Insurance and the Excellent Regulator

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Established in 1984, the Wharton Risk Management and Decision Processes Center develops and promotes effective corporate and public policies for low-probability events with potentially catastrophic consequences through the integration of risk assessment, and risk perception with risk management strategies. Natural disasters, technological hazards, and national and international security issues (e.g., terrorism risk insurance markets, protection of critical infrastructure, global security) are among the extreme events that are the focus of the Center’s research.

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Regulation stands as one of society’s primary tools for managing the risks that pervade modern life. But regulation is not the only tool; insurance is another important risk management tool. In addition to providing a source of compensation for losses after risks have materialized, insurance can serve a regulatory role, helping to prevent risks from arising in the first place. When insurance premiums are risk-based, they encourage policyholders to invest in cost-effective loss reduction measures—an appropriate benchmark for regulatory excellence. Using risk-based insurance as a model, regulators can aspire to develop and enforce rules in such a way that they provide regulated firms with similar incentives to reduce their risk, yielding cost-effective outcomes for society.

Regulators seeking excellence can learn much from insurance. As Bridget Hutter argues in chapter 7, “excellent regulators” today have come to be “defined as excellent risk managers.” Insurance as a model for regulatory excellence follows quite naturally from scholars’ and policy advisers’ recommendation that regulation become more risk-based. If regulation is to do so, then regulators should design their rules and target their enforcement resources in ways that better mimic a well-designed insurance market operating in conjunction with well-designed liability rules.

Insurance markets themselves, though, do not always satisfy the fundamental precept of premiums reflecting risk, something that is clearly the case when it comes to low-probability, high-consequence events—the very kind of events that regulation often must address.
Furthermore, there is empirical evidence that many individuals faced with low-probability, high-consequence events do not purchase insurance, even when premiums are subsidized. This implies that insurance markets for these events will not work unless regulations mandate the purchase of insurance with risk-based premiums. For this reason, governments at times impose requirements that individuals buy health insurance, businesses pay workers’ compensation premiums, or property owners in areas subject to flooding purchase flood insurance.

And yet, compelling people to buy insurance where premiums reflect risk can impose very high costs on individuals with low incomes. For individuals with significant budgetary constraints, financial assistance for insurance premiums may need to be provided through general public funding, such as means-tested vouchers. The best public policy strategy in these cases will depend on the coordinated use of different tools: insurance, regulation, and redistributive subsidies.

Our main purpose in this chapter is to draw lessons from insurance for regulators seeking excellence. The most important of these lessons lies in the need to align public policy effectively with private markets. Both insurance and regulation can benefit each other when public and private strategies are deployed synergistically. The excellent regulator must ultimately understand that it is part of an entire system of both public and private actors and that its success depends on more than just its own policies and practices.

**Risk Management and Risk-Based Regulation**

Although the word “risk” is often associated with dangerous activities -- whether daredevil acts or complex industrial operations with narrow margins of safety -- nearly every human endeavor poses some risk of harm. As a result, no one can go through life avoiding risk altogether, nor can societies protect their members from all risk. But risk can and must be
managed. Sometimes specific risks can be virtually eliminated through regulation, such as when products or work practices are banned. For example, the U.S. experience with mandating the phase-out of lead as a gasoline additive in the 1970s eliminated that particular exposure pathway and its associated public health risks. More often, though, regulation manages risks rather than eliminating them.

Risks can be managed in many different ways. Consider the risk of physical damage, injuries, and fatalities associated with automobile accidents. Regulation aims to reduce this risk through actions that lower the chances of accidents occurring, such as through driver training, speed limits, and equipment standards. It also works to reduce the consequences of an accident through protective measures, such as having manufacturers install seat belts or air bags. Harms can also be lessened by responsive actions taken in the wake of accidents, such as when emergency medical responders and hospital staffs treat accident victims. Across the gamut of activities that make up modern life – from the construction of buildings to the consumption of food and drugs, and from the lending practices of banks to the operation of industrial facilities -- regulation works to manage the risks that arise in the private marketplace.

