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Insuring climate change?
Science, fear, and value in reinsurance markets

by

Leigh Taylor Johnson

A dissertation submitted in partial satisfaction of the
requirements for the degree of
Doctor of Philosophy

in

Geography

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Michael Watts, Chair
Professor John Chiang
Professor Charis Thompson
Professor Richard Walker

Spring 2011

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Leigh Johnson

Abstract

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Doctor of Philosophy in Geography

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Professor Michael Watts, Chair

The planet's changing climatology poses epistemological and practical problems for insurance institutions underwriting weather or property risks: models based on meticulously calculated empirical event frequencies will not project risk in a changing climate system. Seeking to explain the unprecedented scale of recent insured losses, media pieces regularly articulate a narrative that links climate change to an immanently insecure future. This logic has prompted some scholars to place climate change in a new category of risks generated by industrial society that are fundamentally incalculable and uninsurable. This dissertation challenges the epistemological assumptions and empirical validity of the "uninsurability hypothesis" using the case study of (re)insurance and catastrophe modeling for North Atlantic tropical cyclones. In so doing, it turns a critical eye on the depoliticized discourse of climate change emergency.

The research analyzes the development of insurance institutions and definitions of climate change risk over time, applying the theory that risks are reconstructed phenomenon of multiple contingency which always embody contested classificatory and causal stories. Research included over forty extended interviews with academic, regulatory, and private sector employees; observation at thirteen industry, academic, and regulatory conferences; and qualitative and quantitative analysis of corporate and regulatory documents and datasets. The findings trace new constellations of science, value, and fear that are emerging within the (re)insurance industry as it attempts to assess and manage climate risks and secure new paths to accumulation. Three major themes emerge.

First, the dynamics of climate change are being integrated into circuits of insurance and financial capital. The perception of climate risk may buoy the (re)industry's business prospects in the short term by reproducing uncertainty and allowing firms to exclude certain risks from all-perils coverage and repackage them into new products. Climate risks may be incorporated into the central contradictory dynamic of the catastrophe reinsurance market, which requires the continual recurrence of catastrophic losses and devaluation in order to sustain pricing and accumulation in the long term. Meanwhile, investment capital is accessing new risk premiums from the insurance sector through catastrophe bonds, the market for which demonstrates a strategic and selective attempt to capture "returns on place" by finance capital, rather than an "escape" from uninsurable places on the part of (re)insurers.

Second, within both the industry and scientific community, the question of how climate change is influencing catastrophic losses or will do so in the future is far from settled, despite its representation as a closed “matter of fact”. Furthermore, most (re)insurers do not currently account for climate change in their daily underwriting and pricing, and often cite the possibility of compensating for climate effects through future annual adjustments to prices and policies. This apparent contradiction between discourse and practice is the result of a complex set of institutional, political, and economic factors rather than a systematic attempt to deceive the public or exaggerate risks.

Third, privatized economies of science – and particularly probabilistic catastrophe models – are central tools for climate risk management through (re)insurance markets. The expertise of PhD-credentialed scientists is increasingly used in industry contexts to publicize climate change risks, legitimate moves towards five-year forward-looking catastrophe models, and to commodify climate risks into financial exposures and assets. These findings draw our attention the (re)insurance industry’s dependence on the perpetual multiplication of fear and value via technoscientific risk identification, and suggest the profound limitations of attempts to manage climate risks and anxieties through market mechanisms.

For J, CJ, and L – My three pirates

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CHAPTER 1: Introduction

“Climate change is the number one risk in the world ahead of terrorism, demographic change and other global risk scenarios”
– John Coomber, former CEO of Swiss Reinsurance, 2006

Inundated port cities bringing trade and shipping to its knees; Gulf of Mexico oil production crippled by a series of major hurricanes; Lower Manhattan under water; an overtopping Thames paralyzing global financial markets. These images no longer read like scenes from the wildly apocalyptic film *The Day After Tomorrow*; they are scenarios regularly reported in the press. Future climate projections coupled with disastrous economic scenarios are not hard to come by, thanks to a forest of reports turned out by multilateral organizations, environment agencies, global insurers, industry associations, policy think tanks, university research centers, environmental non-governmental organizations, and so on. As the economic risks posed by climate change have become increasingly apparent and publicized, the planetary scale of both financial interdependence and climate change impacts have made it impossible for the institutions managing global capital to ignore them. Potential threats often cited include damage to property and infrastructure from sea level rise and coastal subsidence, declines in agricultural and marine productivity, water shortages, increasing health care and health insurance costs and work days lost, and economic losses due to more frequent or severe weather-related disasters such as heat waves, droughts, floods, winter storms, and tropical cyclones (cf. Nicholls, R. et al. 2007; Epstein and Mills 2005).¹ These are the sorts of impacts that prompt sociologist Ulrich Beck to place climate change in a new category of risks generated by industrial society that are fundamentally “uninsurable” (Beck 1999). Seeking to explain the unprecedented scale of recent insured losses, media pieces regularly replicate the logic linking climate change to an immanently uninsurable, insecure future (see **Figure 1.1**). This dissertation takes Beck’s premise of uninsurability as a point of departure, both challenging its epistemological assumptions and its empirical validity. In so doing, it turns a critical eye on the depoliticized discourse of climate change emergency, allowing us to see “what is done *in the name of risk*” (Baker and Simon 2002, p 18).

1. Climate change as a contemporary concern

The past fifteen years have witnessed the emergence of climate change² as a quintessential keyword (in the tradition of Williams 1985) in debates between governments, scientists, social movements, and corporations (Weart 2003). Climate change has intruded into

¹ There is a large and constantly mushrooming subdiscipline attempting to quantify the economic impacts of climate change with various degrees of confidence using a range of future scenarios for CO₂ emissions. See for example, “The Stern Review on the Economics of Climate Change”, commissioned by the Treasury of the UK (Stern 2006).

² Throughout the text, the term “climate change” refers to anthropogenic climate change, primarily driven by carbon dioxide emissions from the combustion of fossil fuels. I avoid the term “global warming” because *warming* describes only one unidirectional component of anthropogenic climate change – the increase in the average temperature of the earth’s atmosphere resulting from trapped longwave radiation. The notion of *change* at least captures some of the dynamics of variability and volatility, and has the added benefit of not being easily dismissed by climate skeptical arguments pointing to record snowfalls and cold temperatures.

discussions between global elites, penetrating consciousness and preoccupying politicians, planners, and corporate strategists as have few other environmental concerns to date. Its threat is economic—in the form of material losses and declining equity prices and capital valuation—yet also political. Refugee flows, water wars, and ravaging epidemics are just a few of the tropes this discourse consistently invokes. One need only witness the alarm raised in 2007 by a group of retired US generals and admirals warning of the threat global warming posed to national defense, or the debate about climate change, resource scarcity, and migration on the floor of the United Nations Security Council.

Climate change's compelling force is arguably its inescapable global scale—though it will doubtless bring uneven and localized effects and cause more fatalities and devastation in less developed countries, the phenomenon promises to have a planetary footprint (IPCC 2007). As such, it concerns institutions of capital accumulation that have thus far successfully navigated around the financial dangers of environmental degradation, or dealt with them only obliquely. Given the total values potentially at stake a warming world – some five to twenty percent of annual global GDP by one estimate (Stern 2006) – adherence to basic corporate risk management practices dictates that boardrooms and the business elite cannot dismiss the possibility that dire future climate projections could become a reality.

The reinsurance industry³ – which holds hundreds of billions of dollars in exposures to insurers' losses – has been warning business and government about the potentially devastating consequences of global warming since at least the mid-1990s (cf. Swiss Reinsurance 1994). These admonitions have come with increasing urgency as both the scientific consensus around the anthropogenic causes of present climate change and our ability to make projections about impacts have grown. A number of companies and industry associations have thrown their weight behind several government-run loss mitigation programs and continue actively advocating for adaptation policies as well as emissions reductions. Within the (re)insurance industry itself, increasing concern about the quantification of climate risks has magnified an already-existing trend towards quantitative catastrophe modeling of geophysical hazards for the purposes of pricing and risk management (Grossi and Kunreuther 2005). The adoption of these modeling practices has also entailed a turn towards an increasingly technical workforce; major property insurers and reinsurers are likely to employ numerous PhD-credentialed scientists with hazard-specific expertise. Likewise, many companies are involved in sponsoring a proliferating number of academic climate studies, commissioning research projects, and funding symposiums, university chairs, and PhD students. In short, (re)insurance as an industry has become a hub for climate change risk assessment in an attempt to make climate change impacts insurable, ergo profitable, lines of business. The ways in which the industry is going about this project reveal the constellations of science, value, and fear through which the modern risk industry reproduces itself.

³ The world's major reinsurers underwrite more than a trillion dollars in policy limits for thousands of individual insurance companies across a multitude of policy types, regions, and scales. Insurers seek reinsurance in order to expand their own underwriting capacity and prevent massive claims payments from sending them into bankruptcy. A large part of the risks that insurers attempt to reinsure fall in the property/liability and business interruption sectors, which may also be the most vulnerable to climate change. Hereafter this work adopts the standard shorthand of "(re)insurance" to denote both the reinsurance and insurance industries. There are significant differences between the positions of buyers and sellers of reinsurance coverage, but given that there are a great many instances of firms such as Lloyd's, Berkshire Hathaway, Swiss Re, etc. acting as both reinsurers and insurers (and as retrocessionaires selling reinsurance to other reinsurers), it is not often easy to distinguish between the two.

Attention to this process seems especially important given the extreme visibility and rhetorical power of climate change impacts (Beck 2009; Demeritt 2006; Luke 2008). And as both climate risks *and* our knowledge of them grow, so will the market for new insurance and risk-management products. Beyond its traditional market, the reinsurance industry will gain influence in the larger economy as the pace of environmental change quickens and some regions are faced with potentially massive devaluations of fixed capital and real estate through both catastrophic losses and steady systemic changes.⁴ The industry's analyses and pricing of climate-related risks may in some cases determine which impacts are deemed too costly or too dangerous to ignore, and which are deserving of dedicated adaptation policies. They are also likely to influence which sorts of risks companies and governments feel the need to plan for and insure against. Thus the practice of private climate risk assessment is itself a matter of public concern.

The techniques used for tropical cyclone risk estimation are particularly relevant here, and constitute the dissertation's primary case study. Both academic climate science and popular lay understandings of "global warming" posit some connection between hurricane activity and the warming of the earth's atmosphere and oceans. Following the devastating North Atlantic hurricane seasons of 2004 and 2005 the popular connection between these issues became cemented, regardless of the ongoing vigorous debates within the hurricane science community about the extent to which anthropogenic climate change could be blamed for the observed increase in tropical cyclone intensity and frequency. At the same time, the third-party catastrophe models used by (re)insurers to estimate and price risks were radically revised to use five-year forward-looking projections of hurricane activity derived using expert elicitation. Industry alliances, climate scientists, and think tanks alike began championing model-based risk pricing as the best way to "transmit risk signals" to combat the perverse incentives for coastal development generated by federal and state insurance and disaster relief programs like those "doled out" post-Katrina. (Re)insurers argued that, whatever the cause, windstorm risks were previously underestimated and underpriced, used model results to enact an extraordinary reconfiguration of residential policy coverage across the southern and Gulf coasts of the United States, dramatically raising rates, cancelling policies, and sending hundreds of thousands of homeowners onto the rolls of state-run insurers of last resort. Some reinsurers went so far as to assert direct causal links between climate change and the 2004 and 2005 hurricane seasons, deploying a logic of climate emergency⁵ that supported the popular press narrative of displaced New Orleans residents as the first climate "refugees".

In an attempt to understand this conjuncture of scientific uncertainty, environmental anxieties, and economic imperatives, this work draws on and contributes to three major bodies of scholarship: 1) environmental politics, 2) genealogies of insurance, and 3) geographies of financialization.

2.1 Environmental politics and the critique of science

This logic of climatic emergency raises troubling questions for social scientists attempting to destabilize the apparent "matters of scientific fact" marshaled to consolidate the rule of technoscientific experts and naturalize the existing organization of the economy,

⁴ There are faint rumblings of such recognition emerging with regard to places subject to the most visible (and most easily *visualized*) risks of sea level rise and flood (cf. Stycos 2009; Nicholls, R. et al. 2007).

⁵ On other manifestations of climate emergency, see the brilliant work of Iain Boal (2007) and others (de Goede and Randalls 2009; Dibley and Neilson 2010).

environment, and society (Mitchell 2002; Poovey 1998; Goldman 2005; Harvey 1974). While we critique the unquestioning invocation of scientific expertise – what Shrader-Frechette (1991) has called the “naïve positivist” position – for its foreclosure of democratic debate about environmental governance and risk on the one hand (cf. Forsyth 2003; Demeritt 2001, 2006), we do not wish to deny the existence of anthropogenic climate change or the extremely serious implications it holds for the planet and humanity on the other.⁶ How can we maintain a critical perspective on the relationship between scientific knowledge and power without contradicting our firm belief that climate change constitutes a grave global threat that requires massive political and economic transformations?

This problem has not gone unnoticed. Demeritt claims that climate change science in particular “highlights the problem of trust in knowledge and the expert systems that produce it” (Demeritt 2001, 309), noting that results are often presented in ways that foreclose democratic inquiry into the political values and judgments built in “upstream” in the risk modeling process. Following Latour’s despair given Republican attempts to dispute the existence of climate change via the artificial maintenance of scientific controversy (2004, p 226-7), Demeritt maintains that it is possible to distinguish between “good” and “bad” constructions of science, depending on the extent to which the construction has entailed “reasonableness, honesty, and open deliberation” – which in any case depends largely on the broader political norms governing science and society (Demeritt 2006, p 474).

The form and process of scientific “discovery” and debate about risks thus emerge as critical figures for investigation. Noting that it is sometimes impossible to determine which of various risk models are most objective, Shrader-Frechette (1991) advocates for a “procedural” method of risk evaluation that democratically involves non-experts to help define criteria for risk evaluation and to debate which societal hazards are acceptable. In her seminal study on the authority of scientific expertise in risk regulation, Jasanoff (1990) finds that although governments often attempt to shield fundamentally political choices behind the inscrutable findings or opinions of technical experts, facts and values are always commingled in scientific estimations of risk. The calculative apparatus of private insurance and the use of expert elicitation procedures within catastrophe modeling provokes similar questions about the authority and power of science.

I complement this set of questions – derived broadly from science and technology studies and poststructuralism – with core concepts from political ecology, which emerged in response to the dominant tropes of environmental crises that preceded (and in many ways foreshadowed) the contemporary moment of climate emergency. Political ecology attempts to explain the social and political conditions in which environmental degradation and scarcity are produced. Its scholars have employed Marxist political economy to argue that social relations and political disempowerment magnify environmental degradation, eliminate social and ecological safeguards that might mitigate disaster, and enforce class-based inequalities in resource access (Watts, M. J. and Bohle 1993; Davis 2001). Though the first studies of vulnerability largely treated rural agricultural classes facing famine or soil degradation (Watts, Michael 1983; Blaikie, Piers M. 1985; Blaikie, Piers and Brookfield 1987), this analytic was usefully extended to criticize the prevailing behavioralist treatments of other natural hazards in the social sciences (e.g. Burton, Kates, and White 1993).

⁶ For instance, I suspect Tim Forsyth would be appalled that Michael Crichton cites *Critical Political Ecology* in his novel *State of Fear*, a histrionic diatribe against climate change activism (Crichton 2004, p 589).

The present research proceeds from the premise that the environment is *amplified* as a “hazard” under conditions that are socially and economically produced. Those most devastated by natural disasters are often already in the most economically and physically vulnerable situations, leaving them the least able to prepare for and recover from disaster (Wisner et al. 2004). Recently political scholars have expanded their field of inquiry from the Third World and identified similar dynamics within urban environments of the First World (Davis 1998; Klinenberg 2002; Swyngedouw and Heynen 2003). The logic of exploitation and accumulation not only creates more ecologically vulnerable areas; it also concentrates society’s most disenfranchised people in these locations (Gray and Moseley 2005; Davis 2006). As Hurricane Katrina amply demonstrated, in the U.S. the experience of environmental disaster and suffering is disproportionately borne by low-income populations and people of color, and financial institutions such as insurers reinforce this dynamic (Steinberg 2000; Braun and McCarthy 2005). This also holds for the built environment – while the wealthy can afford to pay to insure properties and businesses, insurance coverage is unavailable or unaffordable for many of the billions of people who live in areas at high risk for earthquakes, floods, and tropical cyclones (Palm 1995; Mosley 2003). The human and financial damages of these natural disasters are intensified by unreliable government damage prevention and relief services and hasty, low budget, or scrap construction that make structures more vulnerable to destruction. This perspective on the differential production of risks refuses the teleological renderings of environmental determinism, scarcity, and violence that have long been the hegemonic explanations of choice for famine and “natural” disasters in general (Lohmann 2005).

2.2 Genealogies of insurance and the production of risk

The institution of insurance, hailed as one of the principle indicators and results of modernity’s triumph over pre-modern notions of fate (Bernstein 1998), has also been identified as a historically necessary condition for industrialization, urbanization, and economic development (Wasow and Hill 1986; Pearson 2004). It is a technology whose genealogy is intimately bound with that of probability, risk calculation, and the constitution of the population as an object of liberal governance (Hacking 1990; Rose 1999; Ewald 1991; Daston 1995). Taking particular political articulations of power, knowledge, and rule as their subject, scholars building on Foucault’s (1991) theorization of governmentality have chronicled the development of life, health, worker’s compensation, and pension insurance (cf. Simon 1987; Defert 1991; O’Malley 2002). As a technology of governance, insurance attempted to break down the opposition between labor and capital by positing risks which cut across class identity. Examining the rise of industrial accident insurance in France, Defert (1991) argues that the development of socialized insurance was a boon for financiers, industrialists, and states alike. It deterritorialized and atomized the social group – thus marginalizing the possibility for working-class solidarity – while simultaneously arranging for society to be the general debtor for individual damages claims. This recalls Marx’s reflection on the 18th century’s great irony – that the most developed and interdependent social relations yet to exist in history produced the ideology of the isolated individual – epitomized in the idealization of Defoe’s *Crusoe* (1993 (1857), p 83-84). Simon (1987) and Ewald (1991) brilliantly show how the notion of individual *fault* was supplanted by that of *calculable accident*, where individual will has nothing to do with final outcomes within a population – the given number of accidents and losses is calculable, the only unknown is who they will befall. Geography and politics are bled out of social relations: “social

factors which might have demanded...political solutions are thus deterritorialized; *all that remains is a multi-directional, class collaborative technique resting on a probabilistic apparatus of expertise inaccessible to the non-specialist*" (Defert 1991, p 231, emphasis mine).

Economic sociologists and historians have shown life insurance to be an institution constantly evolving in the face of changing social and political norms concerning morality, ownership, and responsibility (Zelizer 1979; Knights and Vurdubakis 1993; Clark 1999, 2002; Lobo-Guerrero 2010b). As sociologist and scholar of insurance François Ewald points out, the principles on which insurance technology is based did not "fall from the mathematical skies to incarnate themselves in institutions" (1991, p 198); they were only developed in retrospect, following centuries of diverse insurance practice. From this scholarship, we learn that insured risks have varied in the degree to which they meet all the technical standards for insurability enumerated in theoretical literature and textbooks. Insurers may be willing to cover risks not typically considered "insurable" in the face of heavy competition in traditional markets, or if high investment returns have buoyed their balance sheets.

Property insurance, however, has remained relatively unexamined within this tradition (the primary exceptions being Bougen 2003 and Ericson et al. 2003; not coincidentally, both texts were written in the aftermath of 9/11). And although property insurance has been an enterprise of significant interest to natural hazards researchers investigating settlement patterns, environmental vulnerability, and post-disaster recovery (Burton, Kates, and White 1993; Palm 1995; Wisner et al. 2004; Priest, Clark, and Treby 2005), there has been relatively little geographical consideration of the property insurance industry in terms of either the governmental rationalities it employs or the political economies or ecologies of its operation (but see Sturm and Oh 2010; Lobo-Guerrero 2010a, 2010b).

In this dissertation I argue that the industry's encounter with climate change and scientific research is more than a contingent result of contemporary circumstances and profit pressures; rather, it logically follows from the position that (re)insurance occupies within modern capitalism. The financial mechanism of insurance has long been a central pillar in the global economy's organization of nature and production of value. The guarantee of property and liability insurance⁷ – that potential losses will be covered in exchange for a premium paid in advance by the insured – is fundamental to securing private property and credit and establishing faith between counterparties. This security is a prerequisite for the vast number of transactions that collectively comprise the "global economy": global trade, shipping, construction, manufacturing, transportation, energy production, and so on.

Where, then, should a geographical program of research on property insurance and risk within capitalism begin? It must at least consider the paths already trod by Beck (1992), Giddens (1990), and Luhmann (2005), who lay the groundwork for undoing the utopian evolutionary trajectory of modernization theorists and development institutions. They point out that the number of risks society faces has dramatically increased as a result of decisions about industrial development, militarism, and the management of life – that is to say, risks brought on by modernity itself rather than hazards posed by nature. Furthermore, with increased scientific specialization, there is a proliferation of "known unknowns": the more experts calculate, the more risks are "discovered". In Beck's (1999) World Risk Society, exposure to risks becomes the defining feature of modern life, transcending boundaries of class and nationality.⁸ Risks are global in nature, threatening the privileged as well as the poor and posing incalculable threats.

⁷Including related lines of insurance such as marine (i.e. shipping), aviation, and energy.

⁸ Beck largely ignores the persistence and recursiveness of inequality in the "Risk Society".

Beck specifically imagines “climate change and its consequences” as an example of a spatially and temporally debounded risk⁹ that cannot be managed through the calculative apparatus of insurance (1999, p 4). By this logic, uninsurability itself figures as *the* “autonomic signaling mechanism of the risk society” (Collier, Stephen 2008, p 228), delimiting areas in which manufactured uncertainties have superseded the bounds of rational risk calculation. In Beck’s utopian vision, the proliferation of such dangers should galvanize a cosmopolitan “subpolitics” in which social movements advocate for and achieve the reorganization of society along less risky lines.

Significant debate has followed over the theoretical and empirical validity of Beck’s uninsurability thesis, highlighting numerous techniques by which new and seemingly “incalculable” risks are being rendered insurable and governable (Ericson and Doyle 2004b; O’Malley 2003; Collier, Stephen 2008). The uninsurability thesis also underestimates the insurance industry’s capacity for creative market reconfiguration in the face of spatially debounded catastrophic risks (Ericson and Doyle 2004). This research argues that such creative reformulations are made possible by the industry’s strategic double articulation of threats like climate change as both “risks” for some and “opportunities” for others. In fact, the continued economic existence of the insurance industry as a whole depends precisely upon its perpetual identification and reformulation of new threats as risks and opportunities.

Other scholars of insurance have taken note of how the process of risk identification lends itself to infinite replication. As Defert (1991) has argued with regards to the development of life insurance technologies, “each new risk identified has a new cost... each new protection... makes visible a new form of insurable insecurity... security becomes an inexhaustible market” (215). But whereas Defert associates this multiplication of insecurities with the expansion of governmentality and statistical science in the 19th century, I want to suggest that at least for property insurance, the reproduction of “insurable insecurities” is a byproduct of the competitive and expansionary nature of the capitalist economy. This dissertation takes the case of climate change to trace how such insecurities emerge, how they are made insurable, and how fears about the destruction of asset values ultimately make the purchase of the new insurance product necessary.

The catastrophe modeling of new “emerging” risks provides a complementary case in point. New models now on the market include terrorism, pandemic flu, longevity risk (for life insurers and life insurance-based bonds), catastrophic mortality, and “litigation epidemics”. Like earthquakes at the turn of the 20th century, all of these perils were at one point considered “uninsurable”. All have since been subjected to statistical manipulation and modeling in order to estimate their return periods (the frequency with which an event of a certain magnitude can be expected to recur) and damage curves (proprietary algorithms that model the types and extent of damages resulting from a simulated peril). This is not to say that such events are now well understood. For a number perils, modelers have yet to completely achieve what historian of science Ian Hacking (1990) calls “the taming of chance”, by which individual events are explained in terms of their belonging to a large, statistically regular event set (or population). By definition, catastrophic events fall in the long tail of any such distribution and are so infrequent as to make statistical calculations difficult. But because these calculations are in such high demand by the industrial and financial sectors, modeling firms are engaged in constant competitive processes to produce more models for new regions and new risks.

⁹ Others of which include nuclear power and genetic engineering.

On the other hand, as feminist science studies scholars have asked, what risks remain unmodeled and unseen? Here, the critical ethnographic works of Petryna (2002) on Chernobyl victims, Fortun on Bhopal victims (2001), and Murphy (2006) on female office workers in “sick buildings” provide a useful language with which to interrogate the workings of expertise and risk in vulnerable populations. These approaches probe the historical ontology of risks – how they are made materially present and perceptible by experts, social movements, and state apparatuses – or conversely, why other risks remain within the “domain of imperceptibility”, in Murphy’s terms (2006, p 91). They draw attention to particular paradigms’ methods and models of risk measurement, demonstrating how a paradigm’s choice of tools influences the causal chains and systems of accountability it proceeds to authorize. This approach is particularly generative because it can be dialectically linked with the tools of political economy to examine the workings of knowledge production and governance as they articulate with capital accumulation within the insurance sector.

2.3 Geographies of financialization

The mechanism of insurance has long been a necessary and enabling component of financial capitalism, beginning with the extension of fictitious capital in the form of credit and insurance to spur investment in productive forces, finance national debts, and underwrite trans-oceanic movements of resources, commodities, and bodies. Credit – particularly extended in the form of marine insurance arrangements – has remained a crucial device for the geographic expansion and defense of markets from the days of the Genoese Mediterranean (Arrighi 1994). In the contemporary world of globalized capitalism, Leyshon and Thrift (Leyshon and Thrift 1997, p 121) attribute similar agency to insurance firms. They argue that the investment of insurance companies’ and pension funds’ massive capital reserves drove the emergence of the new international financial system and shaped urban and regional development (on pension funds, see also Clark 2000). While their investment divisions were organizing a global expansion, insurers’ underwriting divisions developed increasingly selective micro-rating practices (Squires, G 1997; 2003; Detlefsen 1997) that have contributed to a growing spatial patchwork of insured and uninsured properties and populations.

Insurance – as both a global industry and a theoretical concept of risk transfer – was also deeply enmeshed in the production of the global financial crisis. Though the proximate causes for insurers’ sales of credit default swaps (which infamously devastated AIG and hamstrung reinsurance giant Swiss Re) have been documented, the evolution and nature of the relationship between financial markets and insurance have received little attention from geography. The increasing interdigitation of these sectors and technologies is emblematic of the rise of “financial risk” – rather than money per se – as a unit of exchange within capital markets. Trading “exposure” or contingency, the mere *potential for loss* of exchange value, has increasingly become the basis of transactions.

Though the techniques of catastrophe modeling, the concept of “financial risk” is being mapped onto phenomena as disparate as epidemics and seismicity, demographics and meteorology – explicitly for the purpose of commensuration in the market. At the very least, this suggests a great deal of political work in action to transform ideas of responsibility, liability, and acceptable sources of profit (de Goede 2005). If the techniques of insurance operating through the calculus of probabilities represent “a schema of rationality, a way of breaking down, rearranging, ordering certain elements of reality” (Ewald 1991, p 199), then catastrophe models

are preeminent tools in the contemporary dismantling and rearranging of risk (following Bryan and Rafferty 2006; Martin 2002, 2006). Other scholars have suggested that cat modeling is a powerful technique for making uncertain environmental futures imaginable and governable (Collier, Stephen 2008; O'Malley 2003; Randalls, Samuel 2009). While seconding these arguments, this research also emphasizes modeling as a tremendously successful sociotechnical style of reasoning that renders these contingent futures *exchangeable* in the market.

The practice of building and running these models thus constitutes a “geography of asset creation and destruction” (Lee et al. 2009, p 740; see also Pike and Pollard 2010). This suggests a role for them in the production and reproduction of space, particularly in light of the expected doubling of global catastrophe reinsurance capacity, from US \$205 billion in 2009 to \$410 billion in 2019 (Swiss Reinsurance 2009, p 41). If the dynamics of capitalist investment and disinvestment tend to treat the globe as an uneven “profit surface” (Smith 2008 [1984], p 197), then the (re)insurance industry’s catastrophe models are tools of significant importance in plotting the topography of this surface and determining which “regionalization[s] of value” are worthy of investment, and which offer either insufficient returns or inordinate risk (Leyshon and Thrift 2007, p 103).

Credible risk estimation is only possible due to the ongoing technical development of catastrophe modeling capabilities for specific perils. Originating in the late 1980s and early 1990s, cat models have become *the* dominant risk assessment methodology in property/liability insurance and reinsurance. Following staggering losses from hurricane Andrew in 1992, it became clear that methods of writing business using underwriters’ prior experience and estimations were woefully inadequate. Computationally intensive models began to be more widely used to estimate possible losses and produce “actuarially fair” risk prices for property coverage. In the case of hurricanes, for example, models produce thousands of simulated storm tracks, wind speeds, and precipitation intensities (the “hazard module”). These attributes are then matched to estimated damage curves for specific building stock in the given region (the “vulnerability module”), and finally used to generate loss estimates by analyzing the specific geographical distribution, structure of reinsurance contracts, and size of the (re)insurer’s portfolio (the “financial module”) (Grossi and Kunreuther 2005). Catastrophe models are instantiations of the sort of new computational and geographic technology that Leyshon and Thrift argue have emerged in lockstep with the “capitalization of almost everything”, to “make new classes of risk and new geographies apparent” (Leyshon and Thrift 2007, p 107).

The particular terminology of catastrophe risk modeling itself requires some explanation, insofar as it invokes and creates a shared set of meanings that can be applied across perils. Indeed it is actively cultivated as an extension of language itself, as the director of research at one modeling firm demonstrated in a presentation to clients: “The grammar of cat modeling is like a sentence... it’s actually deeply structured into how we think.” But observation of industry forums and regulatory debates indicate that this grammar is always a work of translation, and always *in formation*. Drawing on Luhmann (1989), Robertson (2006) has nicely interpreted a similar kind of scientific translation afoot in ecosystem services assessment: “Because each specialized knowledge system has established unique standards of proof and verity, ecological information can never enter into legal or capital logics qua ecological information. Instead it must be translated into speech and codes appropriate to law and capital by people who occupy forums of articulation” (p 370).

Formalized speech and codes turn myriad geophysical and biological phenomena into “the nature that capital can see” (Robertson 2006, p 368-9). Model results are typically presented

in terms of “expected loss”; that is to say, the likelihood that losses from a given event (or, for “annual expected loss”, losses within any given year) will meet or exceed a certain amount. The expected loss is the inverse of the “return period”, the projected number of years between events of a certain magnitude. These estimates are typically presented in the form of an exceedance probability curve (see **Figure 1.2**). A “1% expected loss” of \$150 billion for U.S. hurricane, for instance, means that the model in question projects that a hurricane that causing industry-wide losses of \$150 billion will make landfall in the U.S. *on average* every 100 years (by comparison, insurance industry losses from Hurricane Katrina were just over \$40 billion). The expected loss also figures in the calculation of the “risk multiple”, a term expressing the expected excess return (profit) divided by the expected loss. Financially, return period estimations are extremely impactful, since they drive regulatory and ratings agencies’ evaluations of companies’ collateral and reserves – usually based on an analysis of a 1-in-250 year loss. In making diverse catastrophe exposures fungible, financial risk itself seems to gain ontological status. The process bears an extraordinary resemblance to Marx’s account of abstraction, commodification, and fetishization in Volume 1 of *Capital* (1967 (1867)).

Of course, this sort of intricate (and one might add “infinite”) exercise in quantification only operates in one very specific register – that of money. Marx’s “universal equivalent” appears as both the subject and the object of modeling transactions time and time again, establishing a conceptual hegemony over the idea of catastrophe risk itself. Insofar as models are able to estimate loss of life, illness, or injury, these quantities are relevant only to the extent that these lives are insured (through life insurance, workers compensation, etc). The probability of monetary loss, that is to say, financial risk, is the only metric that is logically *relevant* and *commensurable* to the (re)insurers, investors, and ratings agencies who are the consumers of model results. The elision of other socially and politically relevant consequences of natural catastrophes is a matter of course. Likewise, money is the only plausible recompense to those who have suffered a loss. This is what Ewald devastatingly terms the “dualization of the lived and the indemnified”: “the practice of... insurance constantly attests that everything can have a price, that all of us have a price and that this price is not the same for all” (1991, p 204). This is perhaps another way of making the point that the practice of insurance continually reinscribes social differentiation and inequality among populations and landscapes.

3. Risk theory and implications for methodology

The register of “risk” has become something of a master narrative through which the contemporary moment is articulated, particularly in relation to finance and everyday life (Hacker 2006; Martin 2002; Power, Michael 2004, 2007). And perhaps in reaction to the expansion of financial risk into all corners of life, academic scholarship seems to me to have attributed all sorts of contradictory abilities and properties to it. Among many other instantiations, risk has been figured as a new form of money (LiPuma and Lee 2004), a method of differentiation and accumulation (Martin 2006), a mode of rule (O'Malley 2004) and a device for biopolitical securitization (Dillon 2008). But this conceptual flexibility of application may come at the expense of analytical precision about the social and material relations that configure specific risks as such. Many discussions of the role risk plays in mediating relationships between individuals, capital accumulation, and rule seem to resort to either high abstraction or anecdotalism. This is particularly problematic given that much of this work aspires to theory-building. This is asking the concept of “risk” to do too much on the one hand, while leaving

some of the sources of its ideological potency unexamined on the other. It is in relation to these tendencies that the current work endeavors to keep the scales, geographies, and precarities of insurance risks within its analytical field of vision.

Contra Beck's (1992, 1999) position that contemporary being is defined by a "world risk society" in which objective material threats (of our own industrial creation) exist outside our means of ordering and explaining them, this research proceeds from the position that risks - be they environmental, financial, or both - are always mediated by social relations. They are actively constructed through relations of knowledge and power, which influence how subjects, environments, and institutions bear or embody the particular risks of interest (Baker and Simon 2002, Ericson et al. 2003, Zaloom 2004). In examining the new configurations of risk, expertise, and responsibility operating in coastal property insurance, I apply Luhmann's notion that risks are *reconstructed phenomenon of multiple contingency*, "not facts!", which always embody contested classificatory and causal stories (2005, p 15). This allows me to direct critical attention to the ways in which (re)insurance expertise has singled out particular causal chains among many and made them resonate in the popular imaginary.

Crucially, eschewing absolutist definitions of risk does not necessitate a theory of extreme social constructivism, nor a theory that posits the intentional manipulation of expert knowledge on the part of industry. In this context, Haraway's notion of situated knowledges is of more use: objective knowledges must always be situated and *partial*, in that they come from and acknowledge their own positionality and contingency (Haraway 1988). All knowledges are a view "from somewhere", but this does not disqualify the visions so produced from a claim on objectivity. This insistence on situatedness and *place* brings a politics and ethics back into knowledge production, and "allows us to become answerable for what we learn how to see" (p 583). Methodologically, this position allows me to reconstruct certain sets of proprietary knowledge, beliefs, and business practices, opening them to critical analysis without necessitating or implying special access to some absolute yet secret industry truth.

3.1 Methods

The design of the research attempted to answer Baker and Simon's call for a sociology of insurance and risk that traced the development of insurance institutions and definitions of risk over time, while charting the intended and unintended effects of risk management (2002). I carried out the research between 2006-2010 in the U.S., U.K., Germany, and Switzerland, employing a diverse set of qualitative methods. I gained general knowledge of contemporary debates and major players in catastrophe modeling, hurricane science, and the reinsurance industry through non-participant and participant observation¹⁰ at thirteen academic, regulatory, and industry conferences.¹¹ Such meetings are key arenas – forums of articulation, in Luhmann's

¹⁰ At industry conferences, observation nearly always became participation, as I was quickly drawn into catered dinners, cocktail hours, electronic group-based audience surveys, and other activities in which my presence shaped the conversations that followed. At the Hurricane Science for Safety Leadership Forum, I was very much thrust into the role of participant observer, as I gave a brief presentation on my research and took part in the group's guided tour of the "Stormstruck Experience" at Epcot Center, Disneyworld (see Chapter 6).

¹¹ Conferences and meetings observed included the Hurricane and Tropical Meteorology Meeting of the American Meteorological Society, Monterey, California, 2006; the Annual Meeting of the American Meteorological Society, New Orleans, Louisiana, 2008; the American Geophysical Union Annual Meetings, San Francisco, 2006, 2008, 2009, and 2010; the National Association of Insurance Commissioners Fall Meeting, Washington, D.C., 2007; the Risk Management Solutions annual client conference, Scottsdale, Arizona, 2008; the EQECAT annual client

terms (1989) – in which climate-related risk is debated, negotiated, and gains purchase. Once established, narratives are constantly reinterpreted and adapted into larger scientific, political, and economic projects. Observations stretched over a number of years proved critical to mapping how translations from science to industry practice occur.

In order to understand how hurricane-related climate change risk emerged as a subject of concern to (re)insurers and catastrophe modelers, I found it important to engage with both industry players and the academic climate scientists whose work they employ – or in some cases, ignore. To this end, I conducted 42 extended interviews and a great many more informal conversations with employees of catastrophe model vendors, reinsurance underwriters, reinsurance cat modelers, reinsurance brokers, insurers, catastrophe bond fund investors, academic climatologists,¹² and meteorologists.¹³ Interviews took place in London, Munich, Zurich, San Francisco, and Orlando, as well as over the telephone, and typically lasted 60 to 90 minutes.¹⁴ Interview recordings were then transcribed and coded to identify common themes and emergent tensions between responses. In several cases, I returned to interview the same respondent a second time. In order to protect the identity of some interviewees who wished to remain anonymous, for the sake of consistency I have made the decision not to identify any informants by name, even if they granted permission to be identified.

A final qualitative method entailed the ongoing review of a huge quantity of industry literature including corporate reports, white papers, industry newsletters and weblogs, press releases, and regulatory transcripts. I also spent several days with the corporate history group at Swiss Reinsurance in Zurich collecting materials from the company archives. Originally, more quantitative and spatial analysis of homeowners' insurance data was envisioned, but the lack of access to disaggregated granular census data (due to privacy laws) made this work untenable. Chapter 6 presents a few statistical descriptors of the south Florida population and the relationship between income, property value, and insurance expenditures, but spatial analysis of inequality and insurance expenditures could not be operationalized.

5. The plan of the work

I follow several convergent paths to investigate the dynamics of knowledge production and value creation emerging as the risk industry seeks ways to measure and manage the impacts of climate change. Chapter 2 discusses the history of modern property insurance, its centrality to the development of capitalism and urban environments, and the contemporary uneven geographies of insurance coverage. It then presents the central contradiction of the catastrophe reinsurance market, which requires the continual recurrence of catastrophic losses in order to

meeting, San Francisco, 2010; the Hurricane Science for Safety Leadership Forum, Orlando, Florida, 2008; the Standard & Poor's Insurance Linked Securities Summit, London, 2009; the Insurance Futures Exchange briefing, London, 2009; and the Reinsurance Association of America's catastrophe modeling conference, Orlando, Florida, 2010.

¹² Special emphasis was placed on interviewing scientists who had served in advisory roles to (re)insurers or on expert elicitation panels for Risk Management Solutions, as well as those whose research has been funded by reinsurers or brokers.

¹³ Because respondents came from such a wide variety of occupations and positions within the industry and academia, no single list of interview questions could be used. Sample questions appear in Appendix A, although these by no means cover all respondents and conversations were allowed to flow freely.

¹⁴ Appendix B contains a table of interviews, years, and locations.

sustain pricing and accumulation in the long term. I explain price cyclicality as an outcome of this dynamic.

Chapter 3 assesses how the prospect of climate change has been understood and represented by the industry and academic climatologists, particularly in relation to North Atlantic hurricanes. I highlight the open questions and debates within the academic field, which notably contrast with the industry's portrayal of the relationship between climate change and hurricanes as an established matter of fact. Finally, I consider how this "matter of fact" has been successfully maintained despite the internal lack of consensus within the industry itself.

