareholder base of public companies turned over almost completely on an annual basis in the early 2010s.[20] Institutional investors – the large majority of whom engage in short-term trading (defined as holding periods of less than one year) – collectively held 50.4 per cent of the outstanding shares in US listed companies in 2015;[21] in 2012, they held about 70 per cent of value of the US stock markets.[22] At the same time, blockholdings have increased: the percentage of all US listed firms with at least one institutional shareholder owning 10 per cent or more of the shares was 11.9 per cent in 1980; 19.5 per cent in 1995; and 32 per cent in 2015.[23]

Due to these developments, investors switch plans much more frequently, introducing substantial volatility, which forces asset managers to compete for funds based on short-term performance. It is therefore unsurprising that the average holding period for institutional investors is very short; in the

[17] OECD, *G20/OECD Principles of Corporate Governance*, (Paris: OECD Publishing, 2015), p. 29.
[18] A survey of 7,000 respondents in 22 countries by Natixis Global Asset Management in 2017 found that social and environmental objectives are an important factor for around 70% of retail investors, referred to in EU High-Level Group on Sustainable Finance, Financing a Sustainable European Economy: Final Report, January 2018, p. 27 fn. 12.
[19] L.E. Strine, Jr., 'Toward Common Sense and Common Ground? Reflections on the Shared Interests of Managers and Labor in A More Rational System of Corporate Governance' (2007) 33 *Journal of Corporation Law*, 1, 4.
[20] L.E. Strine, Jr., 'One Fundamental Corporate Governance Question We Face: Can Corporations Be Managed for the Long Term Unless Their Powerful Electorates Also Act and Think Long Term?' (2010) 66 *Business Lawyer*, 1, 17.
[21] K.M. Kahle and R.M. Stulz, 'Is the US Public Corporation in Trouble?' (2017) 31 *Journal of Economic Perspectives*, 67, 81.
[22] M.E. Blume and D.B. Keim, 'Institutional Investors and Stock Market Liquidity: Trends and Relationships', Working Paper, Wharton School, University of Pennsylvania (Aug. 21, 2012); D. Millon, 'Shareholder Social Responsibility' (2013) 36 *Seattle University Law Review*, 911, 913.
[23] Kahle and Stulz, 'Is the US Public Corporation in Trouble?', 81.

United States it is a mere eight months[24], whilst average equity portfolio turnover amongst investors in Europe and the USA is 65 per cent higher than expected levels.[25] The market pressures resulting from institutions' short-term time horizon and fiduciary obligations,[26] and greater capacity to enforce more shareholder-centric corporate management, has led Millon to distinguish between the 'traditional' shareholder primacy model, preserving a high degree of board discretion to focus on the long-term and to temper profit maximisation, and a 'radical' shareholder primacy model focusing on quarterly earnings and styling the board as an 'agent' of the *shareholders* (economically, if not legally).[27]

In the context of climate change, Mark Carney characterises such conflicting interests as the 'tragedy of the horizon',[28] the risks from which 'fall beyond the traditional horizons of most actors – imposing a cost on future generations that the current generation has no direct incentive to fix.'[29] The rise of passive index investing threatens to further undermine this investment model: when capital providers invest in the entire equity market, or a subsection of it (either through exchange-traded funds or index trackers), return-chasing over the short-term is likely to lead to mono-dimensionality in portfolio allocation, with money managers allocating capital to corporations that offer likely superior short-term returns.[30] These factors overwhelm considerations of sustainability because money managers may come to disregard environmental, social and governance (ESG) investment principles. For example, as of 2016, less than one per cent of the capital of the fifteen largest US pension funds is devoted to ESG-specific investment, despite each being signatories to the UN Principles for Responsible Investment, and (supposedly) interested in long-term performance.[31] In such circumstances, the tools of weak sustainability – disclosure, transparency and the like – become largely redundant.

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[24] M.W. Roberge, J.C. Flaherty, Jr., R.M. Almeida, Jr. and A.C. Boyd, 'Lengthening the Investment Time Horizon', MFS White Paper Series, July 2017.

[25] IRRC Institute and Mercer, 'Investment Horizons' (2015), irrcinstitute.org/wpcontent/uploads/2015/09/IRRCMercerInvestmentHorizonsReport_Feb20101.pdf.

[26] For instance, for pension funds' need of cash to satisfy the holders of defined pension plans and fiduciary obligations to them, see Millon, 'Shareholder Social Responsibility', 930-1, 938-9.

