(This post is part of a series on the issue of climate change and insurance that my colleague Ted Lamm and I are writing, inspired by a symposium that the law schools co-organized with the California Department of Insurance earlier this year. You can find more information on the symposium here. Ted's prior related post is here.)

With recent devastating wildfire seasons in California and increasing attention to the threats sea-level poses on coastlines across the world, more people are starting to pay attention to the interactions between climate risk and the insurance sector. The insurance sector plays a crucial role in risk management, including risks that relate to weather and climate. Beyond that, availability and pricing of insurance can motivate or hinder private-sector action. So it's important to understand the ways insurance interacts with climate risk. This is a subject I've been researching for more than a decade, and was the topic of the symposium we hosted this summer in partnership with Insurance Commissioner Ricardo Lara, UC Berkeley's Center on Law, Energy, and the Environment, and UN Principles for Sustainable Insurance.

Significantly, the insurance sector, which holds much of the financial risk across the world economy, is increasingly concerned with climate-related risks, especially the ways in which risks are becoming less predictable and more uncertain over time. We are also hearing news about insurer withdrawal from certain markets and fears of rising premiums here in California relating to wildfire risk. Here, I'll discuss some basic principles relating to insurance and climate change, drawing on my prior work in the field. In a subsequent post, I'll provide some insight into how these principles relate to wildfire prevalence and magnitude, sea-level rise, and other specific impacts of climate change in California. (Here, I'll focus exclusively on insurance products and underwriting, or the way they manage risks. Note that insurers also are major investors, and their investment decisions also relate significantly to climate risks.)

Insurance and Risk Management

Insurers' core business is managing and spreading risk. Insurance or comparable risk-management tools are necessary for homeowners to obtain mortgages, for businesses to obtain financing, and for managing many other societal risks. Insurers, through the conditions attached to their underwriting of risks, have the potential to influence the behavior of a wide range of individual and corporate actors—including behavior that may affect greenhouse gas emissions or that may be more or less adaptive to climate change's impacts.

In a typical insurance arrangement, a large number of people or businesses exposed to a

risk of loss pay into a fund that compensates those who actually suffer loss. Insurance allows individuals and businesses to lessen or remove the risk of a bad outcome—at a price. Not only does insurance reduce the likelihood that an individual or business will suffer catastrophic financial loss, but investors and lenders, who may be reluctant to support activities that are vulnerable to shocks and losses, insist on insurance or similar risk-management arrangements to protect their capital investment.

In the absence of insurance, the financial cost of significant personal risks, such as a fire destroying our home, would be untenable for many of us. (Of course, this risk management could alternatively be provided by a governmental entity in some cases–but in most cases it is not.) Institutions that shape our activities–such as the mortgage lending industry and states' motor vehicle regulators–require that we be insured before we take certain actions, such as buying a home or a car. Similarly, our businesses and institutions depend heavily on risk-spreading provided by capital markets. In that context, insurers have a lot of leverage in affecting people's behavior through their policies. Insurance pricing and availability can influence our behavior and constrain our choices, both individually and as a society.

So, for example, the insurance industry played a major role in developing building codes and fire safety standards in the United States, to control their risk exposure. These codes reduced risks, by requiring a new standard of care for the built environment. But insurers are not in the business of simply reducing risks; rather, their business model depends on accurately predicting risks. Consequently, in many cases, insurers may care most about reducing uncertainty so they can more accurately predict risks.

Many have suggested that pricing insurance to reflect the magnitude of risk as accurately as possible will provide a strong incentive for people and businesses to engage in less risky behavior, making risks more insurable. This is true, up to a point. High premiums for mandatory insurance would certainly discourage behavior that increases vulnerability (such as living in high-fire-risk areas). But it's not that simple: escalating premiums create equity impacts on residents who have relied on low insurance costs, and any solution that involves pricing insurance premiums to reflect risks must address these inequities.

Insurability, Insurance Pricing, and Insurance Availability

Insurers will cover risks only under certain conditions. Risks that do not meet these conditions may be considered uninsurable, because the basic model of collecting premiums to pay for losses wouldn't work without them. Disaster risks, including many that relate to climate change, have many of the markers of uninsurability. Here are factors that determine whether a risk is insurable:

- The largest possible loss should not affect the insurer's solvency (ability to have the capital to pay all claims).
- The average loss should be determinable and quantifiable (to allow insurers to plan for risk and set premiums rationally).
- Risks should be independent and well-distributed in time and space rather than correlated (so that the insurer can diversify risks effectively and avoid insolvency or other failures).
- The pool of insureds should not be skewed toward those with high risk, and the insurance contract should not motivate policyholders to fail to take self-protective measures (moral hazard).
- There must actually be a market in which supply and demand yield a price point for any given level of insurance against any given risk.

Insurers can take actions to try to make risks more insurable, especially engaging in research to understand risks as well as possible. But the financial dynamics of disasters are particularly challenging for risk management: not only are basic parameters of disasters themselves unpredictable (for example, how many hurricanes of what magnitude in what location make landfall), but a single year of extremely large covered losses may be high enough to render an insurer insolvent. Unlike, for example, automobile insurance, insurers can't spread disaster risks effectively. The widespread disruption in insurance markets after Hurricane Andrew's wind-related destruction in Florida illustrates this well.