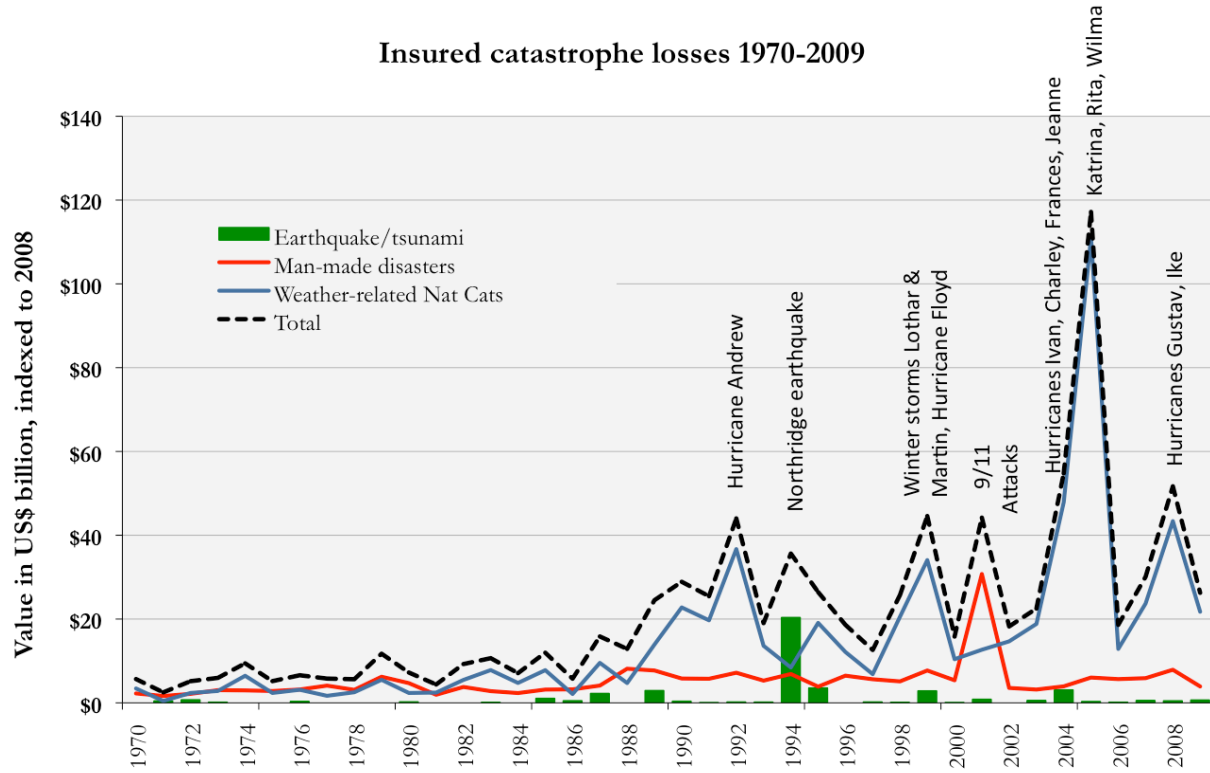
Chapter 4 turns to the apparently confounding finding that most (re)insurers do not currently account for climate change in their daily business practices and discusses the epistemological and political economic factors that may explain this discrepancy. From these, I draw out some conclusions about the relationship between climate fears, property value, and scientific knowledge, proposing that the (re)insurance industry expands through the multiplication of fears and values, which ultimately necessitate the purchase of the new insurance products.

Chapter 5 examines the ways in which more mobile financial capital has begun to access new risk premiums from the insurance sector through the insurance-linked securities market and catastrophe bonds in particular. I argue, *contra* popular explanations, that this market should be understood as a strategic and selective attempt to capture "returns on place" by financial capital, rather than an "escape" from place on the part of (re)insurers. I raise concerns about the ways in which insurance-linked securities are being championed as ideal instruments with which to capitalize on the "opportunities" generated by climate change, particularly since the business model used to grow the mortgage-backed securities market, "originate to securitize", is now being seriously proposed in the catastrophe bond market.

Chapter 6 connects the debates about hurricane risk and climate change adaptation to the politics of coastal governance in Florida. I consider how post-Katrina transformations of catastrophe modeling methods have transformed the availability and affordability of residential property insurance and show how models have been made to articulate with a particular mode of neoliberal governance through private insurance markets. This strategy invokes market-based "transmission of risk signals" to reform risky freeloaders into responsible homeowners. Using census population data on Southern Florida, I suggest the profound limitations and anti-democratic implications of such a politics.

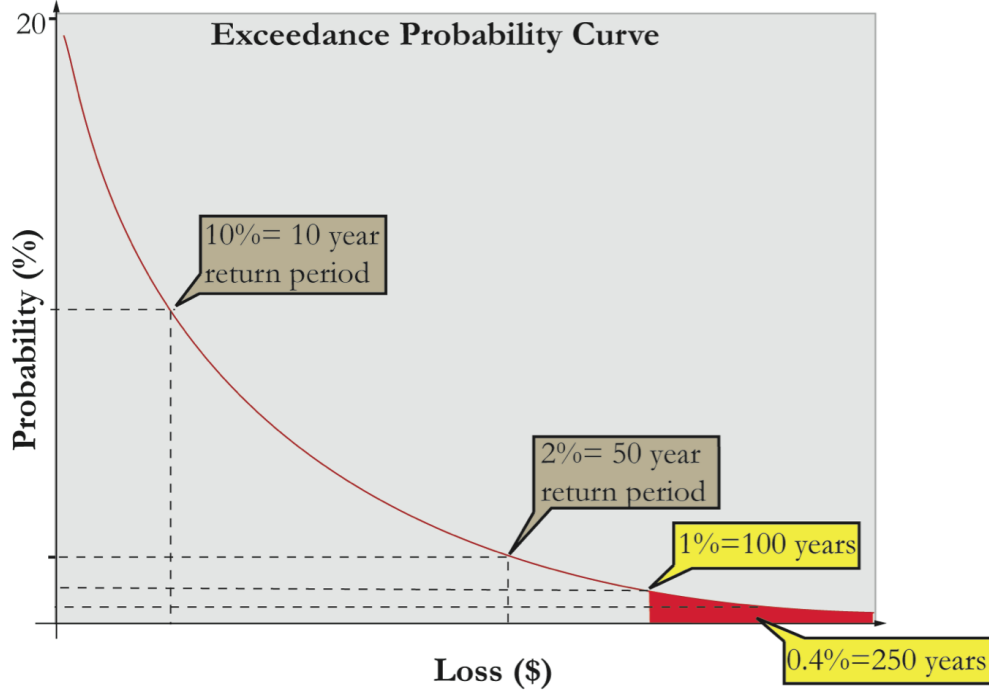
The conclusion returns to the eternal necessity of uncertainty and catastrophe to sustain the reinsurance industry. I consider how the threat of climate change may buoy the industry's business prospects in the short term by providing the opportunity to exclude certain climate risks from all-perils coverage and repackage them into new products. Finally, I argue that the problem is not that we fear climate risks too little – as the "responsible homeowner" paradigm would have it – but instead that environmental anxieties are organized and managed through market mechanisms in the first place.

Figure 1.1



Data from Swiss Re (2010b)

Figure 1.2



CHAPTER 2: Property insurance in modern capitalism

“We would say that more or less everything is insurable.”

– Director of Emerging Risks division in a major international reinsurance company, 2009

To understand the significance of the contemporary insurance industry’s figuration of climate change, we should first step back to examine the basic political economic framework of the industry, its history, and its predominant business models. The first half of this chapter examines the set of exchanges and agreements that constitute the archetypal form of property insurance and demonstrates how this form was fundamental to the development of modern capitalism and its built environment. It traces the development and refinement of insurance through the periods of merchant capitalism in early modern Europe, urbanization accompanying the Industrial Revolution, and the rise of international financial networks at the turn of the 20th century. The second half of the chapter turns to the dynamics and uneven geography of the contemporary insurance industry, paying particular attention to the disparities between the locations of extreme human vulnerability and highest insured economic losses. I conclude with an examination of the problem of cyclical pricing that plagues the insurance industry. I argue that this paradoxical situation, in which the industry as a whole finds itself actively *hoping* for a catastrophe in order to raise average price of coverage, reveals a fundamental contradiction between the value-preserving purpose of the insurance form and the *devaluation* of real property necessary to sustain accumulation within the insurance industry.

1. The historical development of property insurance within capitalism

Despite the fact that most individuals in developed economies are familiar with the institution of private insurance in one form or another, surprisingly little has been written about it. Critical geographers and social scientists more generally have tended to neglect the significance of insurance within the political economy of global capitalism. As international political economist Susan Strange wrote fifteen years ago:

The business of insurance plays a growing and important part in the world market economy. Those who supply it are not seeking power over outcomes – but they exercise it nonetheless. And increasingly so. Yet it is hardly mentioned in texts on world politics; and in economics, the study of insurance is dominated by a few informed specialists, most of whom are ideologically committed to the value judgments of economic liberalism... For fifteen years I have waited, in vain, for someone to write a definitive analysis... of this highly transnational business. (Strange 1996, p 122)

Fortunately, there have since been quite significant studies published (Baker and Simon 2002; Ericson and Doyle 2004b; Ericson, Doyle, and Barry 2003), but these have primarily adopted a sociological framework to analyze private insurance as an institution of indirect governance, surveillance, and social control. And although this analysis is particularly compelling in the era of neoliberal reforms (a topic to which I return to in Chapter 6), it does not attend to the global geographical dimensions of the insurance business to which Strange alludes.

In one form or another, the institution of property insurance has attempted to provide

security against the loss of assets since the birth of the capitalist world economy. The proliferation of various types of these private arrangements over the centuries has perhaps made the private insurance transaction seem like a natural matter of course. But the widespread exchange of money for a guarantee of future financial security developed in response to a set of logistical problems posed by a very specific organization of economy and society at a particular time and location; namely, problems raised by merchant trade in early modern Europe.

The centrality of the private insurance mechanism to the development of early capitalism is worth considering insofar as it lays the groundwork for this chapter's discussion of the risk industry's role in the maintenance of value. Lopez (1976) considers the development of marine insurance and marine law as one of the most significant drivers of the "commercial revolution" culminating with the 14th century, alongside other "inventions" such as credit, navigational aids, and the improvement of shipbuilding. Formal marine insurance contracts appeared in the 13th century and achieved significant scale by the 14th, as traders in the hubs of merchant capitalism developing around the Mediterranean sought guarantees of financial security for their investments and transactions (Lopez 1976; Lane, Frederic 1973). Vessels and their cargo were commonly lost to storms, shipwreck, and piracy; poor shipbuilding and inexperienced crews made matters worse. Ewald (1991) claims that the word "risk" itself is a neologism of insurance technology, derived from the Italian word referring to the damages done by reefs to ships in the maritime trade.

Since sea trading already relied upon credit and bills of exchange, bankers were well positioned to enter the market providing maritime insurance for voyages. They acted as both deal brokers and underwriters, with Genoese and then Venetian bankers dominating the early market. Likewise, the first reinsurance contract was signed in Genoa to redistribute some of the risks for an insured voyage from Genoa to Bruges (Kopf 1929, p 26). By the 15th century marine risks were shared broadly between the banking classes; under the *per parte* ownership system, a single vessel could be owned by dozens of shareholders spread throughout the Mediterranean. Venetian brokers could obtain dozens to hundreds of underwriters for a single voyage. This practice was in fact the origin of the term "underwriter": the merchant purchasing cover would state his wares, ship, and amount of insurance cover desired on the contract, and the broker then circulated the form to other individual bankers, who would write underneath this statement the amount of the total they would insure and for what price (Lane, Frederic 1973).

This general system of marine insurance was later replicated by the Dutch and then the British, and organized around the financial centers of Amsterdam and London. By around 1700, the Dutch had for the first time developed a specialized insurance sector with full-time brokers, underwriters, and dedicated companies (Braudel 1992). This was the era of Dutch hegemony over sea routes and their resultant control over the new mass commodity trade in tea, coffee, sugar, spices, and cotton. European trade rivals – in particular Britain – sought to expand their empires and bring ever-larger peripheries into exchange relationships.

As the scale of European imperial ventures expanded, so did the necessity of insurance. The length of voyages in the open ocean grew, exposing ships to new hazards like cyclones and leaving them less defensible against piracy. The value of the cargo itself was also mushrooming. Insuring the value of ships and cargo – among it slaves, bullion, finished goods, and raw materials – became ever more critical to the maintenance of trade and financial capital flows (Baucom 2005). Multipurpose maritime loans made to fund voyages or purchase commodities abroad could themselves be insured should the borrowers' fleet suffer irreparable losses (Braudel 1992). The extension of credit, the purchase of insurance, and the expansion of Europe's

imperial footprint were inseparably bound.

It was within this context that Edward Lloyd's coffeehouse began operating in London in 1688 and soon became a meeting place for bankers, brokers, merchants, and ship captains. Patrons exchanged news on ship arrivals and departures, merchants and brokers solicited wealthy individuals to underwrite cargos, and ships' captains "compare[d] notes on the hazards of all the new routes that were opening up – routes that led them farther east, farther south, and farther west than ever before" (Bernstein 1998, p 90). It is fitting that all of these activities took place over coffee, the newly popular commodity from the Near East and North Africa, whose supply was wholly dependent on increasingly globalized trade networks, the expansion of exchange relationships, and later, the colonial organization of nature and labor in the plantation system.

In short, the modern form of private insurance and the information sharing necessary to establish trust and capital for underwriting were part and parcel of the expansion of the European world-economy, and were likewise absolute necessities for the sustained accumulation of capital within Europe. In his searing account of eighteenth century finance and the Atlantic slave trade, Ian Baucom points out the peculiar ontological "magic" performed by insurance that made it so critical to the expansion of finance capital: "Insurance thus does not confer a monetary value upon lost things, it sets the money form of value free from the life of things... Absent the security insurance provides, finance capitalism could not exist. The world of things would stage its revenge on value each time some object or another was destroyed, would refasten value to embodied things and make one as mortal as the other" (Baucom 2005, p 96). In less elegant terms, we might say that the insurance mechanism ensures that capital is not tethered to the final fate of the particular earthly goods in which it has been invested, and is instead connected to them only through the universal equivalent of the money form – which is to say, through their exchange value. Insofar as this was true, an investor's loss could always be compensated by monetary remuneration. Thus insurance's promise of abstract security removed much of the typical reluctance that accompanied any proposal to transact business in an unfamiliar and potentially dangerous environment.

The magic of property insurance extended beyond the world of maritime trade to fixed capital investments in the built environment. Insuring fixed structures in the built environment has been a core function of the private insurance industry since the inception of fire insurance in the decades following London's Great Fire of 1666. The growth of the fire insurance industry in the 18th century accompanied and facilitated the urbanization of the Industrial Revolution. Later, insurers' begrudging extension of fire coverage to new skyscrapers in the early 20th century influenced the construction practices, skylines, and real estate markets of contemporary cities.

In the nascent urbanizing centers of the 18th century, stores, factories, warehouses, and residential structures clustered tremendous property values in close proximity. Wooden construction made cities tinderboxes for fire, which could spread rapidly from one building and block to the next, decimating a city's economy and housing stock. "As the century progressed, new sources of combustion hazard appeared and there were novel, larger and more complex risks in the shape of new machinery, processes and materials to insure" – docks, mills, sugar refineries, and breweries among them (Pearson 2004, p 4). Fire insurance thus provided some assurance to industrialists and merchants that large investments in new machinery, technology, and commercial goods would be compensated in the event of a conflagration (Kopf 1929). For this reason, some economic historians have suggested that fire insurance may have been an important facilitator of the technological and commercial innovations of the period (Pearson 2004). But insurance companies could do little to change the fundamental vulnerability of urban

built environments to fire,¹ and the total accumulated value of claims from major city fires often far exceeded the financial capacity of direct insurers, forcing them into bankruptcy.

The new institutional form of *reinsurance* was deliberately developed in response to the problem of urban fire, which was financially crippling for direct insurers due to the *simultaneous* and *extreme* nature of losses incurred across a large number of properties in one location. Thus began the first cohort in a long line of reinsurance ventures launched in the “hard” markets that typify the property insurance sector in post-disaster periods. The first dedicated reinsurer (Cologne Re) emerged in 1846 in the aftermath of the Hamburg fire of 1842. Swiss Re was founded in the aftermath of the 1861 Glarus fire, and the great fires of Chicago (1871), Boston (1872), Baltimore (1904), Toronto (1904), and San Francisco (1906) continued to demonstrate the importance of developing further insurance and reinsurance capacity, particularly in the U.S. where the sector was still in a “rudimentary state” (Kopf 1929, 60). For instance, 35 insurers went bankrupt as a result of the Chicago fire, leaving half of the \$168 million dollars in losses unrecoverable (Guatterri, Bertogg, and Castaldi 2005, p 12).

Reinsurance companies had larger capital bases and cultivated more geographically dispersed risk pools. From their inception until the rise of Bermuda reinsurers in the 1990s, reinsurers were inordinately concentrated in Europe, particularly in Germany and Switzerland – still home to the world’s two largest reinsurers, Munich Re and Swiss Re. But firms depended on international business from very early on; indeed the principle of diversifying catastrophe risk as widely as possible by definition requires a global strategy. In its first three years in business, Cologne Re expanded beyond Germany to write reinsurance treaties in Austria, Switzerland, Belgium, Holland, and France. Founded in 1880, Munich Reinsurance had launched offices in London by 1890, soon after which it expanded to write treaties in the United States. By 1913, 69% of its business came from foreign sources (Kopf 1929).

“Modern” catastrophe reinsurance coverage, including that for tropical storms, winter storms, and earthquakes, arguably has its roots in the fallout from the 1906 San Francisco earthquake and fire. Of the \$350 million in damages (roughly \$7.7 billion today), insurers and reinsurers paid \$235 million to settle claims. The event created a market for earthquake insurance where none had previously existed. Earthquake coverage had typically been excluded from property (re)insurance because – like other large natural catastrophe perils – it was considered uninsurable. But after many (re)insurers survived the disaster despite paying out enormous sums, some companies reconsidered its business potential and began writing California earthquake coverage as a new line of business (Freeman 1932; Guatterri, Bertogg, and Castaldi 2005).² This episode neatly complements Henderson’s (1999) study of California and “the fictions of capital”, in which he contends that the financial industry is particularly adept at creating a profitable role for itself in natural disasters, often functioning to fill the gaps in accumulation generated by catastrophe.

¹ Although there were efforts to establish rudimentary building codes and fire prevention practices after the 1666 fire (Pearson 2004).

² The difficulty in adjusting and settling claims following the disaster was acute, particularly because so many buildings carried layers of coverage from different insurers with conflicting policy provisions and exclusions. Claimants and insurers clashed over what portion of damages had been caused by the earthquake (in which case they were excluded) versus the conflagration that followed. After a great deal of confusion, most insurers adopted a common policy of paying all claims for buildings consumed by the fire unless there was clear evidence that the property had been completely destroyed by the initial quake. Most reinsurers (the majority of which were foreign firms) eventually agreed to pay out and “follow the fortunes of their cedents” (Guatterri, Bertogg & Castaldi 2005).

The fact that insurers began actively pursuing the earthquake market for its particular hazard profile in the decades following 1906 exemplifies a familiar pattern in which risks once thought to be unmanageable become tractable in light of new technologies and assignments of financial responsibility. As Ewald puts it, something that once “seemed impossible to insure later becomes possible thanks to the progress of insurance technology, via coassurance or reinsurance operations” (1991, p 200). It is telling that these reorganizations tend to take place at times in which both hazard-related fears and agglomerations of value are growing. To return to the quotation with which this chapter began, from the director of the emerging risks division at a major international reinsurer: given the right conditions, “more or less everything is insurable”. And if it is not, it must be *made to be so*, as he explained: “you must be constantly assessing and expanding the number of risks you are willing to write, because if you don’t, insurers end up retaining them and your business shrinks and eventually you cease to exist” [i27]. This constant search for new sorts of exposures to commodify is necessary if reinsurance, as a sector of financial capital, is to maintain its hold on premium streams that would otherwise accrue to smaller, more segmented pools of primary insurance capital, or remain outside the financial circuit altogether.

2. The contemporary landscape of insurance

Today, reinsurance coverage is still the primary mechanism by which property insurers survive extreme losses to natural catastrophes.³ Insurers typically purchase a number of layers of coverage from different reinsurers, each with different attachment and exhaustion points. In the example reinsurance program diagramed in **Figure 2.1**, four separate reinsurers are contracted to cover different “layers” of the direct insurer’s losses. The figure demonstrates how all five companies involved are financially exposed to the catastrophe risks that the direct (primary) insurer takes on in its book of business. Similar reinsurance programs are brokered for many thousands of direct insurers globally, each with varying geographic concentrations of exposure to different perils. Reinsurers also sell reinsurance coverage among themselves; that is to say, Reinsurer B may have also purchased \$50 million in *retrocession* cover from Reinsurer D that triggers once B’s ultimate net losses exceeds \$500 million.

Today, residential property insurance coverage in the U.S. generally includes losses due to fire and wind/snowstorm damage, but excludes flooding (covered by the National Flood Insurance Program) and earthquakes (policies are administered separately, usually by states in conjunction with the private sector). In some especially hurricane-prone states such as Florida, wind coverage is sometimes specifically excluded from homeowner’s policies or sold separately. Commercial property coverage typically includes flooding and windstorm damage.

In 2009, globally insurers collected US \$4.1 trillion dollars in premiums for all lines of coverage, equivalent to seven percent of world GDP. Over 40 percent of these premiums were for “non-life” coverage, including property and liability insurance (Swiss Reinsurance 2010d, p 5). With such enormous financial weight, one might expect the industry’s footprint to cover most of the globe. On the contrary, the bulk of insurance and reinsurance coverage collects in a very select group of nations, *within* which it agglomerates in quite specific, highly developed locales. Among financial industries, insurance is noticeable precisely because it does *not* race recklessly

³ Globally, around eleven percent of premium income from non-life primary insurance business is ceded to reinsurers (Group of Thirty 2006, p 18).

around the globe, but often remains confined by state regulation and existing spatial patterns of accumulation.

The first step to elaborating a geography of insurance is an examination of highly insured spaces and their underinsured counterparts – the global spaces of uneven development in insurance underwriting. The vast majority of insurance coverage lies in the most industrialized countries; the United States alone was the source of 37% of global non-life premiums in 2009 and OECD countries as a whole accounted for 86%.⁴ **Figure 2.2** is drawn from Swiss Re’s report “World Insurance in 2009”, and charts these premiums by region. One common metric used for comparison is *insurance density*, defined as the total premiums collected per capita. The Netherlands boasts the highest insurance density (life and non-life combined) totaling more than \$6,500 per capita. The eight highest insurance densities are all found in European countries; Japan (\$4,000) and the United States (\$3,700) rank ninth and tenth, respectively. The global average insurance density (for the 88 countries reported) is an order of magnitude lower, at \$600. **Figure 2.3** charts insurance density for both life and non-life coverage, as well as *insurance penetration*, defined as the total premiums collected as a proportion of national GDP.

At the other extreme, the paucity of insurance coverage in the Global South is startling (see **Figure 2.4**). At five dollars per capita, density in Bangladesh is the lowest of the eighty-eight nations included in Swiss Re’s report, followed by Pakistan and Nigeria at around six dollars. This explains how miniscule the insurance payments were for Pakistan following the devastating monsoonal deluge of 2010, which lasted from July through October and left 2,000 people dead and 6 million homeless. Of the estimated \$6.4 billion in economic damages, only \$100 million were insured. Predictably, the most dramatic lacunae in insurance coverage cluster in Africa, Southeast Asia, and parts of Latin America. The lowest density average by region is found in Africa, at \$49 per capita (a number buoyed enormously by South Africa’s disproportionate contribution of \$735 per capita).⁵

The severity of any particular catastrophe varies according to which metric—fatalities or insured losses—is used. The largest insured loss remains Hurricane Katrina, at over \$72 billion (not including National Flood Insurance Program losses). Of the top ten insured losses to catastrophes from 1970 through 2010, nine were driven by US exposures, seven of which were U.S. landfalling hurricanes.⁶ When the worst catastrophes are measured according to fatalities, however, an entirely different geography emerges. With the singular exception of Japan’s Kobe earthquake, which killed over six thousand people in 1995, none of the top *forty* most deadly catastrophes reappear on the list of forty most costly insurance losses (Swiss Reinsurance 2011, p 32-33). And it is far from a coincidence that Bangladesh, which ranks last in insurance density, leads the list of global fatalities due to natural disasters. The country was utterly decimated by a

⁴ Data for this section primarily comes from the Swiss Reinsurance Economic Research and Consulting group; the 2009 insurance statistics can be found in table form in Swiss Re (2010a, p 5-14); some data can also be downloaded at www.swissre.com/sigma/. The Swiss Re figures are the most widely referenced figures in the industry, as no international regulatory body collects and standardizes these figures. Swiss Re’s team collects global data, authors a tremendous number of publicly available technical reports, and publishes statistics. More granular data sets (of the sort that would be valuable to insurers) are available for purchase.

⁵ Small Pacific island states and most post-Soviet republics go entirely unmentioned in the report, a sign that they are perhaps even less insured than the countries identified by name.

⁶ This statistic will most definitely change in 2011, driven by the Japanese earthquake and tsunami and the Christchurch, New Zealand earthquake. At the time of this writing in March 2011 it was too early to estimate insured losses with much precision, but modeling firms’ estimates for Japanese insured losses ranged from \$15 to \$30 billion; for New Zealand from \$8 to \$15 billion.

tropical cyclone and flood in 1970, which left 300,000 dead.⁷ Second most deadly was the 1976 earthquake in Tangshan, China, which killed 250,000 people; followed by the Haitian earthquake of 2010, with over 222,500 fatalities. Then follow in the top ten: the Indonesian earthquake and Indian ocean tsunami of 2005; tropical cyclone Nargis in Myanmar in 2008; tropical cyclone Gorky in Bangladesh in 1991; the Sichuan earthquake of 2008; the Pakistan earthquake and landslides of 2005; a Peruvian earthquake in 1970; and the Russian heatwave of 2010. In total, more than 2.15 million people perished in the forty deadliest natural disasters from 1970 through 2010. Shockingly, around one million of those deaths have occurred in the years since I began monitoring these statistics in 2004. Nevertheless, the combined financial footprint of these events, totaling roughly \$12 billion in insured losses (indexed to 2009) is smaller than that of 2005's Hurricane Wilma (Swiss Reinsurance 2011, p 32-33).

The insurance industry sees the absence of insurance coverage in the developing world – particularly in the enormous emerging markets of China and India – as a tantalizing opportunity. A 2004 report pointed out the “catch-up” potential of emerging markets, which comprised 86 percent of the world population and 23 percent of global economic output, but only ten percent of global premium income (Swiss Reinsurance 2004a, p 15). Emerging markets grew from 10.5% of global premiums in 2007 to 16.7% just three years later, as “strong premium growth [sharply outpaced] the relatively stagnant premium growth in industrialized economies” (Swiss Reinsurance 2010a, p 25). Non-life premium growth in Asian emerging markets is particularly strong, and rose nearly 18% in 2010 (in China +22%; Vietnam +13%; Indonesia +8.6%) (ibid.).

The scramble for emerging markets is especially intense given that there seems to be an empirical upper limit on non-life insurance penetration at around five percent of GDP (Enz 2000), and insurance markets in the industrialized world are relatively saturated. As premium growth has stagnated – totals actually shrunk in 2008 and 2009 (see **Figure 2.5**) – (re)insurance pricing has entered a downward spiral. Firms battling over the same pieces of risk in the U.S., the U.K., and continental Europe have driven catastrophe reinsurance rates on line down by a global average of 6% in 2010 (see **Figure 2.6**).⁸ U.S. rates dropped between 6 and 15% depending on the location. (Guy Carpenter 2010, p 9).

The already “soft” market of 2009 melted even further with the recovery of equity investments post-2008 and the absence of a mega-catastrophe. The reinsurance brokerage Guy Carpenter estimated that the reinsurance sector as a whole was overcapitalized by \$20 billion at the beginning of 2010, a sum which shrank only slightly to \$19 billion by the start of 2011, despite substantial losses to the Chilean earthquake, Deepwater Horizon, and the Canterbury New Zealand earthquake in the intervening year (Guy Carpenter 2010, p 11-12). In short, the industry is currently awash with surplus that it is desperate to put into circulation. Historically low interest rates have compounded the problem. The situation has become so extreme that within the first five months of 2010, 21 reinsurers returned capital to shareholders through share buy-backs totaling \$8.8 billion. This volume was five times larger than the entire year's buyback totals in 2009 (ibid, p 12).

⁷ The Bangladesh flood of November 1970 was the most deadly natural disaster in the last *century* as well.

⁸ The “*rate on line*” refers to the relative price the buyer pays for a given amount of coverage. For example, if a primary insurer paid a reinsurer a \$500,000 annual premium to assume \$4 million in risk, the rate on line would be 12.5%. Because the expected losses for all perils and regions are not comparable (the cost to reinsure a residential property portfolio in Florida or California would be much higher than for the identical housing stock in Colorado or Arizona), industry reports do not typically list a market-wide “average rate on line”, using an index to chart relative price movements instead (Figure 1.6).

3. “You need a cat”: Cyclicity and the contradiction of insurance security

There are at least three ways that such a problem of overaccumulation can be resolved. First, geographical expansion into new markets to “soak up” more insurance capital has always been a central business strategy of the industry. The only difference over time has been which markets were considered to be “emerging”. The second is the continual search for new vulnerabilities that can be turned into calculable – and thus profitable – risks, a process which Defert (1991, p 215) calls “the identification of new form[s] of insurable insecurities.” The third solution is, of course, the destruction of reinsurers’ capital reserves through huge catastrophic losses or mounting long-term liabilities (such as the asbestos and environmental damage claims that nearly crippled Lloyd’s in the early 1990s). As reserves are tapped to pay claims, reinsurers’ capital is depleted. To the extent that claims payments are used to rebuild structures or replace equipment, circulating capital is transferred to the circuit of *fixed* capital. This is obviously in keeping with Harvey’s rendering of Marxist crisis theory, and in particular his formulation of a “spatial fix” for capital which cannot realize profitable returns in circulation (Harvey 1982). Curiously, Harvey barely mentions insurance despite the fact that it provides such a concrete example of the cycling of capital from financial markets into the built environment.

Following each mega-catastrophe since 1992, opportunistic capital has flowed into the reinsurance sector to start new, “lean” catastrophe specialty reinsurers. Post-catastrophe, the price of coverage tends to rise quite dramatically in response to the depletion of insurers’ reserves. These companies often realize tremendous initial returns on investment thanks to their unencumbered balance sheets and their ability to undercut the older competition, which must charge a certain rate in order to replenish its reserves. Because each new catastrophe seems to reveal something unanticipated with regards to risk correlation or location, primary insurers often scramble to reassess their own exposures and often increase or reconfigure their own reinsurance coverage. In the process, new firms capture market share and the cycle begins anew.

Herein lies the source of the notorious cyclicity of catastrophe reinsurance pricing. As **Figure 2.6** demonstrates, prices oscillate with some regularity between “soft” and “hard” markets. Lane and Mahul (2008, p 11) find that, all else being equal, the point in the pricing cycle alone can affect rates by as much as 73% for the “least risky” portfolios. The price of coverage for risks with higher expected losses are affected to a lesser but still quite significant extent (from 17 to 55%).

Post-catastrophe flows of financial capital maintain this price cyclicity. Following the \$15 billion of insured losses (in 1992 values) caused by Hurricane Andrew, nine insurers went out of business. Surviving firms sought out more reinsurance, particularly in hurricane-prone areas, and reinsurers’ premium income rose 40% between 1991 and 1994 (Paterson 2001). Over \$11 billion was raised through start-ups and recapitalization of existing firms, and eight new reinsurance companies were founded in Bermuda (Mallon 2006). The convergence of the insurance and capital markets following the Gramm-Leach-Bliley Act of 1999 exaggerated this phenomenon, bringing new sources of capital into the market in search of diversification and higher rates of return. There were nine Bermuda start-ups post-9/11 (dubbed the “Class of 2001”) and eleven new firms post-Katrina (“Class of 2005”).⁹ But these firms accounted for only

⁹ Bermuda is the offshore location of choice for start-up reinsurers, given the tax structure (no corporate income tax), speedy regulatory approval, and the pre-existing density of firms and knowledge concentrated on the island.

part of the capital raised following those disasters. New investment vehicles – in particular cat bonds and sidecars¹⁰ domiciled in the Cayman Islands and Bermuda – also gained market share.

Given the language of climate emergency that reinsurers invoked following Katrina, Rita, and Wilma (see Chapter 3), the dynamics of the post-2005 reinsurance landscape warrant examination. Reinsurers absorbed roughly 60% of the more than \$70 billion in 2005 insured hurricane losses. Although four primary insurers failed, most insurers and reinsurers survived the 2005 North Atlantic season quite handily, and according to the President’s Council of Economic Advisors, in 2005 “the share of property and casualty insurers listed as financially impaired by a major insurance company rating agency actually dropped to a 25-year low while the aggregate value of surplus available to insurers for paying future claims increased” (2007, p 120). Industry-wide profits soared, and loss ratios remained low in 2006 and 2007. In 2006, the property-liability industry’s combined ratio¹¹ of 92.4 was its best result since 1949. The next year’s 95.6 combined ratio made 2006-2007 the best year-on-year underwriting performance for the industry since 1954, and the 13.3% return on surplus was the best since 1987 and 1988 (Hartwig 2008). The catastrophe reinsurance business model essentially requires severe losses in one year in order to earn astronomical returns the next. Berkshire Hathaway chairman Warren Buffett’s letter to shareholders in 2007 highlighted this contradiction:

We believe that \$16.9 billion is a record for a one-year gain in net worth – more than has ever been booked by any American business, leaving aside boosts that have occurred because of mergers... [T]hat said, a confession about our 2006 gain is in order. Our most important business, insurance, benefited from a large dose of luck: Mother Nature, bless her heart, went on vacation. After hammering us with hurricanes in 2004 and 2005 – storms that caused us to lose a bundle on super-cat insurance – she just vanished. Last year, the red ink from this activity turned black – very black. (Buffett 2007, p 3)

This “common sense” explanation for cyclicity in the market turns on the dual identity of “Mother Nature” as both the agent of catastrophic destruction and the personification of benevolent restraint, completely effacing the particular market organization that reproduces the cycle.

Although much of the capital that piled in post-2005 realized enormous short-term gains, it also laid the foundations for the current crisis of overaccumulation: “Investors bankrolled the sector to exploit the significant rise in rates following the destructive hurricane season of 2005. Although the financial crisis and Hurricane Ike’s landfall in Texas combined to deplete the amount of capital in 2008 and early 2009... balance sheets have since recovered... Part of this excess capital has been used to absorb the losses so far in 2010 and stifle any upward pressure on rates” (Guy Carpenter 2010, p 11). Despite major loss events in the first half of 2010 – especially the Chilean earthquake and Deepwater Horizon disaster – no reversal in pricing materialized.

The constellation of excess capital and low interest rates left many within the industry in the paradoxical position of actively *hoping* for an active 2010 North Atlantic hurricane season – an externally-sourced devaluation – to put a floor under reinsurance rates. An early September 2010 publication by brokerage Guy Carpenter framed the problem as such: “The reinsurance sector is at a crossroads. On one hand, reinsurers could see capital tighten if the hurricane season

¹⁰ Sidecars are short-term special investment vehicles typically issued by reinsurers to raise capital from opportunistic investors. I do not discuss them further here due to their relatively specialized and limited scope and the dearth of information (either academic or from the finance sector) about them.

¹¹ The combined ratio is a measure of underwriting performance and profitability, calculated as [(incurred losses + expenses)/premium earnings].

produces a large loss. However, should they suffer no significant hit for the remainder of the year, capital could remain plentiful with buyers continuing to call for price cuts” (Guy Carpenter 2010, p 13). Similarly, in July 2010 brokerage Aon Benfield published an interview with major investors in the insurance linked securities (ILS) market. In response to the question “What is your view of growth opportunities in the next several years?” a senior vice president at major Bermuda reinsurer Partner Re said simply: “I think you need a cat.” An ILS portfolio manager at Genworth financial seconded: “I think that’s right.” (Aon Benfield 2010a, p 33).

Even though the 2010 North Atlantic hurricane season was extremely active in terms of total number of named storms (19) and hurricanes (12), due to the influence of the jet stream and the genesis locations of the storms, many recurved eastward into the North Atlantic and the U.S. mainland avoided damaging landfalls – although the Caribbean and Central America were not so lucky. The continued absence of major losses led Guy Carpenter to proclaim that the “current operating environment is among the most challenging in living memory” (2011, p 13). Industry publications looked for any evidence of a “turn in the cycle”, and regularly speculated about what size catastrophe was required to harden the market. Guy Carpenter made concrete estimates of the scale of losses needed:

A loss in the region of \$20 billion to \$30 billion, while not likely to lead to significant rate hardening, would decrease capacity and stabilize the market. A loss exceeding \$50 billion, however, could lead to an immediate correction in pricing. Such a loss potentially could deplete underwriting profit from 2009 and readdress the recent supply/demand imbalance. Multiple losses in the USD20 billion to USD30 billion range also could bring significant change to the market since retention levels would be hit (2010, p 13).¹²

Ironically, although the 9.0 Tohoku earthquake of March 2011 was the strongest earthquake in Japan’s recorded history, the institutional organization of insurance coverage in the country is such that the mega-catastrophe may not create the “inflection point” for which reinsurers were waiting. Industry press is already predicting that the apocalyptic disaster will be “an earnings event, not a capital event” for many reinsurers – meaning that losses could cause companies to miss their earnings targets, but will not cut into their capital reserves (Insurance Insider 2011b, p 1). This is due primarily to the fact that the highly consolidated Japanese insurance market retained its risks domestically or passed them on to the government-backed Japan Earthquake Reinsurance Company, meaning international reinsurance companies wrote less business and held less exposure than would be expected given the total property values in the country. So while the Japanese government has estimated economic losses at more than \$300 billion and Goldman Sachs predicts at least \$200 billion, global reinsurers expect to be impacted by roughly \$30 billion (Insurance Insider 2011a, p 1). In any case, Japan’s effect on rates will not become clear until U.S. cat reinsurance contracts renew on June 1 and July 1, at the earliest (see Chapter 4 section 1.2 for more discussion of renewal timelines).

This highlights the peculiar contradiction of the security offered through private catastrophe insurance mechanisms: although (re)insurers ostensibly sell security and promise to protect exchange value, their services are only necessary insofar as “the world of things” continues to “stage its revenge on value”, to adopt Baucom’s terminology. If the physical environment were ever to cease generating events that caused sudden and massive devaluations of fixed capital, then catastrophe reinsurance would lose its reason for being. Catastrophe – and

¹² Meaning the cumulative losses would exceed the “attachment point” above which reinsurance or retrocession cover is triggered.

the anticipation thereof – functions to reproduce the demand for (re)insurance on the one hand, just as it cycles financial capital into and out of the built environment on the other.

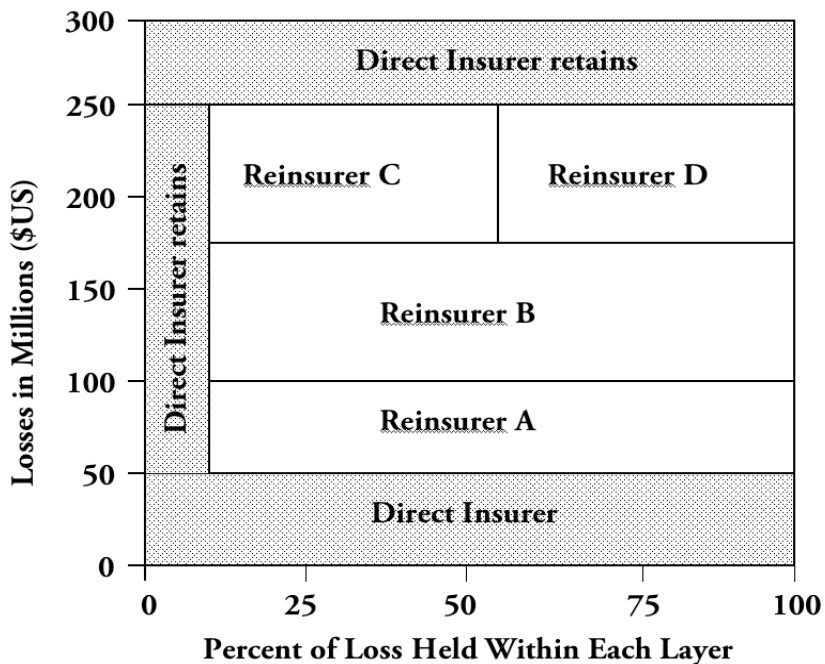
In the aftermath of the Tohoku earthquake and tsunami and the still-unfolding Fukushima nuclear disaster, a quotation used in a 1991 Swiss Re presentation should remind us of the startling regularity with which we have returned to the questions of modernity, progress and catastrophe – and the regularity with which institutions of insurance insert themselves into this discussion:

It certainly seems as though every gain in precision in the coordination of human activity and every heightening of efficiency were matched by a new vulnerability to breakdown.¹³ If this is really the case, then the conservation of catastrophe may indeed be a law of nature like the conservation of energy.

