Risking House and Home: Disasters, Cities, Public Policy

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Editors

2008
Berkeley Public Policy Press
Institute of Governmental Studies Publications
Berkeley, California

Cover: Loma Prieta Earthquake, October 17, 1989. San Francisco, California. Collapsed and burned buildings at Beach and Divisadero streets in the city's Marina District.
Photograph: C. E. Meyer, US Geological Survey

Library of Congress Cataloging-in-Publication Data

Risking house and home : disasters, cities, public policy / John M. Quigley and Larry A. Rosenthal, editors.
p. cm.
Includes bibliographical references.
ISBN 978-0-87772-427-8
1. Disaster relief—United States. 2. Insurance, Disaster—United States. 3. Urban policy—United States. I. Quigley, John M., 1942- II. Rosenthal, Larry A., 1959-

HV555.U657 2008
363.34'80973—dc22

2007043427

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Introduction: Disasters, Cities, Public Policy

1

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The notion of a "disaster" or "catastrophe" in a densely populated region immediately suggests the importance of scale. When a few homes or commercial structures are destroyed, surviving occupants and users may suffer sustained cost and inconvenience. Their ways of living and doing business are severely interrupted and may be forever altered. Surrounding communities may respond to neighbors' losses with charity and generosity. To the extent possible, victims salvage and reuse what goods and equipment they can, and they collect aid from whatever private and social insurance funds may be available to them. Lawsuits are filed when wrongdoers can be held accountable. Government organizes emergency responders and may eventually provide transfer payments to those in need.

These processes of small-scale recovery only marginally affect the regional economy, let alone national markets or global trade. Advanced economic systems agilely absorb these private losses and their external effects. Households and businesses relocate as necessary, and healthy vacancy rates in local property markets facilitate these moves. When a concentrated factor of production is affected, shortages do nudge prices higher in the short run, but competing sources sense opportunity and enter the marketplace.

Most of the administrative costs of small private and social insurance claims are built into premiums and tax bases. The rebuilding of structures and infrastructure costs real resources, to be sure, but these expenditures also spur employment and stimulate exchange in the local economy. In the longer run, capital and labor flows register little or no impact. In general, while transactions costs may be far from zero, the humming engines of diverse regional economies barely miss a beat.

At sufficient magnitude, however, natural and man-made disasters imperil both the well-being of metropolitan areas and national economic growth. Mass loss of life and limb decimates families, communities, firms, and the workforce in ways that the machinery of economic recovery cannot easily remedy. The catastrophes of 2004–2005, for example—Hurricanes Katrina and Rita on the US Gulf Coast; the tsunami that devastated Sri Lanka, Thailand, Indonesia, and

parts of India; the Kashmir earthquake—demonstrate how large economic shocks can overwhelm our initial capacity for adequate response.

Productivity shocks can endure. Noncompensable losses borne by households and businesses often last much longer than national leaders and market stakeholders would choose (or admit). The extent of recovery in an affected area may get dampened and attenuated as populations and businesses relocate and would-be investors lose interest. Major disruptions and the lackluster emergence from them then become a longer-term fact of life in these regions, reminders that even the most advanced societies must sometimes struggle mightily to recover from unforeseen adversity.

In terms of natural disasters at least, it is both the magnitude of loss and its surprise that amplifies the shocks to the economic system. In the modern era, it is difficult to describe a hurricane or flood as having been a complete "surprise," but that does not mean that it has been adequately planned for. Well-functioning markets and governments anticipate risk and capitalize it into resource allocations and social choices. When catastrophes occur in urbanized areas, regional economies can be caught off-guard, perhaps, and large losses may result from the immediacy of harm. Over the longer run, however, seismic and climatic risks get built into the expectations of economic actors and polities. When these expectations and probabilities are accounted for appropriately, they ultimately affect the kinds of savings, investment, insurance, and disaster preparedness that make regions resilient and help them rebound quickly from economic disruption. But there is much evidence that low probabilities of very large losses are not evaluated easily or adequately.

