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# 'Making financial sense of the future': actuaries and the management of climate-related financial risk

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## ABSTRACT

This paper seeks to explore how professionals in the financial sector understand the challenge that climate change presents to economy and society. It is a case study into how 'climate-related financial risk' is understood in a particular area of expertise – within the actuarial profession. There is an increasingly prominent claim among financial regulators that climate change should be considered as an issue of financial risk and stability; it is argued that this will drive capital towards green ends, and an orderly low carbon transition. Responding to this, actuaries are seeking to establish climate-related risk as part of their professional jurisdiction. Yet they are struggling to do so because of their relationship to the investment chain and because the tools they employ for risk management, mostly drawn from financial economics, are fundamentally failing to consider, quantify and financialise climate risks. Instead, the profession is moving toward scenario-based tools for managing climate-related uncertainty that incorporate narratives about policy interventions and market reaction. The paper draws on interviews and ethnographic research conducted with members of the UK-based Institute and Faculty of Actuaries (IFoA) to explore these established and emerging risk management tools and perspectives.

## KEYWORDS

Climate change; actuaries; risk management; green finance; scenarios

## Introduction

The financial sector in the UK is increasingly being called upon to consider climate change as a financial risk and to consider the 'climate-related risks' associated with environmental degradation and the transition to a low carbon economy (TCFD 2016). Following the Paris Agreement on climate change, efforts have also been made by the European Commission and the G20 to plan for and facilitate sustainable investment and growth through the development of 'green finance' (CISL and UNEP 2016, HLEG sustainable finance 2018). In the UK, the Treasury and Department for Business, Energy and Industrial Strategy (BEIS) have sought to 'accelerate' the growth of green finance, signalled by the appointment of a Green Finance Taskforce comprised of financial experts that is making recommendations on how to boost investment in the low carbon economy (HM Treasury and BEIS 2017). These calls are made with the concerns of financial stability in mind, and reshaping finance and capital flows towards long-term, sustainable investment and 'clean growth'.

Specific areas of the financial sector have begun to incorporate climate change in considerations of risk management to a far greater degree. At the European Union level and among UK regulators a slew of directives and supervisory guidelines have sought to direct attention to the financial

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'materiality' of climate risks for pension funds and insurance companies (PRA 2015, DWP 2018, IOPS 2019), indicating the widening 'risk imagination' of financial governance (Campiglio *et al.* 2018, Morris 2018). These high-level warnings have in part been driven by an amassing literature that signals fears about a systemic crisis relating to the potential devaluation or 'stranding' of carbon-intensive and fossil fuel industry assets and the effects this would have on the financial system as a whole (Carbon Tracker 2013, CISL 2015, Economist Intelligence Unit 2015, CISL and UNEP 2016, Lloyd's 2017). Though fears about climate-related financial instability and crisis among policy-makers are palpable, and there is increasing acknowledgement of the systemic and cross-cutting nature of climate risks, the impression that these can be abated through the normal channels of risk disclosure and management remains, if tenuously.

This paper makes a contribution to the emerging literature on the management of climate change as a financial risk by focusing on the actuarial profession, and in particular on actuaries working in pensions and investment. It seeks to understand the approach of this financial services profession as a specific case study into the limitations of managing climate change in this way, especially through established frameworks of risk management and calculative or modelling tools. It argues that existing risk management techniques within the profession, many reliant on financial economics, are failing to cope with the threat of climate change, either in grasping its financial implications or in terms of confronting it as an ecological risk. This is important, not least because actuaries are responsible for the work of asset and liability management for institutional investors of all kinds, often as key actors in the investment decision-making process overseeing sums of money in the hundreds of millions or billions.

Actuaries' professional motto (in the UK) is 'making financial sense of the future', and members of the profession claim expertise at translating all kinds of risks into frameworks and models that convey such risks and the future financial values they affect as manageable in the present (Ferguson and Grace 1998). Increasingly, a small portion of the profession have turned their attention to climate change, in response to the calls from regulators mentioned above, and in an attempt to position climate-related risk within their jurisdiction. In bidding to 'make sense of' the risks associated with climate change, however, these actuaries are confronting the limitations of their risk calculation, risk management and valuation techniques. This failure is forcing them to engage in more experimental modes of risk management, such as scenarios analysis, that by necessity are more explicit about the uncertainties involved and the political and ethical commitments that accompany prospective action, investment and investment advice.

Financially material climate-related risk is often communicated as a market failure associated with potential asset mispricing, disregard of systemic risk or extreme 'tail risks' and the inability to translate uncertainty into quantifiable financial risk (Thomä and Chenet 2017). Actuaries interested in communicating and translating climate-related risks are thus compelled to question market signals and values by drawing on narratives of future imaginaries 'beyond numbers' (Chong and Tuckett 2015, Beckert 2016, Arjaliès and Bansal 2018). In this situation, the calculative devices, models and particular metrics of concern that actuaries use to manage risk clash and vie with political scenarios for a climate changed world, as well as scientific predictions outlining ecological breakdown, all of which are supported by very different technical and political assumptions.

For example, professional actuarial judgement, which is more familiar with considering conservative shifts in interest rates, must contend with possibilities such as 'transition risks', including radical policy changes that might precipitate a rapid low carbon transition with consequences for financial markets. The universe of climate-related financial risk also comprises the physical risks of climate change, and how they might affect investments, insurance, companies and their supply chains, as well as (legal) liability risks that affect actors from frontline carbon emitters to financial service providers such as insurers. The reality is that each of these risk areas is characterised by deep uncertainty.

The actuarial profession is explored from a social studies of finance perspective, inspired by approaches that emphasise the important role that intermediaries within financial services hold in terms of how their expertise shapes investment and markets more broadly (MacKenzie and Millo

2003, MacKenzie, Muniesa, and Siu 2007, Ortiz 2014, Leins 2018). As well as exploring the risk tools and risk imagination of actuaries, though, it places into focus how they fit into the organisation of investment chains in institutional investment, chiefly for pension funds. The reasons it does so are two-fold: firstly, social studies of finance have been complacent when it comes to incorporating the meso – and macro-dynamics of what has been known as ‘money manager capitalism’ (Whalen 2012) or its more recent incarnation, ‘asset manager capitalism’ (Braun 2016); and secondly, how actuaries fit into the organisation of investment chains explains to some degree how they are enabled and constrained to act and advise in particular ways (Arjaliès *et al.* 2017) and how they are able to retain approaches that work to centre financial risk to the fundamental exclusion of the underlying environmental risks that must be addressed (Wright and Nyberg 2015).