This quotation found its way into a presentation titled “Reinsurance: The future of catastrophe” which is now lodged in the Swiss Re corporate archives (as: Baumann 1991, p 1), yet it actually originated with environmental historian William McNeill in an essay on “Control and catastrophe in human affairs” (1989, p 11-12). It was then picked up by enterprise risk management guru Felix Kloman in a 1990 article before finding its way into Baumann’s presentation to the International Captive Insurance and Reinsurance Forum in Bermuda. The circulation of the idea into reinsurance circles is illuminating – if the *conservation of catastrophe* is a truism, it also implies the permanent necessity for reinsurance as an institution of security. The conservation of catastrophe promises a perpetually returning spatial fix. In this light, uncertain climate change impacts seem to offer both threats and promise for the industry. This is the paradox to which the remaining chapters turn.

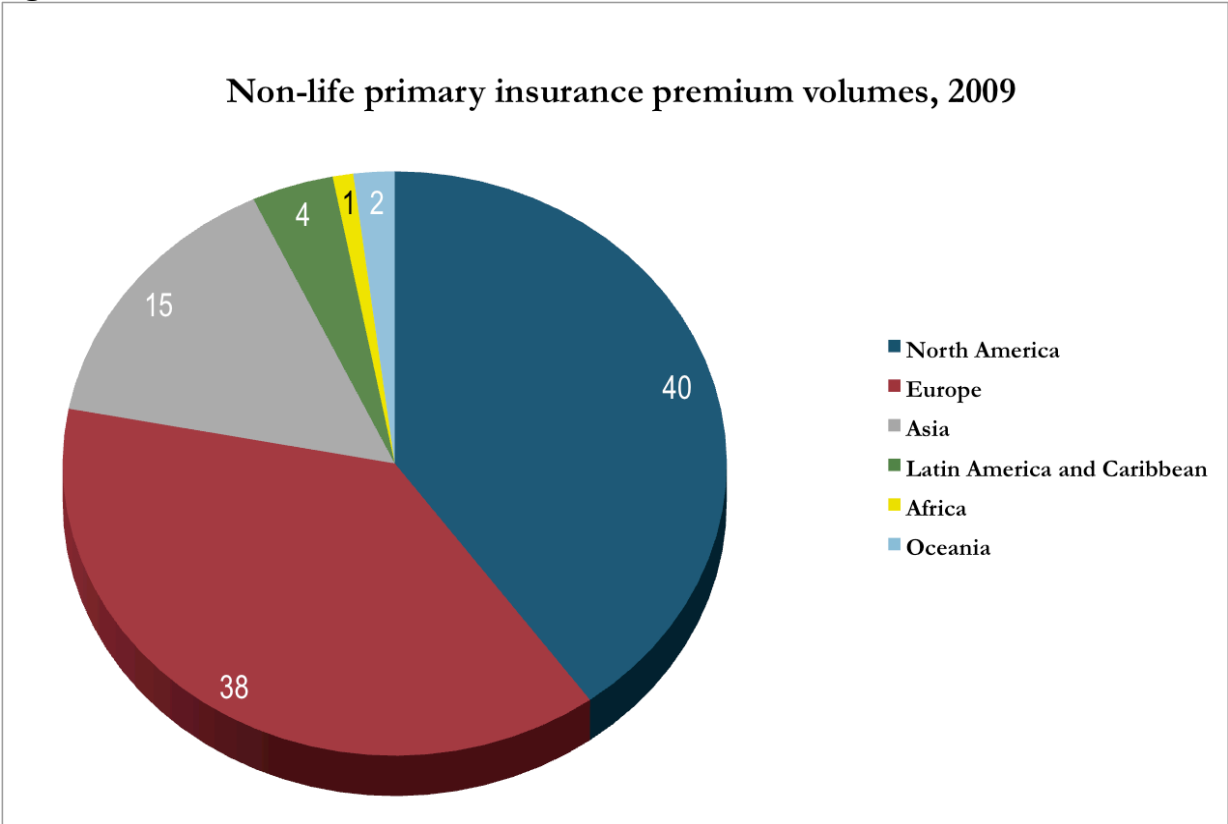
¹³ This was highlighted in the Fukushima case, of course, by the failure of a nuclear energy system, which had been engineered to withstand the (supposedly) most extreme conditions imaginable.

Figure 2.1: Diagram of a standard “cat XL” (extreme natural catastrophe) reinsurance program for a direct primary insurer



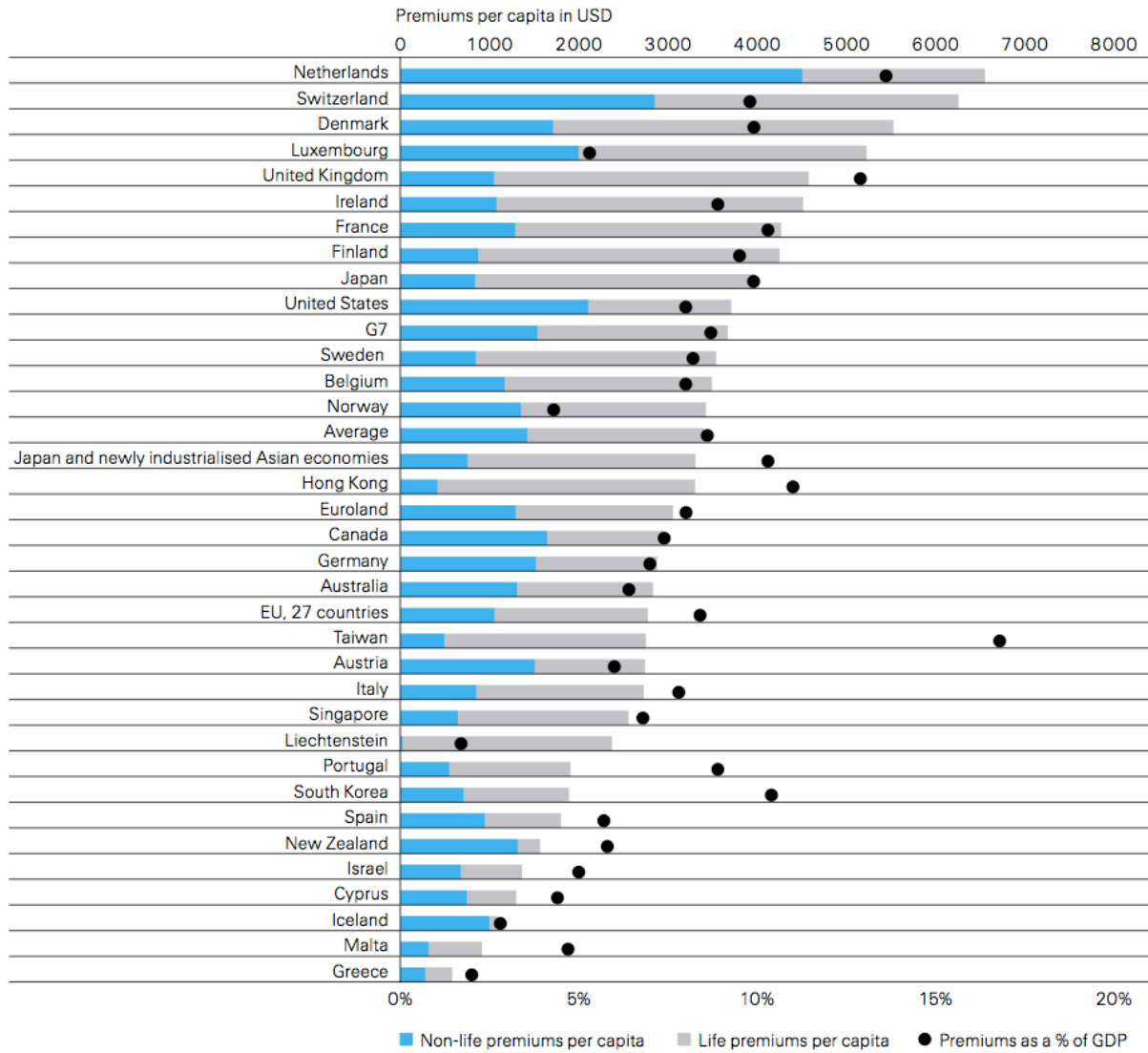
In this case, the direct insurer would be liable for all of the first \$50 million in losses, 10 percent of the next \$200 million, and all losses above \$250 million. Note that the “program” involves four separate excess-of-loss contracts with different reinsurers. Figure adapted from Murnane 2004.

Figure 2.2:



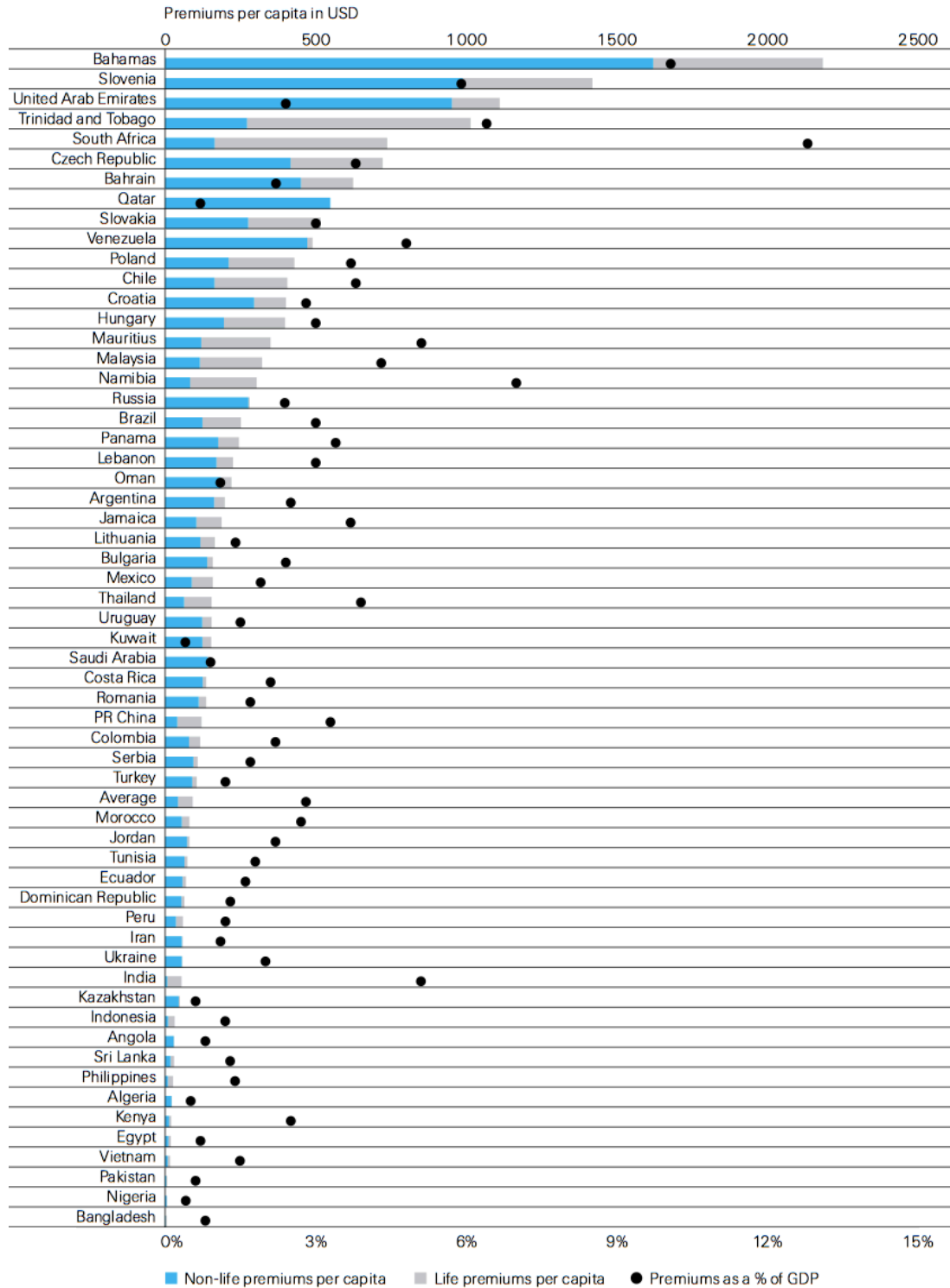
Source: Data from Swiss Re (2010a), figure by author

Figure 2.3: Insurance density and penetration in the industrialized world, 2009



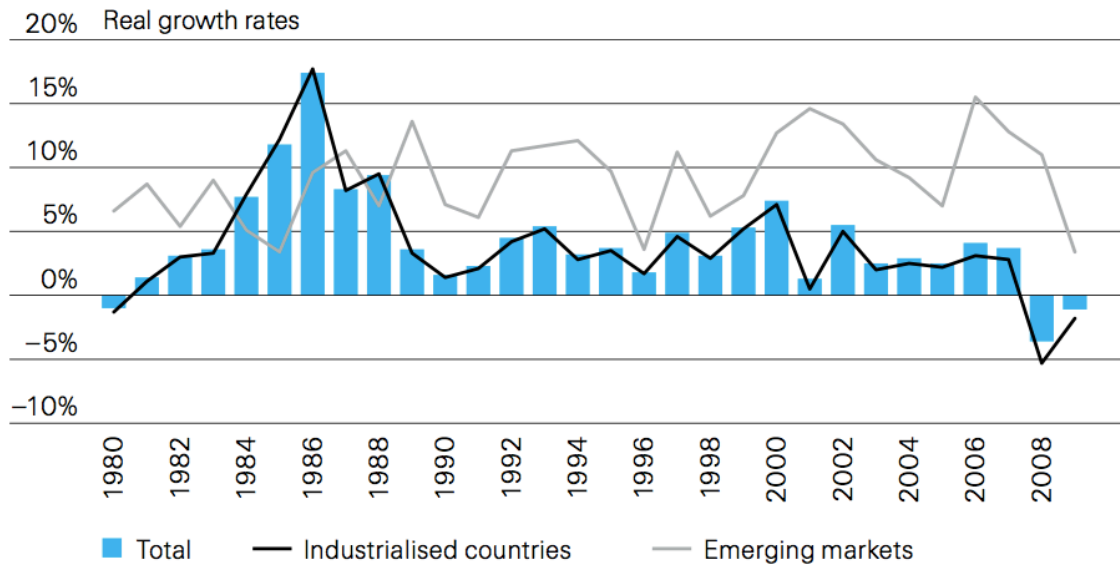
Source: Swiss Reinsurance (2010c, p 13)

Figure 2.4: Insurance density and penetration in the “emerging markets”, 2009



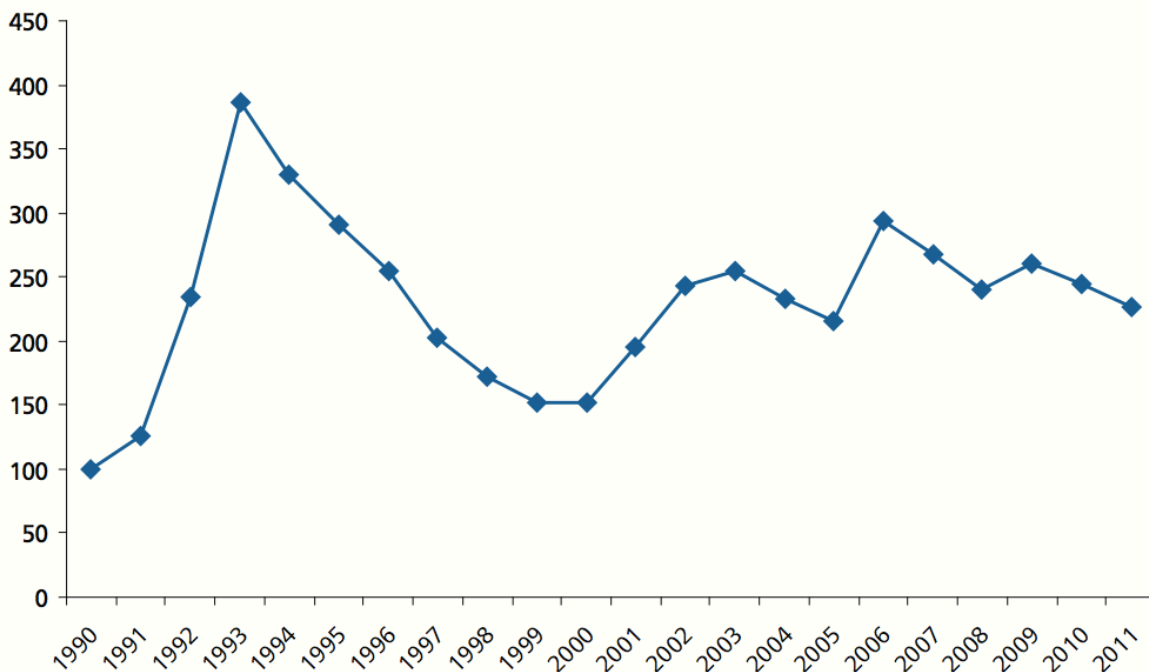
Source: Swiss Reinsurance (2010c, p 19)

Figure 2.5: Real premium growth, 1980-2009



Source: Swiss Reinsurance (2010c, p 7)

Figure 2.6: Indexed global catastrophe reinsurance rates on line, 1990-2010



Source: Guy Carpenter & Company, LLC (2011, p 3)

The index value of 100 was assigned to brokerage Guy Carpenter's estimates of average catastrophe reinsurance rates on line for the 1990 contract renewal year. Thus, rates charged for the same quantity of coverage increased by a factor of four between 1990 and 1993 in the aftermath of Hurricane Andrew. The market softened for the next seven years before hardening post-9/11. The next market softening period was brief due to the record-breaking losses incurred in the 2005 hurricane season.

CHAPTER 3: Climate change risks in insured landscapes: Evidence, narratives, and debate

This chapter weaves together a review of selected scientific literature and debates about climate change impacts, particularly in regard to Atlantic tropical cyclones, with the predominant narrative of climate change emergency articulated by the (re)insurance industry itself and in the popular and business press. It highlights the debates and open questions within the scientific community regarding climate change's impacts on tropical cyclone behavior and sea level rise, and counterpoises these with the language of the (re)insurance industry, which tends to present its perspective on climate risk and cyclone behavior as closed topics about which serious debate is no longer entertained. I consider the different cultures of debate in the scientific and business fields, and point out several political and economic reasons why the language of climate emergency goes relatively unchallenged.

1. Distinguishing concepts

It is often noted with irony that climate change impacts will disproportionately affect populations and infrastructure in developing countries, where both state resources and personal savings are least able to absorb losses and very few households and properties are insured. As discussed in Chapter 2, the largest concentrations of insured value are in North America and Europe, and this fact largely determines the types of climate impacts about which the industry voices its concern. Because the present research has focused on tropical cyclones, I constrain this discussion primarily to the way shifting climate trends may affect hurricane property damages in North America.

It seems intuitively obvious that such changes in the climate would be a cause for major concern within the insurance industry, and (re)insurers have repeatedly raised alarms about the threat climate change poses to their business. But just as the field of climate science distinguishes between questions of *detection*, *attribution*, and future *projection* of climatic change – as set forward in the assessment framework of the Intergovernmental Panel on Climate Change – so too should any discussion of trends in weather-related insurance risks. These distinctions are often lost, particularly in the aftermath of major weather disasters, when the cognitive search for explanations often settles upon epochal and unrecognized shifts in the normal climatological “order of things”.¹

Simply put, *detection* involves determining whether a statistically significant pattern or trend can be discerned in the behavior of a set of variables, such as mean global sea surface temperature. The process of *attribution* implies that a trend has been detected and aims to determine the causal mechanisms driving it, be they from anthropogenic forcing, solar forcing, natural variability, or all of these. *Projection* involves applying our understanding of these causal mechanisms to make plausible suggestions about the future behaviors of the variables of interest. The following sections distinguish between these processes as they apply to the property (re)insurance industry, as quite different issues are at stake in debates over contemporary attribution in comparison to those over future projections.

¹ For instance, the title of a recent article on Britain's rising economic losses to floods in the Times of London: “Warming to blame for floods bill, says Huhne. No, it's just weather, say insurers” (Webster, Ben 2010).

2. Narratives of detection and attribution

With regards to trend detection, as discussed in the Introduction, there is little question that the absolute magnitude of weather-related insured catastrophic losses has grown dramatically since 1970 (see **Figure 3.1**). Landfalling U.S. hurricanes are by far the largest drivers of weather losses and have thus been the primary subject of detection and attribution studies, but European winter storms and flooding are also major contributors. Although usually of relatively lower magnitude, floods are quite frequent and more geographically dispersed, resulting in a larger swathe of properties affected.

Attributing the trend in weather-related losses to particular causes is far more complicated than detecting its mere existence. Some insurers and industry organizations – mostly in the United States – have avoided taking positions on climate change altogether, and argue that loss trends are a result of natural climatic variability and growing populations and concentrations of property value. The majority of non-U.S. insurers and reinsurers have taken strong positions on the existence of anthropogenic climate change, but many are agnostic on whether current loss trends are necessarily attributable to it. They also cite natural variability and growing concentrations of insured value. Only a minority of firms – among them Munich Re and Lloyd’s – articulate the most extreme position, asserting a direct causal connection between anthropogenic climate change and current trends in insured losses. The Association of British Insurers has gone so far as to claim that climate change is already increasing the risk of weather catastrophes between two to four percent per year – a statistical calculation that in fact unsettles Beck’s incalculability thesis with regards to climate change (Association of British Insurers 2004).

The debate over loss attribution is not only a question of academic interest; it has serious ramifications for the entire practice of underwriting property insurance. As already noted, basic underwriting principals dictate that in order for a risk to be insurable, the probability and severity of an event should be calculable, although the precise location and time of loss must be unforeseeable. This implies that the risk meets the following conditions: (1) the likelihood of the peril is known, (2) loss events are frequent enough that the “Law of Large Numbers” (convergence toward the mean value of the population) applies, (3) the correlation between separate loss events in an insurer’s book of business is limited, (4) the potential and probable maximum losses for an event are calculable and financially manageable, and (5) that the pool of insureds does not pose a greater risk of loss than the general population (Berliner 1982). If anthropogenic climate change were already causing significant changes in the location, frequency, or severity of the extreme weather events that drive insured catastrophe losses, these risks might theoretically violate any of the five conditions above. This would allow and perhaps compel insurers to argue that the actuarial calculations on which they had based their rates and business models were no longer valid.

2.1 The contested science of North Atlantic tropical cyclone trends

Not surprisingly, some (re)insurers who attribute contemporary loss trends to anthropogenic climate change have already articulated the argument that their rates and business models must be changed (Association of British Insurers 2004). Nowhere has this been more publicized than in relation to hurricanes in the North Atlantic following 2004 and 2005. A multitude of game-changing events occurred in these seasons that fuelled panic about the

potential link between climate change and tropical cyclones, and it is difficult to overstate the utter astonishment that befell both meteorologists and insurers (see **Figure 3.2**). By its end in December, the 2004 North Atlantic hurricane season was the costliest on record at roughly \$50 billion (unadjusted). It also logged records for the largest storm radii, the strongest hurricane north of the 38th parallel, the strongest hurricane south of the 10th parallel, and the first hurricane ever recorded in the South Atlantic. These demonstrated the troubling potential for changes in extreme event patterns and locations (Pezza and Simmonds 2005). The state of Florida alone was hit with four hurricanes in six weeks, a record last matched by Texas in 1886 (Swiss Reinsurance 2004b).

But these records were summarily surpassed by 2005's series of storms, which formed faster and grew stronger on average than any before (NOAA 2005b). The year broke Atlantic records for storm intensity (Hurricane Wilma had the lowest central pressure ever recorded); number of named storms (27, forcing the National Hurricane Center to resort to naming late-season storms with Greek letters); number of category 5 storms (four, twice the previous record); and financial destruction (roughly \$170 billion in the U.S. and neighboring countries) (NOAA 2005b, 2005a; Swiss Reinsurance 2006). It generated a paradigmatic shift in the way that catastrophe modelers and insurers imagined the damage potential of successive "super catastrophes". Industry insiders still categorize many market conditions, underwriting strategies, and risk perceptions as belonging to "pre-" or "post-KRW" times, underlining the epochal transformation affected by Katrina, Rita, and Wilma. It is hardly surprising, then, that panic about the connection between climate change and extreme events reached a fever pitch in the aftermath of the 2005 season. Likewise, a record number of media reports mentioned insurers' concerns about climate change in the two years following Katrina, often as part of news stories on the dramatic increases in property insurance rates in coastal areas (see **Figure 3.4**). But debate about the relationship between hurricanes and anthropogenic climate change was far from resolved in the scientific community.

Detection and attribution of North Atlantic tropical cyclone trends had troubled climatologists even before the 2005 season, and two landmark studies were in press well before Katrina made Louisiana landfall on August 29th. The publication of these studies in the major scientific journals *Nature* in August (Emanuel, Kerry 2005) and *Science* in September (Webster, P. J. et al. 2005) coincided with media coverage of the disaster unfolding along the Gulf Coast, and they were often interpreted as providing evidence for the unequivocal connection of Katrina, Rita, and Wilma to anthropogenic climate change. *Time* published an October 2005 cover story asking "Are we making hurricanes worse?", and environmental groups called Katrina-displaced people the first climate change refugees. *Time* also named one of the authors, MIT professor Kerry Emanuel, one of the 100 most influential people of 2006 (Kluger 2006).

Both studies focused on trend detection and found evidence that the strength of North Atlantic storms was increasing. Webster and colleagues analyzed satellite records and concluded that the number of *intense* hurricanes (Saffir-Simpson Category 4 and 5 storms) around the globe has nearly doubled in the past 35 years. Ironically, the North Atlantic basin showed one of the smallest statistical increases of all the basins they analyzed; the Western and Southwestern Pacific and Indian Oceans saw a much more dramatic rise in strong storms. The Webster study also found that the total number of "storm days" had been decreasing since about 1995. The frequency of storms or number of days with active storms are rather crude metrics, however, as they give little indication of the sustained intensity and size of the storms – factors which are significant determinants of loss. Bister and Emanuel (1998) applied the concept of *power*

dissipation to tropical cyclones to resolve this problem of comparative measurement. In his 2005 study, Emanuel found that the power dissipation index of tropical cyclones – approximated as the integral of the cubed sustained windspeeds over the lifetime of a tropical storm – had more than doubled in the North Atlantic since the mid-1970s.

$$PDI \equiv \int_0^{\tau} v_{\max}^3 dt$$

This finding is particularly significant for insurers since the monetary damage caused by tropical storms also tends to rise² as at least the cube of the windspeed, v_{\max} .

Nevertheless, recent work has cast doubt on what portion of this PDI trend is actually attributable to anthropogenic climate change. Landsea and colleagues from the National Hurricane Center (2006) have proposed that the current trend may simply be a signature of natural multidecadal variability of Atlantic sea surface temperatures. NOAA scientists at the Geophysical Fluid Dynamics Laboratory Knutson and Tuleya (2004) have argued that the observed warming of sea surface temperatures in the tropical Atlantic is not large enough to have caused the dramatic increase in the PDI observed since the 1980s, and suggest that scientists are still missing some critical explanatory processes. Several studies have found that the *disproportionate* warming of the tropical Atlantic in comparison to other ocean basins is not likely to be linked to greenhouse gas forcing (Emanuel, K., Sundararajan, and Williams 2008; Vecchi and Knutson 2008). These conclusions prompted Emanuel to reconsider his prior position that anthropogenic climate change was the definitive source of tropical cyclone trends in the North Atlantic. In 2010, an exhaustive review of current studies on tropical cyclones and climate change authored by ten leading scholars in the field (Knutson, Thomas R. et al. 2010) concluded that “it remains uncertain whether past changes in tropical cyclone activity have exceeded the variability expected from natural causes” (p 157) and that “detection of an intensity change of a magnitude consistent with model[led climate] projections should be very unlikely at this time” (p 160).

An alternate explanation for the anomalous spike in Atlantic cyclone activity holds that it may be at least a partial artifact of sampling bias. Cores from coastal overwash reveal previous periods of high storm activity in the last 1500 years (Mann, M. E. et al. 2009), and proxy evidence from corals seems to suggest that the 1970s and 1980s – during which massive coastal development occurred in the U.S. South – were two of the quietest decades for storms in nearly three hundred years (Nyberg et al. 2007). Because the historical estimates of storm activity rely on ship’s records, aircraft records, and measures of storm size and intensity at landfall, they likely underestimate the total number of storms and provide an incomplete record of each cyclone’s magnitude (Mann, Michael E., Sabbatelli, and Neu 2007). Only after the Air Force began flying planes into storms in the 1940s and twenty-four hour satellite monitoring became possible in the 1970s could the size and intensity of a storm be monitored over its entire lifetime. Storms that reached hurricane strength for only a short duration were likely to have been excluded from earlier counts (Landsea et al. 2009).

In addition to disputing the existence of definitive physical trends in tropical cyclone

² Emanuel asserts this relationship citing a single study from Australia, but there is a substantial body of recent literature using more sophisticated windfield analyses and statistics that suggest a more complex relationship between sustained wind speeds, gusts, debris, and total time over which structures are wind-loaded (cf. Powell and Reinhold 2007). Damage may in fact rise to the 5th or 6th power of the wind speed. This makes the question of maximum potential windstorm intensities in a warmer climate all the more important.

behavior, some work has likewise argued against the significance of economic trends. Social scientist Roger Pielke Jr. is one of several scholars who remain unconvinced that relative North Atlantic hurricane damages *are* actually rising, once the loss records are normalized for population growth, rising real estate values, and rebuilding costs (Pielke, Roger et al. 2008). Even more intriguingly, new research using hurricane projections from downscaled climate models (from Knutson et al. 2010) to drive economic loss models suggests that it would take at minimum 120 years – and possibly more than 500 years – for an anthropogenic signal to emerge in normalized economic loss data from U.S. tropical cyclones (Crompton, Pielke, and McAneney 2011).

2.2 Projections

This brings us to the realm of projections about future climate behavior. There is no shortage of accessible scientific work on projections (see Solomon et al. 2007), and as a result this section will note only the most significant conclusions and ongoing debates relating to the largest threats to North American insured landscapes: sea level rise and tropical cyclones. Projections regarding sea level rise (SLR) are generally in agreement that global sea levels will continue to rise at or above the rates observed in the 20th century (~1.5 millimeters per year over the last century, accelerating to ~3.25 millimeters per year since the 1990s) (Nicholls, Robert J. and Cazenave 2010). However, huge uncertainty remains as to the magnitude of SLR that is likely to occur by 2100, with expert projections diverging by as much as a meter. Rising sea levels will further magnify the coastal effects of tropical cyclones and extratropical storms, increase coastal erosion and subsidence, and potentially overwhelm seawall defenses in low-lying metropolitan areas.

The fourth assessment report of the IPCC (2007) intentionally excluded dynamical modeling of large ice sheet behavior from its projections of SLR because of the uncertainties involved therein. This led to a mid-range projection of 0.2-0.4 meter SLR by the end of the 21st century assuming a “business as usual” policy towards greenhouse gas emissions, and a 0.6 meter projection under the most accelerated emissions scenario, A1F1. Rahmstorf (2007) finds that when IPCC global mean temperature projections are applied to his semi-empirical linear model that correlates SLR with global average temperatures, the result is a rise of roughly a meter above the 1990 base level by the end of the 21st century. Hansen (2007) argues SLR could be on the order of several meters, given that the primary components of 20th century rise – thermal expansion of sea water and melt from alpine glaciers – did not include significant contributions from the Greenland or West Antarctic Ice Sheets. Melt is expected to proceed much more quickly in the 21st century due to positive feedbacks driving the thinning or collapse of ice shelves and speed-up of outlet glaciers in both Greenland and West Antarctica. Recent satellite altimetry and gravity measurements confirm an accelerated melt rate from these sources (Allison et al. 2009). Pfeffer et al. (2008) test the plausible extremes of surface mass balance models and argue that although a two meter 21st century SLR is physically possible, a rise of 0.8 meters is more plausible.

Whatever the magnitude, the threat of SLR is multiplied by the presence of tropical cyclones that force storm surges into coastal areas. Both theory and modeling suggest that warming sea surface temperatures and changes in the tropical atmosphere should lead to an increase in maximum tropical cyclone intensities (Emanuel, K. A. 1987; Holland 1997; Knutson, T. R. and Tuleya 2004). However, the coarse resolution of global climate models – the smallest

units of which are typically 100 km cells – leaves them unable to replicate the convective processes of cyclones at a global scale. Instead, scientists have downscaled IPCC simulations and used very high-resolution (less than 20 km grid) models to model cyclone behavior in a warmer world. Using these techniques, Knutson et al. (2010) project “mean global maximum wind speed increases of +2 to +11% over the twenty-first century”.³ They also note that the global mean frequency of tropical cyclones is likely to *decrease* between -6 and -34%, but suggest that proportionally more of these storms will be very intense (categories 4 and 5), and will bring around 20% more rainfall near the storm center (Knutson et al 2010 p 159-161). **Figure 3.3** sketches several entirely hypothetical ways in which a distribution of storms could change such that the overall frequency of storms declines while the most intense storms increase in number.

2.3 The post-2005 language of emergency and its discontents

Degrees of certainty, representative significance of data, and ontological structures of causality are only a few of the unsettled philosophical disputes that have emerged in the scientific debate over the relationship between climate change and hurricanes. As the brief review above aims to have demonstrated, the field is openly contested and its conclusions indeterminate. But a reader of the popular press or insurance industry publications might be forgiven for thinking quite the opposite.

In some ways, the triple catastrophes of Katrina-Rita-Wilma in 2005 became to the insurance industry’s climate change message what September 11, 2001 was to the Bush administration’s terrorism agenda: an event or series of events so horrific that its invocation served to silence debate and confer absolute legitimacy on the speaker.⁴ In this sense, the apparent post-KRW exigencies of climate emergency have been actively deployed by the insurance industry. A post-2005 publication by Munich Re entitled “Hurricanes – More intense, more frequent, more expensive: Insurance in a time of changing risks” epitomized this emerging discourse. Authored by the company’s “Geo Risks researchers” in its Munich offices, the piece called for radically recalibrating hurricane risk estimates in response to anthropogenic climate change. Its portrayal of a perilous world of hazards spiraling utterly out of control was encapsulated nicely in one chapter’s title, “Peak meteorological values and never-ending loss records” (2006, p 17). The company ominously warned that the industry’s continued underwriting ability depends “on the development of adequate insurance solutions for catastrophe scenarios that have hitherto been considered inconceivable – we have to *think the unthinkable*” (p 1, italics mine).⁵

The argument reiterated throughout the report is that the enormity of the losses in 2004 and 2005 resolve the question of loss attribution once and for all. Temporal ambiguity collapses any distinction between descriptive analysis of past hurricane seasons and predictions of future trends, and provokes a tremendous degree of affective uncertainty. The discourse of emergency also makes certain conclusions seem inevitable by using the spectacle of unprecedented *financial* loss to argue for the existence of particular a *physical scientific* relationship between climate

³ Although this estimate of mean intensity change over a ninety year period is rather small, it is important to point out that current models generate widely different estimates on the upper bounds of the very strongest storms – which cause by far the largest physical damages and insured losses.

⁴ Here I disagree with Sunstein (2007), who does not see a consolidation of climate concern following Katrina.

⁵ This phrase, “thinking the unthinkable”, appears with ironic regularity in insurance industry discourse.

change and hurricane risk. By this confounding logic, the detection of economic trends is supposed to provide evidence for the attribution of geophysical phenomenon to human activity. This is not to say that the report does not refer to scientific studies; indeed it readily yet selectively refers to studies published by leading academic climatologists (cf. Webster, P. J. et al. 2005; Emanuel, Kerry 2005). But scientific debate is of little import, since the financial panic invoked produces an almost existential urgency that cannot be managed through the ordinary processes of scientific debate and discovery: “risk carriers cannot wait until science has provided answers to all the relevant questions” (p 5). If the indicators of climate emergency are financial, as the report argues, then so are the solutions: replacing simplistic conceptual models and “adjusting insurance conditions, capacities, and price structures” (p 1). And if the trends are caused by human activity rather than natural variability, then the rationale behind raising premiums gains legitimacy within a market-based model of risk management: humans should be forced to pay the “actuarially fair” price for the results of their anthropogenic forcing of the atmosphere. The consequences for (re)insurance pricing then become self-evident: higher rates and more policy exclusions.⁶

In his 2006 annual letter to shareholders, Berkshire Hathaway chairman Warren Buffett invoked similar existential questions to justify radically increasing the reinsurer’s rates and reconfiguring its portfolio:

Was this onslaught of more frequent and more intense storms merely an anomaly? Or was it caused by changes in climate, water temperature or other variables we don’t fully understand? [We] don’t know the answer... What we do know is that our ignorance means we must follow the course prescribed by Pascal in his famous wager about the existence of God. As you may recall, he concluded that since he didn’t know the answer, his personal gain/loss ratio dictated an affirmative conclusion. So guided, we’ve concluded that we should now write mega-cat policies only at prices far higher than prevailed last year – and then only with an aggregate exposure that would not cause us distress if shifts in some important variable produce far more costly storms in the near future. (Buffett 2006, p 7-8)

Although the invocation of Pascal’s wager is a clever rhetorical flourish, it seems unlikely that the Berkshire Hathaway management team considered the seventeenth century thought experiment when deciding to raise rates. As noted in Chapter 2, the dramatic price spike seen across the industry following 2005 was largely a result of depletion of capital reserves following two very damaging years, and as a result, 2006 and 2007 yielded extraordinary profits. Nevertheless, Buffett’s reference to God, faith, and uncertainty – to say nothing of Pascal’s concern about eternal damnation – cultivates the particular moral authority of insurers as trustworthy, prudent risk takers who should not be disparaged for charging higher prices. Following the exceedingly calm 2006 season for North Atlantic tropical cyclones, Buffett pondered in his annual letter:

Were the terrible hurricane seasons of 2004-05 aberrations? Or were they our planet’s first warning that the climate of the 21st Century will differ materially from what we’ve seen in the past? If the answer to the second question is yes, 2006 will soon be perceived as a misleading period of calm preceding a series of devastating storms. These could rock the insurance industry. It’s naïve to think of Katrina as anything close to a worst-case event. Neither Ajit Jain, who manages our super-cat operation, nor I know what lies

⁶ I return to the question of whether Munich Re’s public positions have actually translated into rate increases in Chapter 4.

ahead. We do know that it would be a huge mistake to bet that evolving atmospheric changes are benign in their implications for insurers... (Buffett 2007, p 8)

Here Buffett appears to be defending the company's post-2005 decisions by claiming that further climate change-related losses are inevitable and vigilance is required. Chapter 4 returns to Buffett's logic and considers the significance of management for shareholder value in insurer's climate change discourse. For the time being, these excerpts exemplify how the invocation of Katrina has become a quasi-religious litany of the industry used to cultivate recognition and dread of climate change impacts.