Historically, urban life has been disrupted more intensely and at substantially greater cost by war than by any localized natural disaster. Urban historians, including Paul Bairoch (1988), have analyzed the effects of war and civil unrest on cities. Lessons learned from wars' effects on cities inform current thinking, not only on civil defense against weapons of mass destruction and terrorism, but also on disaster preparedness and risk management more generally.

Originally, of course, a major function of cities was to provide protection for the civil population. Urban design, from antiquity through the age of gunpowder, incorporated river banks, walls, and location as elements of protection from rural invaders. Population agglomerations are easier and cheaper to defend (see Mumford, 1960). More recent events—terrorism in the twenty-first century and strategic bombing in the last century—confirm that higher density urban regions, like Dresden and lower Manhattan, become attractive economic and political targets while serving as protectors of civilian populations (Glaeser and Shapiro, 2002).

Evidence from wars in the last half century confirms that their immediate effects, the destruction of human and physical capital, have been enormous. But casual empiricism suggests that cities have been remarkably resilient over a period of a few decades. Berlin and Warsaw were not restored quickly. But decades later, they have returned to their prominent positions in Europe's urban hierarchy. Evidence from the bombing of Japan in World War II suggests that

city size and specialization are surprisingly robust, even in the face of large disruptive shocks (Davis and Weinstein, 2002).

What can be done in the face of the low probabilities of great devastation caused by war, terrorism, or natural forces? First, we can think of ways to measure these risks, pool them, and then diversify them to the extent possible. This involves questions of risk assessment, requiring disparate calculations based on meteorology, seismology, politics, and statistics. Pooling these risks can provide some form of insurance. But private insurance markets may be hard to sustain in the face of sufficiently rare but costly events. The right form of government intervention to facilitate the institution of insurance at reasonable cost is not at all obvious, and this is a key topic in several of the papers in this book.

Second, we can think of ways to make urban areas more resilient when faced with catastrophe. This may involve the physical design of facilities and urban systems, the diversification of its industrial base, and its physical condition. We can also encourage inhabitants to take cost-effective steps to mitigate risk privately.

Third, we can think systematically about preparing for these eventualities. Arranging for the hasty mobilization of evacuation efforts, emergency shelter and sustenance, and near-term governance and law enforcement is sensible policy. Recent events involving hurricanes and terrorism suggest there are strong distinctions in planning responses for different kinds of catastrophes. In any case, there is now a body of experience that can be used to analyze public and private planning and responses to calamitous events.

These various issues are considered in detail in the papers collected here. Papers by Howard Kunreuther, George Zanjani, Dwight Jaffee and Thomas Russell consider risk and insurance for large-scale disasters. The chapter by Alan Berger, Carolyn Kousky, and Richard Zeckhauser considers obstacles to thinking clearly about low-probability catastrophic events and thus to our definition of risk itself. Papers by Adam Rose, by Howard Chernick and Andrew Haughwout, and by Harry Richardson and his colleagues consider the importance of the resilience of cities in addressing the impacts of catastrophic events upon urban areas. Papers by Kathleen Tierney, and by Alan Berube, Elizabeth Deakin, and Steven Raphael, highlight the importance of planning and preparation for these unlikely events.

Insurance

George Zanjani contributes a provocative case study in his chapter, "Public versus Private Underwriting of Catastrophe Risk: Lessons from the California Earthquake Authority." Zanjani reviews explanations for the relatively low demand for publicly underwritten disaster coverage in California. He documents a substantial decline in the number of California households insured against earthquake loss over the life of the state's insurance program, from nearly one-third in 1996 to less than one-sixth in 2004. The California Earthquake Authority

(CEA) program is based entirely on voluntary participation, and it thereby provides direct opportunities for examining the behavior of private firms and risk-bearing consumers responding to public incentives.