The paper draws on 14 interviews conducted with UK-based members of the Institute and Faculty of Actuaries (IFoA) across several areas of actuarial expertise including risk management, general insurance, pensions, life insurance and investment consulting. These interviews explored actuarial understandings of risk and value generally and related these understandings to wider social and moral responsibilities around inequality and climate change that actuaries might bear as professionals managing the transfer of risk and wealth into the future. Interviewees were initially drawn from a group of IFoA members who opted to participate in the project after a call via the IFoA’s ‘400 Club’, a feedback group comprised of members across the profession. Interviewees were asked about: the most important risks that they managed and the tools they used to manage them; what kind of valuation work they performed; how they understood uncertainty to affect their work; their relationship to models and modelling risk; and finally, how they perceived their role in managing social and environmental risks and the public interest role of the profession, with a specific focus on climate change. The shortest interview was 30 min and the longest 1.5 h, with an average duration of 50 mins.

Further interviews were carried out in the same way but focussed much more specifically on climate risk and were conducted with those who have volunteered within the IFoA’s Resource and Environment (R&E) practice area. Here questions concerned risk perspectives, tools, models and ethical responsibilities, and explored: how actuarial perceptions of risk alter our understanding of climate change; what constrains or enables actuaries to advise on climate risk, including the tools at their disposal and the role of scenarios; actuaries’ influence on the investment chain; the possibility of translating ecological risks into financial risks; and the role of the profession as a whole in considering climate change and other environmental problems. This means that a balance was struck between actuaries with volunteering experience of environmental issues in the Institute, and those who simply expressed interest in the project call. Though the latter group would still comprise actuaries who are more engaged than the average member of the profession on public interest issues. All interviews were audio recorded on the condition of anonymisation of the data to be used and informed consent was obtained. Participation at IFoA roundtable and conference events on sustainable finance and climate-related financial risk, as well as volunteer membership of the IFoA’s Resource and Environment Research and Continuing Professional Development Subcommittee also informed the research.

The remainder of the paper is divided into three further sections. The first section highlights literature on the efforts of financial actors to incorporate climate and other environmental issues into existing systems of risk calculation and management. It notes approaches from the political economy and social studies of finance literature that have sought to identify specific financial professions and intermediaries as important actors in shaping creative responses to climate change as a financial risk. The second section situates actuaries within their particular relations of investment in order to highlight how they are enabled and/or constrained in integrating climate risk concerns in their work. It also argues that the failures of actuaries’ existing understandings and practices of risk management and valuation work compels them to experiment with different understandings of risk, particularly via a possibilistic risk mode employing scenarios analysis. The paper concludes with a summary of the arguments and suggestions for further research.

## Section one: climate change as financial risk and the turn to experimentation

Members of the actuarial profession are experts in quantitative modelling but will interact with models in different ways depending on what area they work in (pensions, life insurance, reinsurance, etc.), their positions within a firm and how they might relate to clients. Modern actuarial science supports actuaries with models that help them to manage investments and asset liability risks (in particular the risk that assets will not meet liabilities as they emerge at a future date) (Franzen 2010). They are therefore concerned with how climate change might act as a driver of various risks, affecting their assumptions about financial and demographic factors, including the effects on the liabilities they manage and the value of their clients' investments.

To date, environmental action in the financial system has overwhelmingly taken the form of private and voluntary self-governance, where technical expertise can shape perceptions of risk, value and investment, and the calculation, measurement and standardisation that are the ingredients of market-based solutions to climate change (Power 1997, Lovell 2014, Thistlethwaite and Paterson 2016). As Christophers (2019) notes, though, there has been very little work on how institutional investors themselves are responding to climate change, partly as a result of the difficulties of accessing such intermediaries in the financial sector. Increasingly, literature in economic geography has paid closer attention to specific agents in the investment chain, such as asset managers and investment consultants, and how they relate to the challenge of climate change and fossil fuel risk (Christophers 2019), or attempt to integrate environmental, social and governance considerations into the work of corporate valuation (Knight and Dixon 2011). While 'investors' capitalising a future that locks us into climate crisis have been something of an abstract category in the literature (e.g. DiMuzio 2012), this paper seeks to focus on a particular actor in the investment world to clarify how climate risk is (and isn't) considered.

### *Creating climate change as a financial risk*

In line with the prominence of self-governance of environmental risk, much of the literature that explores responses from the financial sector to global environmental crisis has explored it as a deepening of what Newell and Paterson (2010) call 'climate capitalism'. Climate capitalism describes the gradual realisation by various actors – governments, businesses, investors – that climate change is a systemic problem that will affect them in some way, and a threat that they must seek to turn into an opportunity. In translating the threat and challenges of climate change into a framework of financial risk and opportunity it is made legible, manageable and attractive to actors in the financial sector. Those critical of climate capitalism argue that what we are witnessing is renewed efforts in the 'construction of climate change as a market transition', whereby an 'ontological dislocation' between the material effects of climate change and the policies formulated to deal with it allow 'justifications for action [to] become increasingly endogenous to the market' (Janković and Bowman 2014, pp. 234–35).

The closer entanglements between the financial sector and the natural world have led others to talk of the 'financialization of nature' (Ouma *et al.* 2018) and the exploitation of 'climatic uncertainty' (Bates 2017) in which new geographical markets, data analytics and financial instruments provide sources of profit for capital. Lehtonen's study of Munich Re, for example, demonstrates how the company manages and distributes knowledge about climate change and asserts the expertise to 'objectify', commodify and repackage as an investment opportunity weather-related natural catastrophes (Lehtonen 2017). The means by which climate change is objectified in this way, Lehtonen argues, include not only sophisticated practices of data amalgamation, arrangement and calculation but also the documents – annual reports, company press releases and magazines – that classify and communicate weather-related catastrophes as important risks (both physically and financially) that nevertheless can be managed, in terms of the distribution of losses, for potential profitable gain. The taming of uncertainty and economisation of climate change is thus constituted (in part) through the communication of risk and opportunity in these texts.