[27] C.M. Bruner, 'Center-Left Politics and Corporate Governance: What Is the 'Progressive' Agenda?' (2018) *Brigham Young University Law Review* 267.

[28] M. Carney, 'Breaking the Tragedy of the Horizon – Climate Change and Financial Stability', speech at Lloyd's of London, 29 September 2015.

[29] Carney, 'Breaking the Tragedy', 3.

[30] The rise of passive investing may be overstated. According to BlackRock, the world's largest passive fund manager, as of 2017, less than 18 percent of global stocks were owned by passive investors. According to the data, there are $22 dollars traded by active stockpickers for every $1 traded by index funds. See BlackRock, Index Investing Supports Vibrant Capital Markets, October 2017.

[31] J. Bailey, B. Klempner and J. Zoffer, 'Sustaining Sustainability: What Institutional Investors Should Do Next on ESG', McKinsey & Company (2016), available at: mckinsey.com/industries/private-equity-and-principal-investors/our-insights/sustaining-sustainability-what-institutional-investors-should-do-next-on-esg.

## 3. The financial system as an agent of change

### *3.1 (In)efficient markets and 'green' investment*

As we have discussed, the financial system may be viewed as an aggregation of money managers investing on behalf of their principals. These capital providers are assumed to have the capacity to delegate their capital to those managers who best match their preferences. Shareholders can invest in firms best matching their own preferences for sector, activity, and risk; fund beneficiaries can choose to invest in investment funds according to the goals and risk appetites of the funds in question; and so on. The role of law in these instances is to provide rules and governance norms to regulate the agency relationship, chiefly to prevent the interests of managers from conflicting with those of providers, but also to ensure that the decisions of those managers are sufficiently transparent, the information providers receive is corroborated, and providers are given sufficient opportunities to move their investments if they so wish. With a few notable exceptions to be discussed further below, such legislative requirements and regulatory guidance are symptomatic of the approach taken to all investment risk.

Such information exchange forms a theoretical foundation of efficient market theory (EMT),[32] which underpins much financial market regulation and, more significantly, shareholder value theory. An important element of EMT is the rational investor model, which posits that provided full information is disclosed, the predictions of agents will be correct on average over time. According to EMT and rational investor models, although the future is not fully predictable, agents' expectations are assumed neither to be systematically biased nor to lead to collective errors, with any deviations from this (perfect foresight) regarded as random. As a result, rational expectations do not differ systematically or predictably from equilibrium results. Absorbing this information results in a price that in theory provides not only an objective 'value' but also an important foundation for risk management and strategy.[33] As Eugene Fama has famously noted, a critical requirement for this price formation is that all 'important current information is almost freely available to all participants'.[34] But what does this mean in the context of financial market regulation?

[32] P. Samuelson,'Proof that Properly Anticipated Prices Fluctuate Randomly' (1965) 6 *Industrial Management Review*, 41.
[33] F.H. Easterbrook and D.R. Fischel, *The Economic Structure of Corporate Law* (Cambridge: Harvard University Press, 1991).
[34] E.F. Fama, 'Random Walks in Stock Market Prices' (1965) 21 *Financial Analysts Journal*, 55, 56.

The logical response proffered is to demand ever-higher levels of disclosure and increased information flows to investors. In the context of green finance, to be sure, scaling up such markets requires a more transparent and information-rich market. Investors, for example, must have sufficient information to judge whether or not a particular investment satisfies a specific definition of 'greenness'; there are problems with the process of identifying which assets might be justifiably categorised as 'green' for sale as bonds or other financial instruments.[35] Investors need information to adequately assess the suitability of particular investments and the lack of uniformity in international standard-setting may act as a brake on further development of the market.

So regulators demand that corporations and financial institutions reduce asymmetries by making disclosures about their climate exposures, trusting the market to do the rest. On this basis, the Securities and Exchange Commission in the USA has issued guidance as to the application of existing disclosure requirements in relation to climate change.[36] In the UK, many companies are required to disclose certain non-financial information, often relating to the impact of corporate activities on the environment and the risks environmental change may pose to the relevant company.[37] This work has been buttressed by the Financial Stability Board Task-Force on Climate-Related Financial Disclosures (TCFD).[38] In the EU, the Non-financial Reporting Directive requires disclosure relating to as a 'minimum, environmental, social and employee matters, respect for human rights, anti-corruption and bribery matters.'[39] More concretely, the EU's March 2018 Action Plan on sustainable finance and the first EU Commission proposals envisage a unified EU classification system of sustainable economic activities and green financial products; improved disclosure requirements on how institutional investors integrate ESG factors in their risk processes; and a new category of benchmarks to help investors compare the carbon footprint of their investments.[40] A cursory review of each reveals the importance placed on the disclosure and transparency paradigms.