Zanjani's analysis of experience with state-sponsored earthquake insurance in California offers several insights. First, California law may have set arbitrarily high minimum coverage in its mandatory-offer law. This law was adopted well before the CEA was formed. Second, a kind of adverse selection was apparent in carriers' choices to enter the program; poorer performers and under-capitalized firms had greater incentives to avail themselves of the perceived benefits of partnership with the government. Concentrated, severe losses in the Northridge earthquake of 1994 were a strong influence on the government's design of the program and the decisions of private companies electing to participate. Companies holding diversified portfolios across personal and commercial lines of business were relatively less inclined to join the CEA. Those doing so focused more upon personal lines sold by direct marketing.

Zanjani provides evidence that traditional, hierarchically managed national companies were reluctant to participate in the state-sponsored program, but nevertheless continued to write relatively small amounts of disaster coverage privately. Realities concerning the cost and style of marketing—directly, through brokerages, or through single-company agencies—influence the general practicality of inducing standard property-insurance customers to add relatively expensive earthquake protection to their existing policies. Interestingly, however, it appears that CEA participation has been moderately associated with growth in the share of the homeowner's insurance market held by participating insurers.

Nevertheless, regardless of the program's apparent stabilization of the post-Northridge homeowner market generally, structural impediments limit prospects for the longer-term success of the California Earthquake Authority. As Zanjani points out, liquidity in the premium pool is reduced by adverse selection among lowest-risk households who opt out of the coverage, whether offered by CEA-participating companies or others. On the other end of the spectrum, guidelines in the program prevent companies from offering the extensive coverage sought by higher-risk, higher-income purchasers, who therefore keep their business with private providers. Lastly, the limited market penetration of earthquake coverage generally may have much to do with shortfalls in the marketing of the insurance products involved. Zanjani reports that this coverage is quite difficult to sell, and companies do not typically offer commensurately higher rewards to their commission-based agents.

In their chapter, "Financing Catastrophe Insurance: A New Proposal," Dwight Jaffee and Thomas Russell briefly review the literature concerning the structural causes for market failure in disaster insurance. Theories cover the imprecision of probability estimates, the inherent interdependence of various risk categories, and the infeasibility of forcing current annual premiums to pay for worst-year losses. Each of these conditions derives from information problems in broader capital markets.

These authors then evaluate existing proposals concerning how to improve government interventions in the disaster insurance setting. The first of these is the proposed legal requirement that insurers indemnify catastrophic losses on the same basis as standard property risk. Another proposal is that thin reinsurance markets be corrected by government participation as reinsurer of last resort. Policy strategies in the latter context include traditional debt finance of reinsurance funds and bulk reinsurance contract auctions conducted by public authorities.

The short-run scarcity of capital in the catastrophe insurance context can be cautiously analogized to the traditional risk of bank runs and financial panic. In this light, Jaffee and Russell advance a new proposal, namely, that the government promise to act as an emergency "lender of last resort," shoring up those insurers incurring cataclysmic payout burdens but unable to access equity refinance quickly enough. Unsecured (but carefully regulated) lines of credit should be offered by the government in such circumstances, in these authors' view. Infusing needed emergency liquidity in the capital markets with tactical precision, Jaffee and Russell argue, will be less costly and ultimately more efficacious than the outright socialization of catastrophe coverage.

The chapter by Howard Kunreuther, "Reflections on US Disaster Insurance Policy for the 21st Century," develops a set of fundamental principles to guide the evolution of disaster insurance programs nationally. He stresses the critical role that the pricing of various kinds of risk can play. Existing programs of risk sharing may not fully utilize those probability estimates and loss projections potentially available to economic actors. When price signals, influenced by informed regulators, accurately reflect the social costs of private actions, firms and households will have stronger incentives to make lower-risk choices. These signals can be imparted through the prices of coverage, but in other ways as well.