Sometimes the need for regulation arises due to individuals’ lack of knowledge of the risks associated with products and services, which justifies regulation to require sellers to disclose relevant information to buyers. Other times regulation addresses what are often inevitable spillovers of risks, where a third party not involved in a market transaction for a good or service must bear some of the harms associated with that transaction. Pollution is a classic example of such a spillover, and environmental regulations are the principal means by which society manages this risk.
But just because regulations are designed to manage risk, this does not mean that they easily achieve their desired objectives. Risks are challenging to regulate not only because markets fail in classic terms due to information asymmetries and negative externalities, but also because humans are not very good at processing information, something particularly prone to occur with respect to low-probability events. Furthermore, a focus on short time horizons often leads people to avoid taking costly action today to mitigate risks that would not materialize for some time to come.

When faced with these and other challenges, what are regulators to do? Many scholars and policy commentators advise that regulation become “risk-based,” by which they generally mean that regulators should analyze risks more carefully when making decisions. Indeed, regulators around the world are pursuing rigorous risk analysis before they create new regulations, and thinking about risk priorities when deciding how to allocate scarce enforcement resources. Examples of risk’s ascendancy in regulatory circles range from elaborate governmental procedures requiring the use of regulatory impact assessments to Malcolm Sparrow’s beguilingly simple admonition that regulators should “pick important problems and fix them.”

Sometimes risk-based is taken to mean that regulators should address the worst risks first. Although such a strategy has a powerful common-sense appeal, it leaves important questions unanswered. For example, even if a regulator targets the worst risks first, nothing in a worst-first principle tells the regulator what exactly to do about those targeted risks. Should the aim be to eliminate those risks completely? Or should the worst risks be reduced to the level of, say, the second-worst risks? How much should society spend to make reductions in the worst risks? If the worst risks are too costly to address in relation to their expected, discounted
benefits—and the risks of asteroids hitting planet earth might be an example—they may not be worth devoting as much attention to as moderate risks, where the expected, discounted benefits from regulation are higher than the expected, discounted costs. What regulators need is a framework for defining what is meant by excellent, risk-based regulation. The theory of insurance can help provide such a framework.

**Insurance as a Risk Management Tool**

Insurance, operating against a backdrop of clear liability rules, constitutes a “regulatory” vehicle for managing risk by compensating harmed individuals and encouraging those who engage in risky behavior to invest in mitigation efforts. Background liability rules impose a duty of care on risk producers, requiring that they pay damages to anyone they are found to have harmed. Insurance can cover those damages and in so doing achieve outcomes similar to an ideal regulatory system. By setting premiums that reflect risk, insurance encourages investments in cost-effective protective measures to reduce future losses from untoward events. Even a brief review of how optimal insurance markets operate can reveal important insights about how risk regulation should ideally function and can provide a basis for regulators seeking to use insurance as a regulatory tool.

Insurance premiums are considered to be risk-based when the price charged to cover an event that has a loss $L$ with a probability $p$ is set equal to the expected loss (that is, $pL$). An insurer will also usually charge an additional cost to cover its own expenses and generate a profit. An insurer normally relies on risk pooling and the law of large numbers when providing coverage against a specific risk. If the risks are independent and there are a significant number of policyholders, then the variance in the expected loss is very small, so the insurer can estimate with some degree of accuracy how large its annual claims payments will be *on average.*
A benchmark model of insurance supply assumes that insurance companies are maximizing long-run expected profits for their owners in a competitive market. In this environment, there are many insurance firms, each of which is free to charge any premium for a specified amount of coverage. The assumption of competition implies that their premiums will be high enough to allow the insurers to cover their costs and make a reasonable profit.

For a risk to be insurable, the insurer must have the ability to identify and quantify, or estimate at least partially, the chances of the event occurring and the extent of losses likely to be incurred; it will specify a premium for which there is sufficient demand and incoming revenue to cover the development, marketing, operating, cost of holding capital and claims processing, and yield a net positive profit over a specified time horizon. In setting a premium, an insurer must consider problems associated with asymmetry of information (adverse selection and moral hazard) and with the degree of correlation of the risk.