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[35] T. Ehlers and F. Packer, 'Green Bonds – certification, shades of green and environmental risks', Bank for International Settlements, 24 August 2016.

[36] Securities and Exchange Commission, Commission Guidance Regarding Disclosure Related to Climate Change, 75 Fed. Reg 6290 (8th February 2010). See D.Brakman Reiser, 'Progress is possible: sustainability in US corporate law and governance', Ch. 10 in this volume.

[37] See Large and Medium-sized Companies and Groups (Accounts and Reports) Regulations 2008, Schedule 7, Part 7 as amended by The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, SI 2013 No 1970. See A. Johnston, 'Market-led sustainability through information disclosure: the UK approach', Ch. 15 in this volume.

[38] Financial Stability Board, Recommendations of the Task Force on Climate-related Financial Disclosures, Final Report, June 2017.

[39] EU Directive 2014/95/EU regarding disclosure of nonfinancial and diversity information by certain large companies and groups. See I. Chiu, 'Disclosure regulation and sustainability: legislation and governance implications', Ch. 37 in this volume.

[40] European Commission, Communication From The Commission To The European Parliament, The European Council, The Council, The European Central Bank, The European Economic and Social Committee and The

*3.2 Weak sustainability: the limits of information disclosure and transparency*

The 'business as usual' approach to corporate and financial governance – the weak sustainability mantra – is exemplified in these recommendations and plans. Indeed, none has introduced any substantive or binding regulation concerning sustainable finance, instead ceding the impetus for the expansion of 'green' markets to private capital. Information management and disclosure, as well as product standardisation are prevalent amongst private, market-led management of investment risk. In this spirit, Carney recently noted that '[f]inancial markets have the potential to improve our prospects for tackling climate change, but only if we make climate risks and opportunities *more transparent*.'[41]

The limitations of this view of investment at the macro-scale in relation to problems of extreme complexity such as climate change ought to be obvious. Whilst disclosure and transparency are necessary in attempting to address such problems, they are not sufficient to do so. There have been notable attacks on the notion of investor rationality, which question the foundations of the rational investor model and EMT; indeed, the entire discipline of behavioural finance is built upon the flaws of such models.[42] Such research reveals that investors are merely 'boundedly-rational' agents who make frequent cognitive errors thanks to 'limited computational skills and seriously flawed memories.'[43] These flaws may result in severe and systematic errors, especially in the face of complexity or pressures for short-term returns, which are omnipresent in financial markets.[44]

More significantly in the context of the challenge of climate change, the levels of uncertainty concerning the probabilities and scale of damages stemming from climate shifts are extremely deep, both structurally in terms of climate science and in terms of tractability, because evaluations of

Committee of The Regions, Action Plan: Financing Sustainable Growth, Brussels, 8.3.2018 COM(2018) 97 final; European Commission, Proposal for a Regulation of the European Parliament and of the Council on the establishment of a framework to facilitate sustainable investment, Brussels 24.5.2018 COM(2018) 353 final; European Commission, Proposal for a Regulation of the European Parliament and of the Council on disclosures relating to sustainable investments and sustainability risks and amending Directive (EU) 2016/2341, Brussels 24.5.2018 COM(2018) 354 final, European Commission, Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 2016/1011 on low carbon benchmarks and positive carbon impact benchmarks, Brussels 24.5.2018 COM(2018) 354 final.

[41] M. Carney, 'Better market information can help combat climate change' *Financial Times*, 28 June 2017 [emphasis added].

[42] N. Barberis and R. Thaler, 'A Survey of Behavioral Finance' in G.M. Constantinides, M. Harris and R.M. Stulz, *Handbook of the Economics of Finance* Vol. 1A, (North Holland: Elsevier 2003) p. 1063.

[43] C. Jolls, C.R. Sunstein and R. Thaler, 'A Behavioral Approach to Law and Economics' (1998) 50 *Stanford Law Review*, 1471, 1477.