Kunreuther's analysis considers government-sponsored loan programs to finance private investment in disaster-resistant improvements to structures as well as other forms of protection. Kunreuther draws lessons from the US experience with the National Flood Insurance Program, suggesting that subsidies in rate schemes have often provided insufficient incentives (and sometimes perverse ones) for households to invest appropriately in averting the gravest kinds of loss. He concludes that properly designed insurance vouchers could make better use of private risk assessment and encourage more households to consider relocating out of harm's way.

Kunreuther considers in some detail the predicament faced by a hypothetical carrier offering coverage against catastrophic loss, and he outlines key prerequisites including actuarial accuracy and profitability. On the former, Kunreuther is cautiously optimistic regarding technological and analytical advances in quantitative risk modeling. These developments may greatly improve the industry's capacity to project event likelihoods and loss scenarios and to overcome problems of risk ambiguity, moral hazard, and adverse selection. More appropriate calculations of deductibles, mitigation obligations, and coinsurance requirements may induce more investment in catastrophe insurance and related lines of business. In turn, regulatory reform might provide greater access for

interested firms to reinsurance and bond finance, enhancing the inducements for such firms to enter the market. However, some particularly high-risk locations, such as seismic zones in California and hurricane-prone areas in Florida, are likely to remain unprofitable for catastrophe insurers.

Kunreuther's central claim is that comprehensive, all-risk policies offer the greatest promise for social protection against the most calamitous risks we face. Economies of scale and scope are powerful in the agglomeration of premium pools across geographies, diversified kinds of natural-disaster risk, and varying levels of risk aversion and mitigation behavior among the insured. All-risk insurance reduces the level of ambiguity about coverage experienced by consumers, thereby boosting the attractiveness of purchasing more comprehensive kinds of policies. These lines of business can best be spurred by public investment in reinsurance.

Kunreuther carefully considers the pitfalls facing comprehensive insurance programs. Chief among these are the likelihood that increases in risk-adjusted premiums will greatly reduce demand, even among households living in low-risk areas. Regions with smaller populations and weaker institutional features may have thin markets in comprehensive insurance, due to small numbers and the unavailability of funds. In some cases, legal and administrative reforms can reduce the threat that national companies will divest themselves of small, local subsidiaries in such circumstances. Yet regional variation in the practicability of all-risk coverage still poses critical obstacles to the design and implementation of comprehensive insurance systems. Kunreuther provides a taxonomy of those challenges and a useful theoretical framework for considering them.

Catastrophe

Alan Berger, Carolyn Kousky, and Richard Zeckhauser consider the issue of risk and insurance more generally in their chapter, "Obstacles to Clear Thinking about Natural Disasters: Five Lessons for Policy." The authors argue that a hallmark of "catastrophe" is high external costs attributable to risk assessment and preparation. These shortfalls are often reinforced by the narrow focus of policymakers. Perceptual and analytic errors involve three key features: social choice "Jeopardizing Assets that are Remote" (JAR); underestimates of, and confusion between, the likelihood of disastrous events and the magnitude of loss experience; and the location of critical activities in the riskiest geographic areas. The latter involves a kind of "coming to the nuisance," risk-inclined choices by private actors in the face of low probabilities—choices that impose substantial external costs on others.

Berger, Kousky, and Zeckhauser are attentive to the distributional consequences of these psychological and analytical limitations on decisions. They survey the historical and policy context, considering examples of floods, earthquakes, wildfires, and insect infestation. They argue that the rules of thumb util-

ized by disaster planners and private actors too often involve a kind of mytholo-gizing that is quite costly *ex post*.

Recognizing the fundamental role uncertainty plays in disaster preparation and mitigation, the authors draw five central lessons. First, they point to the separable yet often confounding tasks of estimating the likelihood of a raw event, on the one hand, and the magnitude of a loss, on the other hand. Second, they argue that assumptions regarding conventional probability distributions bias traditional analysis and lead to large underestimates of the likelihood of the worst catastrophes. Explicit recognition of “fat tails” in the probability distributions for the most calamitous events might correct such biases and also shift more resources towards social insurance and damage avoidance.