If the insurer cannot differentiate the risks facing two groups of potential insurance buyers, and if all buyers know their own risk, then the insurer is likely to suffer unsustainable losses if it sets the same premium for both groups by using the entire population as a basis for its estimate. This situation, referred to as adverse selection, can be rectified by the insurer charging a high enough premium to cover the losses from the “bad” risks. In so doing, the “good” risks might purchase only partial protection, or no insurance at all, because they consider the price of coverage to be too expensive relative to their risk.¹⁴

Moral hazard refers to an increase in the expected loss (probability or amount of loss conditional on an event occurring) due to individuals and firms behaving more carelessly as a result of purchasing insurance. A firm with insurance protection may alter its behavior in ways that increase the expected loss relative to what it would have been without coverage. If the
insurer cannot predict this behavior and relies on past loss data from uninsured firms to estimate the distribution of claim payments, the resulting premium is likely to be too low to cover expected losses. The introduction of deductibles, co-insurance, or upper limits on coverage can be useful tools in reducing moral hazard, encouraging insureds to engage in less risky behavior because they know they will incur part of the losses from an adverse event.

The potential for a high correlation of the risk of extreme events has an impact on the tail of the distribution and normally requires the insurer to hold additional capital in liquid form to protect itself against large losses. The prices charged for disaster insurance must be sufficiently high to cover not only the expected claims costs and other expenses but also the costs of allocating capital to underwrite this risk. Moreover, because large amounts of risk capital are needed to underwrite catastrophe risk, the resulting premium will be high relative to an insurer’s loss expenses simply to earn a fair rate of return on equity and at the same time maintain the insurer’s credit rating.

When adverse selection, moral hazard, and correlated risks can be adequately addressed, the setting of risk-based premiums should result in an optimal level of risk reduction by insured firms. If premiums reflect expected losses, and if businesses must purchase insurance because of either regulatory mandates or the threat of subsequent tort liability, then premiums will operate much like a Pareto tax -- one set at an amount equal to the expected marginal social costs of the behavior being taxed -- forcing firms to internalize the full costs of their business activity. Firms can then be expected to undertake risk prevention strategies whenever the expected costs of doing so will be lower than the decrease in their risk-based premiums.

What Regulators Can Learn from Insurance
The way insurance can perform a regulatory function provides a model for regulators when they approach their work. Regulators can draw at least five lessons from the theory of insurance markets.

First, insurance markets operate efficiently if premiums are risk-based, and regulation also works well when it is risk-based. Insurance, in other words, provides one useful model for operationalizing the widely-touted but ambiguous term, “risk-based regulation.” Regulators will be more likely to achieve outcomes that are efficient when regulations and their enforcement mimic an optimal insurance market by inducing regulated firms to internalize the full expected losses from their activities.

Second, risk-based insurance encourages policyholders to take actions that reduce their losses because when they reduce insurers’ expected claims payments, insurers can lower the premiums they charge. In this way, insurance is performance-based, in that the incentives it provides to policyholders are tied to outcomes. Regulators would do well also to focus on outcomes. In appropriate cases, they should use performance standards or market instruments. They also should rely more extensively on mechanisms that measure how well regulations are working.

Third, insurance markets in theory achieve an optimal level of risk management in society, which is not always the same as eliminating risks. The excellent regulator has a similar objective: to manage a risk so that the expected costs of risk reduction do not exceed the expected benefits of reducing the risk, taking into account the impact this has on other risks.

Fourth, because even excellent regulation will not eliminate most risks, society will need effective ways of compensating those who are harmed. Insurance has a dual function in this regard: providing incentives for reducing risks and compensating individuals through claims
payments should one suffer a loss. Although regulators may not have any direct authority or responsibility for providing compensation, a well-ordered society within which a regulator operates will need to have some means of promoting equity and compensation for those who are negatively affected by regulatory decisions. Background liability rules can provide a useful supplement to regulation.