As the impacts of climate change have begun to affect the severity and frequency of catastrophic events, the modelling of 'catastrophe risk' itself has revealed its more imaginative, adaptive side and much of the focus of the political economy literature has been in this area. Weinkle and Pielke (2017, p. 564) show how questioning the assumptions made in such modelling concerning choice of theory and data, perspectives on the history and future of catastrophes, and the way that models are adapted year-on-year, leads to the conclusion that 'each model is a politically stylized view' that aims to resolve the question of catastrophe risk 'in a way necessary to satisfy extrascientific factors', principally the setting of insurance rates. Johnson (2015) is more explicit still, demonstrating that reinsurer services have even come to anticipate and rely on catastrophes as 'devaluation events' which provide a fix for crises of overaccumulation by destroying capital and regulating the insurance cycle. The financing arrangements and risk management practices involved in catastrophe risk markets appears to allow 'the practical reconciliation of uncertainty and risk', rendering what had seemed incalculable, calculable (Bougen 2003, p. 258). Importantly, again, they also attempt to show how insurers fit within a future changed by a warming climate that remains manageable and open to profitable opportunities. Instead of catastrophe risk and (re)insurance, this article focuses on investment and pensions, yet parallels between the two are notable.

The management of climate change as a financial risk does not proceed smoothly and predictably, nor without contestation, and we can learn about possibilities to contest existing understandings of risk, value and their measurement from the often-failed efforts of market intermediaries. The approaches to climate capitalism above have warranted increased focus on those who enable and mediate climate change as a financialized, market transition. These literatures highlight the efforts, struggles and contradictions involved in rendering environmental risk as a legible, quantifiable, even profitable financial risk (Dempsey and Suarez 2016). In the case of the risk management of climate change, the suggestion here is that we might focus on the role of failure, which in turn is leading to experimentation among financial intermediaries such as actuaries.

Such failures not only expose established understandings to contestation, but in provoking experimentation, also reveal more overtly the political and ethical choices for intended action. Much like Thistlewaite's case study of accountants engaged in corporate sustainability reporting, which demonstrates how conflict and political contestation emerged from experimental governance practices that questioned established accounting practices (Thistlethwaite 2015). Accounting expertise in this case was not simply a form of financialization but a set of 'public practices', whereby the uncertainty involved in experimental reporting revealed conflicting interests and questions of accountability. Similarly, as Callon has argued, carbon markets are an instance of ongoing experimentation that has contributed 'to redefining relations between science, politics and economics, and to raising the question of the mechanisms through which boundaries are drawn between these different worlds' (Callon 2009, p. 536). There are, as we shall see in the next section, some important parallels here to how actuaries are exploring scenario tools to think qualitatively and in possibilistic terms, about the financial risks associated with climate change.

It is this element of experimentation and the collision of the uncertain worlds of investment advice, risk calculation and valuation work, climate science and legislation that the article seeks to emphasise. Against the idea that the way institutional investors and those who advise them are simply complicit in the financialization of climate-related risk, the argument advanced is that a small set of actuaries are grappling with climate change experimentally and in a way that is forcing them to acknowledge more explicitly inherent (and political) uncertainties. Not only does this mean questioning the established understandings of risk management and valuation work in actuarial practice, but it also questions the role that financial economics plays as the theoretical underpinning of these practices. Furthermore, in relying on tools such as scenarios analysis, actuaries and others must be explicit about the kinds of futures they envisage as credible, plausible, desirable and undesirable for both investors and wider society. It is, especially, in the construction of such 'fictional expectations' (Beckert 2016), that we might locate questions of political framings of a climate changed future and how it will be mitigated by the financial sector.

## Section two: the actuarial profession, the investment chain and modelling uncertain futures

Actuaries themselves – as practicing professionals – are relatively absent from literatures in political economy, economic sociology and social studies of finance (see, however, Dlugolecki and Silver 2005, Collins *et al.* 2009, Knight and Dixon 2011, A. Jones *et al.* 2020, van der Heide 2020). Public obscurity is something that the profession has been conscious of for some time (Renn 1998, Dennett 2004). This is perhaps because they are a relatively small and overwhelmingly non-public-facing profession: in 2018 the IFoA's membership was 32,000, just over half of whom were based in the UK. This lack of attention is surprising, however, given their often-important role in advising (and effectively making decisions on behalf of) institutional investors, working with financial regulators, the form of expertise that they exert within the financial services industry and their increasingly widespread existence as consultants.

Investigating how actuaries understand climate-related risk allows us to explore how they might (or might not) shape responses to climate change in the form of understandings of risk and financial assumptions about the future. Actuaries manage investments and asset and liability risks for pension funds and insurance companies, assess solvency and capital needs, design, advise on and manage pension schemes, price insurance contracts and increasingly work in risk management and consulting in financial services beyond their traditional practice areas. Looking at the profession can illustrate how actuaries might affect greener investment outcomes through consideration of climate change, as one intermediary within a 'chain of investment' (Arjaliès *et al.* 2017). This is especially the case for actuaries who practice as investment consultants, and who hold a unique 'relational geography' within the investment chain, situated between pension funds (and other institutional investors) and asset managers (Knight and Dixon 2011, p. 218).

In this section, three different elements of actuarial responses to environmental crisis are discussed. First, the role that the profession has taken in approaching climate change and its associated risk as one intermediary within the *investment chain*. The suggestion made is that climate-related financial risk presents opportunities for actuaries to expand their professional jurisdiction within financial services, yet that they exist within a set of intermediary relations that places actual and perceived constraints on them. Second, the role of *models* is explored. This section looks at how actuaries rely on models based on financial economics to elaborate on and manage positions concerning risk and return. These models are either blind to questions of climate risk or unable to consider the uncertainty associated with it. This is pushing some actuaries towards more qualitative, imaginative, or possibilistic tools such as *scenarios analysis*. The third section investigates this shift and what it could mean for political and ethical contestation of climate-related risks.