Insurability and Disaster Risk

The example of Hurricane Andrew demonstrates how some types of climate-related risk challenge core principles of insurability. A given level of overall risk from a particular kind of insured loss may be perfectly acceptable if losses are likely to be well-distributed and independent. But concentration or correlation of losses—as occurs in hurricanes, wildfires, and other major disasters—makes it more likely that an insurer may will suffer unsustainable losses within a single year. Uncertainty, or ambiguity of risk—the inability to assess and quantify probabilities of predicted losses with sufficient precision—makes insurers reluctant to insure risks, except at high cost. In extreme cases, uncertainty will render a risk uninsurable by rendering risks unquantifiable, concentrated, and unable to be priced at a level consumers or regulators will tolerate.

This recognition of uninsurability happened long ago with flood insurance in the United States. Private insurers largely pulled out of the flood insurance market in the mid-20th century. This was the result of massive, correlated flood-related losses that made insurers view flood risk as uninsurable—or at least insurable only at very high cost through specialty

insurance products. The National Flood Insurance Program fills the gap in private flood insurance. (That program has been beset by challenges others have noted.) While there is still private flood insurance being issued in the US (and its availability appears to be growing), flood insurance is not part of standard homeowners' insurance policies.

As climate change affects weather patterns, changing sea levels and storm surge as well as changing tropical storm and precipitation dynamics, it will become even harder for insurers to manage these already-difficult types of risks. Many of these risks may end up being insured through government-run risk pools–as is already the case with earthquake insurance in California, flood insurance nationally, and a significant amount of weather risk on the gulf coast. Insurers have been working in recent years to develop new financial instruments to try to address those risks by providing incentives for capital investment that can provide funding to address the risks when they materialize. These include catastrophe bonds and other types of insurance-linked securities, as well as other parametric products like the nature-based insurance Ted Lamm discussed in his recent post.

Climate Change and the Future of the Insurance Sector

The most sobering assessments within the insurance sector focus on the uncertainty that climate change has injected into insurers' business model, and the strategic challenges it creates for risk management. Climate change, which injects new uncertainty and a shift away from what scientists have called "stationarity," or physical stability within a range of historical conditions, presents massive challenges for insurers. The most recent annual survey of emerging risks by three major actuarial societies—the professionals whose job it is to evaluate financial risks for the private sector—named climate change as both the top emerging risk and the top current risk. And the International Association of Insurance Supervisors recently noted "the potential for physical climate risks may change in non-linear ways, such as a coincidence of previous uncorrelated events, resulting in unexpectedly high claims burdens," and concluded that "[a]t the macro-economic level, uninsured losses from physical risks may affect resource availability and economic productivity across sectors, the profitability of firms and individual assets, pose supply chain disruptions, and ultimately impact insurance market demand."

In addition to changes in the uncertainties around physical risks, insurers also interact with climate risk through their underwriting of insurance for major projects that emit fossil fuels, or alternatives to those projects. So, for example, energy generation assets, from coal-fired power plants to solar arrays, can be built and maintained only with financial risk management in place, much as individuals cannot obtain home mortgages or lawfully drive automobiles without insurance. Insurers' decisions about underwriting these risks affect

businesses' ability to embark on new projects and maintain existing infrastructure. So it was big news when international insurer Chubb announced, earlier this year, that it would no longer provide insurance for new coal-fired power plants. mines, and related infrastructure. Other insurers are similarly questioning their investments and underwriting in coal.

Many activists see pressure on insurance companies to cease underwriting fossil fuel infrastructure as a key lever for transitioning the world economy away from fossil fuels. And this is not just a political decision; there are sound risk-based arguments for insurance companies to decide to back away from insuring fossil fuel infrastructure, given the future climate-related liabilities the fossil fuel energy sector may face as well as the potential obsolescence of those technologies in coming decades.

The major international insurers, which hold the most risk, are particularly concerned about climate change risks, and are investing heavily in better understanding them—as they sound the alarm within their industry and more generally. Officials at both Lloyd's of London and Munich Re noted, after Hurricane Sandy, the likely connections between climate change and future increases in storm damage. The largest reinsurers and excess insurance carriers, like Munich Re, Lloyd's, and Swiss Re, among others, have devoted enormous resources to understanding and reducing climate risk. The development of sophisticated catastrophe modeling, commercialization of climate change-focused risk-management products, and high public engagement are among the tools insurers are using to address climate risk, in addition to rethinking their underwriting decisions around fossil fuels and other climate risks. Trade organizations like ClimateWise support these efforts. Nonetheless, climate change has barely surfaced as an issue for many U.S. insurers, who write insurance policies on an annual basis and offload much of their risk to reinsurers.

In our recent symposium, I was heartened to see the level of engagement by insurers, advocates, researchers, and public agencies—especially the Department of Insurance, led by Commissioner Lara—on this issue. Insurance industry leaders, and at least some of industry regulators, understand the sector's need to adapt to a changing climate. I'm optimistic that over time, insurance can be an effective tool to better address at least some significant climate-related risks as the sector adapts.