Third, Berger, Kousky, and Zeckhauser focus upon arbitrary probability standards, which ignore large differences in expected losses. Improved cost-benefit analysis, incorporating detailed assessments of dynamic risk and loss conditions, can better identify which forms of investment in social protection are warranted. Fourth, the authors contend that remoteness of impact—in time and space—necessarily leads to underestimates of the linkages between private activity and policy choice. One example they analyze in some detail is fire suppression techniques in pine forests. Myopic strategies, involving over-suppression of fires, have led to infestations of the pine beetle arising from excess habitat. As they illustrate, more comprehensive analysis—identifying and taking seriously the genuine consequences of what humans do and where they do it—can generate better allocations of protective investment.

Finally, Berger, Kousky, and Zeckhauser remind us that population concentrations in the riskiest regions do not arise simply from shortsightedness. Rather, those with more accurate forecasts of both the likelihood and magnitude of potential catastrophe nevertheless occupy such locations because of the positive amenities they receive. Areas prone to hurricanes and earthquakes are often among the most pleasant places to live. Risk inclination and aversion vary among individuals and households, as do the tastes for amenities. Aggregate social choice needs to recognize these distributional considerations. Policy judgments preparing for and insuring against disasters can only be improved by distinguishing between what these authors characterize as “noxious” versus “amenity” risks.

Important economic aspects of disasters involve not only issues of risk and insurance, but also the trajectory of recovery. Predicting, measuring, and explaining economic shocks is only part of the story. Afflicted cities and metropolitan areas may respond to and emerge from calamity differently. Factors describing response experience might include rough measures of success versus failure, indicators of speed and depth of recovery, and the relative efficiency of various government interventions to encourage rebuilding or to accelerate the process.

In his chapter, “Macroeconomic Impacts of Catastrophic Events: The Influence of Resilience,” Adam Rose provides a thoroughgoing introduction to the concept of economic resilience. He presents a provocative case for focusing re-

search effort on the urban recovery process and its dynamics. He draws attention to the linkage of urban recovery with features of other "systems"-style modes of inquiry, including organizational behavior, geography, engineering and ecology. Rose argues that a rigorous theory necessarily must build upon and then enhance macroeconomic time-series testing and impact analyses, such as traditional input-output and computable general equilibrium approaches.

Rose bolsters the case for broadening resilience theory by pointing out numerous deficiencies in existing knowledge. First, he notes that most of the attention to resilience focuses on national-scale disasters, even though many of the worst calamities are predominantly regional in impact. Data identifying intraregional variation are often quite scarce, so the prevailing national focus of existing literature may be largely one of convenience. Rose also notes that natural disasters are typically multisectoral (distinguishing them from shocks in industrial organization and in individual industries, for example).

Moreover, when economic actors operate under stress in crisis, their choices typically depart from those based on long-run rationality. Such conditions reflect the assumptions of imperfect information and bounded rationality quite common in other modes of analysis. Rose argues the existing disaster literature emphasizes stock measures while ignoring the importance of flows from destroyed assets. Such studies too often fail to account for transfer payments and programs providing external aid from higher levels of government. As to the latter, Rose distinguishes the *inherent* resilience of affected cities from the *adaptive* resilience of economies, governments, and polities within regional and national settings. Surveying recent work on both the terrorist attacks on the World Trade Center and Hurricanes Katrina and Rita, Rose suggests that researchers are only now beginning to ask the kinds of questions necessary to craft a resilience theory having broad application.

The central contributions of Rose's chapter in this volume are twofold. First, he presents a method for quantifying "direct" and "total" economic resilience. In Rose's construct, direct economic resilience is an observed deviation from maximum potential output; total resilience incorporates the input-output responses across the economy to estimate aggregate effects. Rather than focusing on related measures of the repair and replacement of damaged stock, Rose presents his flow-based measures as more dynamic and telling indicators of recovery.