### *Actuaries and/in the investment chain*

In the UK, the actuarial profession is represented by its royal chartered body, the Institute and Faculty of Actuaries (IFoA, hereafter the Institute). As well as monitoring and reflecting on standards, qualifications and regulations in the profession, the Institute has a 'public interest' mission. It employs a permanent staff, but its Fellows – who might be employees of insurance companies, pension funds, consulting firms, investment banks or the Government Actuary's Department – volunteer their time, including to a series of boards and working parties focused on various areas of actuarial theory and practice, and to several social and environmental issues that the profession relates to.

The Institute has made an assertive push in recent years to extend its influence among businesses, regulators, governments, the media, think tanks and other bodies active in policy making. This effort to 'promote actuarial science and the value it brings to business and society' comes with an explicit acknowledgement that the profession has sometimes followed, rather than led, 'in key debates that fall within the actuarial universe' (IFoA 2016a, p. 9). Actuaries themselves have long warned that, despite the fact that they 'occupy a pivotal position' in finance, they are at risk of being

'maneuvered into a marginal one by other professions or disciplines that are more enterprising' (Dlugolecki and Silver 2005, p. 106). This fear is well-founded: the profession has found itself in recent decades 'relegated from the boardroom to the backroom' (Collins *et al.* 2009, p. 261) after entanglement in financial scandals and a general recognition that its methods were opaque and failed to keep pace of developments in modern financial economics.

This provides some context for how actuaries have come to recognise the opportunity that climate-related risks present to their jurisdictional claims as a profession, including in relation to the kinds of perspectives they take on risk and the calculative tools at their disposal. From 2010, certain members began to articulate the role that actuaries could play in contributing to both the policy response to climate change as well as the business of managing the risks and opportunities for their clients (Baxter *et al.* 2010, p. 7, Allen *et al.* 2011). Their work on climate change within the Institute has gradually moved from working party research to policy briefings and consultations on, for example, the issues surrounding investment in 'sustainable infrastructure', noting the profitable potential of a 'sustainable pipeline' of large-scale, risk-appropriate projects (IFoA 2016b). The longer-term horizons that actuaries are used to managing assets and liabilities across (perhaps 30–50 years for pension funds) is considered a basic jurisdictional advantage for the problem of climate-related financial risk, which is considered to materialise over similar timeframes.

A decade after their initial publications on sustainability, members of the actuarial profession are still searching for how they might actively contribute to policy or to their clients' needs on questions of climate risk. Discussion in some actuarial circles has attempted to be more radical, framing the challenge in explicitly normative terms, for example, as a question of 'intergenerational fairness' (IFoA 2017), and the Institute has commissioned work that questions how pensions could fare in a resource-constrained, stagnating economy (A. Jones *et al.* 2013). The fact remains, however, that for many actuaries, it is still unclear how considerations of climate change might be practically integrated into their work, even when (and it is not often the case) they acknowledge the potential material risks involved. One scheme actuary interviewed believed it a futile task:

"to try and predict returns in fifty years' time and what inflation is going to be and all the rest of it ... with or without climate change ... eah, who knows anyway ... it's just another uncertainty that's thrown into the mix."

This failure to consider climate risk stems in great part from the perceived impossibility of managing the problem as another kind of risk within the actuary's purview. In the interviews conducted, the problem was presented as both an issue of the practical difficulties of integrating climate risk into existing ways of communicating risk quantitatively, and as a consequence of actuaries being bound by the interests and motivations of asset owners or trustees, as well as regulators. On the role played by trustees, a principal consultant working in defined benefit pensions stated the scenario as follows:

it's very, very rare, I've got to say, for trustees ... if they are persuaded that an investment strategy will deliver the best returns, to turn it down on the basis that there might be more ethical investments to be made. Ethical investments are only looked on positively if they are delivering at least equivalent returns.

This statement demonstrates continuing sentiment amongst actuaries that investments considered of climate change are 'ethical' or even 'political' and therefore outside the realm of trustees' fiduciary duty, which is narrowly interpreted in 'returns-only' terms (Christophers 2019, p. 10, Webber 2018, p. 185), unless they are very particular clients such as charities or public bodies managing reputational risks associated with their endowments. It is generally understood, as one consultant and pensions actuary engaged in resource and environment work suggested, 'that actuaries can play an interesting role ... but [that] the push would have to come from our clients'. This would indicate a surprising reticence even among more involved actuaries to seize or create opportunities in this area.

Such statements highlight issues concerning the relational positioning of the actuary as advisor in the investment chain for pension funds. Actuaries are obligated to take the trustees' decision as sovereign, while giving advice that reflects to the best of their knowledge material risks and

uncertainties that might affect the funding or investment position of the scheme. Reviews of the investment consulting profession have found that '[n]o one in this situation has a clear mandate for taking decisive action or changing direction: trustees tend to feel that they lack the expertise to do so, and advisers that they lack the power to make decisions (Myners 2001, p. 6). This context of inertia allows abdication of responsibility in a decision-making framework where, as is frequently argued, the (actuary) consultant is *de facto* in control, particularly when it comes to recommendations for asset allocation or choice of fund managers (Youngdahl 2013, Jenkinson *et al.* 2016, Competition & Markets Authority 2018, Gelepithis 2019). Actuaries, in other words, hold much of the influence, yet often little will or capacity (perceived or actual) to consider climate change.

This 'passivity' translates into a failure to advise on green(er) investment strategies (Caldecott and Rook 2015, p. 6), a tendency that is compounded by the fact that the UK investment consulting market (which is only 3,500 strong in employee numbers) is concentrated into four to six large firms who have, overall, shown little evidence of changing their advice (PRI 2017, p. 4, 7). Existing studies have found a 'concerning level of illiteracy' around climate change among institutional investors and those who advise them (Knight and Dixon 2011, Harnett 2017, p. 7). Though the interviews conducted for this paper cannot be taken as generalisable evidence about the actuarial profession's knowledge, they appeared to confirm that those who understand the facts of climate change and elements of the relationship between climate change and financial risk are in a minority – one involved actuary labelled it 'super niche'. Failure to advise is further compounded, as an actuary and investment consultant specialising in Environmental, Social and Governance (ESG) issues argued, by the fact that actuaries must rely on asset managers whom they can recommend to ultimately manage investments with climate change in mind in an 'easily packaged way'. Another actuary pointed out that

unless you have one person [on a trustee board] that feels really strongly, or an investment manager that can say, 'invest in this, it's giving you at least the same return and it's good for the environment', it's just not going to happen.