Confoundingly, modelers, brokers, and underwriters with whom I spoke often alluded to the exaggerated character of these representations of immanent danger, and many acknowledged that the underlying science on which these claims were based was less conclusive than some companies' public positions indicated. One broker went so far as to say of Munich Re, "They are full of shit. But they talk a good game!" [i20]. My interview results indicate that, in private, there is *not* an absolute industry consensus on attribution of current extreme events to climate change, nor on how soon such a trend might be detected. For instance, one senior executive at a catastrophe modeling firm told me:

Trying to get to the heart of it – as to what is really changing about catastrophe occurrences – is quite difficult. It is such a huge topic, and a lot of what is said about it is said from a perspective of promoting a position. If you looked at what the scientific evidence is – there is not much evidence in a number of areas... People are saying catastrophes are increasing enormously, and that's why we should do something about climate change. Actually, the evidence that catastrophes are increasing that much is not very strong in most places. The reason why we should do something about climate change is a longer-term perspective. [i6]

Some interviewees also made the point that short-term risk exaggeration on the part of reinsurers could have long-term negative consequences for the public's willingness to believe in the industry's admonitions:

And some [of our] competitors are also spreading these kind of ideas around. I mean, Lloyd's, Munich Re...I don't know if they [are trying] to make the people afraid of that risk and trying to sort of charge the premium now. I don't think it's really responsible to do... I mean climate change is real and has an effect on a lot of things, but just picking up the peaks and taking that as an example is very dangerous because if no hurricane happens in the next five years, no big one, then everyone is going to say, oh, that was all bullshit. You cannot prove your climate change by just looking at the extreme, you have to look at the average. [i23]

This message of caution and circumspection was shared by many of the scientists employed in the industry. A modeler at a highly technical Bermuda reinsurer explained his company's "middle of the road" position on hurricanes as a result of its scientifically-oriented workforce:

"In my mind there's still some still controversy whether there's an unprecedented peak in storminess in the Atlantic... the risk has measurably increased [but]...whether it's actually anthropogenic in cause or natural in cause is still a very open debate in the literature and, yeah, we wouldn't lean either way. We sort of take a middle road ... because we know that science takes times to develop. So we try and take a balanced view of the literature and not be alarmist and, yeah, not just to go with what everybody else is doing...We're also aware, being scientists [who] have previously published or are currently publishing in this field of research, we often know also the limitations in such analysis and such future scenarios... [i31]

This lack of internal consensus is a very significant finding, particularly insofar as it challenges both the industry's public message (cf. ABI 2004, Geneva Association 2009) and the "common

sense” position articulated in the press (cf. Berkowitz 2011, Holding 2011). It is revealing that all three of the individuals quoted above (i6, i23, and i31) hold doctoral degrees in the natural sciences. This arguably makes them more sensitive to the ways that evidence is marshaled to support particular claims, and more confident to voice scientific disagreement (at least in private contexts).

This result supports the findings of a substantial body of work in science and technology studies, where scholars have noted the existence of a “certainty trough” across many scientific and technical disciplines. The metaphor was originally developed by MacKenzie (1990) in his work on nuclear ballistic missile accuracy, which found that the scientists and engineers most directly involved in the development and production of antiballistic missile technology were far more aware of the inherent uncertainties and limitations of the technology than were the generals advocating for its adoption.⁷ These individuals found reasons for doubt that emerged out of “their intimacy with th[e] process of production”; such doubts did not trouble the “program loyalists” who believed the “what the brochures [told] them” (1990, p 371). MacKenzie proposes a heuristic U-shaped curve (see **Figure 3.4**) to represent the relatively high degree of uncertainty held by individuals with the least “social distance” from the site of knowledge production, in comparison with the low uncertainty of program adopters who were not involved in the development of the technology. The right side of the curve represents the less “intimate” and more ossified uncertainty held by individuals who are alienated from the institution producing the technology, or are committed to the superiority of a different technology (in MacKenzie’s case, this includes military advocates of manned bombers). Others in STS have found that the phenomenon permeates many new technological fields (Woolgar 1998; Brown, N and Michael 2003), and the heuristic has been invoked to theorize uncertainty and debate around global climate models in particular (Shackley and Wynne 1996; Jasanoff and Wynne 1998; Lahsen 2005). Although the uncertainty trough explains the skepticism of scientists and modelers in comparison with the certainty of CEOs like Buffet, it is of little help in understanding how and why the narrative of causation and climate emergency is publicly *maintained* despite this internal disagreement and skepticism. I return to this question below after reviewing the historical development of the industry’s concerns.

3. The emergence and consolidation of industry narratives

Regardless of this internal lack of consensus on detection and attribution, references to climate change within (re)insurance industry literature have become ubiquitous. The task of summarizing all representative documents would be staggering and is not the aim of the current research (see Mills, Roth Jr, and Lecomte 2005; Mills 2005; Mills and Lecomte 2006; Geneva Association 2009, for extensive overviews). Rather, this section briefly reviews the development of (re)insurers’ public concerns and identifies the most common tropes in circulation.

A seminal 1994 report by Swiss Reinsurance, entitled “Global Warming, Element of Risk”, is often referred to as a touchstone document – the first of its kind to explicitly articulate the challenges for insurers posed by climate change. However, references to “carbon dioxide contamination of the atmosphere” appear even earlier in the Swiss Re corporate archives, in a 1985 company publication published the next year in English as “Environmental Changes and Catastrophe Hazards” (Tiedemann 1986). Significantly, the earlier text reveals a narrative that is

⁷ Following Collins’ work on uncertainty within natural sciences, where he puts the matter beautifully: “Distance lends enchantment” (1985, p 145).

still very much in formation, in which causal chains and sources of risk are ambiguous and a clear terminology has yet to emerge. The report's table of contents reads like a laundry list of the environmental preoccupations of the day: overpopulation, drought, deforestation, flooding, and desertification. Flooding is the primary focus of the report, although windstorms and hail are mentioned in passing. Anthropogenic carbon dioxide is identified as an atmospheric pollutant that is likely to raise temperatures and increase the "energy content of the atmosphere" (p 23), leading to more torrential rains and catastrophic flooding. Yet the paper draws few conclusions about the impact of anthropogenic carbon dioxide on the planet's climate. It consciously positions the scientific community at the beginning a long process of discovery: "As at the beginning of a well-written detective story, there are many suspects but no definite idea as to who is really the guilty party" (p 22).

Industry publications making more definitive statements did not appear until the early 1990s, following the publication of the First Assessment Report of the Intergovernmental Panel on Climate Change (in 1990, followed by supplementary reports in 1992), the Rio Earth Summit, and Hurricane Andrew's record-breaking losses. Although a few isolated news reports appeared earlier, the connections made in the media between climate change and insurance business also began to mount in this period. Results from a simple Lexis-Nexis search demonstrate the progression of attention (see **Figure 3.5**). Note the spikes in attention following Hurricane Floyd in 1999 and again following the 2004 and 2005 hurricane seasons.

Greenpeace Director Jeremy Leggett has suggested that Greenpeace's efforts to engage (re)insurers around the issue of climate change – which it made in an attempt to enlist the support of a major industry with enough financial influence to counterbalance the oil industry – were instrumental in fostering this recognition on the part of insurers and media (Leggett 1994, 2001).⁸ It seems more likely that the paradigm shift came in response to a severely damaging cluster of extreme weather events, after which (re)insurers scrambled to explain their extraordinary losses to investors. These included \$5.8 billion insured losses to Hurricane Hugo in 1989, \$10.2 billion to wind storms in Central Europe in 1990, \$1.7 billion in the Oakland Hills fire in 1991, and the record \$17 billion of insured damages from Hurricane Andrew in 1992 – after which nine American primary insurers went bankrupt (Nutter 1999; Berz 1999).

A common language and momentum around the topic seems to have emerged in the late nineties and early 2000s. During this period, over eighty insurers and reinsurers – mostly European – signed on to the "Statement of Environmental Commitment by the Insurance Industry" drafted by the United Nations Environment Program (UNEP) Finance Initiative. By signing the non-binding statement, they pledged to:

reinforce the attention given to environmental risks in core activities...Include environmental considerations in operations and asset management... Encourage research... promote sound environmental practice through loss prevention and contract terms and conditions...raise public awareness...and dialogue with public authorities.
(UNEP n/d)

⁸ The Swiss Re archives provide ample evidence that global warming and changing environmental risks were "on the radar" of the industry pre-Leggett. In fact, it may have first been a Swiss Re employee, Hans Zulauf, who suggested the idea publicly. The following comment appeared in Zulauf's prepared comments for an industry meeting in June 1990: "Faced with today's changes in the risk environment in a global society marked by environmental degradation... we are realizing that... we are more exposed to catastrophes than ever. The severity of harm and the public perception of catastrophic risks are becoming more important and maybe even 'Greenpeace' could become a partner in the future risk management approach" (1990, p 3).

The second and third IPCC assessment reports explicitly mentioned the insurance industry as a business sector that was particularly exposed to changes in extreme events, including floods, wildfires, tropical cyclones, tornado/hail, and winter storms. Individuals from (re)insurance companies were lead and/or contributing authors to the relevant chapters (cf. Vellinga et al 2001). While the Second Assessment Report published in 1998 cautioned that there was still no evidence of a causal relationship between global warming and an increasing frequency or intensity of weather-related extreme events (Berz 1999), the IPCC's Third Assessment in 2001 report concluded that climate change is "likely" to be partially responsible for the more frequent or severe heat waves, floods, and droughts observed over recent decades, and "very likely" or "likely" to increase the intensity of these events in the future.⁹ It warned that even a small change in climatic means and variability could lead to quite a large shift in the frequency of extreme events, since the relationship between the two phenomena is non-linear (Vellinga et al. 2001). The Fourth Assessment Report in 2007 repeated the same conclusions regarding attribution of current extreme events, but added that heat waves and heavy precipitation are "very likely" to increase, and intense tropical cyclone activity and extreme high sea level events are "likely" to grow (Solomon et al. 2007, p 52). Finally, as described in section 2.3 above, the hurricane seasons of 2004 and 2005 probably did more than all other loss events and research combined to consolidate the narrative of climate risk for insurers.

4. Uncertainty and preemption

There are at least two major elements that appear in nearly all contemporary versions of this climate risk narrative. The first trope is that of uncertainty with regards to shifting probability distributions and "long tails" of extreme weather events. This is particularly significant for catastrophe reinsurers who are most concerned with the "tails" of exceedance probability curves. A relatively small change in the mean value – for say, tropical storm wind speeds – can be accompanied by a quite significant change in extreme values. Because these extremes are by definition rare, it is difficult to estimate their future magnitude and frequency, or put another way, to predict the length of the tail and the area underneath it. A reinsurance modeler for a Lloyd's syndicate described the trouble this way:

We have a distribution of potential events which causes losses. We define return periods within that distribution, and we settle on a number which we're reasonably comfortable with as a return period loss. With climate change, essentially what you're doing is playing around with that distribution as far as hurricanes and flooding and European windstorms. If you shift the mean by 1% or whatever it is, the uncertainties in the tail of the distribution are much larger than the amount we expect the mean to change over the time scale that we're interested in. But we don't know how the tails are going to change. They might double the 100 year return period loss. We just don't know... I think we're very unsure of how to deal with that. [i10]

Figure 3.6 reproduces a graph from Jagger and Elsner (2006) which illustrates this problem as it applies to the maximum wind speed of an individual storm in a given climate. Depending on the specific Pareto distribution used, the maximum implied wind speed values (and area under the exceedance probability curve) vary significantly.

⁹ The IPCC reports' use of "likelihood terminology" arose out of an attempt to standardize textual representations of probabilistic outcomes. The numerical corollaries are as follows: "more likely than not" > 50% probability; "likely" > 66% probability; "very likely" > 90% probability; "extremely likely" > 95% probability; "virtually certain" > 99% probability (IPCC 2007).

Given the immense values at stake, the significant uncertainty surrounding long- or fat-tailed distributions is invoked to lay the groundwork for the second trope of preemptive planning and action. One communications representative for a major reinsurer underscored the philosophical significance of the shift to a “proactive” approach to climate change in the industry: “Reinsurers in general have communications issues because we’re always talking about failures, the system breaking down, disasters, when things go wrong. So for a while, global warming was a forward-looking topic we could talk about as something requiring positive action” [i26]. The move towards proactive engagement and anticipation had profound implications for the internal business models of reinsurers themselves. The president of the Reinsurance Association of America alluded to the epistemological shift: “we often use the comment that [the reinsurance business is] like driving a car by looking in the rear-view mirror. The business is really built upon historical data trended forward. Climate risk clearly challenges that business model ... You have to look prospectively to try and assess climate risk five years, 10 years, 25 years from now” [i35].

In the course of this research, respondents made use of this seemingly anachronistic “driving through the rearview mirror” metaphor numerous times. Its provenance turns out to be quite revealing, as it positions the evidentiary principles of the industry in relation to both the political economy of catastrophe and the post-9/11 logic of preemption.¹⁰ Apparently, the metaphor originated with Endurance Specialty Insurance CEO Kenneth LeStrange, following the Bermuda Insurance Symposium in 2002. Endurance was a new, highly capitalized specialty reinsurer that had recently opened its doors in Bermuda, part of the post-9/11 “Class of 2001” (see Chapter 2 for a discussion of post-catastrophe Bermuda start-ups). An industry news piece reported LeStrange’s comment to the press:

Our industry needs new approaches to 21st century realities. For far too long, we’ve been driving ninety miles-per-hour down a dark and twisty mountain road, staring in the rearview mirror. In other words, we don’t anticipate change. Technology and new risk analysis tools can help us slow down, turn the headlights on and focus on the road ahead... [At Endurance] we’re now using, or plan to use, every significant risk modeling tool available. (PR Newswire 2002)

In the metaphor, modeling tools are distinguished from actuarial tools as forward-looking technologies with the capacity to help insurers imagine what is beyond the proverbial curve in the road. Rhetorically speaking, this was an extremely effective metaphor that traveled widely and gained additional weightiness when applied to climate change. The obvious absurdity of attempting to pilot a car by looking through the rearview mirror becomes even more acute if everyone inside the car believes the road ahead will not resemble the path already travelled. Companies depending on empirical calculations drawn from the “rearview mirror” are fashioned as technologically deficient and fundamentally lacking in business sense. “Thinking the unthinkable” becomes a task for every savvy firm. One cat modeling director at a Bermuda reinsurer used a similar logic to explain why the shift to near-term, forward-looking hurricane catastrophe models was so significant for the industry:

“I think this was fairly impressive what we did in the last three years after the 2004, 2005 storms when we decided, hey, you know looking at the hundred years isn’t right. There’s something going on in this last fifteen- or twenty-year period when there’s warmer sea

¹⁰ Here I am particularly reminded of the parallels Randy Martin (2006) draws between the logic of securitization and financial risk management on the one hand, and the Bush doctrine of preemptive war on the other. Ironically, of course, the Bush administration did not employ such a preemptive doctrine with regards to climate change.

surface temperatures and we need to reflect that going forward. So we're not going to look so far back into the rearview mirror. [i24]

Such prospective re-envisioning is part of the same rationality of “enactment” that Collier (2008) associates with disaster preparedness planning and vital systems security, which experienced an enormous intellectual renaissance following September 11th. Likewise, de Goede and Randalls (2009) point out the troubling parallels between the renderings of “actionable futures” requiring preemption in both the War on Terror and the discourse of climate security.

I have already mentioned the corollary to this preemptive, forward-looking approach as flagged in Munich Re’s post-2005 publication: “risk carriers cannot wait until science has provided answers to all the relevant questions” (2006, p 5). It is a point of pride for (re)insurers that they must make decisions about which risks to underwrite, and at what price, regardless of the state of academic knowledge or consensus on the subject. Particularly given the academic uncertainty surrounding hurricane projections, preemptive action comes to seem all the more justified, draped in the language of the “precautionary principle” (Sunstein 2005). A modeler for a Lloyd’s syndicate articulated the exigency:

“Compare our position within academia, where you won't see someone predicting a 50-year time period for hurricanes or any major phenomenon, because they simply don't believe they have the data to do that... We practically have to take a step. RMS will tell you that as well. We have to look to potentially much larger events, to try and assess the probability of those events. We have to make pragmatic choices in that respect. [i10]

This call for immediate pragmatic action has been hailed by the media and environmentalists (including Greenpeace’s Leggett (1994; 2001)) as providing further evidence of the reality of climate change, and has been equally celebrated for demonstrating how “big business” interests also stand to lose financially in a warmer world. But this adulation leaves little room to consider the philosophical and political implications of (re)insurers’ turn towards preemption.

Given this observation, I want to return to the question raised in section 2.3: how has it been possible for certain firms promoting a language of emergency to proceed despite the significant scientific skepticism about their claims from within the industry?¹¹ The quotations above suggest that several forces are at work. First, the logic of preemption squares neatly with the (re)insurers’ public performance of precaution. Any company seen publicly questioning another’s representation of the immediacy of climate risks would run the tremendously high reputational risk of being cast as a “climate skeptic” by its competitors and the business press. This could be a death blow given the extent to which (re)insurance business depends upon clients’ belief that the firm is a trustworthy guardian of premiums and is closely anticipating future threats to its capital reserves.

Secondly, the industry’s business culture has few norms or precedent for open debate and scientific dispute. Although academic scientists working within (re)insurance are accustomed to publicly articulating disagreements in intellectual settings – indeed this is a requirement and norm of the scientific field (Bourdieu 1999 [1975]) – doing so in a business context is virtually unheard of. A publically voiced disagreement is generally regarded as a serious attack on the “face” of one’s opponent (Goffman 1959). A PhD-holding scientist working within the reinsurance industry described the sentiment at the first meeting of the industry-sponsored “Risk Prediction Initiative” in Bermuda in 1994:

They invited lots of hurricane and climate and earthquake scientists around, and I think it was very revealing...to the business world about how the scientific world worked,

¹¹ The seemingly obvious economic motives are considered in Chapter 4.

because you had [scientists] standing up and, you know, saying that somebody didn't know what they were talking about ... and having these sort of lively debates, and the business guys were sort of taken aback because you don't really have that, per se... unless you're really pissed off at somebody, whereas this is just sort of the way things work in the scientific world. [i33]

As this chapter has shown, the absence of public debate in the industry does not imply the existence of consensus; respondents were very willing to voice their disagreements and qualms with me in a private context. But in part because the stakes of the climate debate are so high, public criticism of another (re)insurer's position is considered an unsanctioned and disrespectful form of competition. A brief anecdote will illustrate this point. In a conversation with a reinsurance broker, I broached the subject of a mocking blog post made by a professor at the University of Colorado, Roger Pielke Jr., who had previously taken part in one of RMS's expert elicitation panels on near-term North Atlantic landfalling hurricane frequency. Pielke questioned the methods and validity of RMS's elicitation procedure and presented a brief statistical analysis to claim that the elicitation had produced conclusions that were indistinguishable from those that could be randomly reached by a "panel of monkeys" (Pielke, Roger Jr. 2009). Given the angry response to the post from RMS's expert elicitor, Pielke's post seemed to have been interpreted as an insulting gesture. I asked the reinsurance broker his opinion and received this reply:

Well, that's one thing I enjoy about scientific debate. There's lots of fresh – the gloves are off. The business environment, we're normally much more measured than that but I think he was being provocative and playful if you like. I think all he was saying was actually, the [expert elicitation estimate] would have to have come out that way, just by definition. That panel based on all they're asked to do would come out with a number higher than the long-term average because the only models being presented to them, which they were asked to rank, all came out with a number higher than the long term average... Whether those models were right, or whether alternative models came lower, actually I don't know. But that's debate... I think it's right and proper that we have a view on this rather than just parroting what the models do.

Nevertheless, in the current "measured business environment", such debate does not take place in public between major players.¹²

The logic of preemption and near-term modeling continues to undergird the narrative of climate emergency. There are clear economic motivations for both individual agents (the loss of one's job) and firms (the loss of market share) to contain disagreements and produce the appearance of consensus. Here I want to return to the "uncertainty trough" and consider how this case might represent a reshaped topography of certainty (see **Figure 3.7**). If we make the perhaps simplistic assumption that public debate about scientific matters of fact is maintained via tension between the three subject positions in MacKenzie's diagram, it follows that debate would lapse if any of the three positions were evacuated. In the case of (re)insurers' claims about climate emergency, there are very few firms or individuals willing to occupy the position of "alienated" subjects for the economic and cultural reasons enumerated above. And with regards to the use of near-term catastrophe models post-2005, opposition has also been evacuated since (1) all three third-party modeling firms use the near-term method¹³ and (2) ratings agencies expect

¹² One exception is the critique currently being mounted by consulting firm Karen Clark & Co. against near-term modeling techniques (Karen Clark & Co. 2008, 2010, 2011). In some ways this exception proves the rule, since the consultancy acts as an advisor rather than underwriter to insurers – it thus has everything to gain from taking credibility away from the dominant firms.

¹³ Although some allow the user to opt to use a storm catalog calibrated to the historical record, the higher risk estimate tends to prevail due to its use by ratings agencies and reinsurers.

(re)insurers to use the near-term method to determine appropriate capital reserves. What is left is perhaps more of an uncertainty “slope” than a trough per se. It is not surprising that the topography of certainty is shaped by political economic conditions. In the case of climate change, however, the typical argument has been that business interests – particularly the energy industry – have pumped money into climate-skeptical research in order to magnify the public’s perception of uncertainty. Here we see something quite different transpiring, where firms’ structural positions within the market dictate that they accept – or at least, do not publicly contest – the logic of climate emergency. The next chapter broadens this question to examine the inner workings of firms and discusses how and why (re)insurers’ day-to-day business practices diverge from those that would be presumed to derive from this language of emergency.

Figure 3.1:

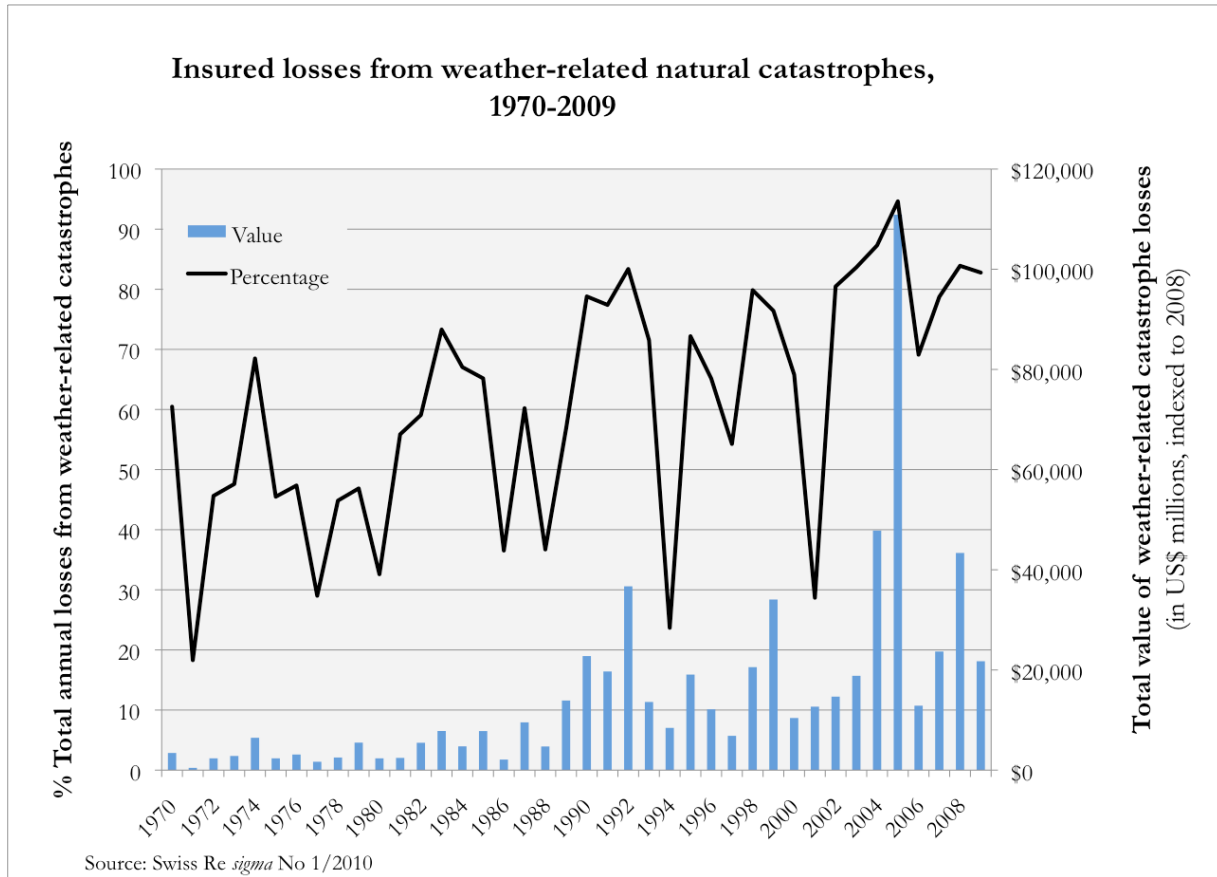
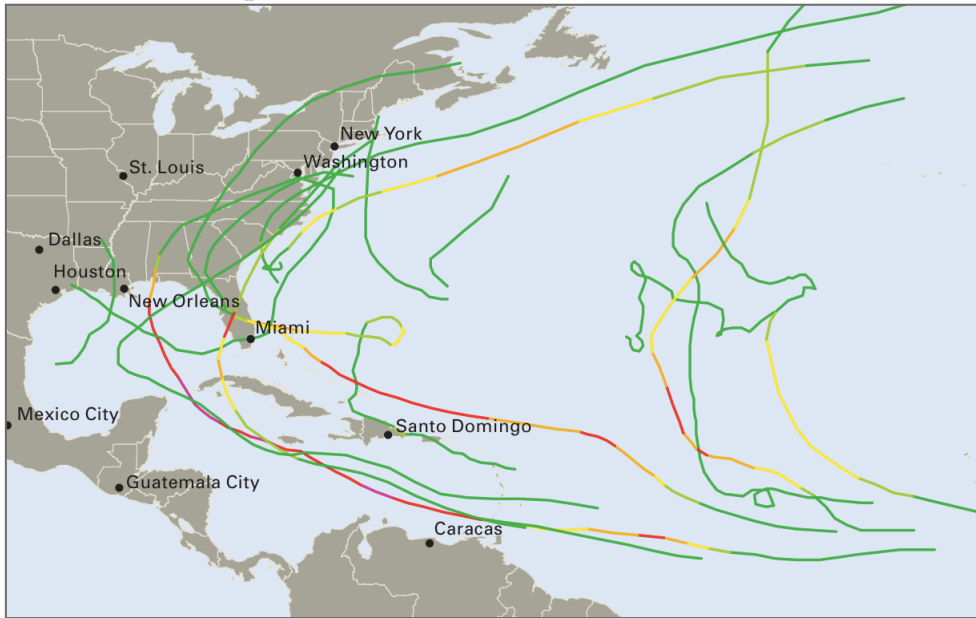


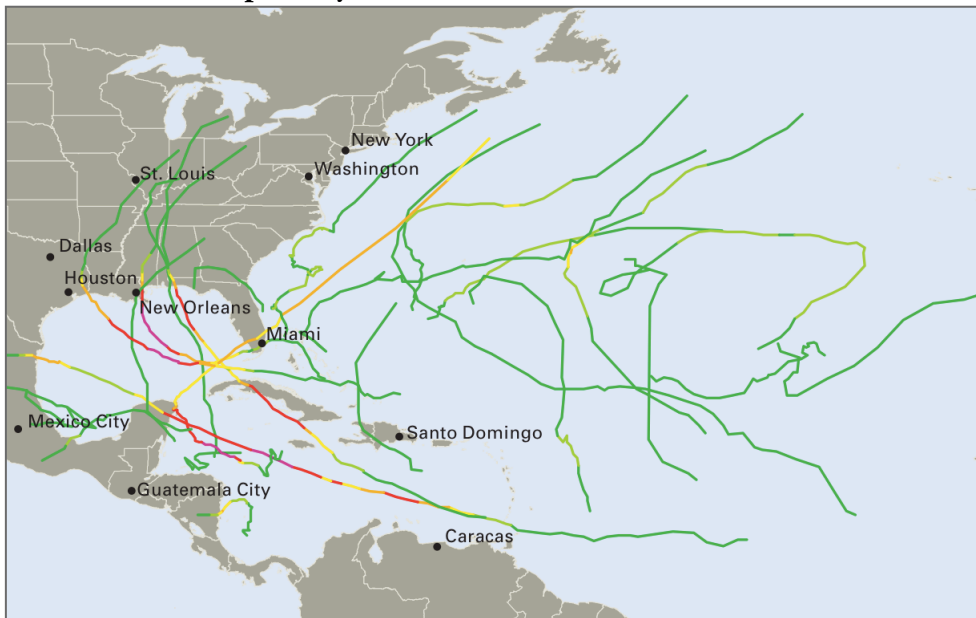
Figure 3.2:

North Atlantic Tropical Cyclones, 2004



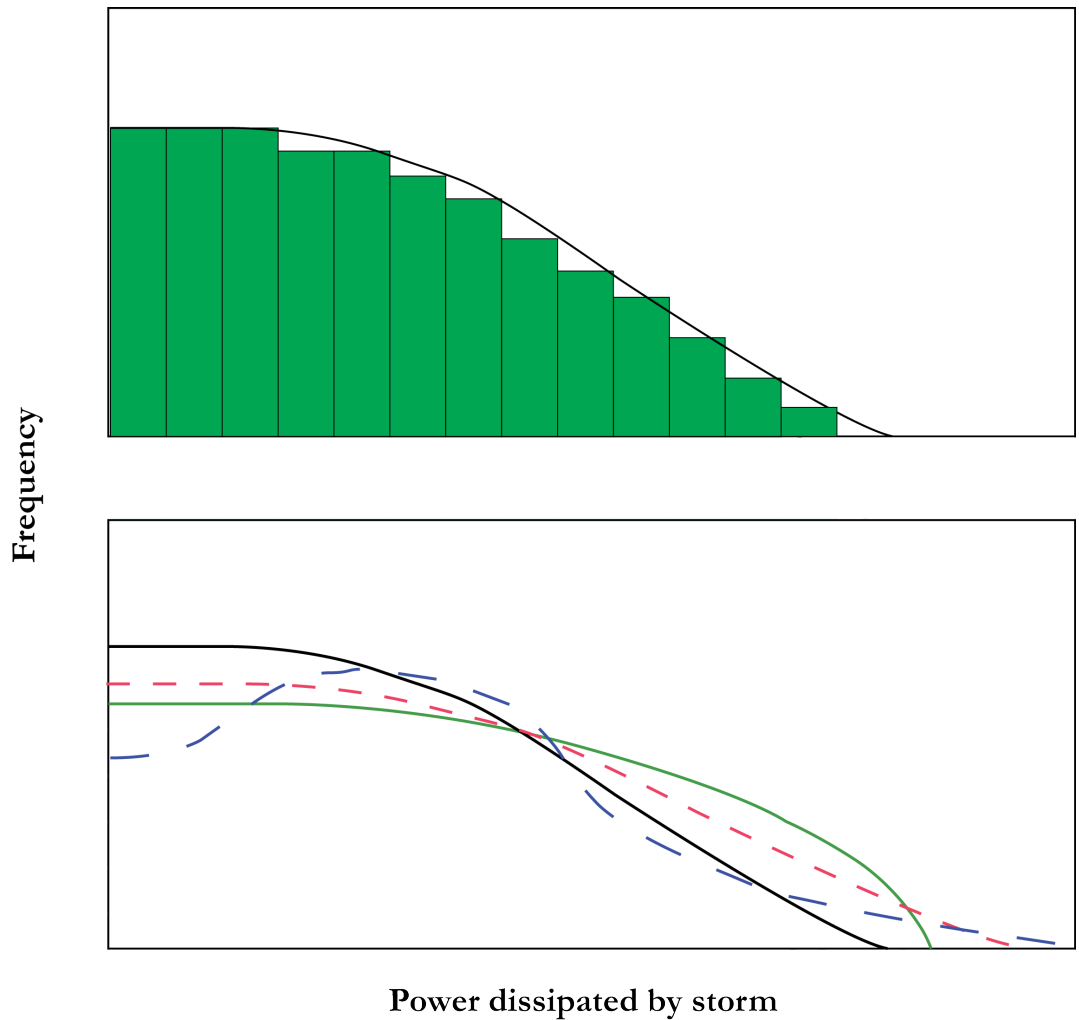
(Saffir-Simpson Scale)

North Atlantic Tropical Cyclones, 2005



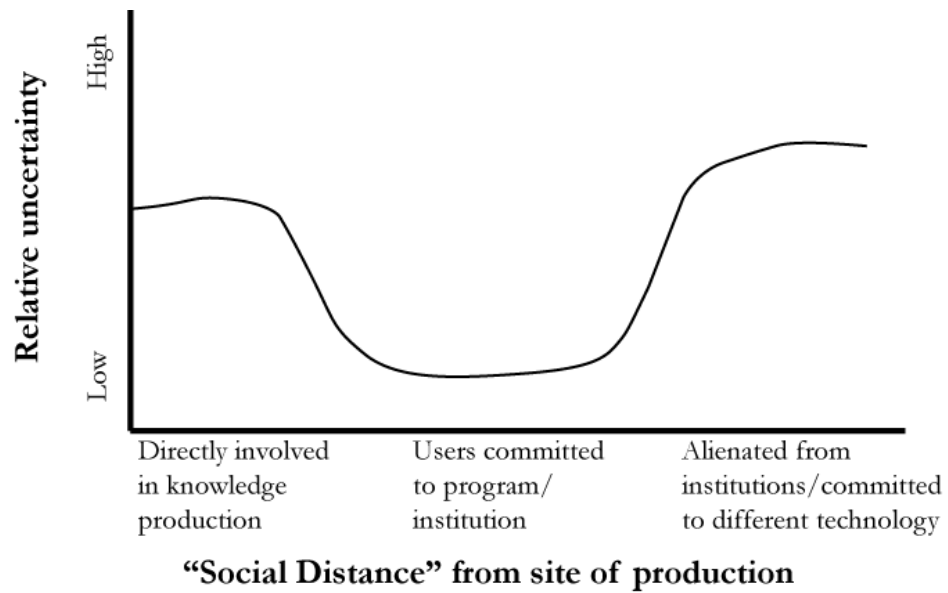
Source: Munich Re 2006

Figure 3.3: Imaginary distribution of power dissipated by tropical cyclones for a given climatology, and possible variations in a changed climate



The upper panel shows an imagined distribution of power dissipated by tropical cyclones in a given climatology. Note that the smoothness and regularity of the distribution is purely for purposes of illustration and does not reflect an actual dataset. The bottom panel introduces three hypothetical new distributions (red, green, and blue lines) for a transformed climate. Note that the tail of the distribution grows in all three variations, even though they all assume a decreased frequency of weaker storms (following the conclusions of Knutson et al. 2010).

Figure 3.4: The “uncertainty trough”



Adapted from MacKenzie (1990, p 372)

Figure 3.5:

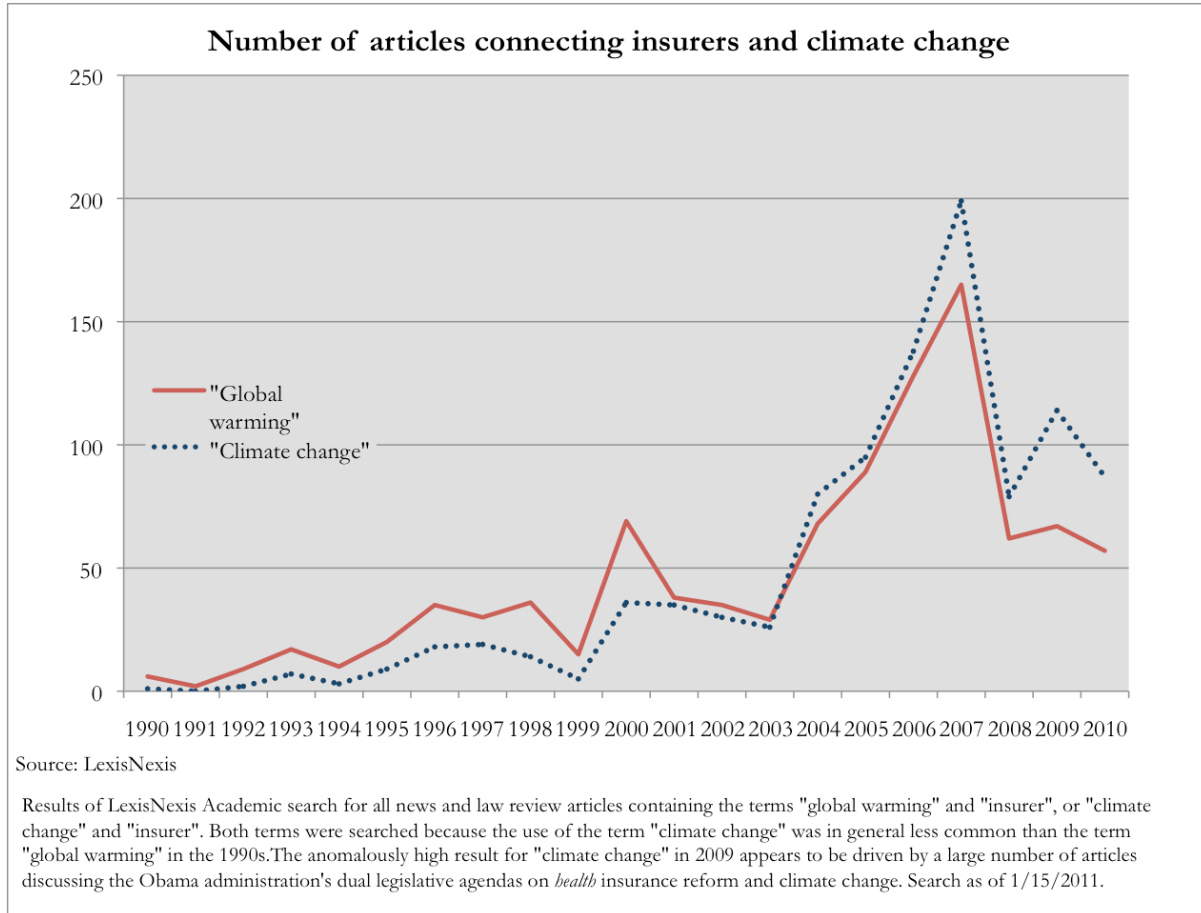
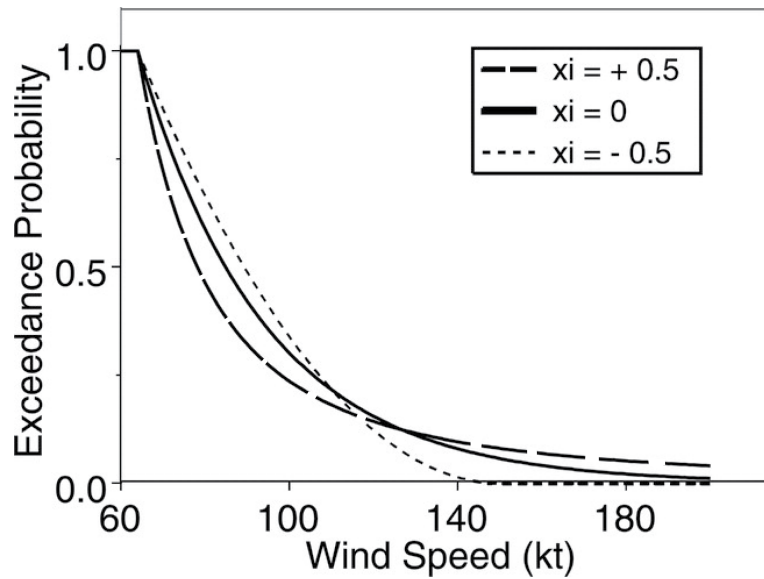


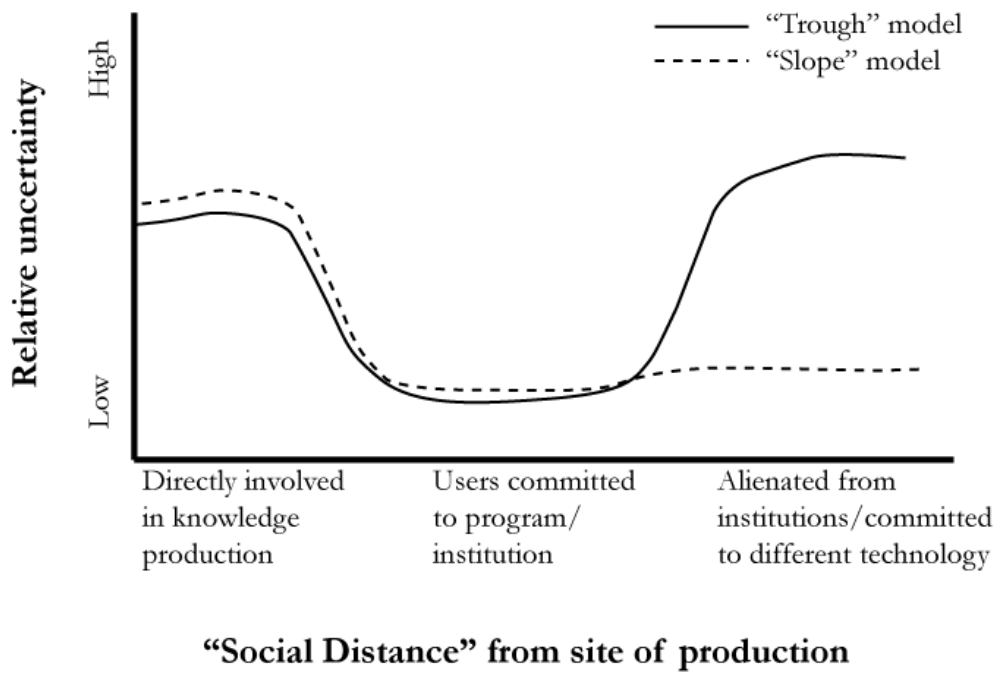
Figure 3.6: Exceedance probability curves for tropical storm wind speeds



Note the variability of the “tail” as it depends on the Pareto distribution used

Source: Jagger and Elsner (2006, p 3226)

Figure 3.7: Modified “uncertainty slope”



Adapted from MacKenzie (1990, p 372)

CHAPTER 4: Climate change and the limits of concern in insurance

The insurance industry is remarkably short-termist... Anybody that has a three-year view is actually an oracle... So people saying, oh god mate, it's all going to go wrong in twenty years time, temperatures are going to be up by two degrees, and sea surfaces will be up by a meter... [They] couldn't give a damn, frankly... not important.