Second, Rose provides a practical example of these concepts, expanding upon previous work with colleagues on the disruption of public utilities from actual and simulated natural disasters and terrorist attacks. His synthesis of disparate studies illustrates this concept of resilience and identifies where his proposed flow-based measure captures differences in recovery rates across industries. Rose also analyzes underlying response phenomena, such as input substitution, price and quantity changes, and the like. A number of these particularities of typical industry response are then tabulated within a unified typology, adding time and urgency dimensions to generate a dynamic view of how urban recovery from disaster actually unfolds.

Numerous critics of the Bush Administration have exposed, in the popular media, problems of leadership occurring in the wake of Hurricane Katrina. However, it remains valuable to place the federal government's recent conduct against the broader tableau of national disaster policy generally. This treatment is the central contribution of Kathleen Tierney's chapter, "Hurricane Katrina: Catastrophic Impacts and Alarming Lessons."

Tierney first provides a detailed description of the sheer magnitude of Katrina and its aftermath. Her summary of human, social, and economic consequences depicts a calamity that even the best organized and funded government effort would have had tremendous difficulty managing. An overwhelmed public authority, at worst, retreats into a kind of administrative denial of the extent of the losses and the shortfalls in emergency response. Tierney notes the dynamics of the idiosyncratic leadership and institutional traditions in both New Orleans and Washington, and she demonstrates that the observed delays, neglect, and disorganization are only the latest examples of well-recognized political patterns.

Tierney then develops a taxonomy of calamities, indexed by breadth of disruption, distinguishing among "emergencies," "disasters," and outright "catastrophes" like Katrina. She orders these events along several dimensions: the geographic scope of impact and response, the sufficiency of existing planning and preparation, the insults to shock-absorbing infrastructure, administrative complexity, the extent and duration of residential displacement, and the longer-run challenges of governance for rebuilding and compensation. Tierney also indicates how differential impacts by race and socioeconomic status have motivated the evolution of the "vulnerability sciences" within sociology and other fields.

A key focus in Tierney's chapter is a detailed critique of national emergency planning for relatively predictable events, such as floods in hurricane-prone areas below sea level where full-function flood-control systems are known to be inadequate. She suggests that homeland security in an age of terrorist threats necessarily reduces federal emphasis on preparation for natural disasters. She characterizes prevailing policy prescriptions as motivated more by wishful thinking and political expedience than by the real consideration of required capacity and the careful development of priorities.

Finally, the interactions among governments, victims, and other stakeholders following an event like Katrina provide their own stimulus for contemplation. Tierney argues that much of the observed social friction and the paralysis of needed recovery efforts are the consequences of a kind of "elite panic." She surveys a variety of rather draconian responses to urban disruption, characterized generally by divisive rhetoric and active discrimination in law enforcement by race and social class. Tierney's chapter also traces the disturbing linkages between social disadvantage and the allocation of public assistance following the very worst urban calamities.

Government Policy

Howard Chernick and Andrew Haughwout's chapter, "Economic Resilience, Fiscal Resilience and Federalism: Evidence from 9/11," returns our attention to the phenomenon of urban resilience, emphasizing the strength and flexibility with which the Manhattan real estate market rebounded following the horrific circumstances of September 2001. Without minimizing the quite drastic short-term impacts of the attacks on families and households, firms, and the public fisc, these authors highlight the surprising resiliency of a large, diversified urban economy. The underlying fundamentals of the market for locations in New York City, combined with formidable infusions of public aid and the prominence of the local economy within its national and state financial systems, meant that even the most extreme form of violent disruption and destruction could not impede longer-term productivity and growth prospects.

The authors observe that the attacks occurred in the midst of a national and local recession. Short-term growth rates were already quite sluggish in the fall of 2001, and there is evidence that the attacks considerably slowed the city's recovery relative to the rest of the country. Despite this prevailing reality, however, rental housing markets in lower Manhattan were quicker to rebound than expected, perhaps in part because of substantial subsidies paid by government to households willing to sign new two-year residential commitments. Office vacancy rates rose substantially at the same time, despite the calamitous loss of space in the destroyed buildings. This was the result of a rapid but short-lived flight from areas neighboring the World Trade Center, though rents remained much flatter than many forecasters had predicted.