There are both upstream and downstream relations within the investment chain that matter, then.

Nevertheless, actuaries already working to promote sustainable finance argue that the actuarial standpoint can serve as an important perspective on climate crisis, forcing a reinterpretation of what kinds of climate risk and ruin are considered tolerable. For example, through use of analogy to insurance companies' 'risk of ruin' (i.e. an insolvency scenario, standardly considered as a 1 in 200 risk over a one-year horizon), Bettis *et al.* (2017), argue that the focus and scale of concern in considerations of climate risk should be on the possibility of catastrophic and civilizational collapse. This reflects perspectives within the economics of climate change that focus on 'fat tails' and worst-case scenarios, which assert that the potential economic and existential damages associated with climate change should compel us to use the 'precautionary principle', adjusting the way we discount present action and the costs of averting ruin much more cautiously than we do at present, and in ways inimical to standard cost–benefit analysis (Wagner and Weitzman 2016).

These representations of climate crisis as 'risk of ruin' are conversations that are much more public facing and addressed to regulators. They stand in contrast to the kinds of conversations that actuaries would have with investors, pension fund sponsors and trustees, their clients. Instead of the focus on the extreme possibilities that an actuary might present to convince regulators, one interviewee argued that climate change risk had to be presented as a likely, straightforward financial risk to clients:

If you were talking to trustees about their investment portfolio you would probably be looking right in the middle of the normal distribution curve ... you're not making a bet in the same sense, you're just trying to find an optimal investment path, so you're saying, OK, this is your distribution of returns to risk, but you've got all this unremunerated risk that we don't think the market's pricing in. We can't know that for sure, but

our hypothesis is that markets are failing to price carbon risk therefore ... you'd probably be looking at what the likely outcomes are there rather than the super extremes. Trustees aren't interested in super extremes.

But another actuary working in investment and heavily involved in the Institute's climate risk work contended that in such a situation 'you get this sort of articulation of risk which conforms to a mathematical model which I think trustees broadly are [conversant] with: the normal distribution. But which is unrealistic in terms of [climate risk].' The problem is that there is no established understanding of how climate risk or its 'likely outcomes' can be priced into actuarial risk calculation, and therefore no given way to manage it as the profession would other risks. Existing efforts to explore carbon risk quantitatively, and the possibility for models to estimate stranded assets within investment portfolios, are understood to be highly misleading (Christophers 2019, p. 16). Yet this is not impeding efforts. A report for the US Society of Actuaries contends that assets at risk of being devalued or stranded 'can be estimated using models based on assumed policy parameters and normative inputs' – via thresholds set around emissions control scheme pricing, for example – and that to seize green finance opportunities, 'optimization algorithms' based on portfolio theory might manage climate-related risks for pension fund and insurance company investments (Sen Tang *et al.* 2018, pp. 20–21). The next section explores how the absence of existing tools allowing for the communication of climate change as an objective risk is related to the way in which the profession's knowledge practices have been subsumed by financial economics, writing out elements of their professional judgement. In attempting, and failing, to manage climate risk through established techniques, actuaries are moving towards possibilistic, scenario-based tools.

### ***Modelling risk and value into the future***

The work that actuaries do on climate risk has in recent years turned to the implications for the profession regarding how they advise their clients and, accordingly how climate risk affects their work in setting financial assumptions. Here, volunteer actuaries in the Institute have focused on raising awareness among fellow members of the profession and scoping out research and tools that quantify potential financial impacts in a way that is useful for their everyday work (C. Jones *et al.* 2018). This includes highlighting the increasing demands from regulators, the questions of professional duty related to their responsibilities as advisors and the increasing evidence of the 'materiality' of climate change as a current and potential risk. Members volunteering for the Institute issued a series of practical guides aimed at different areas of the profession – those who work in defined benefit and defined contribution pensions, general insurance, life insurance and investment – intended to demonstrate that climate-related risk is relevant to all kinds of actuaries in different ways (Hails *et al.* 2017). These were intended to draw attention to how actuaries can, and should, be incorporating considerations of climate change into their work, but of course this will play out in very different ways – those working in life insurance will be more interested in health and mortality effects, general insurers in effects on pricing and reserving, liability risks and investments and in pensions on asset and liability management and fiduciary duty.

Despite these efforts to raise the profile of climate risk within the actuarial profession, the interviews and observation undertaken suggest that climate change and its impact often remain ignored in the assumptions that actuaries make. Those who are responding to the issue of climate risk or listening to the Institute's calls to do so, argue that there is a dearth of adequate information for them to model with or to communicate. As one Chief Investment Officer put it, actuaries are 'waiting for a tool to be proposed to them.' Traditional areas of actuarial work in asset liability modelling and economic scenario generator models show some of the lowest consideration of climate-related risk (Gordon 2021, p. 10). The tools that *are* available which attempt to quantify in some way the financial impacts of climate change and its related risks, in a way that is useful to actuaries, are very few. A recent guide for pensions actuaries (C. Jones *et al.* 2018) identified just three main efforts: from the Cambridge Institute for Sustainable Leadership (CISL 2015), and the consulting

firms Mercer and Aon (Mercer 2015, Aon 2018). These use a combination of macroeconomic scenarios analysis and portfolio stress-testing to explore how various climate-related risks might affect financial assets and liabilities, a strategy that this section returns to below.

Despite the growing sophistication of models, actuaries continue to highlight the importance of communicating risk more broadly, and of specialist knowledge in ‘contextualising’ the ‘technicalising’ calculation that is performed in evaluation and modelling (Jarzabkowski *et al.* 2015, pp. 88–89). In one interview, an investment consultant presented this as a consequence of what ‘type’ of actuary might be under consideration, noting the difference between the ‘traditional “techy” actuary who uses lots of technical analysis and models ... and [those who] will avoid using a model if at all possible.’ ‘As a commercial actuary’, she continued,

who needs to generate revenue for clients, [modelling analysis is] not something they value ... they actually value the broader training on the types of risk they’re exposed to, the options available, than a chart that shows a few bars and a few numbers.