– Reinsurance broker, London, May 2009

Climate change could be a major driver for growth in the insurance and reinsurance industry... Over the long term, it presents more of an opportunity than a threat.

– Schauble, in Kent 2010

Without fear, and without value to protect, there is never any insurance purchased.

– Director of Emerging Risks division in a major international reinsurance company, 2009

This chapter presents evidence from interviews and industry documents that significantly complicates the standard narrative of climate emergency by showing the practical limits of (re)insurers' concerns about climate change. Two factors in particular blunt the extent to which climate change figures as a day-to-day concern for (re)insurers. The first is related to the epistemological problem of probabilistic modeling and uncertainty. Absent climate change, the existing uncertainties surrounding loss drivers and loss modeling – including structural vulnerability, data quality, human behavior, model sensitivity, and natural modes of climate variability – are currently orders of magnitude larger than the additional uncertainties generated by climate change. Thus, individuals responsible for monitoring and modeling total cat exposures within insurance and reinsurance firms often believe that there are far more significant – and in large part neglected – phenomena contributing to insured losses that deserve study before climate change.

Second, the short time horizons and yearly contract renewals of reinsurance mean that policy limits and rates can be adjusted on a yearly basis to account for changing assumptions about event frequencies and magnitudes. With only a few exceptions, reinsurers are not yet incorporating climate change into their pricing structures or underwriting guidelines. Generally they presume that they will be able to raise rates and reconfigure portfolios through what I call a “future annual adjustments solution” as the need arises – at which point major catastrophes may make the market more willing to accept the changes.

If the internal operations of reinsurers indicate that they are less immediately concerned about climate change than their public communications would suggest, how are we to explain these competing narratives? I consider the hypothesis that reinsurers are exaggerating the current effects of climate change in order to legitimate rate increases, but find it unconvincing as a general explanation. Instead, I suggest that reinsurers' public discourses reflect a number of strategic rhetorical attempts to influence political and financial landscapes, reassure investors, and create a more favorable operating environment for the industry while staving off the potential future impacts of climate change.

I conclude by considering how climate risks might also constitute an opportunity of sorts for a (re)insurance industry struggling to sustain its business model in the industrialized world, where premium income is stagnant and competition between insurers is high. I show how

(re)insurers' climate narratives and research operate to reproduce the conditions for the industry's expansion. As property values grow, so too do fears about their loss, which motivate a new cycle of insurance transactions.

1. Everyday practice and the limits of concern

Despite reinsurers' public pronouncements and publications discussed in Chapters 1 and 3, this research finds that the practical extent to which climate change influences (re)insurers' daily business operations is limited in most cases. By and large, firms have not developed formal or informal methods for integrating climate change impacts into their underwriting and pricing decisions. This section presents interview data to support this claim, and then suggests that two major factors are responsible for limiting climate change concerns.

The (re)insurance industry demonstrates an unusual inversion of the prototypical relationship between scientific sophistication and concern about climate change. It seems logical to assume that the less a firm knows about the weather risks it is exposed to, the less likely it is to be concerned about the impact of these risks on its business. But in the (re)insurance case, the opposite appears to be true. A managing director at a major reinsurance brokerage firm explained with regards to his insurance clientele:

I suppose the first thing clients say is, so, what is climate change going to do for us then, in the next couple of years? That's a question that I might hear quite a lot.... I think depending on how well-informed they are...they don't really know. If they're slightly worse than average they may go, "it's probably a problem, isn't it?" Because they haven't really thought about it and they don't really understand the consequences. If they're really smart and they understand the consequences, I think the answer is they're not too concerned. Yeah, they might want to think about how public policy may change, long-term strategic vision - to the extent that any company has any long-term strategic vision. [i20]

Within the industry, distinctions between the "worse than average" and "really smart" firms is often made on the basis of a firm's geotechnical sophistication, roughly gauged by the percentage of the workforce holding PhD degrees. Because the performance of their business is so dependent upon correctly estimating the risk of extreme events with very long return periods, cat reinsurers typically employ a relatively large number of scientists with PhDs or Masters degrees in meteorology, climatology, seismology, structural engineering, and the like. On the other hand, many insurers tend to depend on the expertise of catastrophe modeling firms and reinsurance brokers to help them navigate complex geophysical risks, with the exception of some very large multinational insurance conglomerates that employ their own credentialed geoscientists.

The conclusion of most reinsurance geoscientists is that it is difficult – and in many cases impossible – to discern a climate change signal in loss data, let alone to incorporate climate change impacts into current pricing. Of the eight reinsurance companies whose employees were interviewed for this study, only one – Swiss Re – claimed to be currently accounting for climate change in any of its pricing. Even then this procedure was only applied for pricing European windstorm coverage, primarily for Germany, with a per annum surcharge of 0.5 percent after 2006. An executive at Swiss Re explained: "So it doesn't get felt the first two, three years, but after ten years it starts to be a five to ten percent change in our premium levels" [i29]. We should note, however, that the magnitude of reinsurance rate fluctuations due to market pricing cycles and macroeconomic conditions can be many times larger than five to ten percent (see **Figure 2.6**, Chapter 2), so Swiss Re's professed attempt to "send a clear message" [i29] with its

pricing may initially be lost in the noise. However, if such pricing guidelines were sustained over time, the eventual impacts would be substantial. For example, we could consider a hypothetical case in which a rate-on-line of 12 percent would grow with a 0.5% annual surcharge to account for increased winter storm activity. The price follows the equation for continuously compounded interest:

$$r_t = r_0 e^{0.005t}$$

where r_t is the price at time t , and r_0 is the initial price. Projected forward eighty years – the length of Swiss Re’s study period¹ – a 12 percent rate-on-line would grow to nearly 18 percent. This would amount to a relative price increase of 50 percent for European winter storm coverage.

But neither insurers nor brokers claimed to see any pricing signal currently coming from reinsurers. The director of accumulation risk management at a very large multinational insurance company – who had worked for two reinsurers in the recent past – emphasized the lack of a trend:

I think you will get the answer from most of the reinsurers “Yes, of course [we think about climate change] and we price it in and we monitor it”... But so far, we don't see it in the prices...There is probably a loss trend, especially for European flooding, but on the other hand you have the market pressure. Everybody is in competitive situations and I think this is still an order of magnitude higher in determining the final product price. It's still the competitive environment rather than the loss trend you can observe in the prices.

[i11]

Nevertheless, Munich Re as well as some Lloyd’s syndicates have publicly indicated that they are already or will soon incorporate a climate change surcharge. When asked if this was actually happening, a reinsurance cat modeling director from a Bermuda startup emphasized the overwhelmingly dominant force of market competition: “Oh they’re definitely trying, but in the marketplace that is not happening...it’s just not. Yes, the pricing is reflecting things like the [Atlantic Multidecadal Oscillation], you know, the medium term phenomena, but it’s not reflecting any long-term trends” [i24].

With regards to whether Munich Re’s position on climate change actually translated into changes in their underwriting, a director from a major global reinsurance brokerage firm hesitated and then answered simply: “They are full of shit. But they talk a good game.” He later elaborated:

I went to see [Munich Re] two years ago and said, “What are you doing to do for the rates going forward?” They said, “Well, of course now we really understand about climate change, and the rest of the world understands about climate change, so we're going to put our rates up by twenty percent.” So I said, “Oh really, you are, are you? What does the underwriting department – because they have two [research] departments – say about that?”... And this [underwriting] bloke's going purple in the corner, going, “Uh-uhn, we're not going to put our rates up by twenty percent!” Which is fine, by the way, to have some sort of public persona that says one thing and the business do something else. I think it maybe that's OK. [i20]

Munich Re seems to have decisively split its public persona from its business practice. On the one hand, its publications and employees claim definitive links between climate change and loss records (see also Section 1.1); on the other hand, the director of the Munich Re “geo-risks”

¹ The Swiss Re pricing guideline was adopted following their 2006 study of European winter storms, which simulated insured losses for the year 2085 in two regional climate models, driven by outputs from one coupled atmosphere-ocean global model and two atmospheric GCMs (HadCM3, HadAM3, and ECHAM5) ((Schwierz et al. 2010).

research team that interfaces with corporate underwriting told me in 2009, “There are not many regions with sufficient certainty to incorporate climate change into underwriting practice²... perhaps in 3 to 5 years this will be possible...To some extent, it’s an academic discussion what’s at the root of the increasing loss trends” [i14].³

This striking comment draws our attention to two issues that might easily confound analysis of reinsurers’ positions on climate change. First and most glaringly, the comment is an outright contradiction of the company’s publicized position, a disjuncture that may lead some to suspect intentional manipulation of public fear for the purposes of profit. I consider this argument and suggest counter-interpretations in Section 2 of this chapter. Second, the speaker identifies the dogged problem of relative uncertainty. This forms the subject of the following section.

1.1 Layers of uncertainty

Whatever companies’ ambitions to account for climate change into their daily practice may be, they are blunted by the reality that in the grand scheme of the cumulative uncertainties they face, the relative contribution of climate change is currently rather small. A relative contribution that is both small and difficult to quantify is not easily incorporated into business practice. The director of the Reinsurance Association of America explained the trend to me this way: “I think everyone...[has] accepted the science community’s conclusions about the human impact...but they’re still in the mode of trying to understand what the consequences of that would be on losses” [i35]. Similarly, an atmospheric scientist PhD at a highly technical Bermuda-based reinsurer made a point of assuring me that the company’s reluctance to incorporate climate change impacts into pricing was not due to its skepticism, but to uncertainty: “We’re certainly not denying the effects...of climate change, we’re simply interpreting the literature in a balanced way...I’m sounding like a primary skeptic now, but I’m not. I’m not at all!...[We] just know the limitations of the science at present and we know how uncertain the climate models are” [i31].

Given the large uncertainty and relative delay of climate change impacts, industry scientists I spoke with believed that developing a better understanding of natural variability – such as the Atlantic Multidecadal Oscillation, ENSO (El Niño-Southern Oscillation), and the North Atlantic Oscillation – was much more important for modeling probable losses from North Atlantic hurricane and European winter storms. Brokers appear to be relaying a similar message to their insurance clients:

I tell them to pretty much discount any impact [of climate change] on hurricane frequency or severity... Because its going to have less of an impact than La Niña/El Niño will have anyway, and that's probably still going to be the biggest driver...[We] don't understand the uncertainty of the models looking at the normal variability, let alone introducing climate change... [i20].

Even if cat models could represent the effects of natural variability well, there are other components in the models – the engineering vulnerability and financial modules – which

² This is not to say that (re)insurers do not account for any climate *variability* in their underwriting. Munich Re – like every other company I interviewed – has integrated a near-term outlook on hurricane activity in the North Atlantic in order to account for the Atlantic Multidecadal Oscillation (AMO), which is driving heightened sea surface temperatures in the basin (see Chapter 5 for more on near-term models).

³ After many attempts to set up interviews, Munich Re allowed me to speak to one person on their staff. I was not able to speak with any of the members of the second research team, which is explicitly devoted to climate research.

inevitably introduce additional uncertainties as a result of attempting to render both the three-dimensional built environment and economic and human activity in computer code.

Cat models are the fundamental tools that (re)insurers use to estimate probable maximum losses and average annual losses, but there is such a large degree of uncertainty in their representations of the *current* world that attempting to account for climate change within them would be statistically meaningless. Even when cat models are run retrospectively to gauge probable insured losses from a particular event (specifying nearly all of the event parameters such as wind speeds, wind field, pressure, etc.), the estimates they produce can easily be 50% different from the final reported losses. A modeler and PhD for a Bermuda-based reinsurer highlighted the extent of this problem to argue the futility of integrating climate change impacts into loss estimates. The company's top management had recently asked him to investigate whether they could develop a surcharge for carbon dioxide concentrations that would be integrated into their rates for hurricane coverage:

With or without climate change there's going to be a hurricane going through Miami in the next hundred years. If it's going to be ten percent more intense because of climate change or less intense – it's already in the margin of uncertainty. Let's say climate change has no effect, the modeling for such an event is still plus or minus thirty percent, we don't really know...When [Hurricane] Ike happened [in 2008] for example, the track is known, all the parameters, the strengths, the weights and everything is known, and still we're not able to model this loss to a precision of – if it would be plus minus fifty percent we would be happy, but in some cases it's three, four times different from reality, the scenario applied on the exposure. Then if you add maybe ten percent more for climate change... So it's, at the moment, a total waste of time! [i23]

As another modeler for a specialty cat reinsurer in London put it: “when we're looking at hurricanes charging into the Gulf of Mexico, the last thing on our mind is the fact that the sea level is a third of an inch higher than it was five years ago. It's ‘what happens when a 140 mile an hour wind hits this building’ kind of thing” [i9]. Essentially, any signal of current climate change impacts on insured losses would be smaller than the standard errors already embedded in the model, which can arise from factors as diverse as (1) the necessary approximations when modeling a system due to the limitations of computing power, (2) the non-linear growth in errors arising from the slight variation of initial conditions, (3) the exclusion of relevant geophysical or structural processes from the model, (4) data errors in the location and construction of structures in the built environment, and (5) the difficulty of predicting human behaviors such as claims filed and legal decisions regarding insurers' liabilities.⁴

Additionally, climate change is only one of many “emerging risks” that (re)insurers face, and it may be one of the smaller ones in terms of hidden future losses. Several interviewees mentioned nanotechnology, “litigation” (a clever neologism referring to “litigation contagion”), electromagnetic fields, and cyber-risk as huge potential drivers of loss which have received much less attention. The director of emerging risks research at Swiss Re suggested to me that nanotechnology could be “the next asbestos”, referring to the more than \$110 billion that the industry has either paid or expects to pay to cover claims from silicosis and lung cancer resulting from asbestos use – roughly \$2 million per patient [i27]. Nanotechnology is already producing

⁴ For instance, following Hurricane Katrina, many insurers refused to pay for damage caused by floodwaters since flood is excluded from private insurance policies and is covered by the National Flood Insurance Program. Clients filed lawsuits against insurers but ultimately the courts upheld the contractual exclusions. If the courts had sided with policyholders, the insured losses from Katrina would have been astronomically higher. These sorts of legal decisions cannot be modeled, yet they are the source of huge uncertainty.

particles such as multi-walled carbon nanotubes that persist in the human body with unknown effects, and because most (re)insurance policies do not explicitly *exclude* damages from nanotechnology, the risk is legally covered.

The same principle – if a risk is not explicitly named and excluded from the contract, the (re)insurer must cover it – also holds for unmodeled catastrophic perils, which many respondents mentioned as posing a potentially bigger threat for the property (re)insurance industry than climate change. “There’s huge systemic risk,” said the reinsurance cat modeling director for a Bermuda firm in 2009:

You saw it in September 11th...In reinsurance, nobody even thought about terrorism. We threw it in for free... We only model the big perils; we only model hurricane and earthquake, really. But what happens if, I don’t know, meteors strike: We give that cover for free. You know, tsunami’s another big one. We haven’t had one [affect the insurance industry] for fifty years, people don’t think about it, it’s out of people’s minds. We’re covering that though. [i24]

In short, while climate change impacts may become quite significant for the insurance industry in the future, the multiple layers of uncertainty surrounding both modeled and unmodeled losses are far larger than any contemporary climate signal. But this epistemological problem is not as profound as it may first appear, thanks to the timescales on which reinsurance contracts operate.

1.2 Time horizons and contract renewals

Because the pricing and terms of contracts are renegotiated on an annual basis, reinsurers can integrate new risk assumptions and pricing guidelines each year. This practice is deeply embedded in the industry’s business models and is a major factor contributing to the notorious cyclicity of insurance pricing. Structurally, yearly renewals direct attention and calculation towards the near future – the next contract renewal cycle – and discourages long-term planning. After all, what good is a long-term business plan if reinsurance prices could be 60% or 140% of their present rate ten years in the future?

This demonstrates a fundamental irony of reinsurers’ engagement with climate change impacts: because reinsurance contracts are renewed and repriced on an annual basis, in the short term, climate change risk is largely irrelevant. One reinsurance broker summarized his clients’ perspective as such:

The insurance industry is remarkably short-termist... Anybody that has a three-year view is actually an oracle. Most people are concerned with this year and next. So people saying, oh god mate, it’s all going to go wrong in twenty years time, temperatures are going to be up by two degrees, and sea surfaces will be up by a meter. It’s not important. [They] couldn’t give a damn, frankly... Most people in insurance, they may tell you otherwise for PR purposes, but in practical purposes, couldn’t give a damn. [i8]

This seems oddly contradictory with the huge emphasis that the industry has placed on knowledge transfer and research initiatives with public climate scientists. Although some efforts are being made to transform academic research into useful tools for industry – particularly through Willis brokerage’s “Willis Research Network” – by and large, the timescales on which climate scientists make projections are far longer than those in which virtually anyone in the (re)insurance industry is interested. For example, two reinsurance modelers with advanced geoscience degrees themselves complained that whenever academic climate researchers are brought in to speak at meetings,

[1]: they frame their findings in terms of IPCC scenarios for 2050, 2080, which causes people in the audience to switch off pretty rapidly because it’s way beyond –

[2]: – We’ve all retired by then, basically –

[1]: – way beyond the timescales we’re interested in, running our business” [i9, i10].⁵

This perspective inevitably leads these respondents to the conclusion that real transformations of the industry’s underwriting portfolios and pricing structure must be deferred to the future. As climate change impacts become more visible and data become available to quantify losses, the logic goes, reinsurers will adjust rates and modify portfolios to match the perceived risk changes. But thanks to the yearly renewal structure, this can be done over a number of years in the future, which is in any case far beyond the typical two year business perspective of underwriting departments. At last year’s World Insurance Forum, the chairman of Bermuda catastrophe reinsurer Axis Capital cited the short-term nature of the industry’s catastrophe exposures as a reason that “it should be able to add capital and maintain profitability as climate change [takes] effect over time” (Kent 2010).

Pricing is not the only thing than can be modified: “every year you have the chance to say, OK, I [want] to get more active in this region and withdraw from that region, or at least I’ll cut down my acceptances in a certain region” [i11]. In fact, new decisions can be phased in on a sub-annual basis, since reinsurance contracts for different regions usually renew at different dates throughout the year (some U.S. and much of European property catastrophe business on January 1, Asia property catastrophe on April 1, US hurricane business on June and July 1, Latin America/Caribbean perils on July 1, etc.). Even in “tipping point” scenarios where major climate shifts unfolded over a period of decades, the speed of the change could be more or less adjusted for in annual renegotiation.

The refrain of “change in business will come, but *not now*” was echoed by almost every reinsurer and broker I interviewed. A broker in London articulated the archetypal position:

Obviously, in the medium term, you might be concerned about sea surface temperatures actually impacting coastal areas. But not this year... We run a business that is, at worst [sic], annual and occasionally even less than that. So you can change your business on an annual basis. I don't personally see it as too much of an issue from climate change, from a business perspective. [i20]

But this “future annual adjustments solution”, as I will call it, implicitly assumes both that the market and society can bear these rising rates for an indefinite period of time, and that insurers will be politically able to secure such rate increases from regulators in the United States. As we will see below, neither of these assumptions is necessarily valid. There are also practical limits to reinsurers’ ability to reconfigure their portfolios, given the imperative to maintain business in strategic locations and with important clients (see Chapter 5).

The relative geographical fixity of primary insurers and legal norms governing residential insurance policies mean primaries will face bigger challenges in implementing future annual adjustments. An accumulation risk manager for a multinational primary insurer pointed out that primaries are more exposed to climate risks because, unlike reinsurers, they cannot “steer” their portfolios on an annual basis, stepping in and out of regions when it suits them. Since U.S. insurance companies are licensed to do business at the state level and regulated by state insurance offices, shifting the geographical distribution of a primary insurance portfolio is much more difficult than shifting a largely unregulated reinsurance portfolio. And although primary insurers can reprice policies annually, in the U.S. rate increases must be approved by state

⁵ The second speaker’s comment, that the current personnel will have all retired by 2050 or 2080, highlights the troubling questions of individual incentives and agency that gained so much attention during the financial crisis of 2008. Do underwriters have any incentive to write careful business if the terms of the contract can be negotiated at a later date, or if they are not likely to still be employed at the company when/if the policy incurs a large loss?

regulators and often become the subjects of political battles. Once a contract is in force the insurer is contractually bound to renew it each year unless there is a loss claim on the property. The company has a cancellation right in the case of loss – which many companies exercised in Florida in 2006 and 2007 – but generally primary insurers are very wary of the huge reputational risk associated with refusing to renew customers’ policies, particularly in the case of residential property.

Tellingly, the only two interviewees to express major reservations about the social implications of the future annual adjustments solution were not employed by reinsurers. The same accumulation risk manager for a primary insurer expressed concern that climate change impacts might become uninsurable if society was unable to bear the costs:

...if we have an ever-increasing loss frequency, [climate change impacts] will become very expensive for our clients - at one point in time, maybe even uninsurable.... Yes, we can increase prices and increase prices. But at some point in time, you know, the society cannot afford it anymore, so we have to think about what can be done first [to mitigate and adapt]. [i11]

The speaker’s reference to uninsurable climate impacts might recall Beck’s uninsurability thesis, but there is a major distinction between the two. In this case, the speaker never claims that the risks themselves will become incalculable – only that the financial burden from premium payments could become so large that they can no longer be paid.

The second respondent, the chief research officer at a leading catastrophe modeling firm, pointed towards the political economic structures that lead the insurance industry to offload risk onto society:

Clearly, what happened in Florida in 2006 and 2007 is extremely interesting... the insurance industry has a problem about climate change... because they have the ability to reprice their contracts annually, or to refuse to renew them, and that gives them wonderful flexibility as far as they're concerned. But it means that if you have a situation where hazard levels have increased for society as a whole, you see the insurance industry actually walking away or penalizing people for the fact that their hazard is higher. And that I think is a microcosm of climate change, actually...The insurance industry needs to wake up and be much more proactive in taking action to reduce risk in advance of catastrophes, because otherwise it'll be on the wrong side of climate change. And Florida was a sort of test run for this future. [i6]

The “wonderful flexibility” of the industry turns on being able to shift the burden of unwanted risks onto other parts of society – be it other segments of capital, the state, or individuals. This individuation of climate risk – “penalizing people for the fact that their hazard is higher” – threatens to discredit the industry’s “sales story” of providing security and peace of mind (Baker 1994). How successful this risk shifting will be remains an open question.

2. Reconciling public and private stories

In sum, we are faced with a contradiction between public narratives of mushrooming unmanageable climate risks on the one hand, and differentiated explanations of the limits of concern and possibilities for future annual adjustments and profits on the other. What are we to make of this contradiction? Is it possible to reconcile these two competing narratives?

One hypothesis with great appeal for populist politicians and consumer advocacy groups is that (re)insurers are intentionally exaggerating risks in order to legitimate higher insurance prices. In fact, this hypothesis was an early motivation for this research project in 2006. Such critiques have been leveled at the industry from the news media in Europe and the U.S. For

example, a research director at Aon Benfield recounted his experience doing press for a temperature forecasting project done at the Aon Benfield Hazard Research Center at University College London: “I ended up doing about ten radio interviews, three TV interviews on air. And the question I got every single time is, ‘oh, it’s just the industry trying to talk the risk up, isn’t it?’ ... You have to be alert to that” [i8]. The Miami Herald-Tribune and the New Orleans Times-Picayune, among others, have questioned the honesty of the climate change rationale when Florida and Louisiana residents were hit with massive rate hikes in 2006 and 2007, and have since used the relatively benign seasons of 2006-2009 to cast even more doubt on insurers’ explanations.

But as intuitive and simple as the exaggeration hypothesis may be, I do not believe it can serve as a compelling general explanation. If it were true, we should see more consensus among firms that their current pricing reflects climate change concerns. As discussed in Section 1, the opposite actually seems to hold, as the interview data show that very few (re)insurers currently claim to factor climate change impacts into pricing. There are also structural impediments to collusive cartel pricing due to the highly competitive dynamics of the reinsurance industry since 1992. The entry of lean specialty cat reinsurers in Bermuda, as well as catastrophe bonds and other ILS offerings, means that reinsurers charging significantly higher prices can be easily undercut. Additionally, the reinsurance market is currently in a sustained “soft” point in the pricing cycle, so any first movers factoring in a climate change surcharge would be at an immediate competitive disadvantage. Although there are undoubtedly individual instances of (re)insurers exaggerating risks for pricing purposes, there are far more differentiated and theoretically illuminating reasons for the apparent disjuncture between public narratives and private practices. This analysis concludes that the invocation of rising climate change risks serves strategic rhetorical purposes for (re)insurers in relation to international and national climate policymaking, U.S. insurance regulation, and shareholder demands on management.

2.1 Mitigating future losses through advocacy

First, and most obviously, some leading reinsurers with long corporate histories and dominant market shares are concerned about the longer-term implications of climate change for the sustainability of their business model. This is most applicable to the major European reinsurers – Munich Re, Swiss Re, Hannover Re, and Lloyd’s – who have been in business for over a century and have institutionalized mechanisms for longer term planning. Here there seems to be an implicit acknowledgement that neither perpetually raising rates nor excluding at-risk geographical areas can be a permanent solution – largely due to the competitive disadvantages this would put on firms whose modus operandi is, after all, continued growth. In this sense, raising alarm bells about the rising costs of climate change is a strategic attempt to motivate political action to reduce potential future losses, primarily via adaptation policies. As Swiss Re’s head of sustainability and emerging risk management pointed out in an interview, climate change is not operating on the time scales that private enterprises incorporate into their strategic planning, but it is within the timeframes considered by governments. In explaining the company’s involvement with the “Economics of Climate Adaptation” study, which considered scenarios for the year 2030, he said:

You talk about time scales which should still matter – for sure they matter for governments. They might be difficult to deal with on a strategic level for private enterprises... over a time-scale of ten years, the uncertainties linked to climate change might still be completely embedded in climate variability [i29].

Swiss Re's advocacy for climate policy has included annual efforts at the World Economic Forum and the UNFCCC meetings (Swiss Re was a member of the Swiss country delegation to both the Copenhagen and Cancun climate talks), as well as a seemingly endless number of publications and collaborative studies on the subject.⁶ A communications director for the company explained this in terms of a larger ambition to inculcate the logic of probabilistic and scenario-based risk analysis by governments:

I think there's a fundamental transformation that's going to happen in the next 10 years, in which the types of risk assessment thus far used by the insurance industry, this model will be increasingly adopted by governments to assess total exposure and accumulation risks⁷ across all areas. We already have this in some form in [Swiss Re's] "country risk assessments", and you can see this happening already at Davos. [i25]

Thus, convincing governments to adopt insurers' expertise and technologies to evaluate potential future climates is not only a strategy for managing climate change; it is also one exercise among many to cultivate the governmental rationality of insurance within state apparatuses (Collier, S. J. and Lakoff 2008; Collier, Stephen 2008). As in Chapter 3, we should note the ways in which climate preparedness and precaution articulate with the logics of budgetary rationalization (Collier, Stephen 2008) and preemption more generally.

Along these lines, over the last five years Swiss Re's efforts have shifted from a focus on curbing emissions towards adaptation planning and preparedness more generally.⁸ When asked what Swiss Re considered the biggest barrier to "smart adaptation" and preparedness, the sustainability director responded:

I think sadly that it is still awareness. It's still the case that people might have barely identified the risk they're really exposed to, and that's for good reason, because these risks come with huge uncertainties. So you cannot say tomorrow you face the big event and if it's not coming you have a proof that you're safe... the biggest impediment is often education about risks, common understanding...and then taking the right actions. And these right actions, often they are not cheap. So investing a lot of prevention money into an uncertain future is a very difficult endeavor. Especially if you think also about election periods...[i29]

The point of the company's advocacy, then, is to encourage that the "right actions" (which "are not cheap") are taken at least partially at the expense of the public sector in order to avoid a situation in which the reinsurance industry bears most losses *ex post facto*. Transforming adaptation planning and policy in the public sector is thus part and parcel of any long-term attempt to sustain accumulation within the reinsurance industry and stave off the worst financial impacts of climate change. It also aims to redistribute some of the costs of climate-sourced devaluation to other segments of capital. This is particularly the case for perils such as floods or tornado/hail storms, which are high frequency/low magnitude events with the capacity to persistently eat into (re)insurers' balance sheets, but without causing the catastrophic levels of loss that might generate high returns on equity following capital depletion.

The threat of climate emergency is also invoked in reinsurers' lobbying efforts against U.S. insurance subsidies and price regulation. Quite apart from climate change, the industry would like to see the reform and partial privatization of the National Flood Insurance Program

⁶ This "consciousness raising" is formalized as part of the company's corporate responsibility framework.

⁷ Meaning spatial and temporal clustering of losses.

⁸ This is not to say that emissions policy does not figure in their climate advocacy, but the company felt that adaptation was relatively undervalued and understudied and deserved more attention from the (re)insurance industry in particular.

(NFIP), a FEMA-administered program that provides subsidized flood insurance – granting a 60 to 65 percent discount on the “actuarially fair” prices – for 25 percent of the 5.56 million policies in force (Government Accountability Office 2008; Federal Emergency Management Agency 2010). The industry is lobbying heavily to prevent similar federal involvement in all-perils insurance coverage, as well as to discredit the prevailing U.S. model of insurance regulation premised on consumer protection.

These debates are elaborated further in Chapter 6, but briefly put, industry publications and lobbyists regularly cite the impacts of sea level rise and hurricane intensification to decry the irrationality of the U.S. structure of insurance provision and regulation. They suggest that government programs such as NFIP and state-run “wind risk pools” of last resort, like Florida Citizens Property Insurance Corporation, encourage coastal development in regions that are particularly vulnerable to climate change impacts and drive a cross-subsidy from taxpayers to wealthy coastal residents. Florida is the state of largest concern for (re)insurers because of the enormous values (and thus, potential premium earnings) concentrated there. Furthermore, state regulation of rate increases in the interests of consumer protection could pose a major problem for insurers hoping to implement a future annual adjustments solution to manage climate risks. Publicizing climate concerns provides seemingly indisputable scientific arguments to discredit public policies that have been blocking the expansion of the private property insurance market and reducing its earnings potential.

2.2 “Shareholder value” as management imperative

Less obviously, the invocation of climate change as a current driver of losses could also be an attempt to explain away poor operating results to shareholders. That is to say, if a firm experienced a very large weather-related loss that was not proportional to industry losses, or for which it had not adequately reserved capital or hedged through the purchase of reinsurance/retrocession, an appeal to the heretofore unimaginable impacts of climate change could serve as a partial explanation to shareholders. In addition, the practice of constantly reexamining climate impacts in corporate publications and whitepapers resonates well in the era of “shareholder value”, which dictates that management must constantly assess and anticipate potential threats to shareholders’ equity (Froud et al. 2000).

There is some anecdotal evidence indicating that both of these motivations may explain the behavior of some firms, although far more research would be required to determine if they are generalizable across the industry. Several respondents pointed out that scapegoating of climate change to explain firms’ huge losses was widespread following the 2005 hurricanes, but seems to have quieted since then. A broker complained:

There was a time when [with] every loss, everybody said, “Doh! What a surprise! It’s climate change, we suffered a big loss!” I said, “You can’t keep on saying that. Aren’t you meant to be the experts? How could you be surprised by this?” I think they had to take a more sophisticated newer position about it. [i8]

The same strategy is unlikely to be convincing going forward, and so firms must be seen to actively anticipating climate risks and scouring the horizon for new developments. Funding academic research collaborations is another way to perform this task. Results from collaborations⁹ can be integrated (or at least appear to be integrated) into corporate risk

⁹ Most respondents said they could think of very few instances of research collaborations that resulted in a change in business operations.

management, prevent a firm from being caught off guard, and help it more fully understand and manage its current weather-related risks. This might also include using up-to-the-minute meteorological data to hedge these risks in the so-called “live CAT” futures market. Establishing lasting relationships with research institutions in the present also cements connections that can be relied on into the future as research demands increase.

Firms must also “prove” to investors that they are capable of navigating new risks while producing steady underwriting results. One industry commentator cast doubt on the entire industry’s capabilities in this regard:

If we look at the impact of September 11, 2001, and the 2005 North American hurricane season, we can see that, in two years of the past five, the industry has been shaken by unprecedented losses. Investors and policyholders alike must question the volatility of the industry’s earnings and its ability to get sufficient payback (Zinkewicz 2006).

A steady stream of histrionic press reports – which continue to appear even as I write (Berkowitz 2011; Holding 2011) – repeat the narrative of immense climate risk to insurers’ bottom line.

Reassuring concerned investors requires that companies fashion themselves as climate experts in a way unheard of before 2004. The technical science teams within reinsurance companies have become the “go-to” employees when management or executive boards – whose understanding of climate change impacts can be quite limited – have concerns or are faced with questions from investors or ratings agencies. Said one director of internal catastrophe modeling at a Bermuda-based reinsurer: “It’s in the press a lot. So people hear about that and investors who invest a lot of money in [our company] say [to the board], ‘Are you guys considering the fact that hurricanes could be twice as strong in five years?’ and so we have to have a reasonable answer back to them” [i24].¹⁰ A broker reiterated the market expectations about (re)insurers’ climate expertise: “they have to be seen to be understanding the issue by the public”, including clients and investors [i8].

This holds for perils beyond climate change as well. The concept of “thought leadership” is often invoked to explain the production of peril-specific publications and research initiatives by major reinsurers more generally. Swiss Re is probably the most prolific and systematic in the identification of “Top topics” featured in its *Sigma* series (published at least quarterly) and its occasional “Focus Reports”. Topics featured¹¹ in the “Re thinking” segment of the company’s website as of May 2011 include agricultural risk, climate change, political risk management, insurance-linked securities, liability dynamics, longevity, natural catastrophes, (re)insurance regulations, and the impending European reinsurance regulation Solvency II. A Swiss Re communications director explained to me that the selection of “Top topics” is highly formalized within the corporate structure, with the executive committee annually reviewing nominations for new topics and allocating funding for research and writing. Executives also make strategic decisions about “what is important to publish on in order to gain trust and establish leadership in the market.” Here he articulated the company’s very conscious attempt to lay out the framework

¹⁰ Such overestimation of the magnitude and immediacy of climate change impacts on hurricanes is not limited to worried investors. Warren Buffet demonstrated his own tenuous understanding of the subject in an annual shareholders meeting in 2007, saying “Our exposure goes up every year because of what’s going on in the atmosphere, even though we don’t fully understand what’s going on. [This] could increase expectable losses from any given hurricane season by a factor of two, three, four or five...It would be crazy to offer catastrophe reinsurance at the same rate in 2007 as we did in 2006” (Barr 2007). Recall from Chapter 2 that the newest collaborative study among hurricane experts projects an increase in global mean hurricane intensity of between 2 and 11% by 2100, with a potential decline in frequency.

¹¹ As of May 2011. <http://www.swissre.com/rethinking/>

and language with which these emerging issues will be addressed in the public sphere: “We are an opinion leader in the market place, and the role of the publications is *to take people along with us*. It’s part of the service we provide as a reinsurer” [i25, emphasis mine]. The object is not only to *identify* risks but to suggest the proper way of managing them through the mechanism of private (re)insurance. The speaker’s formulation of “thought leadership” as another “service” provided by the company nicely demonstrates the extent to which the exchange value of the insurance product hinges upon the insurer’s ability to cultivate the imagination of future potential scenarios from which the customer would be financially protected, what Lobo-Guerrero has recently called “performing a future in the present” (2010a, p 243).

In this sense, the proliferation of reinsurers’ climate-related publications, academic collaborations, and so forth are also performances of expertise to establish firms’ credentials as forward-looking and technically savvy. Lloyd’s 2006 Annual Report specifically linked the company’s climate initiative with the maintenance of the its brand image:

Focused activities to maximise the impact of Lloyd’s brand have centred on events programmes... and thought leadership initiatives (for example, Lloyd’s initiated the 360 Risk Project on Climate Change, hosting a climate change forum in July 2006) (Lloyd’s 2007, p 69).

Indeed, one would be hard-pressed to find a major reinsurer that does *not* have some kind of “thought leadership” project on climate change. A number of them have involved outside scientists in larger applied research projects, which typically function through long-term partnerships or specific arrangements between the private firm and a university research center or department. In some cases, the partnerships are specific and goal-oriented; for example, Swiss Re worked with a group at the Swiss Federal Institute of Technology (ETH) and the federal Office of Meteorology to quantify climate change’s effect on European winter storm damages projected through the year 2085 (Schwierz et al. 2010). In others, the relationship might be described loosely as one of academic patronage in which a reinsurer or broker partially funds a university research group, but without direct commercial intentions. For example, Munich Re has sponsored £3 million worth of research at the London School of Economics to quantify the business impacts of climate change, and Swiss Re has donated 5 million Swiss francs (roughly \$4.5 million) for a Chair in Integrative Risk Management at ETH. There are other examples of corporate membership-based industry organizations (the Risk Prediction Initiative in Bermuda and the Lighthill Risk Network in London among them) that also commission research or solicit consulting expertise from academic scientists.

In turn, the major reinsurance brokerages fund their own research collaborations; if they are to win contracts, they must appear to their clients (the primary insurers) to be “ahead of the game” and in possession of equal or greater information and technical expertise than the reinsurers and other brokerages. Willis brokerage – after which Chicago’s Sears Tower has been renamed – runs its own “Willis Research Network” which funds and commissions extreme event research from scientists from at least twenty leading academic institutions worldwide (including the U.S. National Center for Atmospheric Research, Oxford, Cambridge, Princeton, Scripps, and ETH) in what it calls the “world’s largest partnership between academia and the insurance industry”.¹² In 2009 Willis also sponsored the creation of the “Catastrophe Risk Financing Centre” at Oxford’s Smith School of Enterprise and the Environment. Brokerage Aon Benfield sponsors the “Aon Benfield Hazard Research Center” at University College London, which organizes applied physical and social research efforts on hazards including climate change,

¹² See www.willisresearchnetwork.com.

floods, earthquakes, landslides, windstorms, and volcanoes, and offers a masters degree in geophysical hazards. Guy Carpenter has more directly targeted climate research by funding the “Guy Carpenter Asia-Pacific Climate Impact Centre” at the City University of Hong Kong.

The degree to which these partnerships result in knowledge transfer between academia and the firms involved varies. One broker, to whom I was introduced by his counterpart and friend at a rival brokerage, described the rival company’s motivation for sponsoring an academic unit:

i: The long and short of it is... I'm assuming [he's] probably been fairly honest with you about this?

LJ: *Yes.*

i: Well it's a publicity vehicle... cheap P.R. is how they use it. And it is good P.R. I would say... And so we didn't set anything up like that because we'll just look like we're doing it too... However, we have actually just set up a [named sponsorship of an academic unit at a different university]... Which is not dissimilar really! [i20]

Although the organization of the two academic sponsorships is purportedly different, it is clear that the overall tendency is a scramble for academic expertise, a science “arms race”. The metaphor here is not my own; the chairman of the Willis Research Network has explained the need to involve public scientists “because it's only [they who have] the understanding, the transparency, the openness, and frankly, the nuclear modeling weapons compared to the small arsenal that we will have, to actually engage” [i40]. The resulting race is driven at least in part by the Willis Research Network’s huge advantage in terms of exclusive access to academic stars. When asked how and why the WRN was able to gain such a foothold in advance of the other brokers, the chairman of the WRN told me: “We got in first, I had this idea and they let me go at it. Willis was weaker 5 years ago, certainly the weakest of the competitors, so the other firms weren’t really paying attention to what we were doing” [i40].