Finally, in the same way that insurance companies must invest in research and actuarial analysis if they are to compute risk-based premiums, excellent regulators need to build strong in-house analytic capacity to understand their risk environments. Regulators need to make a commitment to delivering public value in ways that comport with sound, neutral, risk analysis; they will fail if they are driven by short-term or parochial interests rather than the well-being of the public.

**Behavioral Characteristics of Insurers**

Although the theory of insurance as a risk management tool provides useful lessons for regulators, insurance markets themselves do not always operate precisely as theory would predict. Insurance firms themselves can deviate from the ideal model due to behavioral factors.

In the case of terrorism, for example, notwithstanding the World Trade Center bombing of 1993, the Oklahoma City bombing of 1995, and other costly terrorist attacks outside of the U.S., the likelihood of large claims payments from attacks in the U.S. was still deemed by insurers in the country to be quite small because, prior to September 11, 2001, the insurance industry in the U.S. had never suffered catastrophic terrorism losses. In fact, actuaries and underwriters did not price the risk associated with terrorism nor did they exclude this coverage from their standard commercial policies.\(^{18}\)
Following the terrorist attacks of September 11th, most insurers discontinued offering terrorism coverage given the refusal of global reinsurers to provide them with protection against severe losses from another attack. The few companies that did provide insurance charged extremely high premiums to protect themselves against a serious loss.\textsuperscript{19} Concern about high premiums and limited supply of coverage led Congress to pass the Terrorism Risk Insurance Act at the end of 2002 that provided a federal backstop up to $100 billion for private insurance claims related to terrorism.\textsuperscript{20}

The ambiguities associated with the likelihood of an extreme event occurring and the resulting outcomes raise a number of challenges for insurers with respect to pricing their policies. Actuaries and underwriters use rules of thumb that reflect their concern about those risks where past data do not indicate with precision what the loss probability is. Consider estimating the premium for wind damage to homes in New Orleans from future hurricanes. Actuaries will first use their best estimates of the likelihood of hurricanes of different intensities to determine an expected annual loss to the property and contents of a particular residence. When recommending a premium that the underwriter should charge, they will increase this figure to reflect the amount of perceived ambiguity in the probability of the hurricanes or the uncertainty in the resulting losses.

A recent web-based experiment provided actuaries and underwriters in insurance companies with scenarios in which they were asked to seek advice and request probability forecasts from different groups of experts and then determine what price to charge for coverage for flood damage and wind damage from hurricanes. It found that the average premium insurers would charge was approximately 30 percent higher for coverage against flood or wind damage risks if the probability of damage was ambiguous rather than well specified and if the experts
were conflicted over their estimates. The data reveal that insurers would likely charge more in the case of conflict ambiguity (that is, when experts disagree on point estimates) than with imprecision ambiguity (when experts agree on a range of probabilities, recognizing that they cannot estimate the probability of the event precisely).  

Regulatory officials can exhibit similar behavioral tendencies. They may avoid necessary action for fear of the consequences to their organization if they make a mistake or an unpopular decision. These tendencies will likely be exacerbated when there is ambiguity and uncertainty, precisely the conditions in which regulators must often operate. The best regulators, like the best insurers, will be aware of their behavioral tendencies and strive to counteract or overcome them.

**Synergies between Insurance and Regulation**

Achieving the regulatory effect of risk-based premiums will often depend on background liability or a mandate to purchase insurance, highlighting the synergistic relationship between insurance and regulation. This relationship can manifest itself in two ways: well-enforced regulation can improve insurance markets, and insurance markets can reinforce regulation.

*How Well-Enforced Regulation Can Reduce Insured Losses*

After Hurricane Andrew devastated parts of Florida in 1992, the state government started to reevaluate its building code standards and enforcement. In 1995, officials in the state’s coastal areas stepped up their efforts to enforce existing high-wind design provisions in the code for new residential housing. In 2002, the state adopted a new building code that incorporated hurricane-resistant design features and required all licensed engineers, architects, and contractors to take training courses on these new standards.