Such actuaries are indicative of a shift away from the highly mathematically grounded forms of risk management towards more managerial and entrepreneurial modes (Power 2007, pp. 3, 13–14). Climate risk and environmental issues generally have begun to be accommodated in investment advice and risk management much more through the contextualising work of narratives, visuals and the construction of conviction (on such work in investment management generally, see Chong and Tuckett 2015, Arjaliès and Bansal 2018) as the feeling grows that, as one actuary interviewed put it, ‘we haven’t necessarily got the answers mathematically ... beliefs are possibly more important.’ This is reflected, for example, in actuaries’ discussion of covenant risks with regard to climate change – the covenant concerns the ability and/or willingness for sponsor firms to pay pensions into the future – where an integrated risk management approach is advocated for that considers firms’ ‘long-term vision for a sustainable business’, and whether it is aligned to a low carbon transition (Hails *et al.* 2017, p. 9). This said, there is understood to be market potential for actuaries who can match quantitative and financial modelling skills with contextual knowledge, as is evidenced in the next section on actuaries’ climate scenarios analysis work.

Models are understood to be essential for pensions actuaries because of the need to report to regulators – namely The Pensions Regulator (TPR) – on solvency positions. Indeed, it was argued by interviewees that tightened regulation was driving the complexity of models as reporting devices. The EU-wide Solvency II regulatory regime fully introduced in January 2016 has driven the use of market consistent valuation for reporting on the value of assets and liabilities in both insurance and pensions. Such market value/mark-to-market forms of accounting claim to represent the value of assets on any given day, totally undermining the possibility of incorporating climate-related risks which will emerge at an uncertain point in the future (Silver 2017b, p. 227). It is widely considered that mark-to-market valuation is detrimental to long-term investments in general, especially in equity and infrastructure, because of how it directs attention to short-term volatility (HLEG sustainable finance 2018, p. 57). In interviews, market consistent valuation was related to inaction on climate risk, particularly toward stranded assets that may experience devaluation in a low carbon transition. One actuary dismissed the threat of stranded assets noting that ‘... short term the market value is what it is. And what we’re interested in is what can we realise if we sell it tomorrow.’ This is contrary to the image of actuaries as professionals concerned with the long-term future that the Institute and climate-aware actuaries are attempting to promote.

The dominance of market valuation is an indication of the influence of financial economics, its wider role in actuarial thinking and practice and its effect on risk management more generally. Actuarial science has a long entanglement with financial economics, with early theories of portfolio diversification in the 1950s, considered the origins of modern finance theory, owing their foundations to actuarial techniques (Brine and Poovey 2017, pp. 299–300). The conventions of financial quantification used over the course of the twentieth century, such as mean-variance analysis and market-consistent approaches superimposed themselves onto actuarial techniques of

discounting, reshaping and building upon but never entirely displacing this earlier convention (Chiapello and Walter 2016). Discounted Cash Flow (DCF) techniques, the staple of how actuaries establish the present value of future cash flows, remain standard tools for valuing corporate assets among financial analysts of various kinds, including in the context of attempting to consider the risk of climate change (2° Investing Initiative and The Generation Foundation 2017, Christophers 2019, p. 11). Value-at-risk (VaR), a statistical tool with roots in portfolio theory made infamous in the global financial crisis, is one of the most common means for assessing possible future investment strategies for defined benefit pensions. It compares the ‘maximum possible loss on a portfolio likely to occur a given percent of the time’ under different levels of risk-taking (Lockwood 2015, p. 722) and is used not least because as one consultant put it, it is a number ‘that people can relate to’ and understand.

The models that actuaries employ and their understandings of the relationship of these models to the decisions they make or the advice they provide are important for how climate change is (or isn’t) considered a risk. Pensions funds and insurance companies rely on VaR and asset-liability modelling (ALM) to consider their cash flows under different economic scenarios and to explore the risks and costs of particular asset allocations, thus helping to determine the kinds of investments they make or recommend. As Silver (who is an actuary active on sustainability issues) notes (Silver 2017a), however, many of these tools are deeply indebted to Modern Portfolio Theory, as initially developed by Markowitz (Markowitz 1952), and its later manifestations. Modern Portfolio Theory, Hawley and Lukomnik (2018, p. 17) argue, has ‘transformed risk mitigation from a qualitative judgment about individual securities to a mathematical calculation based on the nature of the portfolio’. Portfolio diversification is understood as a means to manage risk, and the focus remains on creating an ‘efficient’ market index-linked portfolio that delivers the maximum risk-adjusted rate of return (see Mackenzie 2008, pp. 47–48).

The trend to build indexed portfolios can be witnessed in the rise of ‘passive’ investment management through index investing, as well as in the fact that so-called active investing often mimics its passive counterpart through its focus on market benchmarks or indices (Petry *et al.* 2021). As Christophers (2019) notes, it is in this sense that the majority of institutional investors are approaching the question of climate risk, as something to be hedged through their diversified portfolios rather than as something to be actively managed through, say, disinvestment or thorough engagement of fossil fuel companies. It is rare to encounter actuaries who feel able to challenge market valuation in practice, but a Chief Investment Officer of a pension fund who had a record of volunteering experience on resource and environment issues, and who was attempting to provide a greener offering to fund members, claimed:

The whole fair value concept is misaligned to long risk. I don’t think the market values, but institutions can value. And it may well be that I as a long-term holder have a different evaluation process than what the market seems to result in.

They expressed a clear sentiment that the fund had a responsibility to act as kind of ‘civic investor’ (Amalric 2006, p. 445) in defiance of more passive and market-led modes of investment and understandings of market valuation, and that exclusions of carbon intensive assets had to be part of the default offering to fund members.