[44] E. Avgouleas and J. Cullen, 'Market Discipline and EU Corporate Governance Reform in the Banking Sector: Merits, Fallacies, and Cognitive Boundaries' (2014) 41 *Journal of Law and Society*, 28.

potential economic damage from changes to planetary temperatures are so speculative.[45] The pressures placed on the market to correctly interpret the potential damages inflicted on the economy from climate change are enormous, in the main because the requisite information does not exist in an interpretable form. Even if one could aggregate all data, there is no consensus on the probabilities of warming upon which to base any serious policy prescription. Whilst the TCFD for example encourages financial institutions to engage in scenario analysis for risk management purposes, its most extreme scenario contemplates just 2°C warming by the end of this century.[46] Yet, the World Bank estimates that even under a 'medium business-as-usual pathway' there is a 40 per cent chance of at least 4°C warming by 2100.[47]

This undermines a key tenet of risk management implied by EMT: that financial markets will arrive at a complete set of contracts for all predictable future states by correctly estimating all probabilities of all future events. Market forces are expected to create optimal corporate contracts; if the contracts were not optimal, rational agents would renegotiate them until they were. By implication, there are no states for which no contract is traded. According to this view, instead of providing legal rules to govern corporate exchange, the law ought simply to '[complete] open-ended contracts'[48] and rely on market discipline to regulate conduct and governance.

Yet, the market cannot fully price such contracts when the data are unavailable and subject to such levels of uncertainty.[49] In such circumstances, increased information concerning risks for which we have no reliable probability estimates will not necessarily produce efficient capital allocation. Such observations call into question the central principles of tools used in modern risk management - in particular, cost-benefit analysis (CBA) and Value-at-Risk (VaR). Loosely, these techniques rely on the

[45] M.L. Weitzman, 'On Modeling and Interpreting the Economics of Catastrophic Climate Change' (2009) 91 *Review of Economics and Statistics*, 1, 1.

[46] The TCFD comments: 'In finalizing its recommendations and guidance, the Task Force clarified organizations should describe how resilient their strategies are to climate-related risks and opportunities, taking into consideration a transition to a lower-carbon economy consistent with a 2°C or lower scenario and, where relevant, scenarios consistent with more extreme physical risks.' The TCFD further recommends that only '2°C or lower scenario[s]' are made publicly available. See TCFD p. 35.

[47] As an example of this uncertainty, the IPCC in 2001 argued that global temperatures might rise anywhere between 1.4°C and 5.8°C by 2100. Indeed it has been shown that several of the IPCC's predictions made between 2000 and 2013 for global temperature rises drastically underestimated the probability of eventual temperature rises. For example, climate models projecting greater amounts of warming this century are the ones that best align with observations of the current climate. Such findings suggest that IPCC models remain likely to underestimate future warming. See P.T. Brown and K. Caldeira, 'Greater future global warming inferred from Earth's recent energy budget' (2017) 552 *Nature*, 45. See also World Bank Group, Turn Down the Heat: Confronting the New Climate Normal, 2014.

[48] Easterbrook and Fischel, *The Economic Structure*, p. 35.

[49] Such uncertainty is often termed 'Knightian', which denotes outcomes (be they known, unknown or disputed), for which probability statements cannot be made, because the data are too ambiguous. See F.H. Knight, *Risk, Uncertainty, and Profit* (Cambridge: Riverside Press, 1921).

combination of information disclosure and sophisticated financial risk modelling to produce probability estimates of the costs of losses from various scenarios. However, in the case of CBA, prevailing discounting methodologies often produce perverse results with respect to environmental damages, including from climate change. Discount rates are used to provide net values of present investments, the value of which represents the current worth of a future cash flow or sum of money given a specified rate of return. By its nature, climate change mitigation combines very high up-front costs with an extended period of small benefits which may continue for centuries. When discounted at standard rates, the net present value of such mitigants vanishes.[50] Whilst approaches to climate and environmental degradation have become much more sophisticated in environmental economics,[51] money managers continue to display preferences for discount rates which imply lower impacts on immediate values, even when this results in ignorance of potential for catastrophic losses further in the future.[52]

In tandem, techniques such as VaR are often inappropriate tools for engaging with hyper-complex issues such as setting climate policy or calculating financial exposures to climate change.[53] The compounded effects of events in a non-linear system such as the global climate, in which small changes in one part of the system may lead to large, unpredictable effects in another, mean that environmental damages may be severely underestimated.[54] Rather than following a normal distribution, these risks are heavy- or fat-tailed, meaning that the risks of extreme downsides from large temperature changes are non-negligible.[55] At such levels (in the tails), economic damage becomes severe: Dietz and Stern for example estimate that under such a 4°C warming scenario, annual GDP will be 50 percent lower compared to a scenario where no warming occurs.[56]

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[50] F. Ackerman and I.J. Finlayson, 'The Economics of inaction on climate change: a sensitivity analysis' (2006) 6 *Climate Policy*, 509.