With respect to both the residential and office markets, however, the authors emphasize how quickly the devastation was transformed into economic opportunity. In fact, longer-term residential price growth in the city relative to the rest of the country remained pronounced before and after the attacks, across single-family, multifamily, and condominiums. This fact undermines the notion that some form of "terror tax" reducing structural demand for locations in the Big Apple had ever really taken hold. In the case of office dislocation from the sectors most directly impacted by the destruction, longer-run demand reallocated uptown. New investment in the immediate vicinity of the World Trade Center continues to face regulatory uncertainty, but all indications are that the affected markets could have responded far less resiliently than they did.

Chernick and Haughwout are quick to note that the calamity's impact on New York City's fiscal condition represents a considerably gloomier picture. The city's financial cushion was already stretched thin by the private equity bust and the recession. The authors analyze trends in expenditures for direct relief, reductions in other public services, and increased tax burdens, juxtaposing each with compensatory federal aid flows following the attacks. Substantial expansion in Medicaid programs resulted from disaster-relief payments routed through existing funding regimes. Other fiscal consequences include elevated pension

burdens and overtime payments to compensate for labor-force losses and increased security details.

Prior to the attacks the city had enjoyed the longest period of tax-rate reductions in recent history. After September 2001, these trends were reversed. In the face of budgetary pressures and the loss of so many parcels from the property-tax base, the city compensated by increasing rates substantially to help balance the budget through a decade of major projected shortfalls. However, sound fiscal adjustments supplemented by moderate assistance from New York state and abundant transfusions from the federal government have now allowed the city to roll back some of the property tax increases originally scheduled.

The authors conclude their analysis with a review of the efficiency and equity cases for substantial levels of federal aid granted to a major city's economy and government in the wake of international terrorism. The implicit risk-sharing compacts of localities participating in a federation are counterbalanced by the moral hazard that such jurisdictions will consequently reduce their own investments in protecting against natural and man-made threats, commensurate with the assurance of federal indemnity. The conventional prescription is to balance the extent of federal aid promised with required matching contributions from local sources. Public assistance then complements private insurance, mitigation activity, and philanthropic transfers. Chernick and Haughwout suggest that New York City's recovery from the local and regional economic devastation of the terrorist attack, while far from complete, may well reflect an appropriate balance between the federal safety net and local resilience, both inherent and adaptive.

From the standpoint of basic risk assessment, terrorism borders on the intractable. What will happen? When? And where? These questions may be better analyzed using chaos theory than any functional means-end logic. High-cost intelligence and surveillance, absent the capture of distinct and determinate plans for specific attacks, may add little actionable knowledge about the portfolio of potential threats. At the same time, for a given sequence of events, strides have been made in simulating the damage and losses, utilizing sophisticated urban interaction modeling.

The chapter by Harry Richardson, Peter Gordon, and their colleagues, "The Economic Impacts of Alternative Terrorist Attacks on the Twin Ports of Los Angeles-Long Beach," provides a coherent example of this kind of complex simulation. The authors take two different threats—a radiological weapon used in the port facilities and conventional explosives targeting freeway access bridges—and trace the consequences of these risks independently and in combination. Their specification includes the loss of port services for periods extending from two weeks to four months. For each scenario, they project regional impacts utilizing a comprehensive regional model of input-output linkages.

A key feature of this approach is an effort to account for interdependencies in transportation markets among retail consumers, the workforce, and customer industries acting as shippers and consignees. Depth is achieved by disaggregating geographic units and industrial sectors. The analysis incorporates interruptions in household travel patterns by mode, including workplace commuting

and trips to services, shopping, and social destinations. The authors note the complexity of such simulations, requiring the coordination and calibration of literally thousands of different indicators generated by government and proprietary providers. Available data on trade flows is particularly scarce and often problematic.