For some actuaries, then, the way that valuation and risk models ignore climate change offers an opportunity to critique the importation of financial economics into actuarial science and practice, as well as reflect on traditional actuarial tools. The deference to models which presume market values as authoritative appears to write off the need for thinking about uncertainty more broadly and ironically, even for risk management. As Chiapello and Walter (2016, p. 164) note,

the mathematicians of finance, basing their work on assumptions of an idealized market with a mild randomness representation of uncertainty have shown that ... it is entirely possible to tame risk, whatever the degree to which the risk on the relevant phenomenon (financial market, real economy, demographics, climate change, etc.) materializes, because of the type of randomness chosen.

Metrics such as VaR have powerful and authoritative performative effects, giving the illusion that ‘manageable risk’ can be separated from ‘incalculable uncertainty’ (Lockwood 2015, 729).

### ***Scenarios and the possibilistic risk mode***

It was argued by interviewees that modelling for the risks of climate change would be practically impossible. For equity investment, as one actuary and consultant noted, all the metrics that are usually employed in commonly used stochastic models – including interest rate and inflation expectations – would have to have the effects of climate change overlaid. As they argued, ‘you’d have to be looking at potential shocks to the market ... [and then] it’s almost more of a scenario than an investment model in the classic sense’. Investment consultants note the struggle to incorporate risks that are not seen as ‘objectively’ measurable (Caldecott and Rook 2015, p. 11), but the chances that inflation and interest rates in a climate changed world can be usefully forecast appear slim. In this regard, and confirmed in the interviews, scenarios analysis presents an essential tool for actuaries to communicate the uncertainty associated with climate change.

In contrast to measures such as VaR which seek to reduce uncertainty to risk, scenarios are an explicit engagement with uncertain futures and require imaginative representations of the future. One actuary working in risk management for an insurer noted that after the Solvency II regulation, actuaries working for insurers had to demonstrate they had considered ‘Events Not in the Dataset’ or ENIDs for their reserving, which could not be drawn from historical data. Those who didn’t try to pursue the question mathematically were drawn to scenarios analysis as a ‘pragmatic’ way of addressing uncertainty. There appears to be no set rule on who gets to determine ENIDs, or how they are produced. However, the European Insurance and Occupational Pensions Authority (EIOPA) noted in 2019 that current practice was to use ‘well-known third-party model vendors to model catastrophe events and losses’ (EIOPA 2019), a process which is empowering and enriching a small number of analytics firms who get to ‘curate’ between the science and decision-makers in, say, the catastrophe risk sector (Kob 2020).

Amoore (2013, pp. 12–13) suggests that it is not the risk techniques associated with actuarial science or probability that ‘flourish on the horizon of possibilities’ or which characterise the governance of contemporary fields of economy and security, but rather those of the consulting and information technology industries. The modern actuarial profession has expanded to include far more consulting services beyond the traditional remit of, say, a pensions actuary overseeing a scheme’s assets and liabilities. Possibilistic modes of risk are now much more present in actuarial practice, particularly in the investment consulting field, and among ‘actuaries of the fourth kind’: those who work in ‘enterprise risk management’, responsible for ‘the systematic evaluation of all the significant risks facing an organization and how they affect the organization in aggregate’ (D’Arcy 2005, p. 746).<sup>1</sup> Here the subsumption of forms of traditional actuarial risk calculation by a “managerial” concept of risk management’ appears most evident (Power 2007, p. 3, 13).

Scenarios are now advocated for by the leading climate-related financial disclosure scheme as a means to prepare financial institutions for the impacts of a low carbon transition (TCFD 2016). Although broadly seen as secondary to quantitative analysis, they can act as revealing statements about how financial sector actors see the financial system as a whole, or particular sectors or firms, in the context of a low carbon transition. The scenarios produced by consulting firms and asset managers contemplate futures altered by green technologies and climate mitigation legislation and regulation, as well as different visions in which either government inaction or rapid intervention predominates (e.g. Aon 2018). Factors such as shocks to the financial system from too rapid a low carbon transition indicate that ‘financial stability’ remains paramount in these visions, as opposed to, say, the benefits of decarbonisation itself for mitigating climate change.

The IFoA, in partnership with Ortec Finance, a company that designs software models for asset-liability management, recently produced two papers on climate scenarios for use by actuaries and others in financial services: one focused on a UK pension scheme case study and one on climate

impacts on financial markets more generally (Bongiorno *et al.* 2020a, 2020b). Both papers explore scenarios under three different climate pathways – Paris Orderly transition, Paris Disorderly transition and Failed Transition. The first two scenarios envisage large impacts to financial markets from transitioning to a low-carbon economy but physical impacts in line with the expected emissions under the Intergovernmental Panel on Climate Change’s (IPCC) Representative Concentration Pathway (RCP) 2.6 (emissions begin declining in 2020 and reach net zero by 2066, limiting warming to well below 2°C). Failed Transition envisages a business-as-usual scenario in which transition impacts are limited but physical impacts are extreme and in line with RCP 6, which forecasts global warming of 4°C by 2100. In the pension scheme case study, the modelling translates the impacts to GDP from climate-related risks under the above pathways into financial market effects that actuaries might consider in their pension scheme advisory work (investment returns, inflation and real interest rates and their impacts on assets and liabilities), generating 2000 stochastic economic scenarios for each climate pathway between 2020 and 2060. In this sense we see a return to the risk management tools actuaries are familiar with, although due to the significant uncertainty involved in scenarios ‘the use of judgment is required at all stages in both the formulation and application of [the] models’ (Bongiorno *et al.* 2020b, p. 13).

In each scenario, it is interesting to note the expected work that markets do to ‘price in’ climate risks. In Paris Orderly, markets successfully price in climate-related risks gradually and smoothly between 2020 and 2024. In Paris Disorderly, however, a belated realisation on the part of financial markets to such risks results in an abrupt re-pricing of carbon-intensive assets, ‘stranding’ them in 2024 and having knock-on effects on market sentiment and volatility for a further two years. Finally, in Failed Transition, there are a series of market re-pricing periods across the century as a response to increasingly severe physical impacts of climate change. As well as this, the scenarios incorporate ‘climate pathway narratives’ built on policy and technology assumptions including carbon pricing, energy efficiency subsidies, fossil fuel phase-outs and the uptake of low carbon technologies.