When Hurricane Charley made landfall at Port Charlotte in the same state in 2004, the value of the more robust regulation of building construction became clear in the form of lower
insurance claims. The Institute for Business and Home Safety reported data from an insurer with more than five thousand policies in effect at the time in heavily hit Charlotte County. According to an analysis of the approximately 2,100 hurricane-damage claims filed on these policies, homes built after 1995 had an average claim severity 60 percent lower than homes built in prior years.\(^{22}\)

*How Insurance and Third-Party Inspectors Can Support Regulation*

One of regulatory agencies’ biggest challenges lies in inspecting facilities, as typically a regulator does not have enough inspectors to audit all the firms under its purview. When a regulator inspects compliant, low-risk firms, it wastes scarce inspection resources, not to mention the time of firms’ managers. But without a well-designed inspection process, how can the regulator know that any firm is low risk? At the same time, low-risk firms need a credible way to distinguish themselves from high-risk competitors. One way to do this would be for the regulator to delegate part of the inspection process to the private sector, through insurance companies and third-party auditors. If a firm chose not to avail itself of such an opportunity to be inspected by third parties, the regulator could reasonably infer that the firm is more likely to be high risk. In this way, insurance and third-party inspection not only could substantially reduce the number of firms the regulator has to audit, but the regulator could deploy its inspectors more efficiently. As more low-risk firms credibly reveal themselves to the regulator, the likelihood would increase that regulatory inspectors would be auditing more of the high-risk firms.\(^{23}\)

In practice, the use of third-party inspections and insurance has demonstrated beneficial effects. The Hartford Steam Boiler Inspection and Insurance Company (HSB) initiated private boiler inspections coupled with insurance as far back as the 1860s. HSB always viewed insurance as secondary to loss prevention, with a large part of insurance premiums used to cover engineering and inspection services. To reduce future risks, HSB conducted extensive research
on boiler construction, which eventually led to much more safely designed boilers. In addition, one of the key factors contributing to the reduction in boiler accidents over time has been a regulatory requirement adopted in all states that boiler owners submit to an annual inspection by a licensed third-party inspector.\textsuperscript{24}

Insurance has also played a positive role in the regulation of workplace accidents. The U.S. Occupational Safety and Health Administration (OSHA) has been regulating workplace safety directly since 1971. Although OSHA regulation promotes safety to some extent, research shows that market-based workers’ compensation insurance has created significant incentives for firms to maintain safer workplaces.\textsuperscript{25} Today, almost every wage and salary earner in the United States is covered by some kind of workers’ compensation system that requires employers to buy insurance to compensate their workers who are injured on the job. Since premiums are usually linked to performance, firms have financial incentives to invest in reducing safety risks. It has been estimated that, if the incentives of workers’ compensation were removed, there would be an increase of over 30 percent in work-related fatalities in the United States; this translates to an annual increase of 1,200 workers who would die from job-related accidents.\textsuperscript{26}

**The Need for Effective Public-Private Partnerships**

Given the synergistic relationship between insurance and regulation, government officials and insurers must forge effective public-private partnerships to achieve societal goals.\textsuperscript{27} The United States’ experience with its National Flood Insurance Program (NFIP) illustrates the vital need for effective coordination between the public and private sectors in addressing risk management problems.\textsuperscript{28}

After the Great Mississippi Flood of 1927, there developed a widespread belief among private insurance companies that flood peril was uninsurable. It was thought that floods could
not be insured by the private sector alone for several reasons: adverse selection; exceedingly high risk-based premiums (so high that no one would be willing to pay them); and catastrophic flood losses that would cause insurer insolvencies.29

In response to concerns that private flood insurance was not widely available, Congress created the NFIP in 1968 to make insurance available to homeowners and small businesses. Administered through the Federal Emergency Management Agency (FEMA), the NFIP offers flood insurance to residents and businesses in participating communities, written and serviced by qualified private insurers at rates set nationally by the NFIP. Homeowners in designated flood-prone areas who have a mortgage from a federally backed or federally regulated lender are required to purchase flood insurance for the duration of the loan; however, it appears that this requirement is not evenly and robustly enforced around the country. In addition, policyholders who own older buildings that do not meet local floodplain building standards pay premiums discounted roughly 40–45 percent from the actuarially fair or risk-based price, although their premiums are still higher than those paid by owners of compliant structures.30 In the aftermath of major hurricanes that made landfall in 2004, 2005, 2008, and 2012, the NFIP has had to borrow a total of nearly $27 billion from the U.S. Treasury to meet its claims obligations. In addition, because premiums have not reflected risk, property owners have not faced adequate incentives to undertake cost-effective risk mitigation.