In the scramble to perform their expertise, one-upmanship between firms prevails, resulting in an avalanche of glossy publications, press releases, and sponsored projects. Niklas Luhmann’s (2005) perceptive comments on risk research suggest the paradoxical results:

[We] must abandon the hope that more research and more knowledge will permit a shift from risk to security. Practical experience tends to teach us the opposite: the more we know, the better we know what we do not know, and the more elaborate our risk awareness becomes. The more rationally we calculate and the more complex the calculations become, the more aspects come into view involving uncertainty about the future... (p 28).

This brings us full circle to Defert’s (1991) argument about the multiplication of “insurable insecurities” (see Introduction and Chapter 2 section 3). Through the expansion of risk identification and calculation, here exemplified by the proliferation of research initiatives and publications organized by the risk industry, the provisioning of climate security is fashioned into an inexhaustible market.

3. Making markets: The multiplication of fear and value

*“The underlying business model of banks is greediness;
the underlying business model of insurance is fear.”*

This comment came from the director of emerging risk research at a large reinsurer as he candidly explained the industry’s general business strategy to me in 2009. He continued straightforwardly: “without fear and without value to protect, there’s no insurance purchased.”

These statements may be rather intuitively obvious, but they seem to me remarkable nonetheless because of their source. His conscious identification of fear as an organizing principle of both insurance sales and purchases provides an extremely useful avenue for exploring the proliferation of risks as a function of insurance institutions themselves.

In the *Grundrisse*, Marx insists that production under capitalism creates not only the commodity, but also its consumer – “not only...an object for the subject, but also a subject for the object” [1993 (1857), p 92]. I turn to this dialectic to show how it might elucidate both the multiplication of insurable insecurities and their consuming subjects. As the quotes above indicate, markets for weather-related catastrophe coverage are made as the political economy of the risk industry articulates with economic anxieties about climate change, producing both the *objects* and *subjects* of the insurance transaction.

Besides fear, economic (exchange) value is of course the other component motivating the transaction. As private insurance has long been inextricably bound up with modern capitalism’s expansion and its production of surplus value, it is no surprise that insurance purchases and the total insured value of properties exposed both rise alongside economic growth. And as values rise, so do the fears about their potential loss. Florida is a commonly cited example: due to massive population growth and a real estate market booming on the heels of cheap credit, one industry trade association estimates that 1992’s Hurricane Andrew would have cost double its original \$15 billion in insured losses if it had hit Florida a decade later (ABI 2005). So as anxieties grow about climate change’s impacts on fixed capital and assets, in some senses (re)insurers find themselves with an “inexhaustible market” for products.

This insight also helps to make sense of reinsurers’ claim that insurance services will be in greater demand – and command higher prices – in a future climate. This promise aims to convince investors of the continued prospects for reinsurance as an industry, particularly given its predicted demise by some observers of the “convergence” between reinsurance and capital markets. At the World Insurance Forum in 2010, the managing principal of the prominent cat fund Nephila Capital claimed: “Climate change could be a major driver for growth in the insurance and reinsurance industry, but only if prices change to reflect the changing risk...Over the long term, it presents more of an opportunity than a threat” (Schauble, in Kent 2010). Note that the “opportunity” invoked by the speaker very much turns on the ability to increase rates. As with other rhetorical formulations of the business opportunities that will from new climate vulnerabilities, the actual locations and perils that might bring in new premiums remain unnamed articles of faith.

If demand for insurance protection were indeed to increase as a result of rising climate vulnerabilities, this would mark a significant reversal of fortune for insurers and reinsurers troubled by market saturation and premium stagnation in the OECD countries (see Chapter 2). While increased storm, flood, and fire risks, among others, would mean more losses in absolute terms, in *relative* terms the price that (re)insurers could charge to assume those risks could increase disproportionately due to public fears about climate change impacts and the resulting imperative to purchase more coverage to protect values perceived to be at risk. This surcharge (or rent, as it were) is quite conceptually distinct from the *additional* surcharge on capital that would result from a massive catastrophe that depleted (re)insurers’ reserves, of the sort discussed in Chapter 2.

In this chapter I have elaborated the reasons why climate change does not currently figure into (re)insurers’ daily practices, while highlighting the strategic reasons that the industry publicly invokes the threat of global warming. I have avoided making the facile claim that

insurers and reinsurers intentionally exaggerate risks and adopt scare tactics about global warming out of profit-seeking. There are probably instances of this occurring, but as a general explanation, such a claim misses the point. It is not necessary to suppose the existence of any sort of industry collusion or exaggeration. Rather, the industry reproduces the conditions for its own existence through its everyday operations. This is true in both a discursive and material sense. That is, the industry identifies new risks about which investors and/or the consuming public should be alarmed, and also reinforces the structures of compensation and the organization of property that make particular populations relatively more vulnerable – and other populations more able to pay for security. Such an understanding of risk production makes it possible to both believe in the dire threats posed by global warming and maintain a critical perspective on how these risks are measured, priced, packaged, and distributed. For as Francois Ewald (1991) reminds us, no particular form of insurance is an inevitable response to a certain set of problems, it is always just one of the possible ways of applying a technology of risk. This is to say, it is a question of politics.

CHAPTER 5: Insurance-linked securitization of catastrophe risk

This chapter steps back from the global (re)insurance market's immediate intersection with climate change to examine broader shifts in the political economy of reinsurance and asset-backed securitization. A much-heralded "convergence" between the reinsurance and capital markets began in the mid-1990s (Culp 2002; World Economic Forum 2008). Simultaneous waves of deregulation and market consolidation coupled with growing financial losses to natural catastrophes paved the way for an array of new instruments with which to hedge and speculate upon weather and other natural hazard risks. These include instruments to hedge against "everyday" risk – typically weather derivatives based on temperature or precipitation – or contracts to cover massive loss following a catastrophic natural disaster – typically insurance-linked securities such as cat bonds and industry loss warranties. Given the significant and growing body of geographic literature on weather derivatives (Pollard et al. 2008; Pryke 2007; Randalls, S. 2006; Thornes and Randalls 2007), this chapter focuses on the insurance-linked securities market, which is in much more direct competition with reinsurers in any case.

Catastrophe bonds (or cat bonds) and insurance-linked securities more generally have been heralded as solving the problems of illiquidity and "lumpiness" that characterize the catastrophe reinsurance industry – that is to say, the irregular and unpredictable demand for very large quantities of liquid assets to pay claims (Jaffee and Russell 1997; Kohn 2004). Cat bonds are sponsored by insurers and reinsurers and offer a relatively high return to investors in exchange for protection from some particular kind of catastrophic loss events exceeding a certain pre-specified trigger value. They are designed to move especially concentrated geographical exposures off of a firm's balance sheet and outwards into the broader financial markets. The multi-year structure of cat bonds also allow insurers and reinsurers to secure coverage at a set price for a number of years (typically three) rather than renegotiating prices on a yearly basis – particularly significant given the cyclicity of reinsurance pricing. The most frequently securitized perils have typically been the natural catastrophes with the greatest potential to destroy insured property and generate associated business interruption and workers compensation claims: hurricane damage, earthquakes, and winter storms. But other phenomena as diverse as influenza pandemics and longevity "crises" are also constituted as financial risks forming part of the same asset class.

This chapter departs from the majority of academic treatments that explain insurance-linked securities as simply offering a financial solution to the problem of place-bound reinsurance underwriting (and the apparently ageographical logic that follows). I argue that greater analytical traction and geographical sophistication can be gained by also considering the ways in which the insurance-linked securities market has been constituted as a "way in" for capital markets, giving investors direct access to previously untapped premium incomes from the world of insurance risks. In other words, the place-bound vulnerabilities of fixed assets drives a revenue stream from asset owners to the guarantors of financial compensation (typically insurers); as the provision of catastrophe insurance is securitized, these place-bound vulnerabilities have been turned into an exploitable, diversifying asset class for financial capital. This reconfiguration of hazard risk into asset class suggests some intriguing inversions of Pike and Pollard's (2010) insistence on attending to "the ways in which the geographies of assets and liabilities impinge upon their value and tradable potential" (p 36). Rather than detaching reinsurance from its ties to place, the insurance-linked securities (ILS) market fashions

geographic liabilities as strategic resources from which new income streams can be derived by enabling purposive, scalable, and selective relationships to the vulnerabilities of the built environment. Insurance-linked securitization is thus a deeply geographical and globalized project that should become a topic of significant interest for the new geographies of finance (Clark 2006; Lee et al. 2009; Leyshon and Thrift 2007; Pike and Pollard 2010). Its more-than-passing resemblance to debt securitization should also prompt serious examination of the nascent push to write insurance business with the direct intention to securitize it, particularly in light of climate change.

1. Escaping from place through the capital markets?

Though some critical scholarly attention has been paid to insurance-linked securities, (Bougen 2003; Jagers, Paterson, and Stripple 2005; Randalls, Samuel 2009; Sturm and Oh 2010), relatively little attention has been paid to the investor's side of the transaction, nor to the role that space and nature play in the creation of "investment-worthy" products. Most focus instead on insurers' and reinsurers' efforts to displace risk into capital markets, framing them within ongoing discussions of Beck's risk society in which modernity's technological developments become the source of catastrophic risks that exceed the boundaries of calculability and control. It is within this context that Bougen asks whether catastrophe bonds might signal the emergence of a risk network with "the necessary degrees of coherence between institutions and technologies...for the practical functioning of catastrophe financing" (2003, p 255). Similarly, Jagers et al (2005) argue that insurance-linked securities such as cat bonds are strategic forms of privatized environmental governance that will allow the insurance industry to dodge the most costly impacts of climate change by spreading losses in the capital markets. Sturm and Oh (2010) employ a parallel logic to argue that catastrophe bonds allow reinsurers to solve the problem of ever-growing catastrophic losses through "scaled and networked recovery schemes" that *displace* and spread risk (p 154).

These explanations are accompanied by consistent portrayals of capital markets as bequeathing financial powers that free the insurance industry from its fatal ties to absolute space. When the materiality of nature and space are considered, it is to highlight them as *problems*, with all of their messy specificity. Insurance-linked securities have largely been theorized as a "way out" or "scaling up" for the insurance industry – as solutions, albeit incomplete, to the well-documented limitations of scale, capacity, and capital reserves within reinsurance markets. Though these formulations usefully explain insurers' and reinsurers' motivations for seeking alternate sources of capital for underwriting, they seem to me unable to explain why any investor would willingly buy in to the market. This is arguably because they neglect the extent to which the insurance industry's *specific historical relationship to space and nature makes it a potentially promising investment opportunity* for other market participants. If we accept this thesis, then the dynamics of ILS investing and their mediation by financial and technical experts suggest new modes of economization of human and geophysical environments.

1.1 The structuring of catastrophe bonds

Catastrophe bond structures are routinely used to securitize risks of earthquakes, hurricanes, winter storms, and extreme mortality. Bond issuances are always tied to specific perils in at least one geographic region (for example, California earthquake or European winter

storm). Some bonds are structured such that different tranches of the same bond cover the sponsor for losses arising from separate perils in different geographic regions. Finally, a growing number are explicitly multi-peril across all tranches, meaning that the same dollar of principal is exposed to two or more identified risks and locations (see **Figure 5.1** for absolute and relative capital on risk by peril and region). The payout “trigger” mechanism on a bond may be based on the specific losses suffered by the cedant, an estimate of industry-wide losses, a modeled loss using event parameters fed into a catastrophe model, or an indexed measure of event parameters such as average wind speed or ground shaking.¹

Some rather elaborate legal structures are required to facilitate cat bond issuances. As illustrated in **Figure 5.2**, typically a sponsoring insurer² or reinsurer – the cedant – creates an independent and legally distinct Special Purpose Vehicle (SPV) that is domiciled offshore, most often in the Cayman Islands. The first cat bond was listed on the Cayman Islands stock exchange in 2007, but the domicile quickly overtook other offshore competitors such as Bermuda and Ireland. It was already a popular domicile for SPVs of collateralized debt obligations because there is no withholding tax on coupon payments to investors from the bond’s collateral account.

A recent bond issuance provides a general outline of the securitization process and the basic structure of the market. In May 2010, Allianz (“the cedant”) sponsored a \$150 million bond, technically issued by its “Blue Fin II” SPV in the Cayman Islands. The SPV acts as a reinsurer to Allianz, which pays it a premium that is deposited in a trust. In exchange, the SPV issues notes to investors, whose principal is deposited in the same trust. The notes are structured in two tranches, both of which cover losses from US hurricanes and earthquakes. The deal was jointly managed by Swiss Re Capital Markets and Aon Benfield, modeled by catastrophe modeling firm AIR, and rated by Standard and Poor’s. The senior and junior tranches were rated B- and BB, respectively (Trading Risk 2010a). The \$60 million of more senior notes pay investors a quarterly return on U.S. Treasury Money Market (TMM) funds³ plus an additional 9.25%, while the \$90 million of riskier junior notes pay TMM plus 14%. The bond would “trigger” and pay out to Allianz only if the losses⁴ to its portfolio exceed a particular (publically undisclosed) amount before its maturity date in May 2013 (Trading Risk, 2010b). If the bond triggers, the SPV transfers part or all of the funds in the trust to Allianz to cover losses. If it has not been triggered by May 2013, investors receive their original principal in addition to their final quarterly return.

Figure 5.3 diagrams a hypothetical catastrophe bond arrangement similar to Blue Fin II, demonstrating how the additional securitized cover for losses over \$800 million sits “on top of” the existing reinsurance coverage that the primary insurer holds for natural catastrophes affecting

¹ Indemnity triggers are based on the sponsoring (re)insurer’s losses in the specified geographical region exceeding a monetary value as a result of the peril covered. Increasingly cat bonds are also being written with parametric triggers based on indices or measures of the physical properties of the event itself, or indices of industry-wide loss. A third trigger device is modeled loss, in which the payout comes only after a specified catastrophe modeling firm runs a post-event deterministic model (using parameters of the actual event) and returns a modeled loss value above a particular monetary value (Hagedorn et al 2009).

² State Farm and military insurer USAA are currently the most active primary insurers ceding risk through the cat bond market, but roughly half of all issuances come from primaries.

³ Treasury money markets became a sort of default compromise on collateral structure after total return swaps based on the LIBOR fell out of favor in autumn 2008. I am importing the more familiar “junior” and “senior” terminology used to describe tranches of collateralized debt obligations because naming conventions in the ILS market are frustratingly inconsistent.

⁴ The Blue Fin notes would be triggered by “modeled losses”.

its US book of business. Like many packaged securities, cat bonds often structure the exposure in a number of tranches with varying returns. The protected tranches often ensure that investors do not lose their principal, and may be rated as investment grade by ratings agencies. The unprotected tranches offer higher rates of return, but feature no such guarantees on the return of the principal.

1.2 Questioning frames and methods for studies in OTC markets

Studying capital markets, particularly privately placed (or “over-the-counter”) markets like ILS, presents some serious methodological and theoretical challenges. Perhaps in part because of these challenges, sociologists, anthropologists, and geographers studying finance have tended to investigate public exchanges, conducting observations and using records from trading floors or computerized trading rooms (cf. Knorr-Cetina 2005; MacKenzie 2006; Millo 2007; Zaloom 2004; for an exception see Lepinay 2007). But there is relatively little chance of conducting some variety of participant observation research from “the inside” of an over-the-counter ILS trading desk, both because of the degree of specialized education, experience, and status required for employment in the small sector and the legal strictures of non-disclosure by which employees are bound. Researchers attempting to observe market dynamics from “outside”, however, encounter the relative opacity of OTC deals transacted behind closed doors and the highly specialized financial language and formulae used to discuss the market in public forums. Because catastrophe bonds are sold in unregistered sales according to terms set in Rule 144A⁵, there is no official clearinghouse of information about investors or deals. The intensity of public scrutiny now being heaped on the private trades of investment banks and hedge funds does not help matters, as some of the individuals best positioned to answer research questions have become more wary of outsiders asking for any information that might be construed as sensitive. These barriers make it tempting to rely simply on mediated reports about the market from the business and popular press, and this has been the strategy of choice for most work on ILS to date. But this method can also lead one to implicitly replicate the assumptions with which the press narrates the story, and this may be part of the reason that many scholars have continually framed ILS as simply an escape from place for the reinsurance industry.

Understanding the implications of ILS for geography also requires us to take investors seriously as market actors who require specific kinds of information about risks embodied in securities. As Bryan and Rafferty (2006) point out with regards to derivatives, there is a deep and unproductive tendency within critical academic and popular literature to treat these markets with “rhetorical, populist, and moralistic” disapproval for the speculation they encourage (cf. LiPuma and Lee 2004). Insurance-linked securities – and particularly the evocative name “catastrophe bonds” – seem to inspire similar disapproval, or at least bewilderment, from outside observers who think of investors blithely “gambling” on something as fundamentally unpredictable as the weather or seismic activity three years into the future. Even Bougen’s (2003) thoughtful essay treats the catastrophe bond form as a strange “mutant offspring”, spectacularly fascinating because of the apparently unbounded risk appetites of “financial speculators for whom no gamble is too great” (256-7).

Indeed, the entirety of Michael Lewis’s (2007) cover story in the *New York Times Magazine* on catastrophe bonds is premised on the metaphor of gambling “In Nature’s Casino”.

⁵ Governing unregistered private resales of securities to qualified institutional buyers, under the U.S. Securities Act of 1933.

The caption on the magazine cover, published on the two-year anniversary of Hurricane Katrina's landfall, reads: "There will be another Katrina (or worse). It will cost insurers and governments a fortune (or worse). Some hedge-fund managers are betting on it." The language of gambling is not accidental, appealing as it does to deep-seated cultural norms about legitimate versus illegitimate profits on risk (de Goede 2005). These moral sensibilities are stoked even further by the cover image ("Hurricane #1" from Sasha Bezzubov's series "Things Fall Apart") featuring an exterior wooden staircase which presumably once led to a home but now ends abruptly, suspended in empty space (see **Figure 5.4**). The implication seems to be that investors are making reckless bets on destruction and human suffering.

It is worth noting that a representation of the ILS market that treats investors as reckless gamblers is essentially also an acceptance of Beck's uninsurability thesis – as if to say, "only the truly irresponsible trader would willingly take on incalculable catastrophic risks that even reinsurers have seen fit to shunt to the capital markets." In fact, insurance-linked securities are purchased by many different kinds of investors – including hedge funds, pension funds, and reinsurers themselves – operating with various degrees of sophistication and within diverse corporate bureaucracies for reporting and risk management (cf. Clark and Thrift 2005). There will inevitably be a few investors with uninformed or simply "aggressive" positions on catastrophe risk, just as there will be some Wall Street traders who pride themselves on making apparently reckless high-stakes bets within a corporate culture and compensation structure that rewards these choices (cf. Ho 2009). But investor's boundless and implicitly irrational risk appetites could not serve as a systemic explanation of the existence of the ILS market even before the financial meltdown of September 2008 (which took several cat bonds with it), much less afterwards.

The timing of this research, overlapping as it did with the global meltdown of credit markets in September 2008 and their subsequent slow recovery, provided an unexpected view of the highs and lows of the ILS market. In the spring of 2008, market boosters were giddily optimistic about the growth potential of ILS. Despite – or ironically *because of* – the subprime crisis and mounting troubles with securitized credit instruments such as collateralized debt obligations, the ILS market was buoyant. Broker-dealer Benfield opined:

"In fact the credit crunch of 2007 highlighted the benefit of ILS as an uncorrelated risk and this, combined with high returns from a relatively benign year for (re)insurance losses, has confirmed the acceptance of ILS as an 'alternative asset class' leading to interest from a wider spectrum of investors" (Benfield 2008, p 8).

The year 2007 saw the largest volume of ILS issuance in history, and "taking the development from 2004 to 2007 and using this as a basis for further projections, some people had already forecast that capital markets would take over traditional reinsurance" (Wallin 2010).

But eventually the credit crisis made itself felt, both through defaulting bonds and through sell-offs in the secondary markets by highly-leveraged hedge funds desperate to raise cash. Four active cat bonds used Lehman Brothers as the total return swap (TRS) counterparty for the bond's collateral assets. As of mid-2010, three of these had defaulted either in part or full, jeopardizing around \$335 million of reinsurance coverage for U.S. hurricanes purchased by Allstate and Munich Re, and \$100 million for California earthquake coverage purchased by Aspen Reinsurance (Trading Risk 2010b). Following the Lehman meltdown, five months passed without a single new cat bond issuance. Deal architects were cognizant of the fact that investors (and their corporate risk managers) were no longer willing to take on the counterparty credit risk that a TRS collateral structure entailed, and by the spring of 2009, new bond issuances had virtually abandoned the TRS structure in favor of investing collateral in money market funds,

medium-term notes, and tri-party repurchase agreements (Aon Benfield 2010b).

Although the ILS market had not fully returned to the same volumes of 2007, by mid-2010 investors were awash with capital from maturing bonds and eager to buy. The gyrations of the past two years precipitated changes in the composition of the ILS investor base, the staffing and management of banks' ILS desks, preferred collateral structures, and the mechanisms triggering bond payout. But it appears that the fundamental form of the cat bond market has survived; these changes reflect attempts to refine the ways in which place-based risks are rendered investment-worthy in the post-Lehman world.

2. Making insurance investment-worthy

The (re)insurance industry has rarely been a favorite of traditional equity investors. Returns in the property-liability insurance and catastrophe reinsurance industries are notoriously volatile from year to year, making it an unattractive target for investment except immediately after major loss events when returns are quite high (see Chapter 2). High volatility is only the beginning of the problem, though; the industry is also relatively encumbered by high fixed costs associated with sales and marketing and post-loss claims adjustment (Kohn 2004), activities that typically require maintaining a spatially dispersed network of offices, sales personnel, and adjusters. And because underwriting has traditionally been built upon long-term relationships in which trust figures centrally, (re)insurers can be reticent to drop strategic clients and reconfigure their underwriting portfolios to ride every pricing wave. All of these factors compelled one equity analyst speaking at a conference sponsored by a cat modeling firm to declare that the property-liability industry “*is, was, and always will be a lousy business to invest in, in the aggregate.*”

Despite these frailties, the fact remains that the property-liability insurance industry commands a staggering real income stream in the form of premium payments, with more than \$1.7 trillion collected globally in 2009 (Swiss Reinsurance 2010c, p 8). This is precisely the sort of alternative asset class that was targeted for asset-backed securitization in the 1990s. That trend pivoted on “the identification of a particular geography of revenues which were previously considered trivial or off-limits and [incorporating them] into the financial system by grossing up” (Leyshon and Thrift 2007, p 101). A number of factors made insurance-linked securities feasible and attractive: the repeal of Glass-Steagall in 1999, thus removing the regulatory separation of insurance, investment banking, and securities underwriting in the U.S.; a series of disasters that depleted reinsurance capital and raised rates of return for investors; and markedly lower profit rates in traditional equity markets that sent fund managers searching for new asset classes. Schematically, using the terms of Harvey (1982) and Smith (2008 [1984]), the ILS market could be read as a way for circulating capital in search of higher profit rates to take advantage of the physical vulnerability⁶ of fixed assets and the resulting purchase of insurance coverage by asset owners.

Returning to Pike and Pollard, insurance-linked securities suggest not just that “the geographies of assets and liabilities impinge upon their value and tradable potential” (2010, p

⁶ Here, “place-based” and “place-bound” are meant to refer to the specific physical encumbrances of *absolute space* (Smith 1984) manifest in the built environment. In some cases it is the actual physical *immobility* of an asset that creates its vulnerability – for instance, a high-rise development or refinery in the path of a hurricane. In other cases, the co-location or connection of activities with physical places – for instance, around airports or hospitals – creates vulnerabilities to system disruption (with resulting claims for business interruption and workers compensation).

36), but also that the spatial encumbrances of assets and their relations with the geophysical world create *new kinds of tradable potentialities*. The work of producing and packaging these potentialities is as much an epistemological project of *creating recognition* as it is a technical feat of mathematics and financial engineering. One fund manager spoke to me about the revelatory moment he realized the immense opportunities in the ILS market. As we sat in an ornate multi-story hotel lobby surrounded by marble, skylights, and trained ducks swimming in a bubbling fountain, he gestured around him and reflected with a tone of wonder:

Once you realize that all of this – everything you see! – is insured and reinsured...well, we started realizing that there are billions and billions of dollars in premiums every year!
[i*]

Throughout the mid-2000s, such realizations were multiplying across the specialist investor community, aided by immense efforts to develop the technical tools to parse and recombine premium sources.

2.1 Establishing equivalence

In order for catastrophe (re)insurance premiums tied to particular landscapes to be constituted as investment-worthy assets, the chance of their loss (in the form of payouts following a disaster) must be calculated and abstracted into an exchangeable form. The technique of catastrophe modeling was a wholly necessary – but not alone sufficient – condition for the developments in ILS that have followed. Catastrophe modeling couples the generalized scientific and technical methods of peril simulation with highly granular data on the underlying geographies of *exposure* in the built environment. These components are combined, outputting the statistics necessary – particularly the expected loss and correlation with other bonds– to assign the bond a price in the securities market.

The geographic correlation between such contingent exposures is a domain where ILS-specific cat modeling promises statistical results. All three major modeling firms (Risk Management Solutions, Applied Insurance Research, and EQECAT) now conduct their own risk analytics and offer investor-targeted software platforms for analyzing ILS offerings (see **Figure 5.5**). Investors use such software for scenario testing and monitoring aggregate exposures in their ILS portfolios through measures as Value-at-Risk and Tail Value-at-Risk. Other teams at these modeling firms are hired by bond sponsors to produce the risk analysis segments of bond offering circulars. These technical reports set out the terms of the issuance and provide an assessment of the magnitude of risks and likelihood of losses on the bond.

The relationship of the catastrophe modeling apparatus to the ILS market is an example of the developments that Leyshon and Thrift (2007) argue typify financialization. They point out the importance of “new forms of expertise, fuelled by computing power and software” (p 101) that have allowed new income streams to be “aggregated from existing obligations which were never before considered to be capable of coalescence” (p 103). The relationships of liability and protection embedded in a bond do not themselves constitute an asset prior to their assessment via cat model. The structure of cat models allows modules to be removed and inserted at will, enabling risk commodification and comparison across spaces and events. It is the *process of establishing equivalence that creates the asset*; it does not exist as a tradable commodity or income stream unless and until it has been modeled and assigned an expected loss.

Here we are faced with a substantive departure from the Marxian-influenced geographical analyses of the commodification of nature, in which natural resources or processes are turned into profit sources (for a typology, see Castree, Noel 2003; 2008). Here it is *the*

imagination of a contingent possibility of loss that is commodified. In the case of ILS, risks are not homogenized (as LiPuma and Lee 2004 would suggest), but are “made fungible in terms of the measure of their exposure to contingency” (Dillon 2008, p 311). Catastrophe modeling’s importance to the entire ILS market provides a startlingly concrete example of Randy Martin’s argument about risk management as a means of surplus extraction:

intricate quantifications of risk refine the process of differentiation of value by breaking up or bringing together what were once treated as stable affiliations of people and place, geography and history.... financialization is the process by which social affiliations are reconfigured to extract wealth as an ends by means of risk management (2006, p 6).

Establishing equivalence then allows for selective recombination. Return period, expected loss, probability of trigger, and correlations across bonds are some of the metrics that investors use to diversify portfolios between perils, for instance mixing “some Cal quake with a little Japan wind” [i37].

2.2 Disintermediation

Particularly given this development of third party expertise, some reinsurers feared that securitization’s ability to separate the operational expenses and fixed costs of the insurance business from premium income streams posed an existential danger. They worried that the ongoing trend of disintermediation, in which clients circumvent traditional large financial institutions to access credit directly from the capital markets, would lower prices to levels at which institutions with large fixed costs would be unable to compete. Making matters worse, the industry was careening through huge rounds of mergers and acquisitions in the late 1990s, and reinsurance pricing had been falling steadily ever since its post-Hurricane Andrew peak in 1993. One operating director at an insurance company wrote in 1998, just after cat bonds began taking off: “Insurance leaders thus have two choices – get in front of the [securitization] trend or get run over by it” (Hengesbaugh 1998, p 119).

Reinsurers did make efforts to get in front of the ILS trend, and not simply as underwriters trying to “displace” their own risk into capital markets or gain liquidity. Rather, they followed investment banks’ lead and began structuring and managing deals for other firms in the insurance industry, generating new fee-for-services income.⁷ They also relied on their proprietary expertise in insurance risk to launch securities desks that invested in cat bonds and acted as “market makers”, thus providing an avenue to selectively access premiums from other reinsurer’s risks.

As for protection buyers, ongoing disintermediation within the financial services and insurance industries has meant that insurance-linked securitization is just one of a number of techniques for transferring risk without, or in addition to, traditional (re)insurance purchase. This general family of practices is referred to as Alternative Risk Transfer, or ART. The Enterprise Risk Management paradigm now popular within financial organizations and corporate management more generally (see Power, M 2005) encouraged the use of a wide variety of ART mechanisms, such as captive and “rent-a-captive” self-insurance, insurance-linked securitization, contingent capital structures for post-loss financing, credit and insurance derivatives, and multi-risk products that roll numerous corporate loss exposures into one contract (Culp 2002).

⁷ Not coincidentally, this was the same period in which Randalls (2006) notes that reinsurers and investment banks began trading in weather derivatives markets.

Likewise, within the investment landscape, cat bonds are not the only ILS products on offer. Estimates of total market size are complicated by the sales of unpublicized offerings of insurance-linked securities – typically by sponsors hoping to obtain coverage discretely – in club deals to groups of highly specialized investors. At this stage in the relatively young life of the ILS market, cat bonds are by far the most visible products. Other securities such as those linked to life⁸ or automobile insurance policies are also sold onwards, and a diversified ILS portfolio often also includes non-catastrophic risks as well as catastrophe swaps and derivatives.⁹ Another closely related product is known as an industry loss warranty, whose pay-out depends on a specified net industry losses (thus ILWs might be written for California quake \$50 billion, Florida wind \$20 billion, and so on). These are reinsurance swaps for which dedicated ILS funds and hedge funds often post the collateral and assume the ultimate risk (Barrieu and Albertini 2009). Over-the-counter catastrophe swaps have also grown in popularity with the introduction of new third-party indices based on industry loss or physical event measurements. Although it is difficult to determine the notional value of these contracts due to the extremely private terms on which they are written, a 2008 estimate by the World Economic Forum put the combined totals for catastrophe swaps and industry loss warranties at \$10 billion (World Economic Forum 2008).

Given the nature of private offerings, it is hardly surprising that the profile of investors in the cat bond market is quite specialized. Around 45 percent of the total investments in the cat bond market are made by roughly twenty-five dedicated “cat funds” – privately managed funds that began in the years post-9/11 and post-Katrina when there were large returns to be had on capital. They are essentially single-strategy hedge funds, investing only in catastrophe bonds. Quite a few of these dedicated funds are either direct spin-offs from reinsurance or insurance companies, or were launched with seed money from insurers who retain some financial interest. The segmentation of the remaining investor base varies rather dramatically depending on larger capital market conditions, but Swiss Re reported the following breakdown for 2009: institutional investors and mutual funds 23%; hedge funds 14%; investment banks 9%; reinsurers 5%; primary insurers 3% (Swiss Reinsurance 2009).

3. The search for “zero beta”

Investors are not simply attracted to the ILS market for the access it grants to previously untapped or unintegrated sectors of the economy; after all, the story of tapping new income streams could be told about virtually every alternative asset classes. The ILS market’s uniqueness lies in the *1) purposive, 2) scalable, and 3) selective relationships it enables with the*

⁸ Although in 2008 the total volume of tradable securities linked to life insurance was larger than cat bonds – roughly \$ 24 billion versus \$13 billion – life securitizations are inordinately for capital restructuring purposes within life insurance companies (Barrieu and Albertini 2009).

⁹ Compared to the weather derivative markets, trading in catastrophe derivative products has been rather staid. Products exist in the form of event-linked futures (IFEX contracts traded on the Chicago Climate Futures Exchange) and futures and options contracts indexed to measures of individual storm intensity (traded on the Chicago Mercantile Exchange). Total volume on these markets is quite small, however (\$95 million year-to-date by September 2010 (Trading Risk 2010c)), and parties wishing to make large trades are often thwarted by the absence of market makers. These are only the most recent in a list of catastrophe derivatives and options products most notable for their failure to take off, beginning on the CBOT in 1992. Similarly unsuccessful projects were launched out of the Bermuda Commodities Exchange and the New York Catastrophe Risk Exchange (Aon 2008; Csiszar 2007).

geography of the built environment and geophysical hazards. I consider each of these qualities in turn.

First, given that the probability of loss on a cat bond is tethered in part to material properties of the environment rather than economic markets, cat bonds are often championed as “zero beta” instruments. In modern portfolio theory, beta is a coefficient denoting the correlation of an asset’s returns with the entire financial market; high beta values denote that an asset’s returns are highly sensitive to the behavior of the larger market.¹⁰ Beta represents systemic risk – precisely the culprit often blamed for the interconnected meltdown of the mortgage-backed securities and credit derivatives markets in 2007 and 2008. A “zero beta” instrument holds obvious allure, and media reports often attribute the entirety of investor interest in cat bonds to the *purposive* search for a non-correlated asset class, particularly following the credit crunch and financial crisis. The rationale is that the disasters that could cause cat bond values to fall (or default) cannot be triggered by volatility in the economic markets, and so investors are less likely to suffer losses in both sectors simultaneously. This seems intuitively obvious enough: a dislocation in currency markets might ripple through commodities and financial derivatives markets, but it bears no ontological relationship to earthquake or hurricane activity.

From the simple perspective of returns, it is more or less the case that catastrophe bonds have passed what one modeler called “the mother of all correlation tests”, the financial meltdown of 2008. **Figure 5.6** illustrates the return profiles for the S&P 500, Barclays BB US high yield bond index portfolio, and a basket of catastrophe bonds indexed by Swiss Re from January 2005 through July 2010. Cat bonds weathered the financial storm in the fall of 2008 with higher values and less volatility than the BB notes, which suffered from more direct ties to global financial markets. The relative success of the catastrophe bond market in comparison to the S&P 500 and other equities is one of the primary reasons that the ILS market continues to attract interest from “real money” (i.e., unleveraged) funds such as pension and sovereign wealth funds.

Nevertheless, cat bonds also demonstrate the impossibility of an entirely “zero beta” product. By virtue of ILS’s position as one of many alternative asset classes and its shifting attractiveness depending upon interest rates, some correlation with the wider market is unavoidable. Prior to the Lehman collapse (see Section 2), the ILS sector showed 4 to 8% correlation with the S&P 500, and 30% in the months following September 2008 (Insurance Insider 2009). Even if we consider only the insurance loss element apart from a bond’s financial structuring, wider economic conditions can influence human behaviors that drive total losses, such as propensity to file claims, exaggerate claims, commit insurance fraud, or litigate (thus driving up liability claims).

Second, the ILS market’s credentials as a relative diversifier grows further when considered alongside the second advantage of *scalability*. Among one of the common drawbacks of alternative asset classes are the relatively small size of individual offerings and total capacity for investment. This makes it difficult for managers trying to invest large volumes of funds; high transaction costs and the piecemeal nature of deals can make otherwise attractive alternative investments not worthwhile. “The beauty of cat bonds,” one tactical asset allocator said, “is that you can put \$500 million in!” [i38]. Recently, for example, State Farm issued a \$250 million U.S. multiperil cat bond, the entirety of which was purchased by a *single* multi-asset manager, thought to be the Ontario Teachers Pension Plan (Trading Risk 2010e).

¹⁰ Beta is an essential component of the Capital Asset Pricing Model, the dominant method for pricing securities using modern portfolio theory. For an extensive account of the development of CAPM and the ways in which the model and its users shape markets, see MacKenzie 2006.

Third, investing in insurance-linked securities instead of the insurance industry as a whole allows investors to engage with place-based risks *selectively* and opportunistically when returns are high. This allows investors to avoid the recalcitrant problems of reinsurers' capital structure and the material encumbrances of their sales networks. A pension fund asset manager articulated this rationale:

Where the reinsurance market is broken is in its capital deployment abilities. It's crazy to keep betting the same odds if the price you're getting paid for it is going up and down. How much you bet on heads should change based on how much you're getting paid for it in a cyclical market. [i37]

Commentators and fund managers often use the metaphor of “accordion capital” to describe the injection of funds from the capital markets into ILS when reinsurance capital is scarce and rates are high, and the subsequent removal of these funds when returns fall below those available in other sectors.¹¹ The influx of this capital is often credited for dampening reinsurance price cycle amplitudes in recent years (see **Figure 5.7**).

Selectivity also manifests itself spatially, as many (though certainly not all) investors prefer higher paying risks known as “peak perils”, most notably U.S. hurricane and U.S. earthquake risks (**Figure 5.3a** and **5.3b**). These perils generally have the largest *risk multiple*, a measure of the relative return per unit of risk calculated by dividing the expected return by the expected loss. Institutional investors and multi-strategy funds, whose assets are often already widely diversified, are especially apt to focus on peak perils. The same pension fund manager explained:

I'll probably always have a heavy tilt towards Florida wind because that pays the most. Reinsurers, on the other hand, continue writing business like Australia wind that pays them one percent or something like that. Those are stupid risks at shitty returns. Why make fixed capital investments when I don't have to? Reinsurers in some sense do have to in order to maintain offices, clients, networks. But we don't have to. [i37]

This illustrates a fundamental ambivalence in the relationship between ILS capital and geographical space: on the one hand, cat bonds commodify contingency by grounding it in its ties to place and geophysical nature, while on the other hand, cat bonds' high returns are possible thanks to a strategic avoidance of the material encumbrances and associated costs of less profitable places and business relationships. This cleaving allows investors to access place-based premiums and risks without requiring them to take on the fixed investments needed to originate those premiums.

4. Spatial encumbrances and relational ties

This relationship recalls the “strength of weak ties” that Engelen (2009) adapts from Granovetter (1983) to explain the proliferation of synthetic securities and derivatives preceding the credit crisis, and the subsequent retreat to stronger trust-based networks following the sub-prime meltdown in the third quarter of 2007. When uncertainty is relatively low, strong ties based on trust “lose their functionality, while at the same time tying agents to networks that could block their move to other networks that offer more profitable exchange opportunities” (Engelen 2009, p 132). In these circumstances, distant ties proliferate, often on the basis of the “production of trust” by third parties such as private rating agencies. In times of larger

¹¹ However, in the case of dedicated cat funds, when older bonds mature the returned capital must be reinvested in new cat bond offerings irrespective of the returns.

uncertainty, however, agents tend to retreat to transactions with tried and trusted business partners.

In the market for catastrophe coverage, reinsurers are typically the tried and trusted partners who expend resources to maintain local offices, sales personnel, and long-term underwriting relationships. At some points, these strong ties prove restrictive as they prevent reinsurers from abandoning relatively unrewarding risks. And because cat bond contracts are written for particular places, they allow investors to select risks based on their geography, rather than being bound to underwrite less profitable risks – Australia wind, for instance – simply to maintain long-standing relational ties with a company with a large book of business in Australia.

Traditional reinsurance business culture presumes that firms and their clients maintain long-term business relationships and share tacit “gentlemen’s agreements” that very large losses paid by the reinsurer will result in a number of years of payback in which renewal premiums will be higher in order to compensate the reinsurer. This is coupled with a tacit expectation that clients will not jump ship to another reinsurer in such periods of payback. A model manager for a Bermuda-based reinsurer explained the business culture’s norms of loyalty:

Generally, if there is a loss, things change quite dramatically with respect to pricing very quickly. So if you’ve got the frequency wrong or if you got the severity in your model wrong, there’s a claw-back that happens that’s very informal and very much based on relationships over time... After an event, if you’ve written a given deal for ten years and you established a relationship with that particular company, you know their business, you know the people running the operation, and there’s sort of – again it’s very soft – but there’s sort of an obligation after that event for them to allow you to participate on the deal the following year at the increased terms... We can’t have a contractual obligation like that, we would get in trouble... But there’s an understanding that you’re not going to go to the cheapest provider next year because there’s new capital coming and maybe selling the capacity at twenty percent higher than last year when the rest of the market wants fifty percent... That’s been a historical thing that’s been a little bit mitigated with the new ILS-type structures and these hedge funds that come in quickly into this. [i24]

As the speaker alludes, changing accounting regulations and the growth of insurance-linked securities undercut traditional reinsurers’ ability to price business using the payback model in the 1990s and 2000s. These new market developments made it much easier and more attractive for insurance buyers to change their loyalties, and eroded what was once a major cushion against uncertainty in the reinsurance business model – the ability to “claw back” unexpected major losses on a contract through premium increases in future years.