[51] According to the Economist Intelligence Unit (EIU): 'A]s climate change is also a systemic problem, with issues of wider societal concern, it is often appropriate to apply a lower discount rate, consistent with public-sector actors that have longer time horizons than individuals. When the expected losses are considered from the point of view of a government… they rise dramatically. From the public-sector perspective, the expected value of a future with 6°C of warming represents present value losses worth US$43trn—30% of the entire stock of manageable assets.' See EIU, The cost of inaction: Recognising the value at risk from climate change, 2015, p. 2.

[52] D. Barton, 'Refocusing capitalism on the long term: ownership and trust across the investment value chain' (2017) 33 *Oxford Review of Economic Policy*, 188.

[53] C.A. Azar and K. Lindgren, 'Catastrophic Events and Stochastic Cost-benefit Analysis of Climate Change' (2003) 56 *Climatic Change*, 245.

[54] S.H. Schneider, 'Abrupt non-linear climate change, irreversibility and surprise' (2004) 14 *Global Environmental Change*, 245.

[55] N.N. Taleb, Y. Bar-Yam, R. Douady, J. Norman and R. Read, 'The Precautionary Principle: Fragility and Black Swans from Policy Actions', NYU Extreme Risk Initiative Working Paper, 24 July 2014.

[56] S. Dietz and N. Stern, 'Endogenous growth, convexity of damage and climate risk: how Nordhaus' framework supports deep cuts in carbon emissions' (2015) 125 *The Economic Journal*, 574.

The limitations of such modelling exercises have of course been well-demonstrated in financial markets over the previous decade. Yet, the uncertainty relating to climate change risks is at least comparable to the risks to the financial system posed by structured securities in the prelude to the financial crisis. Based on this complexity and as explained by the tragedy of the horizon, the information disclosure paradigm lacks real utility; these challenges are not soluble through standard risk management. Moreover, even if such estimates could be made accurately, there is no mechanism with which investors and institutions may protect themselves from losses via hedging through countervailing policies, insurance or investment diversification to offset the risks involved to the value of their assets and future profitability. Estimates place the level of so-called 'unhedgeable risk' at around half of the total of potential impacts on financial asset values.[57] A symbol of the absurdity of hedging against such risks – and the short-termist approach to despoiling the planet in the name of corporate profit – is Elon Musk's declaratory ultimate hedge: to colonise Mars.[58]

## 4. What can be done?

For the reasons outlined above, relying upon the information disclosure paradigm to determine optimal policy in promoting sustainability is a conceptually flawed endeavour. To the extent that gaps and understanding about the range of probabilities governing the effects and risks of climate change persist, existing principles which supposedly govern both investor behaviour and financial market outcomes cannot be relied upon to the exclusion of strong-form sustainability reforms. In short, a 'command-and-control' approach is required to address private sector free-riding behaviour and mismatched resource allocation, in addition to market-led sustainable finance developments. This must include binding, mandatory public law and regulation. The need for such mechanisms becomes even more pressing considering the depth and scale of the risks posed by climate change and other ongoing transgressions of planetary boundaries.

In the context of the financial system, there are existing foundations that may be built upon to tackle such risks. For example, there are established stress-testing regimes already in place that (whilst imperfect) have become established elements of financial regulatory architecture. Similarly, in the case of bank capital requirements and central bank monetary policies, high-level interventions to support (or disincentivise) particular forms of bank lending have already been enacted at the EU level.

[57] Cambridge Institute of Sustainability Leadership, Unhedgeable Risk: Stress Testing Sentiment in a Changing Climate, 2015.
[58] Michele Hanson, 'Elon Musk's Mars project is the ultimate symbol of our throwaway culture', *The Guardian,* 2 October 2017.

### *4.1. Stress-testing*

Banks in many jurisdictions currently undergo annual stress-testing. Such tests allow authorities to determine whether banks' capital and liquidity buffers are strong enough to resist seriously adverse conditions and, where necessary, to require institutions to build-up further strength. The reason for this is quite straightforward: stress-testing – if done properly – can prepare the financial system for common shocks that hit individual institutions simultaneously, thus reducing the fragility of the financial system. Because financial institutions cannot raise funds in circumstances where all are facing losses, stress-testing scenarios can prepare institutions for protracted periods of losses or seized-up funding markets. Yet this is not the only function of stress tests: they act principally as an ex ante front-stop tool to prevent the build-up of risks within the system. Because of this, stress-testing is arguably 'the most powerful prudential tool we have at our disposal for safeguarding the resilience of the financial system.'[59]