In July 2012, President Obama signed the Biggert-Waters Flood Insurance Reform Act to reform and improve the NFIP. This law, which passed with overwhelming bipartisan support, recognized that flood insurance premiums should reflect risk and took steps to put the NFIP on a more financially sound foundation. But as higher premiums began to be phased in for some properties, many legislators wavered in their commitment to risk-based pricing given concerns
raised by many of their constituents that they would not be able to afford coverage or that they were being treated unfairly. In response, Congress passed and President Obama signed the Homeowner Flood Insurance Affordability Act in March 2014, which eliminated or delayed the implementation of many of the rate changes made in the Biggert-Waters Act, leaving the financial soundness of the NFIP still in jeopardy and reducing the incentives for property owners to take needed risk management measures.

The NFIP is an example of a public-private cooperation to achieve risk management objectives. The program still needs a better way of aligning public and private action to maintain financial stability, promote optimal mitigation, and ensure equity and affordability. Going forward, insurance premiums need to be risk-based to communicate accurately the degree of the flood hazard and to encourage investments in loss-reduction measures. To address affordability concerns of low- and middle-income homeowners, means-tested vouchers can be coupled with hazard mitigation requirements to be financed with low-interest loans. The requirement for hazard mitigation would reduce future disaster losses both for the NFIP and for low- and middle-income families. The voucher program would cover a portion of the higher insurance premium as well as the costs of the loan for mitigating damage to the residential property. Homeowners who invest in mitigation measures would be given a premium discount to reflect the reduction in expected losses from floods, whether or not they had an insurance voucher. Well-enforced cost-effective building codes and seals of approval would provide an additional rationale for undertaking these loss-reduction measures.31

The need for a coordinated, well-designed public-private partnership to manage flood risks provides a broader lesson about regulatory excellence. As discussed in chapter 1, success for regulators ultimately depends on more than just the actions that the regulator takes.
Regulatory success depends to a large extent on the actions that regulated entities take, as a regulator’s raison d’être is to shape those entities’ behavior so as to improve societal outcomes.

In addition, regulators need a supportive and well-designed legislative mandate and infrastructure. If the optimal solution to a regulatory problem is for regulators to compel businesses to internalize high spillover costs—much like the NFIP needs to charge premiums that reflect risk—regulation can only be effective if the legislature remains committed to the underlying objectives. If legislators backslide in the face of political pressures, they can blunt the credibility of needed regulation. In the forty-year history of the implementation of the U.S. Clean Air Act, for example, Congress extended legislative deadlines for compliance with national ambient air-quality standards, presumably slowing the pace of air-quality improvements.32 Today, some firms may be less likely to take seriously the need to invest in steps to lower greenhouse gas emissions if their managers anticipate legislative capitulation once significant compliance costs start to accrue.

The legislative backlash against the Biggert-Waters Act arose because the premium increases authorized by that law were not paired with other mechanisms to help low- and middle-income property owners. The NFIP saga not only reveals the need for ways to make risk-based insurance affordable through mechanisms such as means-tested vouchers and low-interest loans; it also offers another lesson for regulatory excellence. Even when regulations’ benefits outweigh their costs, these impacts will not be evenly distributed throughout society. Some segments of society will end up bearing more of regulations’ costs or suffering more of their other direct or indirect adverse effects.33