The scenarios that have been selected and developed are done so based on their supposed plausibility, rather than as stress tests for worst case outcomes. As the authors note, this means that there is a ‘strong bias towards optimism’ in [the] results’ (Bongiorno *et al.* 2020b, p. 7) and the exercise thus runs contrary to the approach above that works from the ‘risk of ruin’ (although RCP 6 would no doubt mean ruin for many). This optimistic bias may be read as overly strong, as it has been widely recognised since the Paris Conference in 2015 that internationally agreed climate commitments have been inadequate to meeting the goal, embodied in RCP 2.6, of limiting warming to 2°C. This was still the case when updated commitments were reviewed in early 2021 (UN Climate Change News 2021), calling into question the use of these pathways as plausible scenarios for the financial sector. The authors of the IFoA-ORTEC scenarios argue that being able to compare the Failed Transition pathway with the Disorderly and Orderly Transition pathways makes the models conducive to assessing ‘trade offs’, including between ‘investment opportunities’ such as ‘innovative renewable energy or transport technologies’ (Bongiorno *et al.* 2020b, p. 26). The Ortec scenarios work is already in use informing the investment policies of asset owners, asset managers and insurance companies across the world.

Crucially, in all climate-informed scenarios for the example UK pension scheme, the funding position is worse than in a scenario that is not informed by climate scenarios analysis. Impacts on equity returns, real estate returns, and to a lesser extent UK gilts and credit contribute to this outcome. As the authors argue ‘[g]iven that most models currently used by actuaries do not make explicit adjustments for climate change, these modelled results make it seem quite likely that pension schemes may be systematically underestimating the funding risks they face’ (Bongiorno *et al.* 2020b, p. 5). Indeed, the financial models only run to 2060, because in the Failed Transition scenario, impacts become so great that the stability of the entire financial system is in question (Bongiorno *et al.* 2020a, p. 31).

These scenarios develop narratives of the future which seek to combine climate science (e.g. climate sensitivity to warming) with macroeconomic effects on growth and eventually financial impacts on other headline economic metrics and assets and liabilities. Importantly they also build in stories about the agency of market actors and (less so) policymakers, to affect a climate changed future. This leaves the scenario developers assumptions open to contestation. For example: on the exclusion of the prospect of ‘tipping points’ in more extreme warming scenarios or even the catastrophic physical effects of milder warming; or on the timeframe, scale and possibility of market actors realising and ‘pricing-in’ climate risk to ensure a smooth transition to a low carbon economy.

Other narratives and scenario work can be used to challenge these ‘plausible futures’. The established Shared Socioeconomic Pathways (SSPs) narratives include a broader range of intervening factors, including international cooperation on sustainable development agendas. More specific to the financial sector are efforts that widen the scope to nature-related risks or explore the difference between futures with stricter regulatory oversight against those assuming market-led transitions (Kedward *et al.* 2020). The efforts of financial analysts must accordingly engage and vie with scenarios from climate science, as well as existing expectations around legislative action for a low carbon transition (e.g. see IAA Resource & Environment Working Group 2018). There is no reason yet to believe that this scenarios work or disclosure of climate-related risk generally will effect significant change (Christophers 2017). But like the scenarios that large fossil fuel companies themselves produce, they offer an insight into competing visions of corporate and financial futures designed, no doubt, to reassure, but increasingly open to political contestation.

## Conclusion

This article has sought to demonstrate the challenges that a particular set of financial intermediaries face when trying to incorporate climate change into their work, and how some in the actuarial profession are interpreting these challenges. It contributes to a greater understanding of how climate change is being managed as a financial risk, and how forms of financial expertise shape the nature of investment and markets more generally. The approach here focuses on the actuarial profession in two ways: firstly as part of a chain of investment, demonstrating how its members are constrained and enabled to act as advisors on climate-related financial risk; secondly, it concentrates on how actuaries’ financial and modelling assumptions for managing risk and value into the future are shaped by financial economics, and how some in the profession are contending with these assumptions, including by moving towards scenarios analysis and a more explicit acceptance of uncertainty and a greater role for professional judgment.

The article demonstrates that where actuaries are engaged in considering climate change, they are struggling with how to integrate it as a financial risk into their everyday work. This is partly as a result of their particular place within the investment chain, which means that – in pension scheme management – they are both genuinely constrained by asset managers and trustees, but also failing to advise on climate, or to take climate risk as an opportunity, despite a position of often considerable influence and responsibility. For a great part of the profession, this appears to be because climate change is considered outside of the remit of their risk management responsibilities or capacities. Yet even for those already engaged in climate work either through volunteering within the IFoA or in their professional role, efforts to assert actuarial expertise have made slow progress.

The article also argued that many of the conventional ways in which actuaries think, calculate and attempt to manage risk are barriers to integrating climate change into their work. In this regard, the hope is that this paper has demonstrated how there is some contestation around such conventional thinking within the actuarial profession, particularly in regard to the role of financial economics as a kind of ‘structuring discourse’ for the way that risk is modelled and managed (Walter 2016). In turning towards modes of possibilistic risk management that more explicitly consider uncertainty,

employing scenarios with narratives about future low carbon transitions, actuaries are compelled to engage with climate science and outline assumptions about the action of markets and governments over time.

It is the case that there are no magic bullets in terms of financial or mathematical tools to incorporate climate risk so that the true cost of climate change externalities will be priced into markets. We should understand externalities in this context as political economic contestations over the extent of accountability and responsibility for climate change. More forward-looking, possibilistic risk modes found in tools such as scenarios analysis can be useful in revealing how different actors are imagining what they see as plausible, credible and desirable futures, and how they are invested in such futures. They should be made amenable to climate scenarios, public scrutiny and the political arguments that outline the need to decarbonise the economy at scale and speed. Actuaries should begin to incorporate such scenarios much more explicitly into how they advise institutional investors.

## Note

1. Actuaries of the 'first kind' are life actuaries (since seventeenth Century); of the 'second kind', non-life actuaries (20th Century); of the 'third kind', investment actuaries; of the fourth kind, Enterprise Risk Management actuaries; and Embrechts highlights an actuary of the 'fifth kind' with skills in big data and analytics (Embrechts 2017).

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