Mooted novel approaches to stress-testing in the context of carbon exposure emphasise the vulnerability of the financial system to so-called 'stranded assets.' Put simply, stranded assets are those assets owned or held by corporations or other business enterprises, which are currently unused, and are at potential risk of never being used, due for example to changing regulations, especially in relation to climate change. In joint research, the Carbon Tracker Initiative and Grantham Research Institute in 2013 showed using the example of stranded assets that at the prevailing capital expenditure of fossil fuel site and field development, at least $6.74 trillion would be wasted in developing reserves that are likely to become unburnable.[60] Another study estimates that financial system exposures to carbon-intensive sectors in the EU alone exceed €1 trillion, with potential losses of between €350 billion and €400 billion, even under an orderly unwind.[61]

Importantly, in the case of stress-testing for losses eventuating from climate risks – as opposed to regulatory shifts relating to carbon assets – no formal scenarios have yet been introduced.[62] Based on what we have discussed above, input stressors into such tests must progress *beyond* those posed by so-called 'transition risks' that currently dominate debates on environment-related stress-testing. As we have noted, the physical risks from climate change are both highly uncertain and fat-tailed;

[59] S.G. Cecchetti, 'On the Separation of Monetary and Prudential Policy: How much of the pre-crisis consensus remains?' CEPR Discussion Paper 10949, November 2015.
[60] Carbon Tracker Initiative and Grantham Research Institute, Unburnable Carbon 2013: Wasted capital and stranded assets, 2013.
[61] F. Weyzig, B. Kuepper, J.W. van Gelder and R. van Tilburg, 'The Price of Doing Too Little Too Late; the Impact of the Carbon Bubble on the European Financial System' Green New Deal Series No.11, 2014.
[62] See L. Hook, 'Central bank chiefs sound warning on climate change', *Financial Times*, 9 April 2018.

complete ruin scenarios are possible and, according to many climate models, non-negligible. These are precisely the circumstances in which stress tests are most useful. Importantly, as noted by Goodhart: 'At present, the relevant authorities can choose any scenario for the stress test that they think fit, apply proprietary and undisclosed modelling to assess the outcome, and use the results to jack up required capital (and liquidity) to whatever level they prefer…'[63] Stress-testing the banking system in relation to extreme climate scenarios, and not delimiting such tests to the issue of regulatory risk, is therefore plausible. Significantly, regulators in some jurisdictions already employ variants of such tests. One such variant is known as 'reverse stress-testing': financial firms are required to assess scenarios and circumstances that would render their business models unviable, in the process identifying potential business vulnerabilities.[64] Such tests are designed partially to force firms to consider tail risks.[65] Other variants have been introduced by national central banks: when issuing directions for use under risk management processes the Brazilian central bank used powers derived from Basel guidance to require large banks to assess their individual exposures to ESG risks and the potential impact on equity capital.[66]

Using stress-test scenarios as planning exercises therefore not only provides the institutions and regulators themselves with indications as to the robustness of the financial system, it also allows regulators to tailor hypothetical scenarios to match potential large real swings in asset prices, including those that financial risk modelling deem unlikely, yet would be catastrophic if realised. Imposing high hurdle rates in climate risk tests would reduce the profitability of carbon-related investments penalised by such exercises. As with reforms to asset risk-weighting, discussed below, incorporating such factors into the stress-testing regime would be analogous to a tax on the funding of climate-damaging activities, addressing the flow of finance toward such projects directly.[67]

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[63] C.A.E. Goodhart, 'In praise of stress tests', in R.W. Anderson (ed.) *Stress Testing and Macroprudential Regulation: A Transatlantic Assessment* (London: Centre for Economic Policy Research London, 2016), p. 141.
[64] See for example, Bank of England, Stress Testing, bankofengland.co.uk/stress-testing.
[65] S. Batten, R. Sowerbutts, and M. Tanaka, 'Let's talk about the weather: The impact of climate change on central banks' Bank of England Working Paper No. 603, May 2016.
[66] Requirements for such evaluations were established by Basel Circular 3547 which requires a comprehensive assessment of capital adequacy over a one-year horizon including *'risk of environmental externalities affecting institutional activities…even if they cannot be effectively measured.'* See K. Alexander, 'Stability and sustainability in banking reform: Are environmental risks missing in Basel III?' (CISL & UNEP FI, 2014), p. 18.
[67] J. Cullen, 'After HLEG: EU Banks, Climate Change Abatement and The Precautionary Principle' (2018) 20 *Cambridge Yearbook of European Legal Studies* 61.