Sometimes distributional considerations can affect the design and implementation of a regulation, such as when the U.S. Environmental Protection Agency developed a new source
performance standard for coal-powered utilities in the 1970s that required the installation of expensive scrubbers, rather than the use of lower-cost, low-sulfur coal, in part to protect coal operations in central and eastern parts of the United States, which produce high-sulfur coal.\(^{34}\) The distribution of regulatory impacts cannot be ignored, but, the better way to address them may be through separate, means-tested transfer programs or tax adjustments.\(^ {35}\)

**Conclusion**

This foray into the world of insurance offers important lessons for the regulator seeking excellence. At one level, the theory of insurance provides a model set of aspirations for the regulator, namely to reduce risk to optimal levels and create incentives that will induce cost-effective change. Of course, insurance cannot be a substitute for all regulation. In reality, insurance markets often do not operate as they should in theory. Indeed, for that reason, insurance itself often depends on effective regulation, including well-enforced mandates that risk producers or risk bearers buy insurance.

How the burdens of both insurance premiums and regulatory costs are distributed matters, particularly when the costs of insurance and regulation weigh disproportionately on individuals with already limited resources. Finding appropriate means of redressing inequities is essential for effective systems of social insurance as well as regulation, but the best way to deal with these distributional considerations may be through independent governmental programs, such as means-tested vouchers or tax credits. Even though such resource distribution programs are often administered by separate governmental entities, this does not detract from their relevance to the regulator. It only reinforces the notion that an excellent regulator does not operate in isolation.
In the end, regulation and insurance aspire to much the same objective: optimal risk management, with due attention to equity concerns. It makes sense, then, to coordinate insurance with regulation when developing society’s overall risk management portfolio. Regulators seeking excellence can take from insurance markets a model for how to operate, and they can also search for appropriate opportunities to use insurance and third-party inspections to supplement their own regulatory efforts. Excellent risk regulation cannot be undertaken in a vacuum; it needs to work in alignment with liability rules, insurance markets, and the rest of society.

Notes

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13 The loss corresponds to the risk producers’ liability to compensate those who bear the untoward consequences of the risk. More details on the features of risk-based insurance discussed in this section can be found in Howard Kunreuther and Erwann Michel-Kerjan, “Economics of Natural Catastrophe Risk Insurance,” in Handbook of the Economics of Risk and Uncertainty, edited by Mark J. Machina and W. Kip Viscusi (Amsterdam: Elsevier, 2013).


15 For discussion of the ambiguity in the concept of “risk-based regulation,” see Cary Coglianese, Listening, Learning, and Leading, 44–46.


19 Howard Kunreuther, Mark Pauly, and Stacey McMorrow, Insurance and Behavioral Economics: Improving Decisions in the Most Misunderstood Industry (Cambridge University Press, 2013). To illustrate this point, prior to September 11, 2001, Chicago’s O’Hare Airport had $750 million of terrorism insurance coverage at an annual premium of $125,000. After the terrorist attacks, insurers offered the airport only $150 million of coverage at an annual premium of $6.9 million. This new premium, if actuarially fair, implies the annual likelihood of a terrorist attack on O’Hare Airport to be approximately 1 in 22 (that is, $6.9 million divided by $150 million), an extremely high probability. The airport was forced to purchase this policy since it could not operate without it. Dwight Jaffee and Thomas Russell, “Markets under Stress: The


22 For further details about this example, see Howard C. Kunreuther and Erwann O. Michel-Kerjan, At War with the Weather (MIT Press, 2009), on which this section draws.


The path forward described in this paragraph is developed in Kousky and Kunreuther, “Addressing Affordability.”

James E. McCarthy and others, “Clean Air Act: A Summary of the Act and Its Major Requirements” (Congressional Research Service, November 26, 2008), p. 3. Of course, if the alternative to extending air-quality compliance deadlines had been to eliminate entirely federal authority to regulate air quality, then the extended deadlines were the better outcome (assuming that the underlying air-quality standards reflected an optimal level of pollution reduction). For a related argument, see Richard Zeckhauser, “Preferred Policies When There Is a Concern for Probability of Adoption,” *Journal of Environmental Economics and Management* 8, no. 3 (1981): 215.