While reinsurers are relatively encumbered by spatial and relational ties, the variety of perils and regions for which cat bonds are issued should theoretically allow for spatial and temporal circuit switching as opportunistic investors add or remove capital from the primary or secondary markets. In practice, lack of liquidity in secondary markets can prevent this. Much like derivatives markets, trading of existing cat bonds can become more active as potential loss events develop. Secondary trading on “live cats” – typically limited to weather perils whose development can be monitored and forecast – allows real-time hedging and speculation, while “dead cat” trading is based on buyers’ and sellers’ estimations of whether an event in the recent past is likely to generate enough losses to trigger a payout on a particular set of notes. These types of hedging imply access to asymmetrical information, either in the form of proprietary meteorological forecasting, sophisticated modeling expertise, or proprietary information, and are thus usually the domain of hedge funds and reinsurance funds rather than institutional investors, who tend towards a “buy and hold” strategy.

The financial relationships between at-risk landscapes and the capital invested in cat bonds has remained relatively unseen, as only a few bonds out of the hundreds issued have actually been triggered by physical insurance losses. The most notable default to date is Kamp Re, sponsored by the primary insurer Zurich Financial Services to cover \$190 million in U.S. hurricane and earthquake claims if Zurich's total losses exceeded \$1 billion in a three-year period. The deal, which received a BB+ rating from Standard & Poor's, closed on July 28, 2005. Just one month later Hurricane Katrina began to wreak havoc on the Gulf Coast and by October Kamp Re notes were trading at pennies on the dollar in expectation of a total loss (Lane, Morton and Beckwith 2010). Kamp Re matured in August 2008 and finally completed payments at the end of 2010, returning only \$46 million of principal to investors (Trading Risk 2011a). Hurricane Ike's colossal damage to offshore energy assets in 2008 also looks likely to trigger a loss on \$67.5 million in notes covering Glacier Reinsurance for US wind and quake, which were trading at around ten cents on the dollar in mid-2010 (Lane and Beckwith 2010).¹²

But these events have not discouraged investor interest in the high-paying U.S. wind risks, and in industry circles some consider it fortunate that catastrophes finally *did* result in some high profile losses on cat bonds in order to demonstrate their reliability as an alternative risk transfer mechanism for cedants. Lewis (2007) quotes one well known hedge fund founder, John Seo of Fermat Capital Management, whose fund had significant exposure to the Kamp Re losses from Hurricane Katrina: "I would be embarrassed if we had a big event and our loss wasn't commensurate with it. It would mean that we didn't serve society. We failed society." Although many may be skeptical of a hedge fund's chief executive claiming that his company aims to serve society, his comment underscores an awareness that cat bonds are often perceived as tools of unprincipled speculators who will ultimately fail to make good on their promises and leave insurers in the lurch (a sentiment articulated by Bougen (2003), among others). Even if backing out of a contract were possible – and the principal held as collateral is supposed to safeguard against such maneuvers – investors recognize the acute reputational "headline" risk that would result.

As longer-term investors and securities desks continue to earn good returns on cat bonds while sustaining relatively few losses, their commitment to the sector appears to have deepened. So while there are surely opportunistic investors in cat bonds as with any other securities, there are plenty prepared to stomach cat losses and continue investing. One manager of around \$1.5 billion in ILS investments explained in an interview,

If there is a big event that we're on the hook for, that's ok, we're not going anywhere. We've already earned enough in the market since 2006 to make up for a one in 250 [year] event. The math is too compelling to go running away when a cat happens [i].*

It is precisely because catastrophic losses continue to occur that this math remains compelling; without continuing catastrophic damages, returns for investors fall because (re)insurers can draw on internal capital and access other reinsurers' capital cheaply. This fact has profound implications for how the capital markets assess and "access" climate change risks.

Catastrophe fund managers consistently frame climate change as a preeminent business opportunity for the ILS market, which they say will benefit from growing demand for new

¹² It is currently unclear how catastrophe bonds will be affected by the Japan Tohoku megaquake and tsunami of March 11, 2011. At least six bonds currently "on risk" had some exposure to Japanese quake. As of April 4 2011, Munich Re's \$300 million Muteki cat bond was trading at less than one cent on the dollar and was expected to be a total loss for investors. No formal announcements have been made, however, and final loss calculations will take some time. At least one other bond looked likely to incur serious losses (Trading Risk 2011b).

products to hedge climate risks. If increasing climate-related losses lead to higher reinsurance rates, this will also open the door to competition from alternative sources of risk financing from the capital markets eager to provide roughly equivalent coverage at lower – yet still quite remunerative – rates on line. For this reason, the growth of the insurance-linked securities market and “lean” specialty cat reinsurers could represent a major structural impediment to reinsurers’ ability to implement a future annual adjustments solution for climate risks. In this sense, some of (re)insurers’ articulated climate anxieties may also speak to a deeper structural transformation in insurance markets that means reinsurers cannot rely on the industry’s historical business model of “payback” and customer loyalty to absorb potentially large climate-linked losses.

Because insurance-linked securities in the property catastrophe realm typically have short maturities ranging from a single season to three years at maximum, investors can quickly redeploy capital to take advantage of short-term profit opportunities based on changing information. Theoretically, these short maturities would leave investors with ample time to reconfigure their portfolios should decisive evidence of growing climate change impacts on extreme events emerge for any particular region. Along these lines, a Zurich-based fund investing in event-linked securities (ELS)¹³ published a white paper to dispel prospective investors’ concerns that climate change made the sector a risky bet:

If managed properly, climate change bears no higher threat to an investment in ELS than it does for most other industries. This is mainly due to the possibility of short response times to new information, and is in contrast with current media emphasis on insurance in this context... Because of traditional and newly developing protection needs, climate change offers a significant opportunity for the ELS market and its investors (Bromann 2006).

The white paper makes an explicit attempt to contradict media coverage portraying the insurance industry as especially exposed to climate change, but it also calls into question some of the more dire warnings coming from within the industry itself and counters with a familiar argument about “short response times” and price adjustments.

5. “Writing to securitize” climate risks?

This introduction to the dynamics of the catastrophe bond market has considered how the place-based physical vulnerabilities of fixed capital and (re)insurance are rendered investment-worthy for financial capital. It has argued against prevalent explanations that catastrophe bonds are a result of (re)insurers’ attempts to “escape from place”, instead highlighting the numerous ways that investors use cat bonds to tap into the “zero beta” opportunities afforded by geophysical risks. At the time of this writing, in fact, dedicated catastrophe hedge fund managers were complaining that overcapitalized reinsurers were not passing *enough* risk onwards to the capital markets: “Right now the market is struggling with lack of issuance, not lack of investors” (Aon Benfield 2010a).

But some reflection is in order lest we lapse into overstatement or vagueness about the implications of insurance-linked securitization. Jagers et al. (2005) argue that reinsurers’ issuance of insurance-linked securities is “becoming a dominant response” (259) and “exit option” (269) for responding to climate change risks, allowing it to avoid bearing the costs of climate impacts. But the outstanding capital invested in natural catastrophe bonds at the market’s

¹³ Futures-like instruments whose payout is linked to the physical parameters of, or damage caused by, specific events in a given time frame.

highest point in 2007 was less than \$14 billion, only around 60% of which covered weather-related perils. This represented 27% of global catastrophe reinsurance limits that year. The traditional catastrophe reinsurance market is still by far the dominant provider of reinsurance protection, accounting for 88% of the roughly \$170 billion in global property reinsurance limits at year's end 2008 (GC Securities 2009). At the end of 2010, total value of cat bonds outstanding had declined to roughly \$11 billion.

Rather than representing (re)insurers' dominant strategy for displacing risks, insurance-linked securitization is used selectively, according to the degree that particular geographic, economic, and geophysical characteristics make a set of risks (a) regionally concentrated with high value exposures, which are (b) readily modeled, (c) in excess of the ceding company's desired risk profile in the region, and (d) not cheaply insurable through traditional reinsurance or retrocession coverage. Placements of securitized risks in the capital markets are thus highly contingent upon competitive pressures and the cost of capital in reinsurance and financial markets.

In closing, there are several outstanding concerns and questions that connect ILS to the agendas of financial and economic geography more broadly. In the process of elaborating the organizational structure of the ILS sector and the motivations of its participants, the chapter may run the risk of inadvertently depoliticizing financial risk and echoing the "upbeat analyses conducted throughout the [asset-backed securities] boom ... that appeared to show risk was being systematically reduced and shifted to those best able to bear it," as Wray puts it in his new afterword to Minsky's 1987 notes on securitization (2008). It is critical, then, to consider the ways in which ILS might be creating new risks of its own – and what the political stakes of these might be.

In this respect, it is difficult to miss the parallels between ILS and mortgage-backed securities and credit derivatives markets, especially since the similarities were *deliberately* invoked by market boosters before the full extent of the subprime meltdown and credit crisis became clear. At the beginning of 2008, the *Geneva Papers on Risk and Insurance* published a series of papers discussing how growth might be kick-started in the ILS market, particularly in order to address the increasing damages from extreme events in a changing climate. In one article entitled "Extreme Events, Global Warming, and Insurance-Linked Securities: How to trigger the 'tipping point'", the authors suggest that ILS market players should "think creatively", drawing on the growth model of credit derivatives, which they laud as "one of the most successful stories in recent capital market developments" (Michel-Kerjan and Morlaye 2008, p 165; see also Charpentier 2008).

Although the special issue authors all point out the ILS market's current limitations, they also share the assumption that expanding underwriting capacity through ILS is a self-evidently desirable goal. For instance, the chief financial officer of Zurich Financial Services writes: "... the process of [asset-backed] securitization has contributed to the recent transformation of the banking industry, and we should ask ourselves whether the banking model ("originate to securitize") could be valid for insurers too" (Wemmer 2008). Likewise, hedge fund manager Seo articulated his hopes of expanding capacity rather than simply shifting the same pieces of risk around:

Everybody [in (re)insurance] manages their risks so that they don't have any unhedged exposure... Through their own self-imposed discipline, they're covered. But if the cat bond gives them the chance to expand their capacity and pass it into the cat bond facility... that could be very interesting... we need more bonds like that (Aon Benfield 2010a).

This is essentially an argument for creating cat bond structures that would encourage insurers to write new insurance business expressly for the purpose of securitization. In so doing, new kinds of previously uninsurable risks and regions would become insurable. This logic bears a rather alarming resemblance to that used in the mortgage-backed securities market and particularly to subprime loan securitization; that is, that consumer access to debt financing from capital markets would allow a previously excluded segment of the population to become homeowners.

Much as the financing of consumer debt was a temporary “solution” to the problem of stagnating income and rising inequality in the U.S. (Rajan 2010), cat bonds are being framed as a financial fix for the political failure to develop solutions to mitigate and adapt to climate change. If cat bonds and ILS products in general do reach a “tipping point” of the kind Michel-Kerjan and Morlaye (2008) seek, in which “writing to securitize” climate risks becomes a principal strategy for insuring vulnerable landscapes, the prospects for climate-appropriate development and adaptation would seem very dim. We should recall that, although the securitization of consumer debt arguably concealed the problem of rising inequality from public view for some time, in the end it greatly exacerbated the phenomenon and resulted in what many have called the “greatest transfer of wealth” in history from American taxpayers to financial capital, in the form of the Troubled Assets Relief Program of 2008. It is unclear precisely what the impacts of further ILS securitization of climate risks will be, but it seems quite possible that “writing to securitize” could initially encourage the provision of insurance in riskier places, but then force a subsequent reversal and retreat from these landscapes in the wake of a major catastrophe or once the burden of insurance prices became too heavy for households and regional economies to bear.

Again, recent history gives us cause for concern. In the wake of September 11th, as insurers scrambled to exclude terrorism coverage from new and renewing policies, the New York state insurance commissioner protested that this shedding of unwanted risks would ultimately “make businesses and consumers the last stop on the ‘Pass-The-Exposure Express’” (Serio 2002, p 25). In their incisive work on the role of uncertainty in the political economy of insurance, Ericson and Doyle (2004a, 2004b) apply this metaphor to explain the way that the insurance industry as a whole functions in relation to the financial apparatus of the state. Their conclusion is especially interesting given how well it sums up the behavior of insurers and financial capital in general following the economic meltdown of 2007-2008:

Insurers are eager to gamble on uncertainties as long as they keep reaping profitable returns. However, an extraordinary catastrophic loss leads them to hop on the pass-the-exposure express and seek refuge until they can restructure the market and gain confidence that they will again be on the winning side. The refuge is provided by governments, who help underwrite faltering insurance markets. This socialism for business enterprise can supersede any socializing effects on behalf of the insured (Ericson and Doyle 2004a, p 169).

Ultimately, in cases of extreme crisis the entire financial services industry depends on state intervention to provide an economic backstop, either through direct infusions of capital (the bailout model) or by acting as an insurer of last resort (the subsidy model). The ultimate economic burden is devolved to taxpayers on the one hand, and sovereign debt markets on the other. There is little reason to believe that the market in securitized geophysical risks will prove an exception to this rule.

Figure 5.1a

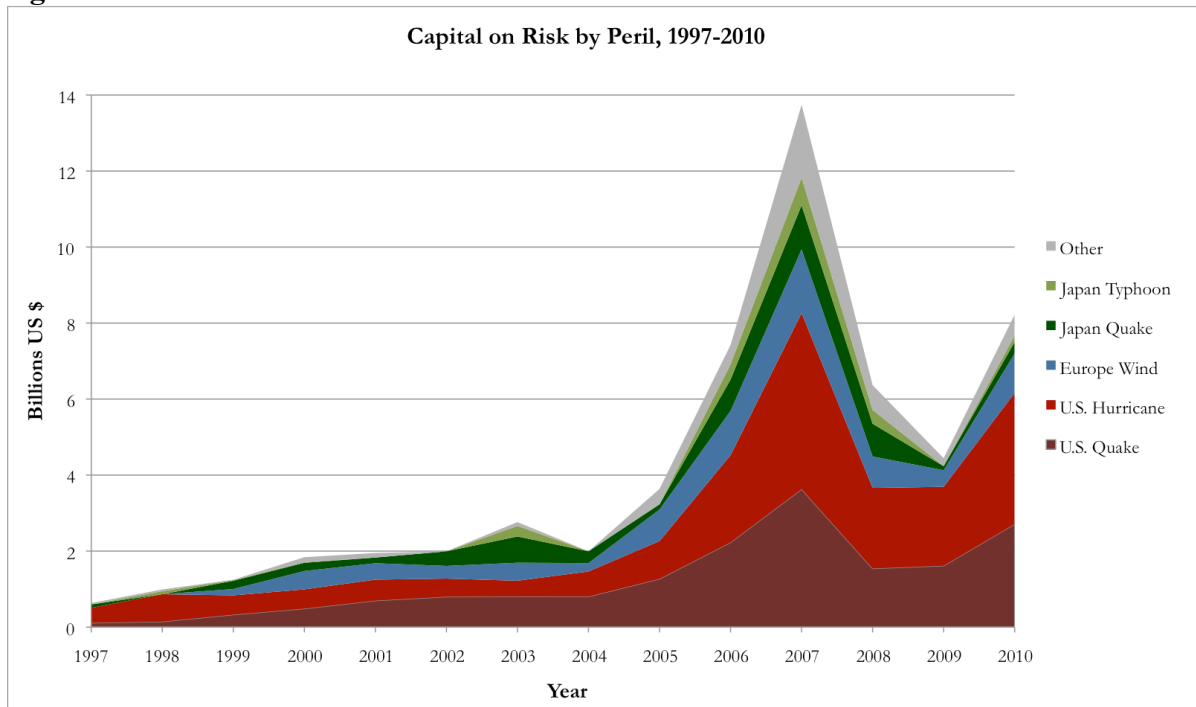
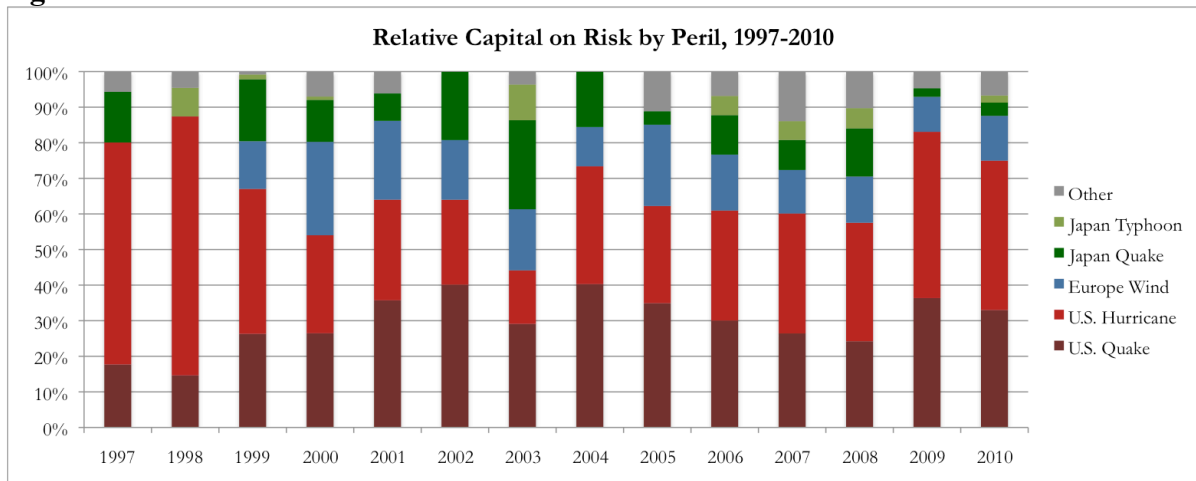


Figure 5.1b



Data provided by Guy Carpenter & Company, LLC

The total principal amount of bonds covering two or more perils (in which the entire principal is exposed to both perils) has been included in each of the peril categories they cover; therefore, the total figures do not reflect the total volume of bonds issued.

Figure 5.2: Typical catastrophe bond deal architecture

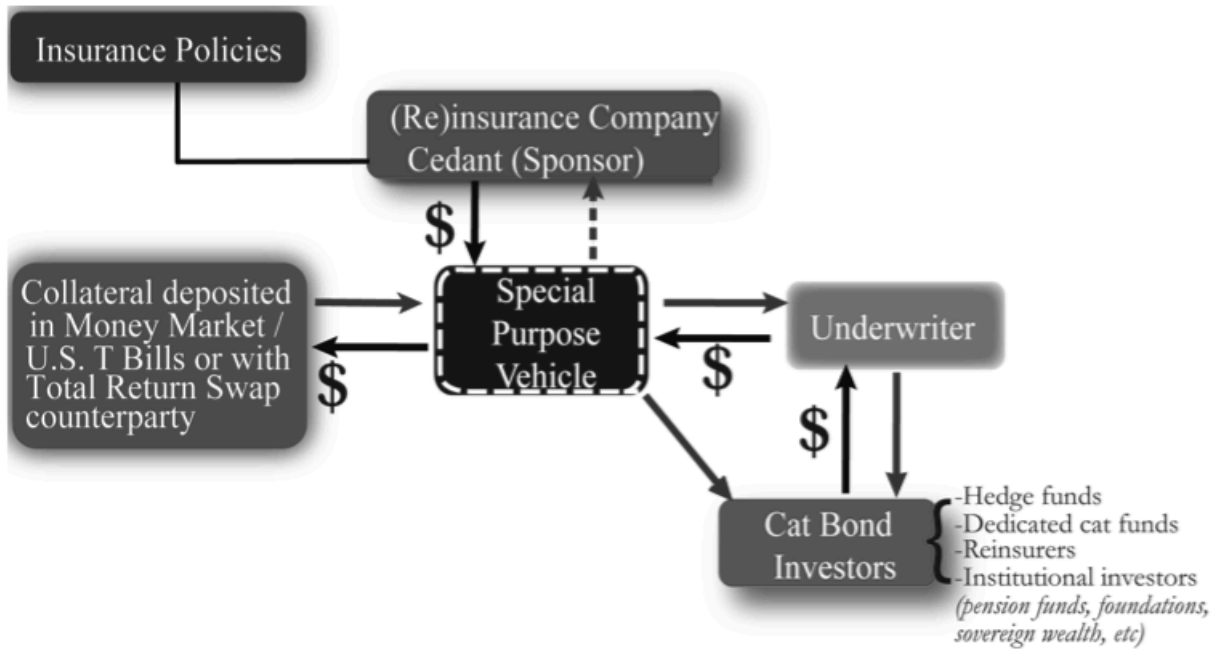


Figure 5.3: Hypothetical reinsurance program and cat bond structure for a large insurer's natural catastrophe coverage

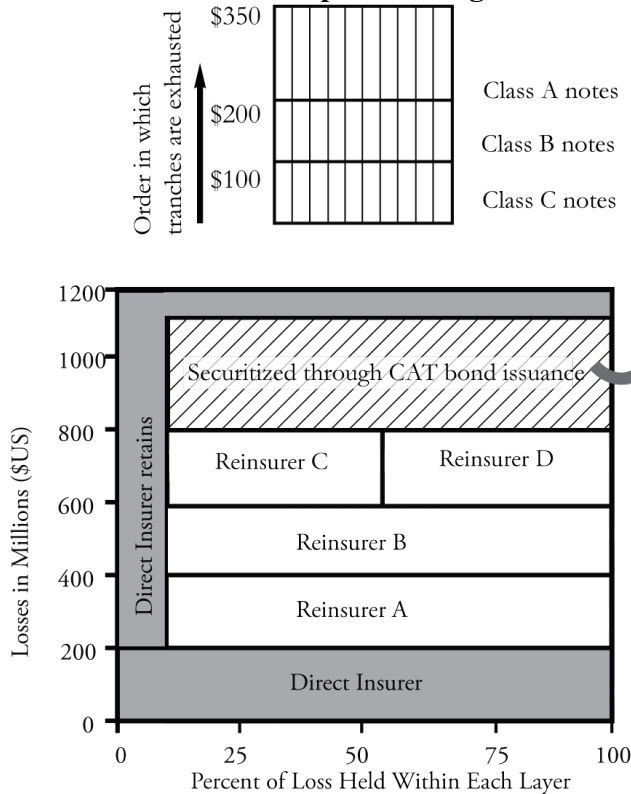


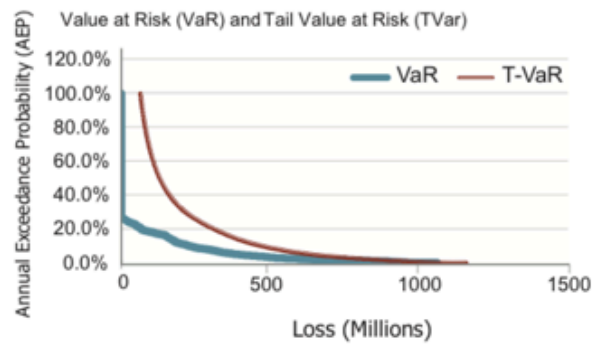
Figure 5.4: New York Times Magazine Cover, August 26, 2007



Figure 5.5: Sample output from RMS’s *Miu* software platform

Class Correlation Matrix	Cat Bond A	Cat Bond B	Cat Bond C	Cat Bond D	Cat Bond E	Cat Bond F
Cat Bond A	1.0	0.1	0.0	0.0	0.0	0.0
Cat Bond B	0.1	1.0	0.0	0.0	0.0	0.0
Cat Bond C	0.0	0.0	1.0	0.5	0.3	0.3
Cat Bond D	0.0	0.0	0.5	1.0	0.4	0.3
Cat Bond E	0.0	0.0	0.3	0.4	1.0	0.5
Cat Bond F	0.0	0.0	0.3	0.3	0.5	1.0

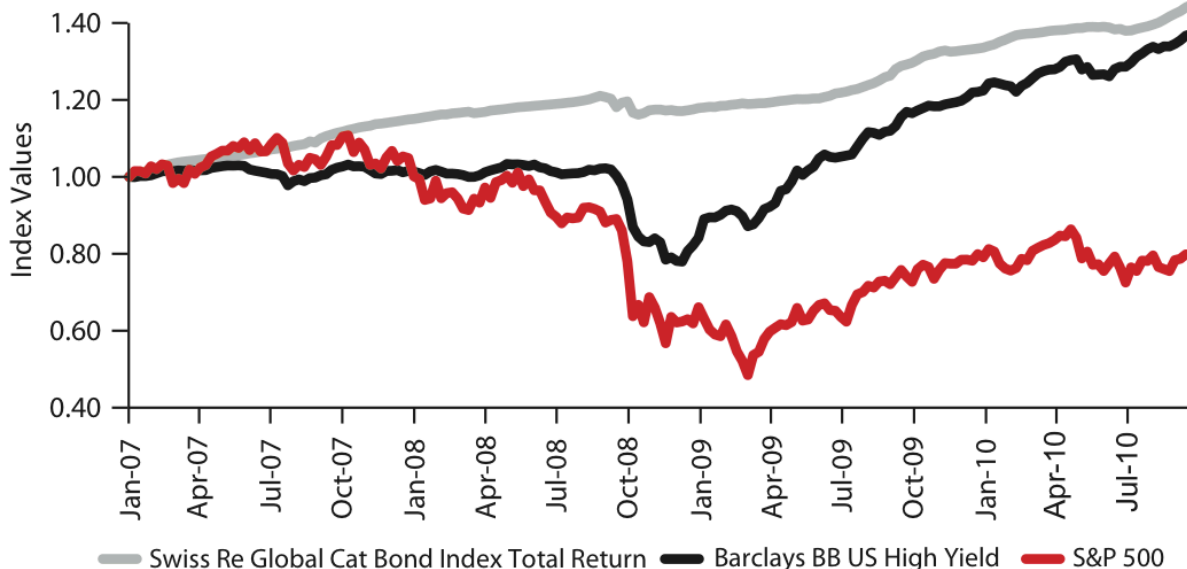
The class correlation report provides a simple and intuitive way to describe the correlation between pairs of insurance linked securities (ILS). When a new ILS enters the market it can be quickly included in a portfolio and its impact on other securities quickly analyzed.



Key Threshold Annual Exceedance Probabilities		
AEP	VaR	TVaR
0.10%	1,061,205,25	1,158,233,986
1.00%	867,055,28	954,980,102
5.00%	393,127,82	639,665,837
10.00%	228,747,08	471,782,520

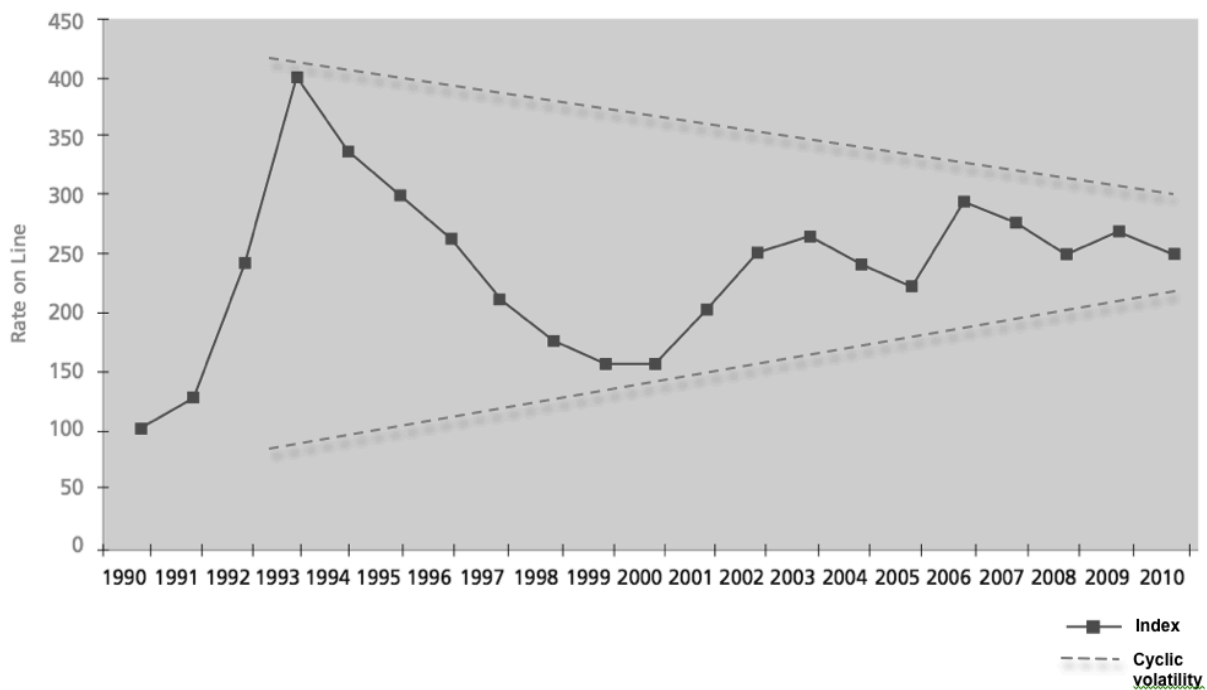
Source: Risk Management Solutions (2010, p 2-3)

Figure 5.6: Relative Cat Bond Performance



Source: Swiss Re Capital Markets, in Trading Risk (2010d, p 19).

Figure 5.7: Global catastrophe reinsurance rate on line (Indexed to 1990)



Source: Guy Carpenter (2010, p 9)

CHAPTER 6: Governing Risk Pools through Catastrophe Models

1. Private Science to create responsible citizens?

While mortgage-backed securities and credit derivatives markets spun out of control in 2007-2008 prompting the U.S. government to extend an insurance backstop to companies such as AIG that it deemed “too big to fail”, individual homeowners were being taken to task for their own irresponsibility. Although this contradiction was most obviously manifest in the media scorn heaped upon subprime buyers who had purchased extravagant houses whose value far exceeded what they could ever pay off, the narrative of reckless individual homeowners also featured in the fierce debates about coastal development, climate risk, and insurance subsidies that emerged after the 2005 hurricane season. This chapter investigates these ideological and political debates in order to enumerate the forces now shaping the governance of coastal risk in the United States.

Although the problem of managing coastal development and insuring the built environment along the Atlantic and Gulf Coasts is a longstanding one, it has grown far more severe over the last fifteen years. Population growth in the southeastern states exceeded the national average and real estate development (particularly in Florida) expanded disproportionately on the heels of cheap credit. Coupled with the changing class composition of coastal counties, these circumstances resulted in skyrocketing aggregate property values and huge potential losses to tropical cyclones and flooding. The destruction of coastal wetlands and restriction of natural storm outlets multiplied the risks even further.

Given these conditions, the massive damages caused by the 2004 and 2005 North Atlantic hurricane seasons were not a surprise to many scientists, engineers, planners, and geographers who had been warning of the potential devastation for quite some time (cf. Van Heerden 2004; Davis 2004; Pielke, Roger et al. 2008). Rather, they were a predictable outcome of decades of development and building decisions, catalyzed by warmer-than-average sea surface temperatures and steering winds. These two extraordinary years laid the foundations for an ideological battle over the institutions of coastal property insurance and governance.

Taking the particular case of tropical cyclone risk analysis, this chapter argues that the adoption of catastrophe modeling represents a pivotal development for the governance of coastal built environments. It traces the recent reconfiguration of modeling following the 2004-2005 hurricane seasons and suggests how modeling practices are made to articulate with a particular neoliberal discourse of coastal governance and insurance, which sees the reform of “morally hazardous” coastal populations into responsible private homeowners as one of its central goals. Proprietary modeling results, translated into market prices and policy changes, are presented as the most efficient mechanism for transmitting risk signals. Pricing based on model outputs is supposed to encourage responsible choices and rational behavior by individual citizens, who are presumed to need market disciplining in order to reverse the “perverse incentives” created by subsidized insurance and disaster relief. Turning specifically to the case of South Florida, the chapter uses census data to pose some empirical and theoretical challenges to the apparently common sense solutions suggested by such a politics.

2. The moving window: Forward-looking models and the rule of experts

Following the devastating North Atlantic hurricane seasons of 2004 and 2005, property insurance companies attempted an extraordinary reconfiguration of U.S. coastal policy coverage. They cited results from revised catastrophe models to raise premiums, limit policy provisions, or drop coverage entirely in some places. As discussed in Chapter 3, the immense damages sustained—and the spectacular destruction of Hurricane Katrina in particular—ushered in a new insurance discourse of radical risk and uncertainty.

Two complementary developments enabled this transformation. First, as cat modeling gained popularity as a technological practice in the mid-to-late nineties, property claims data itself was privatized. The Insurance Services Office, a dominant ratings and data provisioning company for the American insurance industry, acquired the American Insurance Services Group and its Property Claim Services in 1997. AISG was previously a claims information affiliate of the American Insurance Association, a trade association. Prior to 1997, PCS's geographic data on U.S. catastrophe damage claims was publicly accessible. Its privatization made fact-checking by regulators and advocacy groups increasingly untenable; claims data could still be had, but at a tremendous cost. Consumer groups now face an insurance sector that guards data on premiums and claims as trade secrets to be revealed only to state insurance regulators, and then only when demanded by state laws.

Second, an extraordinarily large volume of claims data was generated by the 2004 and 2005 storms. The assimilated claims from the seasons “revealed deficiencies in industry-standard catastrophe risk models” (Council of Economic Advisors 2007, 120) and gave insurers, reinsurers, and modelers new evidence with which to assert that prior models did not accurately represent or parameterize the physical and economic impacts of storms. The largest private modeling firm, Risk Management Solutions (RMS), developed its new model using “the world’s largest compilation of high-resolution hurricane claims [from 2004 and 2005],” from which it “extracted a considerable amount of important and previously unavailable knowledge relevant to risk modeling” (Risk Management Solutions 2006).

Within the private modeling sector, RMS led the charge to revise model parameters. Following a series of “expert elicitation panels” with academic climatologists, a procedure which the company billed as a “rigorous methodology for making use of expert judgement” in conditions of “deep uncertainty”, RMS began marketing a radically revised hurricane model in 2006. The model abandoned the accepted practice of using the last 100 years of storm loss data to generate probabilistic storm runs, instead using the best guesses of four academic and government climate scientists as parameters to simulate the next five years of hurricane activity. As Jasanoff (1990) finds in her study of scientific and technical experts who advise federal regulatory agencies, expert elicitation is a common practice in the absence of sufficient data for conventional statistical risk assessment analysis, and its results often help institutions enlist support for controversial decisions. The stakes of this particular elicitation were raised considerably due to the enormous financial sums involved, and the public academic credentials of the expert scientists were repeatedly invoked in order to lend authority to the scientific credentials of private models.

The reconfiguration towards short-term means, in which a bad hurricane season carried far more weight than it would in a long-term (100 year) calculation, increased risk price estimates dramatically. Calculated rates jumped by 40 percent in many coastal areas, and remained at this level in the next year’s model release. Faced with these results, some of the

experts on the RMS panel subsequently questioned the firm's use of their estimates, prompting a media and consumer uproar. Despite this rash of negative publicity, Applied Insurance Research followed suit and introduced its own five-year forward-looking model, citing demand from reinsurers.

3. The model of the world becomes the world of the model

One director of analytics at a major reinsurance brokerage is fond of saying, “models destroy and create capital” [i40]. By changing the underlying frequency distributions and assumptions about vulnerability in the built environment, updates to catastrophe models can completely transform the capital reserve requirements of firms. To echo Sinclair's moniker for bond rating agencies, catastrophe modeling firms have become “new masters of capital” (2005). Lewis describes the ramifications of RMS's update to its North American hurricane model post-Katrina:

The scientists were, in effect, the new odds-makers. It was as if the casino owner had walked up to his roulette table, seen a pile of chips on 00 and announced that 00 would no longer pay 36:1 but would henceforth pay only 18:1. The agencies that rated the insurance companies – S&P, Moodys, etc. – relied on the scientists to evaluate their exposure. When the scientists increased the likelihood of catastrophic storms, S&P and Moodys demanded that the insurance companies raise more capital to cover their suddenly more probable losses. And so in addition to the more than \$40 billion they had lost in Katrina, the insurance companies, by edict of the ratings agencies, needed to raise \$82 billion from their shareholders just to keep their investment-grade rating. And suddenly they weren't so eager to expose themselves to losses from hurricanes” (Lewis 2007).

The virtual world of the model became very real indeed by virtue of the fact that the market shared a *collective belief* in the practice of modeling. Although weaker than the sort of performativity MacKenzie (2006) describes with respect to the Capital Asset Pricing Model, this is undoubtedly a case of “the world of the model” becoming “a model of the world”.

This turn to near-term projections, which are by definition less likely to adhere to the Law of Large Numbers, is difficult to assess from a scientific perspective.¹ On the one hand, near term projections usefully incorporate what scientists know about the uniqueness and specificity of current North Atlantic oceanic and atmospheric conditions into risk models. This includes information about stratospheric winds impacted by the Quasibiennial Oscillation, the steering effects of the present phase of the North Atlantic Oscillation, and the sea surface temperature trends influenced by the Atlantic Multidecadal Mode. Knowledge of these conditions may help scientists anticipate storm track steering and potential intensity, among other characteristics. On the other hand, near-term models suffer from the decreased accuracy and heightened uncertainty inherent in attempts to project conditions over five years as opposed to 100 years. Slight variations in initial inputs or parameters may result in widely differing risk estimates; these in turn can be used as evidence in insurers' applications for rate increases that dramatically exceed those that a long-term model would suggest. They also serves as a ready explanation for stark differences in risk pricing between different cat models, different insurers, and different geographic areas.

¹ Jasanoff asks some provocative questions that we might apply to this case: Can there ever be an objective basis for determining “bad science”? Does “bad science” inevitably make bad policy, and can good policy ever be made in the absence of good science?

In 2007, the Property and Casualty Insurance Committee of the National Association of Insurance Commissioners launched an investigation into the effect of new cat model revisions on coastal property insurance availability and affordability, and began deliberating whether catastrophe modeling firms should be regulated by states.² Consumer advocates and some state insurance commissioners made serious allegations of collusion and price-fixing between insurers, ratings agencies, and cat modeling firms (cf. National Association of Insurance Commissioners 2007a, 2007b). The intransigence with which Allstate refused the Florida Office of Insurance Regulation's 2007 subpoena for documents also seemed to suggest malfeasance.

Nevertheless, I am not interested in implicating private firms in collusive schemes. Allegations of corruption or mismanagement of science or data obscure other insights that can be gained by taking modelers and insurers at face value. My goal is not to assail models as somehow falsifying reality, but rather to show how they articulate with contemporary private modes of governance to “establish, deploy, promote, and intensify” particular truths (Rose 1999, p 95). We should acknowledge that political and economic outcomes (perhaps not to our liking) can result from the use of good models *without* any violation of the “right and proper” practices of modeling or pricing. The next section details one such example, demonstrating how model outputs have been drawn into neoliberal modes of governing risk and coastal development.

4. Disciplining the risky homeowner

In his reading of Foucault's (2008) lectures on neoliberalism, Thomas Lemke (2001, p 203) suggests that governmentality's analytical strength “consists of the fact that it construes neoliberalism not just as ideological rhetoric or as a political-economic reality, but above all as a political project that endeavours to create a social reality that it suggests already exists”. In the same vein, Wendy Brown points out that the extension of neoliberalism is a deeply normative, “constructivist project: it does not presume the ontological givenness of a thoroughgoing economic rationality for all domains of society but rather takes as its task the development, dissemination, and institutionalization of such a rationality” (Brown, Wendy 2004, para. 9). Here I argue that catastrophe modeling is one of the primary tools with which empirical social reality is coaxed to more closely resemble the idealized normative one of neoliberal rationality. The techniques and outputs of cat modeling have been embraced by proponents of a particular neoliberal vision of private coastal environmental governance. Their mission is the moral reform of irresponsible coastal dwellers and the fiscal disciplining of profligate state and federal governments. Industry advocates defend model-based risk pricing as the best way to “transmit risk signals” to individuals in an effort to combat perverse incentives for coastal development generated by government insurance and disaster relief programs.