*4.2. Bank capital requirements*

In relation to individual institutions, the purpose of capital regulation is to protect the solvency of a bank by ensuring there is a large enough capital buffer to absorb losses on its assets. The entire capital adequacy ratio is underpinned by a system of asset risk-weighting - the riskier the asset on the bank's books, the more capital the bank needs to fund it with.[68] Their role in principle is not designed to mitigate planetary boundary risks, particularly at the systemic level.[69] However, amending bank capital requirements to guard against the planetary boundary risks would serve a dual purpose: the banking system would be more robust to possible losses thanks to a reduction in exposures to such risks and the activities targeted would become more expensive to fund.

As financial stability is a prerequisite for sustainability, capital requirements must however remain risk-based, and the definition of 'green' clear and regulator-driven.[70] Preparatory work into the feasibility of lowering capital requirements against certain 'green assets' is already being done in the EU;[71] it is claimed, such requirements are excessively high under the current asset risk-weighting regime.[72] However, there are two fundamental objections to this approach to credit risk. The first is that 'green' investments, whilst perhaps more desirable from a public policy standpoint than 'non-green' investments, are no more creditworthy than non-green assets.[73] The second is that research indicates that incentivising loan origination in this way would produce marginal results; banks will simply price loans less aggressively in the event that capital requirements are lowered.[74] Accordingly, we would reverse the calculus. Rather than focusing on the incentive-generation effects of 'green supporting factors', capital requirements ought to instead be used to penalise so-called 'brown' projects, or those carrying high-ESG risk. As noted in the HLEG Interim Report:

> [a] 'brown-penalising' factor, raising capital requirements towards sectors with strong sustainability risks, would yield a constellation in which risk and policy considerations go in

[68] Basel Committee on Banking Supervision, Basel III: A global regulatory framework for more resilient banks and banking systems, December 2010 (revised June 2011).
[69] Alexander, 'Stability'.
[70] HLEG Final Report, p. 68.
[71] J. Brunsden, 'Brussels looks at easing bank capital rules to spur green investment', *Financial Times*, 10 January 2018.
[72] EU High-Level Group on Sustainable Finance, Financing a Sustainable European Economy: Interim Report, July 2017, p. 32.
[73] S. Matikainen, 'Green doesn't mean risk-free: why we should be cautious about a green supporting factor in the EU', 18 December 2017, LSE and Grantham Research Institute on Climate Change and the Environment, Commentary, available at: www.lse.ac.uk/GranthamInstitute/news/eu-green-supporting-factor-bank-risk.
[74] Alexander, 'Stability'.

the same direction [as rewarding green projects]. Moreover, it would be more focused and easier to rationalise as capturing the risk of sudden value losses due to 'stranded assets'.'[75]

Constructing methodologies for modelling these risks is outside the scope of this chapter, although it is worth noting that prudential financial regulation such as capital regulation has a 'precautionary motive' implying that when levels of uncertainty are high, institutions ought to increase their capital to guard against losses from indeterminate financial risks.[76]

There is a great deal of recent literature on the topic of the links between financial and ESG risk, particularly climate risk. Fossil-fuel companies derive huge volumes of funding via banks; between 2004 and 2014, the world's 25 largest commercial banks channelled at least $1.85 trillion to the top fossil fuel industries, compared with just $171 billion to renewable energy.[77] Mechanisms for introducing substantial brown penalising factors as a partial solution to correcting these imbalances ought therefore to be explored. At the macro-level, banks' large exposure limits could also be reduced. Such limits are imposed to place a cap on either single counterparties or close groups of counterparties relative to banks' capital, including sectoral concentrations.[78] Capping banks' exposure to carbon-related assets, or exposures subject to elevated environmental risks, would be one method of reducing bank funding of such industries, whilst commensurately ensuring greater systemic resilience.

### *4.3. Central bank monetary policies*

A further alternative would be to target monetary policy at supporting climate-friendly projects. Particularly since the financial crisis, central banks have pursued many programmes to achieve this aim, including ultra-loose monetary policies such as quantitative easing (QE), and generous liquidity provision to the banking system. The scale of some of these programmes is immense; QE operations since 2008 have contributed to aggregate global central bank balance sheet expansion of approximately $10.5 trillion[79] and central banks now hold significant volumes of bonds from both the public and private sectors on their balance sheets.