Richardson, Gordon, and colleagues analyze several scenarios in turn and report the damage and losses estimated for each. They categorize losses as direct, indirect, and induced. For a four-month shutdown of both ports, the net regional impact in Southern California from all three components is estimated to be $34 billion in output and more than 200,000 worker-years of lost productivity. The authors also evaluate the long-haul impacts of the radiation plume, adding another $4.1 billion in output and nearly 45,000 worker-years in lost labor. When the model is expanded to include interstate and international losses throughout the transportation networks for which these ports serve as nodes, the consequences include another $90 billion in cumulative losses.

Hurricane Katrina laid bare the social disparities in the New Orleans region and the differential access of residents to emergency evacuation. Census data on auto ownership among poor households provides one measure of these disparities. In their chapter, "Socioeconomic Differences in Household Automobile Ownership Rates: Implications for Evacuation Policy," Alan Berube, Elizabeth Deakin, and Steven Raphael organize the data on emergency mobility in ways that relate closely to the analysis of spatial access in labor markets generally.

These authors demonstrate that escape plans overly dependent on private transportation were utterly inappropriate for the poor, predominantly African-American households occupying those neighborhoods sustaining the worst flooding. The chapter shows that this problem is by no means limited to New Orleans. In fact, a large number of those metropolitan areas facing endemic risk of natural disasters have concentrations of poor and minority populations, with relatively low rates of auto access and ownership. The discussion strongly suggests that the horrific consequences of underserved public-transit evacuation routes—which suffered system-wide breakdowns at the height of the Katrina's aftermath—could easily have been anticipated by emergency response planners.

The authors highlight an additional aspect of disproportionately low auto-ownership rates in poor neighborhoods. They document the ways in which spatial segregation of disadvantage further prevents differently situated households from sharing available car-space with the needy during an emergency. For example, while average white residents in the US live in neighborhoods where just eight percent of households lack a single automobile, approximately twenty percent of the average African-American family's neighbors are without cars. The greater the degree of segregation by neighborhood, the greater burden that regional transportation policy bears in focusing evacuation resources in places that are disproportionately poor and not easily mobilized by private means.

Berube and colleagues conclude their study with a careful review of the policy miscalculations leading to failure of bus evacuation plans in New Orleans. In hindsight, it is hard to discount their suggestion that expanded access to auto-

mobiles, or perhaps emergency ride-share programs, would have made a substantial difference. Particularly in the poorest and most racially segregated neighborhoods, private escape by car would have helped compensate for tragic deficiencies in the planning and management of public-transit efforts to move the most disadvantaged residents quickly out of harm's way.

The proceeding chapters offer a diverse treatment of the economic and public policy aspects of urban disasters. We hope the current volume contributes toward analysis and public discourse on modes of preparing for and recovering from the catastrophes that we cannot perfectly anticipate, but which we know await us. Interactions among firms, households, insurers, and governments continue to evolve, as the nature and extent of various threats to our well-being grow ever more varied and complicated. Despite the considerable challenges, however, the vibrant economies of our largest metropolitan areas demonstrate remarkable resilience, even in the face of the most calamitous events. Perhaps vibrant regional economic expansion is its own best form of insurance.

Several rather general points are suggested by this collection as a whole. First, experience with the lowest-probability, highest-gravity risks shows that markets and governments may necessarily fail to prepare for and respond to them as well as they might. Second, the most promising types of government action may be those persuading *households to mitigate their own risk privately.* Third, more comprehensive forms of all-risk insurance and loss mitigation are available to us in principle, but the tradeoffs from lowered consumption, increased savings, regulatory and transactions costs, and high-capital reinsurance funds may be exorbitant. Finally, additional research is necessary to determine how intra- and interurban network goods—including emergency evacuation and response plans to aid the neediest amongst us—can be made most survivable and resilient.

Insurance