According to many economists, legislators, and insurance industry lobbyists, the National Flood Insurance Program (NFIP) and individual state-financed property insurance programs (which write property coverage – excluding flooding – for homeowners who are denied coverage from private insurers) are the culprits that have encouraged the growth in value and number of housing units in coastal counties. The results, they claim, are both economically inefficient and immoral. The fact that government debt and federal spending on disaster relief in coastal areas have increased – despite the fact that the NFIP was founded with the express intent of decreasing the size of post-disaster federal expenditures – is one of the most often-cited inefficiencies. The

² At the time of this writing, no such regulations have materialized, although the state of Florida does have its own panel which reviews catastrophe modeling firms' loss projection methodologies.

President's Council of Economic Advisors repeated the typical argument to highlight these "perverse incentives" in 2007: "The availability of flood insurance has lowered the risk to banks of financing real-estate investment in locations vulnerable to flood losses. As a result, ...[d]emand for Federal disaster aid may arguably be higher than it would have been had the NFIP not facilitated development in high-risk areas" (p 115). While insurance consumers are incentivized to build or live in risky areas, so the argument goes, subsidized homeowners' premiums offered by state-run (often named "Citizens' Property Insurance Corporations") programs discourage and disallow private insurance underwriters from developing innovative and entrepreneurial solutions to handling risk.

The economic arguments against government-sponsored insurance and relief are wedded to moral claims that fault the government for the growth of a dependent and complacent coastal population, while they chastise individual homeowners for placing financial burdens on the rest of the populace. Government insurance programs and their beneficiaries are routinely excoriated for the unfair economic burden they impose on taxpayers who "choose" not to live in at-risk regions of the state or country. Critics are quick to cite the \$20 billion in taxpayer-funded claims payments made by the NFIP in the aftermath of Hurricane Katrina as an example of the irrational and unethical subsidies to coastal homeowners by "non-risky" populations. They also impugn such programs as exacerbating "moral hazard", a value-laden term used by insurers to describe the phenomenon by which "insurance discourages those who are insured from taking actions to reduce potential losses" (Council of Economic Advisors 2007, p 107).

Through the widely accepted language of moral hazard, insurers and economists claim that government insurance makes policy holders less likely to retrofit or prepare their homes for storms, to repair potentially vulnerable structural components, and ultimately, less likely to choose to reside in safer locations (Lehrer 2008; Council of Economic Advisors 2007; Litan, Nutter, and Racicot 2007). Insurance is also faulted for incentivizing insureds to make post-storm home repairs that are above market-cost. Theorists of moral hazard generate mathematical proofs demonstrating that any rational actor is likely to slip into freeloading on even the best-organized state insurance and relief efforts. According to this logic, FEMA relief efforts and NFIP payments to underinsured victims in the wake of major hurricanes only exacerbate moral hazard by making homeowners expect billions in "Katrina-style federal bailouts" and discouraging them from keeping their insurance coverage limits consistent with the value of their property (cf. Grace 2007).

Rate regulation by state insurance departments is also portrayed as a major impediment to mitigating climate risk in coastal environments. In an interview timed to coincide with the National Association of Insurance Commissioners' public hearing on the potential regulation of catastrophe models, the vice president of the National Association of Mutual Insurance Companies warned regulators that their overreach might "prevent...insurers from helping society manage climate-related risk" and "create disincentives for property owners and policymakers to take action to mitigate climate risk" (Detlefsen 2007). Regulation, according to the Council of Economic Advisors, can exacerbate the problem of homeowner irresponsibility in coastal areas while discouraging technological innovation:

Rate regulations [on homeowners' insurance] can make it difficult for insurance companies to set premiums that accurately reflect available information about risks, which can exacerbate moral hazard and adverse selection problems...The rate review process may also discourage insurance companies from proposing complex pricing plans which, though difficult to explain and justify to state rate boards, more accurately reflect detailed information about the risks associated with individual insurance policies (CEA

2007, p 119).

Significantly, this representation of systematic risk mismanagement and perverse government incentives is enthusiastically endorsed by leading hurricane scientists. In the summer of 2006, ten of the most respected operational and theoretical hurricane climatologists put aside their heated disagreements on the effects of climate change to pen a startling statement to the press (Emanuel, K. et al. 2006). They argued that, regardless of whether or not anthropogenic warming had increased hurricanes' destructiveness,

*a Katrina-like storm or worse was (and is) inevitable even in a stable climate...Rapidly escalating hurricane damage in recent decades owes much to government policies that serve to subsidize risk. State regulation of insurance is captive to political pressures that hold down premiums in risky coastal areas at the expense of higher premiums in less risky places. Federal flood insurance programs likewise undercharge property owners in vulnerable areas. Federal disaster policies...serve to promote risky behavior in the long run...[T]he...urgent problem of our lemming-like march to the sea requires immediate and sustained attention. We call upon leaders of government and industry to undertake a comprehensive evaluation of building practices and insurance, land use, and disaster relief policies that currently serve to promote an ever-increasing vulnerability to hurricanes.*³

What interests me about this statement, besides the scientists' unusually strong criticism of public policy, is how it articulates with the technical and ideological framework of private insurers' modeling practices. A statement like this one provides expert confirmation of the coastal crisis and likewise authorizes solutions to correct "risky behavior" and stop undercharging property owners in vulnerable areas. Public scientists' endorsement of the private sector's ideological framework is another contribution towards the legitimation and success of the governance project.⁴

If these scientists, economists, and industry advocates are united in their identification of the problem – the immoral and irrational subsidizing of coastal risk – they are equally agreed on the desired solutions: model-based, "actuarially fair" risk pricing and the overhaul or complete termination of the National Flood Insurance Program and state Citizens' Property Insurance Corporations. They argue that catastrophe modeling results and flood maps, translated into market prices and policy changes, are the most efficient and correct mechanism for transmitting risk signals. Such "actuarially fair" pricing is lauded for encouraging "responsible behavior" (Mills et al 2005, 3) and "sensible choices" (Economist 2007) by individual citizens, who are presumed to be individual homeowners who require market disciplining in order to reverse the perverse incentives created by federal flood insurance and disaster relief.

Model outputs generate quantitative "confirmation" of the moral correctness of the industry's ideological position. The assumptions embedded in the lines of model code are praised

³ The statement was signed by Kerry Emanuel, Richard Anthes, Judith Curry, James Elsner, Greg Holland, Phil Klotzbach, Tom Knutson, Chris Landsea, Max Mayfield, and Peter Webster.

⁴ A caveat is in order here. In the above situation it becomes quite difficult for me to demarcate "public" from "private" science, since at least three (and probably several more) of the statement's authors have participated in RMS's expert elicitation panels and many are involved in consulting with reinsurers, financial analysts, and so on. Several of them have their own private consulting and forecasting firms. I by no means point out these affiliations to discredit these scholars; rather, I mean to demonstrate how the political framework of "moral hazard" has become deeply enmeshed with – and arguably co-productive of – their scientific practice, and vice versa. This troubles the contemporary distinction between "public" and "private" science (see an October 2010 issue of *Social Studies of Science* dedicated explicitly to this issue).

because they produce numerical results that scientifically validate the case for a neoliberal reform of risk management. Science itself has demonstrated the most proper and natural form of governance. By this logic, quantitative results which inadvertently encourage “responsible citizenship” in coastal populations are evidence that the model is operating correctly and that all parameterizations and inputs are appropriate. Catastrophe models and the private property insurance apparatus operate as “technologies of responsabilisation” (Rose 1999, 74) for the individual, and as “permanent economic tribunals” to interrogate government-run insurance schemes (Foucault 2008, p 247).

But unlike the classical governmental projects of the 18th and 19th centuries that sought to measure, conduct, and make responsible the behavior of a general population by means of a public authority wielding scientific data or statistics, this mode of governing is decidedly private. Governance is meant to work through the financial institution of private insurance, using private technical-scientific devices, to act on the private family’s residential choices and behaviors. The object of governance differs in one illuminating way from what Rose (1999) identifies as the two domains of classic liberal governmentality: public space and the private family. Although the private family is still front and center in contemporary projects to make homeowners responsible, the concept and features of *public space* are notably absent from this model. Given the disappearance of urban public space under neoliberal political regimes and the dramatic multiplication of suburban single-family homes (Sorkin 1992), it is little surprise that this model of coastal governance aims to reform private spatial practices rather than to affect public spatial planning, land use, and development decisions.

The “unit” of reform is the stereotypical homeowner and (his) family, who must be economically coerced into “choosing” to accept their responsibilities. Responsible homeowners are economically rational and moral citizens who put no burden (via taxes or debt) on society, but rather “own” their risk themselves through private insurance arrangements, the price of which must be calculated using the most technically sophisticated private tools. In language typical of an individualized mode of environmental governance, *The Economist* (2007) declared that loss prevention and mitigation in flood-prone areas in the UK requires “changing behavior, not just writing cheques”, otherwise “people tend to do stupid and lazy things...when no personal financial consequences flow from their decisions.”

A whole series of organizations have arisen to bring about such behavioral changes in risky populations. These groups, usually self-identified as “public-private partnerships”, teach the single-family homeowner proper techniques for securing the home from disaster. The Federal Alliance for Safe Homes (FLASH), for example, pursues its mission of “Strengthening Homes and Safeguarding Families” by hosting a website full of “Do-it-Yourself” instructional videos.⁵ Videos depict male heads of household performing home wind inspections, emergency board ups, and flood preparation. The Institute for Business and Home Safety’s website echoes the Do-it-Yourself ethic with an “I did it” gallery where homeowners submit stories about their retrofitting accomplishments.⁶

As if to underscore Sorkin’s (1992) metaphor of “variations on a theme park”, which he uses to describe the suburbanization and privatization of public space and social life, the Federal Alliance for Safe Homes has joined forces with State Farm, Renaissance Reinsurance, and Simpson Strong Tie (a major manufacturer of steel structural ties and reinforcements) to fund “Stormstruck: A Tale of Two Homes” at Disney’s Epcot Center in Orlando, Florida (see **Figure**

⁵ www.flash.org

⁶ www.disastersafety.org

6.1). I toured the facility soon after it opened as a participant in the “Hurricane Mitigation Leadership Forum” funded by Renaissance Reinsurance in 2008. Visitors to the exhibit are first given 3-D glasses and ushered into the “Severe Weather Replicator”, an enclosed theater that simulates the effects of a hurricane in a suburban Southern neighborhood. The theater trembles violently, built-in wall fans blow “wind”, and each seat is equipped with a device that spritzes the audience with water at unexpected intervals. After witnessing the simulated destruction of one home, the interactive film asks the audience to design a safer home by making choices about building materials, roof type, window protection, and landscaping. After each audience member has relayed their choice via individual touch screen, the votes are tallied and the “Replicator” simulates another storm as it would impact the improved home. Following the film, the audience is ushered into a series of displays for adults and children. The promotional video for the attraction⁷ features interviews with patrons who have just completed the “Stormstruck Experience”. Unsurprisingly, all appear to be single-family homeowners – almost all white – who discuss their newfound sense of empowerment. The men explain how they will personally transform their own homes to be more storm resistant, while the few women featured comment on landscaping and roof style. Throughout the entire “experience”, no mention is made of the existence of mobile homes, apartments, or condominiums, or of any living arrangement other than the nuclear family.

5. The hazards of politics by other means

This neoliberal vision of improvement considers individuals’ choices as both the source of and solution to coastal property loss. At present, technical-scientific reconfigurations of risk calculation facilitate this strategy of doing politics by other means. They provide numerical arguments that enable their proponents to dodge the messier social and political questions of coastal governance, and instead direct economic forces to act on families as discrete individual units. Legal scholar Tom Baker criticizes the rationale of neoclassical economists and insurers who deploy the “common sense” logic of moral hazard to argue against state-subsidized programs:

By ‘proving’ that helping people has harmful consequences, the economics of moral hazard justify the abandonment of legal rules and social policies that try to help the less fortunate; and, by providing a “scientific” basis for the abandonment of legal rules and social policies, the economics of moral hazard legitimate that abandonment as the result of a search for truth, not an exercise of power (Baker 1996, p 241).

What new questions might arise by understand catastrophe modeling as “providing a scientific basis for the abandonment of...social policies”? As *both* the search for knowledge and the exercise of power? We would need to become more attentive to the ways the models utilize social variables in their inputs and outputs, and how the uses of models have differential effects on the behavior and circumstances of target populations.

We might also begin to put some pressure on the taken-for-granted, “scientifically proven” concept of moral hazard. Baker suggests that the economic theory of moral hazard is insufficient because it represents individuals as being entirely in control of their situations and ignores institutional and social constraints on actions to prevent or minimize insurance losses. He also points out that the theory of moral hazard assumes individuals always act in accordance with rational choice theory (which would lead them to take advantage or freeloader off of insurance

⁷ The promotional film for Stormstruck can be viewed at <http://flash.org/video.php?id=82>

coverage, exhibiting reckless behavior rather than disciplined stewardship of the insured item), and that money is always a full compensation for loss. By this logic, any loss – no matter how physically or emotionally painful – will be borne by the individual because he or she will be monetarily compensated for it. Besides the obvious critique of neoclassical *homo economicus* from behavioral economists, who point out that individual decisions quite often do *not* match those that follow from rational choice (Akerlof and Shiller 2009; Ariely 2008), a more pointed political critique would ask how “free” some individuals are to “choose” to become more responsible citizens in the first place (cf. Wisner et al. 2004). What other social, economic, familial, and cultural circumstances shape decisions about residence and loss prevention? And moving beyond methodological individualism, how do planning and land use decisions at the municipal, county, state, and federal levels affect building patterns, wealth concentrations, and environmental design along coastlines?

The insurential focus on the single-family homeowner as the “unit” for improvement may also consolidate homeownership and insurance availability along class lines. An example from South Florida demonstrates the disproportionate burden that homeowner’s insurance premiums place on lower-income households. Using the U.S. Census Bureau’s 2007 American Community Survey data, I selected a group of contiguous counties in South Florida (Broward, Palm Beach, Miami-Dade, Monroe, Collier, and Lee) and analyzed the home owning population to test whether the percentage of annual household income spent on property insurance changes meaningfully depending on the value of the property or the level of income. The results (see **Table 6.1** and **Table 6.2**) indicate that although the percentage of income spent on property insurance changes only slightly depending on the property value, premiums consume a disproportionate part of household income for households earning less than \$50,000 per year. Over 22 percent of these 5,478 households spent more than 12 percent of their annual income on property insurance premiums, while in no case did expenditures on insurance exceed 4.5 percent of annual income for households earning over \$250,000. This confirms a common argument for consumer protection-oriented insurance regulation: homeowners’ insurance is a relatively inelastic commodity for which demand does not increase with income. As a result, lower income households are disproportionately burdened with its costs.

If we need further evidence of the class-based agenda of free market coastal governance, a representative of the Competitive Enterprise Institute speaking at the “Hurricane Mitigation Leadership Forum” in Orlando provided an astounding exemplar this logic. Speaking as part of the “Safe Nat Cat” lobbying alliance between insurers, free market think tanks, and environmental groups in December 2008, CEI analyst Eli Lehrer told the audience – of which I was a part – “Only rich, stupid people, like Britney Spears, should be able to build on the coast”. **Figure 6.2** reproduces Lehrer’s accompanying PowerPoint slide, which elicited laughter from the audience. Lehrer was emphatic that he did not wish to prohibit coastal residence or new development; rather, these should be confined to those able to pay the “actuarially fair” price for insurance to live in “the most sensitive coastal areas”. If the logic of the Safe Nat Cat alliance succeeds in its goals of dismantling consumer-oriented rate regulation and federally-subsidized flood insurance, this could result in an even higher percentage of low income households’ expenditures being redirected towards insurance premiums. If this did not result in the “hollowing out” of the home-owning population and the movement of low-income households

into the renting population, it would at least make these households more likely to underinsure the value of their properties or forego insurance coverage altogether.⁸

The insurance industry's project to send "clear market signals" to incentivize good coastal governance and climate change adaptation also seems woefully limited once we consider the proportion of that population living in apartments, public housing, rentals, or temporary occupancy dwellings (see **Table 6.3**). Across the state of Florida, only 54 percent of housing units are detached single family homes, while 10 percent are mobile homes and 30 percent are apartments. In South Florida (in the counties analyzed in the example above), the share of single-family homes is even smaller, roughly equivalent to apartment stock at 44 percent. Although the majority of housing units throughout the state are owner-occupied (see **Table 6.4**), roughly 30 percent of units are rentals or non-standard arrangements in which occupants do not purchase dwelling insurance at all.

If the discourse of responsible homeownership is silent about the place of non-homeowning populations in the ideal market-based coastal governance regime, it is deafeningly mute about the "responsibilities" of any entities except private individuals. Corporations and whole industries with major influence over the coastal built environment are completely ignored. Real estate development comes to mind most immediately in Florida, but in states such as Texas and Louisiana the energy and petrochemical industries certainly exercise far more control over the coastline (and its demise, as it were) than do homeowners.

In closing, although I've argued that catastrophe models are critical tools in the elaboration of the neoliberal vision of responsible homeownership, I want to make clear that there seems to me no *a priori* reason why the technology of catastrophe modeling might not also be used to lay bare the new risks created by coastal real estate development, the destruction of wetlands, hardscaping, channel dredging, and so forth. The methods of modeling are, and will continue to be, critical for the evaluation of climate risks and potential adaptive responses. The crucial question is whether model *output* can be rendered in terms *other than* the expected loss of exchange value. This would require a broad rethinking of the kinds of "vulnerable assets" that can be represented with such tools. For much as Ewald argues with respect to the technology of insurance, catastrophe models are only as limited as our social and political institutions for organizing and mitigating risk make them.

⁸ Usually possible if the home is owned "free and clear" without a mortgage. This is especially concerning given the prevalence of mobile homes in South Florida, which are often owned outright.

Figure 6.1: “Stormstruck” Experience at Epcot Center, Walt Disney World, Orlando, Florida



Property Insurance Premiums as Percent of Annual Household Income * Property Value Crosstabulation
Broward, Palm Beach, Miami-Dade, Collier & Lee Counties

Insurance Premiums as Percent of Annual Household Income	Property Value						Total
	\$0-\$249,999	\$250,000-\$499,999	\$500,000-\$749,999	\$750,000-\$999,999	\$1 million +		
0-1,499	1384	1221	406	159	203	3373	
1.5-2,999	1187	1404	441	107	162	3301	
3-4,499	810	1289	335	104	103	2641	
4.5-5,999	502	736	167	56	51	1512	
6-7,499	317	494	108	39	33	991	
7.5-8,999	190	320	78	26	23	637	
9-10,499	125	222	50	23	18	438	
10.5-11,999	84	144	24	12	17	281	
>=12	397	572	183	52	94	1298	
Total	4996	6402	1792	578	704	14472	

Directional Measures

Ordinal by Ordinal	Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Somers' d	.039	.007	5.638	.000
Symmetric Insurance as % HHI	.044	.008	5.638	.000
Property Value Dependent	.035	.006	5.638	.000

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

Ordinal by Ordinal	Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Kendall's tau-c	.037	.007	5.638	.000
Gamma	.053	.009	5.638	.000
Spearman Correlation	.048	.008	5.796	.000 ^c
N of Valid Cases	14472			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 6.1

The ordinal measures of association for this cross-tabulation are quite weak, though they do indicate a very slight positive ordering of pairs (Gamma = .053; Tau-c = .037; Somer's d = .039; all significant at alpha = .0001 due to large sample size). The fact that these measures are not stronger tells us that the property insurance premiums are not particularly progressive or regressive in relation to total property value. Monroe County (the Florida Keys) is also represented in the ACS PUMS data as part of Miami-Dade County.

Source: U.S. Census Bureau American Community Survey 2007, Public Use Microdata Samples

Property Insurance Premiums as Percentage of Annual Household Income * Household Income Crosstabulation
Broward, Palm Beach, Miami-Dade, Collier & Lee Counties

	Household income (\$)							Total
	0-49,999	50K-99,999	100K-149,999	150K-199,999	200K-249,999	250K-299,999	300K+	
Insurance Premiums as % of Annual Household Income								
0-1.499	592	1146	677	266	179	121	392	3373
1.5-2.999	812	1093	786	330	112	55	113	3301
3-4.499	739	1175	520	125	61	16	5	2641
4.5-5.99	581	729	151	46	6	0	0	1513
6-7.499	514	413	58	5	0	0	0	990
7.5-8.999	439	171	27	0	0	0	0	637
9-10.499	329	101	7	0	0	0	0	437
10.5-11.999	239	43	0	0	0	0	0	282
>=12	1233	64	0	0	0	0	0	1297
Total	5478	4935	2226	772	358	192	510	14471

Directional Measures

	Value	Asymp. Std. Error ^a	Approx. Sig.
Ordinal by Ordinal			
Somers' d	-.418	.005	-.73,646 .000
Symmetric			
Insurance as % HHI Dependent	-.454	.006	-.73,646 .000
Household income Dependent	-.387	.005	-.73,646 .000

a. Not assuming the null hypothesis.
 b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

	Value	Asymp. Std. Error ^a	Approx. Sig.
Ordinal by Ordinal			
Kendall's tau-c	-.377	.005	-.73,646 .000
Gamma	-.542	.007	-.73,646 .000
Spearman Correlation	-.499	.007	-.69,241 .000 ^b
N of Valid Cases	14471		

a. Not assuming the null hypothesis.
 b. Using the asymptotic standard error assuming the null hypothesis.
 c. Based on normal approximation.

Table 6.2

The ordinal measures of association for this cross-tabulation are far stronger than the first. They indicate that the two variables are ordered in opposite directions, and the associations are relatively strong ($G = -.542$, $Tau-c = -.377$, $d = -.454$) and all are significant at the $\alpha = .0001$ level. A preliminary attempt to parse out the dependent variable into an even greater number of categories (in which the ">12%" category was subdivided into 5 categories) yielded only slightly stronger measures. This is probably due to the extremely long tail of the distribution of household income. Monroe County (the Florida Keys) is also represented in the ACS PUMS data as part of Miami-Dade County.

Source: U.S. Census Bureau American Community Survey 2007, Public Use Microdata Samples

Figure 6.2: Presentation Slide from Lehrer, Competitive Enterprise Institute, at the “Hurricane Science for Safety Leadership Forum,” Orlando, Florida, December 2, 2008

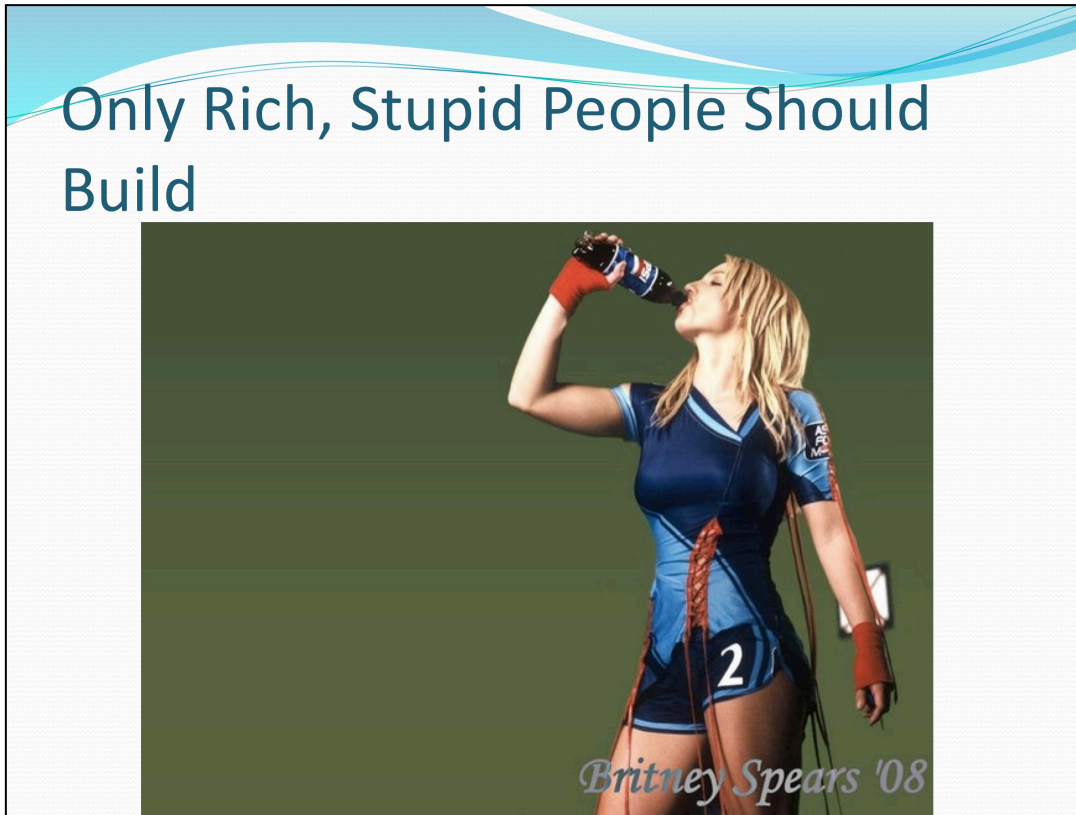


Table 6.3: Occupancy by type of structure, Florida 2007

	Mobile Home	Single Family detached	Single Family attached	Apartment	Other	Total*
Florida	10.1%	54.1%	6.1%	29.5%	0.1%	8,716,601
South Florida	3.9%	44.1%	8.9%	43.0%	0.1%	3,019,115

Table 6.4: Tenure type, Florida 2007

	Owned with mortgage	Owned free and clear	Rented for cash	Other	Total*
Florida	46.4%	24.2%	27.9%	1.5%	7,088,958
South Florida	46.5%	22.2%	29.9%	1.3%	2,398,892

For consistency with analysis in Tables 5.1 and 5.2, “South Florida” includes Broward, Palm Beach, Miami-Dade, Lee, Collier, and Monroe. Totals between tables differ due to fewer responses to the Census question regarding tenure type.

Source: U.S. Census Bureau American Community Survey 2007, Public Use Microdata Samples

Conclusion: The conservation of uncertainty and the limits of fear and value

“We demand rigidly defined areas of doubt and uncertainty!”
- Douglas Adams, *A Hitchhiker’s Guide to the Galaxy*

In Douglas Adams’ science fiction satire *A Hitchhiker’s Guide to the Galaxy*, philosophers tasked with pontificating over society’s most difficult and troubling questions discover they will be made redundant by a highly sophisticated supercomputer. The new machine, Deep Thought, is purportedly capable of decisively answering every conceivable question posed to it, and the first task it has been given is to discover the meaning of “Life, the Universe, and Everything”. The philosophers storm in to protest: “Under law the Quest for Ultimate Truth is quite clearly the inalienable prerogative of your working thinkers... what’s the use of our sitting up half the night arguing that there may or may not be a God if this machine only goes and gives us his bleeding phone number the next morning?” They vociferously proclaim, “We demand rigidly defined areas of doubt and uncertainty!” The computer calmly interjects to suggest a remedy. Although it says it is certain to come up with The Answer, the calculation will take seven and a half million years to run, and in the intervening time, “it occurs to me that running a programme like this is bound to create an enormous amount of popular publicity for the whole area of philosophy in general. Everyone’s going to have their own theories about what answer I’m eventually to come up with, and who better to capitalize on that media market than you yourself?” (Adams 2004, p 154 - 155).

I was reminded of the philosophers’ demand while attending a four-day educational conference on catastrophe modeling in 2010, sponsored by the Reinsurance Association of America. Over the course of the meeting, attendees (primarily employees of reinsurance and insurance companies who managed parts of their firm’s catastrophe modeling program) chose from a huge variety of talks on topics including new cat models for previously unmodeled perils and regions, sources of uncertainty in storm surge modeling, technical advances in geocoding and geodatabases, new engineering findings about structural vulnerabilities to hurricanes, updates to third-party catastrophe models, improved industry exposure databases, and insurance portfolio optimization using cat model outputs. Amidst this air of methodical technical knowledge transfer, Karen Clark, who is often referred to as “the mother of catastrophe modeling”¹, launched an intervention. In her presentation, she marshaled the words (and portrait) of Donald Rumsfeld to disrupt what she called the “seduction of science”, and to remind the modelers of the problem of “unknown unknowns”, or “the things we don’t know that we don’t know”. She went on, “Learn to say ‘I don’t know.’ If used appropriately, it will be often”.

“You can never prove us wrong!”

Although this acknowledgement of uncertainty might seem surprising – and it certainly contradicts the claims of some scholars who have criticized climate scientists’ totalizing belief in models (Demeritt 2001; Forsyth 2003; Tsing 2004) – these sorts of comments actually surfaced with great regularity over the course of this research. In fact, the Rumsfeld quotation and/or

¹ Due to her early work developing a catastrophe model that closely predicted the actual losses from Hurricane Andrew (roughly \$16 billion in 1992 dollars) while the rest of the industry underestimated damages by at least an order of magnitude (Lewis 2007; Martin 2002).

Nicholas Taleb's *Black Swan* theory² were invoked by at least one speaker at *every industry conference* I attended. Rumsfeld's famous quotation was uttered at a press conference on February 12, 2002, in response to a journalist's inquiry whether there was "any evidence to indicate that Iraq has attempted to or is willing to supply terrorists with weapons of mass destruction? Because there are reports that there is no evidence of a direct link between Baghdad and some of these terrorist organizations." Rumsfeld replied:

Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know that we know. We also know there are known unknowns; that is to say, we know there are some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tend to be the difficult ones. And so people who have the omniscience that they can say with high certainty that something has not happened or is not being tried, have capabilities that are – ... they can do things I can't do (Rumsfeld 2002).

It is not surprising that the (re)insurance industry adopted this idea with such gusto, as it lends authority and gravity to the logic of preemptive risk identification and "thinking the unthinkable". In pointing out the difficulty of *proving* a counterfactual – demonstrating that a relationship resolutely *does not* exist – Rumsfeld's comment encourages the belief that as-yet unknown risks could lie anywhere. Uncertainty and anxiety are actively cultivated rather than assuaged. This recalls the phenomenon Nikolas Rose has noted in health and life insurance: "insurential expertise...works through amplifying the very anxieties against which security is to protect" (1999, 160).

In the "unknown unknowns" paradigm, the continued absence of an event or piece of evidence can never prove that it is not *on the verge of* occurring or being identified. Much the same argument was identified by a PhD modeler working for a Bermuda reinsurer, who noted the philosophical problem of confirming cat models' projections of expected loss and return period: "It is impossible. For a 250 year loss you would have to wait at least 100 years [to have any idea]. That is why we always say 'you can never prove us wrong!'" [i21]. This is the peculiar epistemological magic of modeling. Because their object exists only in the probabilistic future, models are never absolutely falsifiable – yet by the same token, they can always be improved via the incorporation of the new observations and science. A broker explained why he regularly used Rumsfeld's quotation in presentations to clients:

I thought it was remarkably profound actually...it's absolutely true. The fact is that there's so much – things come out that hit us. Certainly every time there's a loss...the models are wrong for a new and interesting reason which hasn't been picked up before.[i8]

It is this consistent return of uncertainty after each major loss that paradoxically maintains the value of catastrophe modeling as an enterprise. In contrast to the output of Value-at-Risk models, in which traders of collateralized debt obligations apparently placed absolute trust (MacKenzie 2008, 2009), catastrophe models have become technical devices about which uncertainty is *actively acknowledged* and *even cultivated*. For instance, the CEO of Risk Management Solutions wrote in a trade journal in 2009:

Catastrophe models...are but shadows on the wall of the complexities of the physical phenomena that we call earthquakes, hurricanes, windstorms, floods and fires. Our knowledge of the frequency of the more catastrophic manifestations of these events is

² Which holds that the future is inordinately shaped by highly improbable events that humans are particularly poor at imagining before they occur, but especially adept at rationalizing after the fact (Taleb 2007).

fraught with significant uncertainties. And with each new event, such as Hurricane Ike,³ new knowledge is revealed that must be prudently incorporated into the models. Large events can also reveal unforeseen correlations. Exposures previously assumed to be independent are often coupled when a super-catastrophe occurs... The World Trade Center loss was the insurance industry's black swan – an unexpected risk with unexpected correlations (Shah 2009, p 32 - 33).

McNeill's notion of the "conservation of catastrophe" in complex societies (1989, see Chapter 2) promises an unending supply of similar black swans, guaranteeing the consistent production of new areas of doubt and uncertainty.

We have seen how the identification and definition of new domains of uncertainty – such as those produced by Katrina, 9/11, and the Tohoku earthquake – renew the need for expert judgment and risk management products. Every new and previously "unthinkable" phenomenon whose dynamics were not properly captured in catastrophe models expands the domains that models are expected to represent. Much as Mitchell (2002) has argued in the case of techno-managerial development expertise in Egypt, the *failures* of expert knowledge are quickly refashioned into legitimations for its continued deployment. A catastrophe modeler for a Lloyd's syndicate outlined the post-disaster situation in which vendor modeling firms always seem to find themselves: "A lot of people said [of the RMS 2006 update], 'It's a knee jerk reaction to Katrina', but in many ways [RMS] had to, because you have to respond to the latest science, and you have to respond to what you find out. If they ignored this new set of data, then we'd all think they were mad" [i17]. The process of revision is never-ending: at the time of this writing in 2011, RMS had just released a major update to its hurricane model that is heavily influenced by claims data, wind speed observations, and storm surge estimates from Ike and Katrina. The result is a 30% to 110% increase in estimated hurricane losses, depending on the region and return period modeled (Trading Risk 2011c).

Production via risk exclusion

As Adams' philosophers confronting the supercomputer are keenly aware, uncertainty can produce opportunities if it balances an inscrutable question with the promise of *eventual* – but not immediate! – resolution. This is perhaps why Beck's uninsurability thesis is empirically false; *all* insured risks, not simply those produced by industrial modernity, were at some point considered uninsurable and represented as such. Recall from the discussion of uncertainty and insurability in Chapter 4 that in order for a new insurance product to be "made", the risk that it meant is to protect against must first be *excluded* from general all-perils cover. This process is not accomplished overnight, and it is possible that Beck has misread the gradual process of exclusion and new product creation as evidence of the absolute absence of coverage. Losses from the particular risk must first mount to the point that they constitute a drag on insurers' general underwriting profits; firms must identify and implement exclusions in the course of contract renewals over a number of years; meanwhile, actuarial/modeling departments must

³ Although Hurricane Ike was only a Category 2 storm at landfall in Galveston, TX in September 2008, its 120 mile radius of hurricane-strength winds was larger than Katrina's, and it had two separate well-defined areas of maximum winds. It was also relatively slow-moving. These factors combined to produce a large area of coastal storm surge, a long time period over which structures were wind-loaded, and a slowly dissipating storm after landfall. As a result, Ike wrought a tremendous amount of inland and offshore energy damage and totaled over \$10 billion in insured losses.

develop new exceedance probability curves and rating guidelines to allow firms to underwrite the “new” peril.

This insight expands the existing scholarship on the multiplication of insurable insecurities and the financialization of risk by showing that the process of risk exclusion is a generative rather than nullifying act. The (re)insurance industry reproduces itself not only through the endless identification of new risk frontiers – credit defaults, pet insurance, index-based weather insurance, and so on – but also through the process of *subdividing, isolating, and excluding* risks that are *already embedded* in policies in force. Given the problem of stagnating premium volumes and market saturation in the industrialized world, we should expect to see many more instances of risk exclusion for the purposes of new product creation in the future.

Here is where the “opportunity” posed by climate change appears. Newly perceptible risks will generate demand for security and additional insurance coverage – demand that can then be funneled into new insurance products as soon as a company’s legal team has completed the process of excluding such guarantees of security from its existing policies and its actuarial and scientific teams have determined the pricing and portfolio composition most likely to generate profits. It seems likely this will be the form that the “future annual adjustments solution” (see Chapter 4) ultimately takes. Although it is unclear how long such a strategy can be maintained in the face of a changing climate, competitive pressures could compel firms to follow along regardless of the sustainability of the business model. As Marx reminds us, “every participator knows that the thunderstorm will come sooner or later, but everyone expects that the lightning will fall on the head of his neighbour, after he himself shall have had time to collect the golden rain and store it up safely. *Après moi le déluge!* is the battle-cry of every capitalist and every capitalist nation” (1967 (1867), p 269).

In the midst of intricate assessments of risk that dismantle and reassemble the qualities of the built environment and geophysical systems for the purpose of value extraction, it is difficult to see what, if anything, remains of insurance as a technology of popular solidarity in the tradition of the mutuals (Simon 1987). Nevertheless, if insurance technology is ever to hold out the prospect of climate security for all, it will require the dismantling of the dominant tropes of fear and climate emergency. The voices in Chapters 3 and 6 would have us believe that the public *fears too little* about coastal risk and climate change. While it may indeed be the case that the American public’s belief in the reality of climate change has faltered in the wake of economic crisis and Tea Party reaction, I hope to have disputed the recourse to fear as a device for organizing social and political responses to climate risk in the first place. Fear is routinely mobilized by both the left and the right to legitimate controversial actions ranging from the War on Terror to geoengineering, from racial profiling to banning financial derivatives. Left explanations of the financial crisis often imply it was triggered by the foolhardy absence of fear or its twin, “irrational exuberance”. In any case, the message always seems to be that populations do not fear *enough*. Here I have shown the profound limits to such a politics of fear with regards to climate change risks, where fear of the future may structurally operate to sustain the private (re)insurance industry at a time when its rate of returns might otherwise be falling. The mechanism of private insurance, in which “everything can have a price, all of us have a price, and... this price is not the same for all” (Ewald 1991, p 204) is not simply inadequate to the task of managing society’s climate vulnerabilities. Rather, its techniques of risk estimation and valuation promise to further magnify them.

Appendix A: Sample interview questions

For (re)insurance modelers and underwriters

- What is your educational or professional training?
- What are your current job responsibilities?
- How is the company evaluating and responding to climate change, if at all?
- To what extent does the question of climate change enter your daily work, if at all?
- Do you notice differences of perspective or business model between the companies you have worked for?
- Which catastrophe models do you use? Why?
- What internal models, if any, has the firm developed?
- How does the firm incorporate cat model results into business practice?
- In your opinion, what would be an acceptable degree of cat model error when run in hindcasting mode?
- Does the firm have any formal or informal relationships with academia?
- What are the firm's rules regarding data sharing and intellectual property in cases of collaboration with academia?
- (For modelers working on tropical cyclones within (re)insurance firms): If you were given the resources to hire the ten brightest climatological minds and set them to work on a single problem for your company, what would it be?

For climate scientists/meteorologists

- What have been your experiences with the (re)insurance industry? With the vendor modeling firms?
- Do you currently act in any private advisory or consulting capacity to any (re)insurers? Are you paid?
- If you are involved in any academic collaborations with the industry, how are those projects funded? How are research questions developed and implemented? How are results/IP managed?
- Have you ever been invited to take part in RMS's expert elicitation panels?
- If you took part in RMS's expert elicitation panel, can you tell me about the process and your impressions of it?

For reinsurance brokers

- How concerned are your insurance clients about climate change?
- Do you see reinsurance pricing incorporating climate change impacts?
- How does the firm use vendor catastrophe models? What internal models, if any, has the firm developed?
- Does the firm have any collaborations/connections with academic scientists? If so, why? Has that research influenced your business?

Appendix B: Table of formal interviews

Almost all quotations taken from interviews are denoted in the text using the format “[i#]”, where the specific number corresponds with an entry in the table below. In a few cases the identifier “i*” is used. In these cases the numerical identifier of the speaker has been withheld because the comment might reveal the identity of the speaker through cross-referencing with his/her other comments.

Year	Numeric ID	Place
2008	1	San Francisco
2009	2	Ft Collins, CO
2009	3	Ft Collins, CO
2009	4	Phone (Boulder)
2009	5	Phone (New York)
2009	6	London
2009	7	London
2009	8	London
2009	9	London
2009	10	London
2009	11	Munich
2009	12	Munich
2009	13	Munich
2009	14	Munich
2009	15	London
2009	16	London
2009	17	London
2009	18	London
2009	19	London
2009	20	London
2009	21	Zurich
2009	22	Zurich
2009	23	Zurich
2009	24	Zurich
2009	25	Zurich
2009	26	Zurich
2009	27	Zurich
2009	28	Zurich
2009	29	Zurich
2009	30	Zurich
2009	31	Zurich
2009	32	San Francisco
2009	33	San Francisco
2009	34	San Francisco
2010	35	Phone (D.C.)
2010	36	Miami
2010	37	Orlando
2010	38	Phone
2010	39	Phone
2010	40	San Francisco
2010	41	San Francisco
2010	42	San Francisco

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