[75] HLEG Interim Report, p. 31.
[76] F. Valencia, Bank Capital and Uncertainty, IMF Working Paper WP/10/208, September 2010, p. 3
[77] Fair Finance Guide, Undermining our future: A study of banks' investments in selected companies attributable to fossil fuels and renewable energy (2nd November 2015) p. iv.
[78] Bank for International Settlements, The treatment of large exposures in the Basel capital standards, 30 April 2018.
[79] A.G. Haldane, M. Roberts-Sklar, T. Wieladek and C. Young, 'QE: the story so far', Bank of England Staff Working Paper No. 624, October 2016. A small proportion of these QE operations are presently being unwound.

The scale of such interventions raises the question of whether these central bank initiatives ought to be used to promote particular forms of lending. In the context of this chapter, this form of lending naturally would be related to sustainable investment. One way to encourage banks to invest more in green assets would be to treat certain green assets as eligible for monetary policy programmes such as QE.[80] As noted by Barkawai, QE could be used as a mechanism to kickstart investments in green infrastructure, by amending the choice of assets bought by central banks in monetary policy which, he suggests, is not currently 'sector neutral.'[81] Arguably, this is all the more pressing considering that conventional QE operations have tended to favour high-carbon assets for investment purposes. According to a study by the LSE of the UK and Eurozone, existing QE policies exhibit a 'high-carbon skew' which could have a long term impact on environmental sustainability. According to the study, the bulk of these purchases have been made in the two most carbon-intensive sectors of the economy: utilities and manufacturing.[82] Moreover, in the Eurozone, for example, ABS comprised of auto loans are eligible collateral under the ECB QE framework.[83]

It seems curious that government-sponsored programmes such as QE, which are designed *inter alia* to keep the banking system lending, might be used to support investment in industries that are themselves carbon-intensive, and undermine government targets elsewhere. Identifying and remedying these biases, is one of the most concrete short-term measures to take. In fact, according to the Grantham study, no assets relating to renewable energy companies were used either in the QE programmes of either the ECB or the Bank of England, yet oil and gas companies' bonds comprised 8.4 percent and 1.8 percent, respectively.[84] The academic literature suggests that the impacts of QE purchases pass through imperfectly to other asset classes and the larger economy; there is evidence of a disproportionate jump in the price of eligible assets after the introduction of these corporate bond purchase programmes. These factors alone seem inconsistent with the overarching aims of European and UK policymaking on the environment. A review of the collateral framework for central bank

[80] As noted by Chain Reaction: 'The [central bank] can use monetary policy to create incentives for commercial banks to lend more to sustainable industries or businesses by making cheaper refinancing options available for banks that lend sustainably, and/or by accepting assets such as green bonds as collateral for central bank borrowing...' See B. Kuepper, T. Steinweg and G. Thoumi, 'Sustainable Banking Initiatives: Regulators' Role in Halting Deforestation', Chain Reaction Research, July 2017, p. 3.

[81] A. Barkawi, 'Why monetary policy should go green', *FT Alphaville*, 18 May 2017.

[82] S. Matikainen, E. Campiglio and D. Zenghelis, 'The climate impact of quantitative easing', Grantham Research Institute on Climate Change and the Environment Policy Paper, May 2017. Their calculations indicate that 62.1% of ECB corporate bond purchases take place in the sectors of manufacturing and electricity and gas production, which alone are responsible for 58.5% of Eurozone area greenhouse gas emissions, but only 18% of gross value added (GVA). For the Bank of England, manufacturing and electricity production – responsible for 52% of UK emissions – make up 49.2% of the eligible benchmark, but only 11.8% of GVA.

[83] Indeed, the ECB has purchased ABS comprised of loans for the purchase of Volkswagen cars. See A. Barker, 'ECB suspends purchase of loans backed by VW assets', *Financial Times*, 27 September 2015.

[84] Matikainen, Campiglio and Zenghelis, 'The climate impact'.

lending schemes and haircuts should therefore provide a starting point, with the aim of prioritising investment in low-ESG-risk assets.

## 5. Conclusion

In this chapter we have examined the modern risk management paradigm, which emphasises the capacity of investors and beneficiaries to evaluate risk and make meaningful and efficient investment choices, provided they are granted full information and the investment chains they subsist in are properly governed. In the case of modern financial markets however – and specifically in relation to the complexities inherent in the challenge of climate change – we remain unconvinced that such principles hold much water; in fact, they may be counterproductive because they perpetuate the façade that risk management techniques may be used to address the externalities created by market activities. In the light of these observations, we have canvassed some possible remedies. Such mechanisms are stronger and more direct forms of intervention than currently considered in most jurisdictions, although progress is slowly being made. In our view, the evaluation of such reforms is made ever more pressing by the potential for future irreversible and catastrophic damages.